# Notice and Agenda of a Board Workshop

Tuesday, February 28, 2012 at 4:00 p.m.

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| MEETING LOCATION: | District Administration Building<br>12770 Second Street, Yucaipa |
| MEMBERS OF THE BOARD: | Director Ian Cuthbertson, Division 1<br>Director Bruce Granlund, Division 2<br>Director Jay Bogh, Division 3<br>Director Lonni Granlund, Division 4<br>Director Hank Wochholz, Division 5 |

**I. Call to Order**

**II. Public Comments** At this time, members of the public may address the Board of Directors on matters within its jurisdiction; however, no action or significant discussion may take place on any item not on the meeting agenda.

**III. Staff Report**

**IV. Presentations**

A. Water Quality Assessment of the Beaumont Management Zone: Identifying Sources of Groundwater Contamination Using Chemical and Isotopic Tracers [Workshop Memorandum No. 12-033 - Page 11 of 278]

B. 2011 Draft Delivery Reliability Report for the State Water Project [Workshop Memorandum No. 12-034 - Page 105 of 278]

**V. Operational Issues**

A. Sewer Collection System Integrity Testing [Workshop Memorandum No. 12-035 - Page 201 of 278]

**VI. Development Issues**

A. Development Agreement for Tract No. 13375 Located on Oak Glen Road Approximately 1,500 Feet East of Fremont Street, Yucaipa [Workshop Memorandum No. 12-036 - Page 203 of 278]

Any person with a disability who requires accommodation in order to participate in this meeting should telephone Erin Anton at (909) 797-5117, at least 48 hours prior to the meeting in order to make a request for a disability-related modification or accommodation.

Materials related to an item on this agenda submitted to the Board of Directors after distribution of the workshop packet are available for public inspection during normal business hours at the District office located at 12770 Second Street, Yucaipa. Meeting material is also be available on the District's website at www.yvwd.dst.ca.us

**VII. Capital Improvement Projects**

A. Status Report on the Construction of the Yucaipa Valley Regional Brineline [Workshop Memorandum No. 12-037 - Page 205 of 278]

B. Status Report on the Construction of the R-10 Recycled Water Reservoir and Booster Complex [Workshop Memorandum No. 12-038 - Page 210 of 278]

C. Status Report on the Construction of the Crow Street Pipeline Facilities [Workshop Memorandum No. 12-039 - Page 212 of 278]

D. Status Report on the Construction of the Recycled Water Booster Facility at the Reservoir R-12.1 Complex [Workshop Memorandum No. 12-040 - Page 213 of 278]

E. Status Report on the Construction of the Wochholz Improved Salinity Effluent (WISE) Project [Workshop Memorandum No. 12-041 - Page 214 of 278]

**VIII. Administrative Issues**

A. Request for Proposals for Environmental Services Related to the Construction of Drinking Water Reservoirs and Recycled Water Reservoirs in Pressure Zones 16 and 17 [Workshop Memorandum No. 12-042 - Page 217 of 278]

B. Ratification of State Water Resources Grant Agreement No. 11-162-550 for the Construction of Recycled Water Facilities [Workshop Memorandum No. 12-043 - Page 239 of 278]

C. Change Order No. 3 to the Contract with Sukut Construction for the Yucaipa Regional Brineline Extension and Non-Potable Water / Outfall Pipeline Project (Phase 1 & 2) [Workshop Memorandum No. 12-044 - Page 256 of 278]

D. Change Order No. 1 to the Contract with W.A. Rasic Construction for the Yucaipa Regional Brineline Extension Pipeline Project (Phase 3) [Workshop Memorandum No. 12-045 - Page 259 of 278]

E. Change Order No. 1 to the Contract with Canyon Springs Enterprises dba RSH for the R-10.3 Recycled Water Storage and Booster Complex [Workshop Memorandum No. 12-046 - Page 262 of 278]

F. Notice of Completion for the Contract with Sukut Construction for the Yucaipa Regional Brineline Extension and Non-Potable Water / Outfall Pipeline Project (Phase 1 & 2) [Workshop Memorandum No. 12-047 - Page 265 of 278]

G. Authorization to Solicit Bids for the Construction of the 12.1 Recycled Water Booster Station [Workshop Memorandum No. 12-048 - Page 274 of 278]

H. Authorization to Petition for the Vacation of Crow Street, Calimesa [Workshop Memorandum No. 12-049 - Page 276 of 278]

**IX. Director Comments**

**X. Closed Session**

A. Conference with Real Property negotiator(s) (Government Code 54956.8)
Property: Assessor's Parcel Number: 301-201-29
Agency Negotiator: Joseph Zoba, General Manager
Negotiating Parties: Palmer General Corporation
Under Negotiation: Terms of Payment and Price

B. Conference with Labor Negotiator (Government Code 54957.6)
District Negotiator: Joseph Zoba, General Manager

Employee Organization: IBEW Local Union 14356 - YVWD Employees Association

C. Conference with Labor Negotiator (Government Code 54957.6)
District Negotiator: Joseph Zoba, General Manager
Employee Organization: Supervisor Bargaining Unit

D. Conference with Labor Negotiator (Government Code 54957.6)
District Negotiator: Joseph Zoba, General Manager
Employee Organization: Confidential Employee Bargaining Unit

E. Conference with Labor Negotiator (Government Code 54957.6)
District Negotiator: Joseph Zoba, General Manager
Employee Organization: Exempt Employee Bargaining Unit

**XI. Adjournment**

STAFF REPORT

**NEWS FOR IMMEDIATE RELEASE**

**February 22, 2012**

**Contacts:**

Ted Thomas, Information Officer (916) 653-9712

# DWR Reduces State Water Project Allocation

**SACRAMENTO –** The Department of Water Resources (DWR) today reduced its estimate of the amount of water the State Water Project will deliver this year. DWR dropped its projected delivery total, or allocation, from 60 percent to 50 percent of the requested amount of slightly more than 4 million acre-feet.

‘’Stubbornly dry conditions this winter give us no choice but to roll back our water supply estimate,” said DWR Director Mark Cowin. “We continue to hope, however, that wetter conditions in the remaining winter weeks will allow us to boost deliveries back up.”

DWR noted that precipitation so far this winter has been only about half of normal and the mountain snowpack is less than a third of normal.

Water Year (October 1-September 30) runoff from rain and snow is forecasted to be far below average in both the Sacramento River and San Joaquin River systems. The median runoff forecast of 9.4 million acre-feet for the Sacramento River system would be the $16^{th}$ driest in 106 years. The February 1 median water year runoff forecast of 3.2 million acre-feet for the San Joaquin River system would be the $21^{st}$ driest in 111 years. Average runoff is 18.3 million acre-feet for the Sacramento system, and 5.9 million acre-feet for the San Joaquin.

Much of California’s water comes from the mountainous country from Shasta Lake in the north to the American River basin in the south. DWR’s eight precipitation gages covering this area recorded an impressive 130 percent of average rainfall and snow in October, but only 43 percent in November, four percent of average in December, 84 percent of average in January, and 18 percent of a normal February total to date this month. Overall, this “Eight-Station Index” area to date is at 51percent of its seasonal precipitation average. Records go back to 1920.

Similarly, precipitation gages in the San Joaquin basin recorded 125 percent of the average monthly precipitation for October, 32 percent for November, zero percent for December, 80 percent for January, and 20 percent of a normal February to date. This “San Joaquin Five-Station Index” to date is at 47 percent of its seasonal average. San Joaquin Basin records go back to 1904.

Initial State Water Project allocations have seldom been reduced. Previous times were in 2001 (from 40 percent to a final allocation of 39 percent of requests); 1991(85 percent to 30 percent), and 1977 (100 percent to 90 percent). In 2000, the initial Allocation of 50 percent was increased to 100 percent, but finally dropped to 90 percent.

All allocations, or supply estimates, are conservative, based on factors including reservoir storage, pessimistic weather projections, and projected runoff into streams, reservoirs and aquifers. Carryover reservoir storage from last winter remains high (110 percent of normal for the date), but a high pressure ridge this winter has diverted most storms to the north of California.

The Sierra snowpack graphically shows how California has been shortchanged this winter. Water content in the statewide snowpack is only 30 percent of normal for the date, a mere 25 percent of the average April 1 measurement, when the snowpack is normally at its peak before the spring runoff. Mountain snow normally provides approximately one-third of the water used in California as it melts in spring and early summer.

The large differences in snowfall totals in the 2010-2011 snow season and thus far this season, demonstrate the variability that is possible in California’s precipitation and water storage. Models of California’s future climate indicate that rain and snowfall is likely to become even less predictable. This variability makes it critically important that California continue to invest in water conservation and water recycling, as well as improve the flexibility and adaptability of our statewide water systems.

It is still possible – though statistically unlikely -- that late-season storms could salvage the water year, similar to the “Miracle March” of 1991, which recorded three times that month’s average precipitation at the conclusion of an otherwise desperately dry winter in the fifth year of a drought.

The 50 percent State Water Project allocation announced today is not severely low. Last year, an unusually wet year, the final allocation was 80 percent of the slightly more than 4 million acre-feet requested by the 29 public agencies that distribute SWP water to more than 25 million Californians and nearly a million acres of irrigated farmland. The final allocation was 50 percent in 2010, 40 percent in 2009, 35 percent in 2008, and 60 percent in 2007. The last 100 percent allocation – difficult to achieve even in wet years because of fishery agency restrictions on Delta pumping to protect threatened and endangered fish – was in 2006.

**Electronic snowpack readings are available on the Internet at:**

**http://cdec.water.ca.gov/cgi-progs/snow/DLYSWEQ**

**Electronic reservoir level readings may be found at:**

**http://cdec.water.ca.gov/cdecapp/resapp/getResGraphsMain.action**

**See DWR's new Water Conditions page at:**

**http://www.water.ca.gov/waterconditions/**

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# NOTICE TO STATE WATER PROJECT CONTRACTORS

**Number:** 12-05

**Date:** February 21, 2012

**Subject:** 2012 Table A Allocation Decrease

**From:** Carl A. Torgersen
Deputy Director, DEPARTMENT OF WATER RESOURCES

The Department of Water Resources (DWR) is adjusting its projection for meeting the State Water Project (SWP) contractors' 2012 Table A requests.

DWR is reducing its projected delivery capability from 2,503,354 acre-feet to 2,086,130 acre-feet. This reduction equates to a drop in allocations from 60 percent to 50 percent for long-term SWP contractors. Enclosed is the revised 2012 SWP Allocation Table.

This decrease is primarily due to the well below average statewide snowpack and precipitation. DWR will continue to monitor the situation and may revise the allocations if warranted by the year's developing hydrologic and water supply conditions.

Based on this updated allocation, DWR will use the 60 percent delivery schedules submitted by the contractors earlier this year in developing new schedules, unless revised schedules are submitted. DWR will send an approved monthly water delivery schedule to each long-term contractor in February.

If you have any questions or need additional information, please contact Robert Cooke, Chief of DWR's State Water Project Analysis Office, at (916) 653-4313.

Enclosures

# 2012 STATE WATER PROJECT ALLOCATION
# (ACRE-FEET)

| SWP CONTRACTORS | TABLE A (1) | INITIAL REQUEST (2) | APPROVED ALLOCATION (3) | PERCENT INITIAL REQUEST APPROVED (3)/(2) (4) |
|---|---|---|---|---|
| **FEATHER RIVER** | | | | |
| County of Butte | 27,500 | 27,500 | 13,750 | 50% |
| Plumas County FC&WCD | 2,320 | 2,320 | 1,160 | 50% |
| City of Yuba City | 9,600 | 9,600 | 4,800 | 50% |
| Subtotal | **39,420** | **39,420** | **19,710** | |
| **NORTH BAY** | | | | |
| Napa County FC&WCD | 29,025 | 29,025 | 14,513 | 50% |
| Solano County WA | 47,606 | 47,606 | 23,803 | 50% |
| Subtotal | **76,631** | **76,631** | **38,316** | |
| **SOUTH BAY** | | | | |
| Alameda County FC&WCD, Zone 7 | 80,619 | 80,619 | 40,310 | 50% |
| Alameda County WD | 42,000 | 42,000 | 21,000 | 50% |
| Santa Clara Valley WD | 100,000 | 100,000 | 50,000 | 50% |
| Subtotal | **222,619** | **222,619** | **111,310** | |
| **SAN JOAQUIN VALLEY** | | | | |
| Oak Flat WD | 5,700 | 5,700 | 2,850 | 50% |
| County of Kings | 9,305 | 9,305 | 4,653 | 50% |
| Dudley Ridge WD | 50,343 | 50,343 | 25,172 | 50% |
| Empire West Side ID | 3,000 | 3,000 | 1,500 | 50% |
| Kern County WA | 982,730 | 982,730 | 491,365 | 50% |
| Tulare Lake Basin WSD | 88,922 | 88,922 | 44,461 | 50% |
| Subtotal | **1,140,000** | **1,140,000** | **570,001** | |
| **CENTRAL COASTAL** | | | | |
| San Luis Obispo County FC&WCD | 25,000 | 25,000 | 12,500 | 50% |
| Santa Barbara County FC&WCD | 45,486 | 45,486 | 22,743 | 50% |
| Subtotal | **70,486** | **70,486** | **35,243** | |
| **SOUTHERN CALIFORNIA** | | | | |
| Antelope Valley-East Kern WA | 141,400 | 141,400 | 70,700 | 50% |
| Castaic Lake WA | 95,200 | 95,200 | 47,600 | 50% |
| Coachella Valley WD | 138,350 | 138,350 | 69,175 | 50% |
| Crestline-Lake Arrowhead WA | 5,800 | 5,800 | 2,900 | 50% |
| Desert WA | 55,750 | 55,750 | 27,875 | 50% |
| Littlerock Creek ID | 2,300 | 2,300 | 1,150 | 50% |
| Mojave WA | 82,800 | 82,800 | 41,400 | 50% |
| Metropolitan WDSC | 1,911,500 | 1,911,500 | 955,750 | 50% |
| Palmdale WD | 21,300 | 21,300 | 10,650 | 50% |
| San Bernardino Valley MWD | 102,600 | 102,600 | 51,300 | 50% |
| San Gabriel Valley MWD | 28,800 | 28,800 | 14,400 | 50% |
| San Gorgonio Pass WA | 17,300 | 17,300 | 8,650 | 50% |
| Ventura County WPD | 20,000 | 20,000 | 10,000 | 50% |
| Subtotal | **2,623,100** | **2,623,100** | **1,311,550** | |
| **TOTAL** | **4,172,256** | **4,172,256** | **2,086,130** | |

SWPAO
2/17/2012

# PRESENTATIONS

Yucaipa Valley Water District

# Workshop Memorandum 12-033

**Date:** **February 28, 2012**

**Subject:** **Water Quality Assessment of the Beaumont Management Zone: Identifying Sources of Groundwater Contamination Using Chemical and Isotopic Tracers**

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On April 29, 2008, the Riverside County Board of Supervisors created the Groundwater Quality Evaluation Committee to review technical data presented by experts and make recommendations to the Riverside County Board of Supervisors regarding growing concerns of groundwater quality in the Beaumont water basin area related to septic systems.

On February 15, 2012, the Riverside County Department of Environmental Health distributed a final report prepared by the University of California, Riverside regarding the impacts of septic systems on the groundwater supplies in the Beaumont Management Zone. This report titled, Water Quality Assessment of the Beaumont Management Zone is attached for your review.

A meeting of the Beaumont/Cherry Valley Water Quality Committee is scheduled for Monday, February 27 at 6:00 p.m. at the San Gorgonio Pass Water Agency located at 1210 Beaumont Avenue in Beaumont. A representative from the California Regional Water Quality Board will discuss the UCR report at the meeting.

The purpose of this workshop item is to provide a summary of the meeting.

# Final Report:

# Water Quality Assessment of the Beaumont Management Zone: Identifying Sources of Groundwater Contamination Using Chemical and Isotopic Tracers

University of California, Riverside
SWRCB Agreement No. R8-2010-0022

Department of Environmental Sciences
University of California
Riverside, CA 92521

February 3, 2012

*Water Quality Assessment of the Beaumont Management Zone –Final Report*

## Introduction

Nitrate contamination from human activities adversely affects both surface and groundwater in the United States, however determining sources of nitrate is often difficult due to non-point pollution sources and complex groundwater systems within watersheds. A prior study (Wildermuth 2007) identified elevated nitrate levels in some groundwater wells within the Beaumont Management Zone (BMZ) in Riverside County. Subsequent action by the Riverside County Board of Supervisors placed a moratorium on new on-site waste disposal systems (i.e., private septic systems) unless they were designed to remove 50% of the nitrogen in the effluent stream. The Beaumont Board of Supervisors formed the Ground Water Quality Evaluation Committee (GWQEV) and directed them to review technical data on groundwater quality and express their concerns regarding groundwater regulation in the Beaumont Management Zone. The Committee disputed the findings of the Wildermuth 2007 report and has identified potential shortcomings in sampling design and project execution (GWQEC 2009). In the Committee's report to the Supervisors dated June 15, 2009, they make the following findings and recommendations:

"*1. Findings: The Wildermuth report titled: Water Quality Impacts from On-site Waste Disposal Systems in the Cherry Valley Community of Interest March 2007 Wildermuth Environmental Inc. had parameters that were too narrowly focused; used well water sources located in close proximity to on-site wastewater disposal systems and used exaggerated build out approximations.*

*Recommendation:*

• *An independent third party study conducted by someone other than Wildermuth Environmental, who conducted the initial report, is needed to evaluate this perceived regional issue. The study should evaluate beyond those areas studied in the initial report, consider reasonable build-out projections and consider other possible sources of groundwater contamination such as septic systems in the Cherry Oaks Tract and beyond to the Hidden Meadows Tract area and the surrounding communities including the City of Beaumont."*

This project was funded as a Supplemental Environmental Project by the State Water Resources Control Board, in response to the recommendation by the GWQEC and a desire for improved understanding of groundwater quality and risks in the BMZ. Using existing information on wells and surface water in the BMZ, scientists at the University of California, Riverside selected 40 wells and 11 surface water sites for sampling during 2011. All wells sampled were in active use and were operated by private homeowners, businesses, public agencies or water districts. The sites selected provided good spatial coverage of the BMZ and included regions where waste is handled by septic systems and consolidated sewers.

We utilized dual isotopic analysis of nitrate in rigorously collected groundwater samples to ascertain the source of nitrate and determine if denitrification is affecting nitrate isotope signatures in groundwater. We also measured a suite of pharmaceutical and personal care products (PPCPs) to confirm the presence of human waste in surface and groundwater and to aid evaluation of nitrate concentration and isotope data. Major ion chemistry, nutrient chemistry, dissolved oxygen and landuse data were also measured and used to aid our interpretation of the isotope and PPCP data.

Using a variety of methods including mass balance modeling and multivariate statistical analysis we attempted to answer the following questions about groundwater water quality in the BMZ:

**1. Can different groundwater regions within the BMZ be defined using isotope, PPCP and general chemical parameters?**

1A. Do areas with septic systems have different chemistry than areas with sewers?

1B. Do areas where groundwater is recharged with water from the State Water Project or wastewater treatment plant effluent have different chemistry from other areas?

**2. What sources contribute nitrate to groundwater of the BMZ?**

2A. Do different regions within the BMZ have different sources of nitrate?

2B. Do regions of the BMZ with different types of human waste disposal (i.e., septic vs. sewer) have different sources of nitrate?

2C. What areas of the BMZ, if any, have nitrate that appears to come from animal or human waste?

**3. How much nitrate from human waste is making its way into the groundwater of the BMZ?**

3A. Can models based on isotopes and mass balances be used to estimate septic inputs?

3B. How much would nitrate concentrations decline if sewer service was extended to regions within the BMZ currently using septic tanks? How long would it take for reductions to occur?

## Methods

### *Sampling Sites*

Forty wells were chosen for sampling from the Key Well Water Quality Program (Wildermuth 2010; Table 1 and Figure 1). The 40 wells provide good spatial coverage of the BMZ and encompass a large variety of the land-use types found in exurban areas such as Beaumont: residential areas served by septic and sewer, chicken farms, horse ranches, fruit orchards, cemeteries, golf courses, and riparian river wells. Location information of all sampling sites was provided by Dr. Cindy Li of the SWRCB, Samantha Adams (Senior Scientist II, Wildermuth Environmental, Inc.) and the Beaumont Cherry Valley Water District (BCVWD).

*Water Quality Assessment of the Beaumont Management Zone –Final Report*

An additional 11 surface water sampling sites including State Water Project (SWP) recharge basins, storm water storage basins, and major creeks and storm drains were sampled. SWP recharge water was re-sampled in July 2011 to investigate water quality when only Project water was being used for recharge. A set of samples was also collected near and below the discharge site for the City of Beaumont Wastewater Treatment Plant.

To aid data analysis, the BMZ was subdivided into four zones based on differences in landuse and methods used for processing and disposal of human waste (Figure 2). **Zone 1** is an area in the southern part of the BMZ which could be affected by wastewater treatment plant effluent discharged into Cooper's Creek and San Timoteo Creek by the City of Beaumont. **Zone 2** is located in the northern part of the BMZ and included production wells within the bed of Little San Gorgonio Creek. Groundwater recharge in this zone is thought to be dominated by percolation of mountain-front flow. A large percentage of Zone 2 is wildland terrain and the remaining area is low-density housing where human waste is handled by on-site waste disposal systems. **Zone 3** is more heavily urbanized and is located south of Zone 2. Most of the homes and businesses in Zone 3 use on-site waste disposal systems and a small percentage are served by sewer. Zone 3 is also the site for groundwater recharge using storm flows and water from the State Water Project (i.e., San Gorgonio Pond and BCVWD Pond). **Zone 4** is an urban area located between Zone 3 and Zone 1 and most of the homes and businesses are served by a consolidated sewer system.

***Collection of Water Samples***

Groundwater sampling began in March 2011 (wet season) and continued into July 2011 (dry season). Because the holding times for PPCPs and nutrients were short, we could not collect and process more than 5 to 10 samples per sampling trip, thus sampling had to be spread over several weeks.

Groundwater samples were collected from well-heads using a rigorous procedure designed to avoid contamination and yield samples representative of local groundwater. Wells used for municipal water supplies were allowed to run at least overnight prior to sampling and in most cases were in continuous operations for many days prior to sample collection. Most of the wells used for individual homes, ranches or businesses had pressure tanks. At sites with pressure tanks, water was drained from the pressure tank with the well pump turned off, then power was restored and the tank refilled. This procedure was repeated once more after which the well pump was turned on and run continuously for 15-20 minutes.

At municipal well heads and pre-flushed pressure tanks, measurements of water quality (pH, temperature, conductivity, and dissolved oxygen (DO)) were made at 10 minute intervals using a calibrated YSI meter to ensure water was representative of local groundwater. When three consecutive measurements produced variation less than the criteria listed in Table 2, the well water was directed into a 5 gallon bucket from which subsamples for individual chemical analyses were then collected. This HDPE bucket was rigorously cleaned in the laboratory by a 3-

day soaking in 18 megaohm deionized water followed by multiple rinses with more deionized water and 6 rinses with well water. Between sampling sites the bucket was rinsed three-times with deionized water and 3 times with well water. Field personnel wore powder-free nitrile gloves during sample collection.

Surface water samples were collected by dipping a clean HDPE bucket underwater with a gloved hand or a clean 1-liter HDPE bottle was dipped underwater using a telescoping pole. All sample bottles was rinsed 3-times with sample before filling. Two duplicate well water samples and one duplicate surface water sample were collected for this project to verify field collection methods were rigorous. At least one blank was taken during each sampling trip (8 blanks in total).

Samples for major anions, cations, nutrients and stable isotope measurements were subsampled out of the 5 gallon bucket or 1-liter bottle (Table 3). A Solinst peristaltic pump was used to withdraw water from the bucket/bottle and force it through a 0.45 μm, Whatmann Polycap GW capsule filter. The filters were pre-cleaned in the laboratory by flushing 4 liters of deionized water (18 megaohm) through the filter. In the field at least one-liter of sample water was passed through the Polycap filter prior to collection of water samples. Each capsule filter and length of peristaltic pump tubing was used for only a single sampling site to prevent cross-contamination. Major cation and anion samples were collected in new 125ml HDPE bottles that had been soaked in deionized water (18 megaohm) for several days and rinsed three times with filtered sample water; these samples were stored at 4°C. Samples for nutrient fractions were collected in new 60ml HDPE bottles that had been soaked in deionized water (18 megaohm) for several days and rinsed three times with filtered sample water; these samples were filled to the neck and stored frozen at -20°C. Filtered samples for DOC were collected in sample-rinsed 40 ml amber vials (pre-muffled at 450 °C) and preserved with 2 drops of trace metal grade HCl (pH~2). Immediately following collection, samples were kept on ice in a cooler until they were delivered to the UCR laboratory where they were either stored at -20°C or 5°C prior to analysis.

Samples for PPCP analyses were pumped out of the sample bucket using the peristaltic pump and into 1-liter, pre-cleaned glass sample bottles that were triple rinsed with sample. These bottles were cleaned with laboratory detergent, a brush, and hot tap water. After scrubbing, the glass bottles were rinsed three to four times with deionized water and rinsed consecutively with 5 ml MTBE, 5 ml HPLC grade methanol and 5 ml ultra-pure water. The bottles were then stored in a dedicated glassware cabinet to prevent external contamination of samples. At the lab, the PPCP samples were extracted within 48 hours of sampling. Every 10th PPCP well sample was collected in duplicate.

Bottle blanks were produced by filling a clean sample bottle in the laboratory with deionized water. Field blanks consisted of deionized water run through the peristaltic pump tubing and Polycap cartridges and into clean sample bottles in the field. Bottle and field blanks were collected before on each sampling date and analyzed as regular samples. For major ions, nutrients and isotopes of nitrate, and all other analytes with the exception of PPCP compounds,

*Water Quality Assessment of the Beaumont Management Zone –Final Report*

all blanks produced analyte concentrations below the method detection limits and demonstrated that our sampling procedures were robust. Some of the PPCP field and laboratory blanks produced measureable analyte quantities and are discussed below. All analyses were conducted following the procedures outlined in the February 17, 2011 Quality Assurance Project Plan.

During collection, samples were labeled with individual site codes, sample date and time, and numbered consecutively. The result was a unique identification number for each sample collected. These identification labels were entered directly on the chain-of-custody (COC) form in the field. A COC form accompanied every sample brought into the UCR laboratory. Samples were stored in refrigerators and freezers in locked laboratories.

***Major Ion, Nutrient and Isotope Analyses***

The chemical species we determined were chosen to: (a) provide diagnostic indicators of the presence of human waste in groundwater (e.g., $NO_3$, TN, DOC, isotopes of $NO_3$, PPCP), (b) to help identify distinctive groundwater regions within the BMZ and provide information on potential pollutant sources (e.g., major cations and anions) and (c) provide general knowledge of groundwater conditions in the Beaumont region (e.g., pH, acid neutralizing capacity, specific conductance, Cl, phosphorus, boron and $SO_4$).

Specific conductance was measured with a laboratory conductivity meter equipped with a graphite conductivity electrode with a cell constant of $K=1\ cm^{-1}$. Laboratory pH measurements were made with a high quality pH meter equipped with an Orion-Ross combination electrode. The pH meter and electrode were calibrated using pH buffer solutions (4, 7 and 10) and the calibration checked by measuring the pH of two weak-HCl solutions ($10^{-4}$ N (pH: 4.0) and $10^{-5}$N (pH: 5.0)). Acid neutralizing capacity (ANC) of samples was measured by Gran Titration using the calibrated laboratory pH meter and Ross electrode. Hydrochloric acid with a normality of 0.1 was used to titrate the sample past the equivalence point. At least four titrant-pH measurement pairs were made between pH 4.3 and 3.7 and used in the Gran computation. Bicarbonate concentration was calculated based on measured ANC and pH value (equation 1).

$$[HCO_3^-] = \frac{(2\times ANC)-10^{-14+pH}}{1+2K_2\times 10^{pH}} \qquad \text{(Equation 1)}$$

Where $K_2 = [H^+]\times[CO_3^{2-}]/[HCO_3^-] = 10^{-10.3}$.

Total dissolved solids (TDS) was calculated based on measured specific conductance and the following equation (2):

$$\text{TDS (ppm)} = \text{Specific Conductance} \times 0.67 \qquad \text{(Equation 2)}$$

Major anions (Cl, Br, $NO_3$, $NO_2$, $PO_4$ and $SO_4$) were measured using chemically suppressed ion chromatography on a Dionex ion chromatograph following EPA Method 300.1. Major cations were measured by inductively coupled plasma - atomic emission spectroscopy (EPA Method 200.7).

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Total dissolved nitrogen (TDN) was determined in samples after NaOH-potassium persulfate digestion, with the nitrate produced by the digestion measured by EPA Method 353.2. Dissolved organic nitrogen was estimated as the difference between TDN and the sum of inorganic nitrogen (nitrate+nitrite). Ammonium was not measured for this project, but the well oxygenated condition of most samples indicates it would be present in very low concentrations. Dissolved organic carbon was measured on a Shimadzu TOC 5050 analyzer employing high-temperature Pt-catalyzed combustion (EPA 9060A).

Isotopes of nitrate were measured using the microbial denitrifier method (Révész and Casciotti 2007). In this method, bacteria (*Pseudomonas* aureofaciens) were used to convert $NO_3$ into $N_2O$ gas which was then analyzed for isotope ratios ($\delta^{15}N$ vs. air and $\delta^{18}O$ vs. VSMOW) in a Delta V Plus isotope ratio mass spectrometer (Thermo Scientific) at the Facility for Isotope Ratio Mass Spectrometry at UC Riverside.

For the ICP-AES, ion chromatography and nutrient assays we employed NIST-traceable standards and constructed multi-point calibration curves that spanned the entire range of sample concentrations. For stable isotope analyses we used NIST or IAEA certified isotope standards in each analytical run and corrected isotopic values for non-linearity and sample size differences if needed.

***Pharmaceutical and Personal Care Products***

The analysis of pharmaceutical and personal care products (PPCP) in water was based on the methods developed by Vanderford and Snyder (2006). At UC Riverside, rigorous procedures were used to validate the recovery, precision, and determine the instrument limits of detection (ILOD). The compounds of interest are shown in Table 4. PPCP analyses were conducted on all well and creek samples and in State Water Project water at groundwater recharge facilities within the BMZ. The use of UPLC-MS/MS to detect PPCP in water included several steps. These steps were preparation of stock and working solutions of the target compounds and their labeled counterparts, sample preparation, sample solid phase extraction, instrument calibration and QA/QC evaluation.

***Solid Phase Extraction*:** Compounds of interest were extracted from water samples using Oasis HLB solid phase extraction (SPE) cartridges (Waters Corporation, Milford, MA). Prior to extraction, surrogate compounds were added to each sample. A pre-filtered water sample of 1 L was passed through a cartridge and the compounds of interest were retained while interferants passed through. The compounds of interest were then eluted and reconstituted to 1 mL prior to analysis.

***Standard Preparation:*** PPCP compounds and their isotopically labeled counterparts were purchased from Sigma Aldrich (St. Louis, MO), Toronto Research Chemicals (North York, Ontario, Canada), United States Pharmacopea (Rockville, MD), and C/D/N Isotopes, Inc. (Poimte-Claire, Quebec, Canada). Individual stock solutions (100 $\mu g\ L^{-1}$ or 10 $\mu g\ L^{-1}$ for each compound) were prepared by weighing the exact amount of each compound and dissolving in

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methanol. A multiple PPCP working solution (100 ng $L^{-1}$ of each compound) was prepared by appropriate dilutions of the stock solutions in methanol.

***UPLC-MS/MS Analysis***: Analyses were conducted using an Aquity UPLC system coupled with a Trinity triple quadrupole mass spectrometer equipped with an electrospray ionization source (ESI) (Waters, Milford, MA). The column was a BEH C18 (100 mm X 2.1 mm i.d. with 1.7 µm particle size). Individual tune files were created by infusing the individual compounds to determine the optimum capillary and cone voltages, collision energies, product ions. The ILODs ranged from 0.1 to 10 ng/ml for individual analytes, for the listed PPCPs.

**Quality Control:** For PPCP samples, deuterated surrogates (10 ng ESI + and 25 ng ESI -) for each analyte of interest were added to samples prior to extraction to assess method performance as well as correct for matrix suppression, solid phase extraction variability, and instrument variability. Field replicates were to determine the reproducibility of the PPCP analysis. Losses of each analyte and its deuterated counterpart are known to decrease at the same percentage throughout the extraction, cleanup with SPE and analysis. Therefore, the recovery of surrogate compounds was used to correct for concentration losses of the non-deuterated compound.

PPCP field blanks were collected on each sampling date to assess potential sample contamination levels that could occur during field sampling and sample processing. Field blanks (DI water) were taken to the field, transferred to the appropriate container, preserved, and otherwise treated the same as a sample. With the exception of two batches of samples collected in May 2011, all the field blanks were not contaminated and the values were below the detection limit for each analyte. During the two May 2011 runs we measured trace to low levels of several PPCP compounds in both the field blanks and laboratory prepared blanks. Following this incident all glassware was rewashed and new reagents were prepared. The PPCP data from these two batches was discarded and was not used in any data analyses in this report. The wells from these two PPCP batches (BCVWD #1, 4, 5, 6, 10, 12, 14, 19, 20, 21, 23, and 26) were resampled in July 2011 and the field and laboratory blanks were below detection for all PPCP compounds.

Performance evaluation of the UPLC for analysis of PPCP was made by analyzing standards of the normal and deuterated target PPCPs. When the linearity of the standard curve or reproducibility of replicated samples exceeded limits of errors, instrument recalibration was conducted. Chromatographic instruments were typically calibrated by cleaning or changing the sample injection port, changing or reinstalling the column, cleaning the cone, changing the gas filters, or changing/fabricating the detectors.

## Results

### *Quality Control*

**Precision:** Precision is the reproducibility of an analytical method. Within each analytical run, measurements of precision was performed at a 10% frequency (i.e., one duplicate for every 10 samples) or at least once if the run contains less than 10 samples. Both certified reference material and natural samples were used in measurements of precision. The relative percent

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difference for all duplicate measurements was lower than 10% for all the analytes we measured meeting the QAPP target.

**Accuracy:** Accuracy is a measure of how well a measured analyte value compares to the true value. In this study we estimate analytical accuracy using spike recoveries made in reference solutions and natural samples. For all analytes accuracy fell in the range of 85-115% meeting the QAPP target.

**Field Duplicates:** The field duplicate samples were collected in the same manner and as close in time as possible to the original sample. Two well water duplicates and one surface water duplicate were collected during this study. Percent relative standard deviation (%RSD) for the vast majority of analytes was a few percent or less. In cases where analyte levels were at or near the detection limit (for example Fe), %RSD values could be higher (Table 6).

***Physical and Chemical Characteristics of Surface and Groundwater***

**Field Temperature:** Field temperatures for groundwater ranged from 11.6°C to 21.9°C, with an average of 17.9 ± 0.4°C (n=52) (Table 5). The coldest groundwater was observed in Zone 2 and the warmest groundwater was observed in Zones 1 and 4 (Figure 3). Most (87%) groundwater temperatures were 15°C - 22°C and 23% of them were between 19-20°C (Figure 4A). Field temperature of surface water (8.5-24.2°C) was highly dependent on air temperature and the elevation where sampling occurred.

**pH:** Sample pH was measured both in the field and lab, and the difference between these two measurements was less than 10% for all samples. Only pH measurements from the lab were used in this report. The average groundwater water pH was 7.50±0.05 (n=55) with a range of 7.01-7.83 (Figure 4B), except for two wells near San Timoteo Creek with pH of 8.70 and 9.28 respectively (Table 5). No strong spatial patterns were evident for pH (Figure 5). Surface water pH was similar to groundwater pH and ranged from 6.86 – 7.85.

**Field Dissolved Oxygen:** Field dissolved oxygen (DO) was between 0.29 to 10.63 mg/L, with an average of 6.89±0.34 mg/L (n=55) (Table 5). In 15% of groundwater samples (6 wells), DO was lower than 4 mg/L (Figure 4C). Five of these six wells, with DO lower than 3 mg/L, were located along San Timoteo Creek. This may indicate higher possibilities of denitrification occurring in the groundwater of these sites (Figure 6). The other groundwater sample with low DO (3.63 mg/L) was observed at a horse ranch (site 1207012). Dissolved oxygen in all the other groundwater samples was higher than 5 mg/L (Figure 4C). DO concentrations in surface water were all higher than 4 mg/L (Table 5).

**Specific Conductance:** Specific conductance was measured both in the field and in lab, with less than 10% difference between these measurements. Specific conductance ranged between 333 – 708 µS/cm, with average 452±12 µS/cm, except two wells at horse ranch and chicken farm on San Timoteo Creek with specific conductivities of 965µS/cm and 1147µS/cm respectively (Table 5 and Figure 4D). Sixty eight percent of groundwater specific conductance values was

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between 333-463 µS/cm (Figure 4D). S Except for Cooper's Creek and lower San Timoteo Creek, the specific conductance of surface water was lower than that in groundwater ($p=0.001$) (Figure 7).

**Acid neutralizing capacity (ANC):** Acid neutralizing capacity was between 2030-4114 µeq/l with an average of 3232.52±56.93 µeq/l, excluding the high values found at the horse ranch and chicken farm (5784 µeq/l and 5329 µeq/l respectively (Table 5)). 87% of groundwater samples had ANC between 2700-4000 µeq/l (Figure 4E). However, surface water had significantly lower ANC compared with groundwater with p value 0.001 (2471±387µeq/l), excepting lower San Timoteo Creek surface (Figure 8).

**Total Dissolved Solid (TDS):** Total dissolved solid was calculated based on specific conductance and Equation 2. Resulting spatial variability was identical to that observed for specific conductance (Figure 9).

**Dissolved Organic Carbon (DOC):** Dissolved organic carbon concentrations in groundwater were significantly lower than in surface water with $p<0.0001$ (Table 5). The average DOC concentrations in groundwater and surface water were 0.20±0.04 mg/L and 3.8±0.53 mg/L respectively. DOC distribution in the BMZ is shown in Figure 10. DOC concentrations in 79% groundwater samples were lower than 0.25 mg/L (Figure 4F). The highest groundwater DOC (1.7 mg/L C) was found at the horse ranch well (site 1207012).

**Major Ions and Nutrients:** Major ions were measured for each sample and the data is listed in Table 6. A Geostiff diagram was produced for each well and surface water site to describe the major ion chemistry. The Geostiff diagrams were then plotted in Figure 11. In general, bicarbonate was the dominant anion, followed by sulfate in Beaumont groundwater samples (Figure 11). The major cations were calcium and magnesium, followed by sodium (Figure 11). Geostiff diagrams show that surface water contains different major ion concentrations than groundwater. Triangle plots showing the percentages of major cations and anions are presented in Figure 12 and broken down by sample type and Zone.

Nitrate is a key indicator of groundwater quality (Hill, 1982; Pionke and Urban, 1984; Koh et al, 2009), long-term monitoring in the BMZ has shown increasing concentrations, especially in the period of 1960-1980 (Figure 13). During the 1960-1980s the rate of nitrate increase was on the order of 0.15 mg $NO_3$-N/L/year. Increases in groundwater nitrate-nitrogen after 1990 (where evident), range from 0.05 to 0.1 mg $NO_3$-N/L/year. For the wells shown in Figure 13 nitrate-nitrogen levels vary from 0.60 to 21 with an average of 3.5±0.54 mg/L during our survey period 2011 (Table 6). The distribution of nitrate-nitrogen in BMZ is shown in Figure 14. Thirty nine of 55 groundwater samples (71%) had $NO_3$-N concentration lower than 2.5 mg/L (Figure 15A). Forty four of 55 groundwater samples (80%) satisfied the drinking water standard < 5 mg/L requested by the Regional Water Quality Control Board. Alternatively, 11 of 55 groundwater samples (20%) exceeded the standard required by the Regional Water Quality Control Board. The highest nitrate-nitrogen groundwater was observed at the horse ranch well

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(21 mg/L at site 1207012, Table 6), followed by groundwater near the City of Beaumont waste water treatment plant #1 (WWTP#1) and at site 1007022 (Figure 14). Surface water had significantly lower nitrate-nitrogen concentrations than groundwater ($p = 0.017$) with an average of 0.86±0.11 mg/L (range of 0.32-1.50 mg/L) (Figure 14).

Bicarbonate was the dominated anion in both Beaumont groundwater (~73%) and surface water (~59%) (Figure 12). The average bicarbonate concentration was 201±5.1 mg/L and 164±26.3 mg/L in groundwater and surface water respectively. Groundwater bicarbonate varied from 103 to 352 mg/L, and 90% of well water bicarbonate was between 150-250 mg/L (Figures 15B and 16).

Sulfate was the second most abundant major anion in Beaumont groundwater and surface water, and represented 12% and 20% of the total negative charges respectively (Figure 15C). Groundwater sulfate varied from 8.6-79 mg/L (Table 6), with an average of 27±2.3 mg/L. Most of the groundwater had sulfate lower than 30 mg/L (Figure 17). Surface water sulfate (mean 42±5.44 mg/L) was statistically higher than groundwater sulfate in the BMZ ($p=0.01$).

Chloride represented about 10% and 18% of the total negative charges in Beaumont groundwater and surface water respectively (Figure 12). The average groundwater chloride was 18±2.9 mg/L, and varied from 4.0 mg/L to 147 mg/L (Figure 18). Most (85%) groundwater samples had chloride concentrations lower than 30 mg/L (Figure 15D). Surface water had significantly higher ($p = 0.04$) negative charge percentage and higher absolute chloride concentration (25±6.1 mg/L) compared to groundwater. Higher chloride values were observed along San Timoteo Creek and sites close to the SWP recharge basins (Figure 18).

Fluoride accounted for less than 5% of total negative charges, and ranged from 0.3-3.0 mg/L with an average of 0.50±0.06 mg/L (Table 6). Seventy three percent of the groundwater fluoride values were between 0.25-0.50 mg/L (15E). The variation of surface water fluoride was from 0.04-0.64 mg/L, with no statistical difference between groundwater and surface water fluoride concentrations (Figure 19).

The average phosphate concentration in Beaumont groundwater was 0.06±0.01 mg/L (Table 6). All but two sites were below 0.15 mg/L phosphate, the cemetery site (1002958) at 0.61 mg/L and the chicken farm at 0.26 mg/L (1208432) (Figure 15F and Figure 20). Phosphate was not detected in 18 of the 55 well samples. Surface water had significantly higher ($p<0.001$) phosphate concentrations (0.47±0.18 mg/L) compared with groundwater.

Calcium was the dominant cation in Beaumont groundwater, and accounted for about 50% of positive charges (Figure 12). Groundwater calcium varied 1.8 mg/L to 90 mg/L (Figure 21A), with average of 45±1.9 mg/L. Most groundwater calcium concentrations (93%) fell between 28 and 66 mg/L (Figure 22). The highest calcium level in groundwater (90 mg/L) was found at the chicken farm located adjacent to Cooper's Creek. Calcium was also the dominant cation in surface water with an average of 35±4.8 mg/L.

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Magnesium was the second most common cation, accounting for about 25% of the total positive charges in both groundwater and surface water (Figure 12). Average magnesium concentrations were 15±0.8 mg/L and 13±1.8 mg/L in groundwater and surface water respectively. Most (89%) magnesium concentrations in groundwater were between 8 to 22 mg/L (Figure 21B). No significant difference in magnesium concentrations was observed between groundwater and surface water ($p=0.34$). The highest magnesium concentrations were found at the horse ranch (site 1207012) and chicken ranch (site 1208432) with 35 mg/L and 32 mg/L respectively (Figure 23).

Sodium was the third most abundant cation, accounting for 25% of the total positive charges both in groundwater and surface water (Figure 12). Sodium in groundwater varied from 11 to 85 mg/L, with an average of 29±2.6 mg/L (Figure 24). However, 84% of groundwater had sodium lower than 40 mg/L (Figure 21C). Sodium in surface water was not significantly different than groundwater, with an average of 28±6.1 mg/L.

Potassium was least abundant base cation, with less than 2% of the total positive charges (Figure 12), with an average value of 1.6±0.08 mg/L. Eighty percent of groundwater samples had potassium concentrations between 1-2 mg/L (Figure 21D). However, surface water potassium (3.3±0.82 mg/L) was significantly higher ($p < 0.0001$) than groundwater (Figure 25).

All the other cations (aluminum, boron, and iron) accounted for less than 1% of total positive charges in groundwater. Aluminum and iron were only detected at a few sites (Table 6).

***Isotopes of Nitrate: $\delta^{15}N\text{-}NO_3$ and $\delta^{18}O\text{-}NO_3$***

The measurement of $\delta^{15}N\text{-}NO_3$ in groundwater is an established method of identifying sources of nitrate (Aravena et al., 1993; Aravena and Robertson, 1998; Kendall, 1998; Roadcap et al., 2002). In the BMZ, $\delta^{15}N\text{-}NO_3$ varied from 2.0‰ to 21‰ with an average of 5.3±0.6‰ (n=55) (Table 7). About 70% of the groundwater samples had $\delta^{15}N\text{-}NO_3$ lower than 5‰ (Figure 26A) Higher $\delta^{15}N\text{-}NO_3$ values were observed in groundwater and surface waters along San Timoteo Creek and Cooper's Creek, in groundwater recharge waters within Zone 3, and in several wells within Zone 3 (Figure 27). Moderate to high values of $\delta^{15}N\text{-}NO_3$ were observed in the BCVWD wells within Zone 2. The lowest groundwater $\delta^{15}N\text{-}NO_3$ values were found in Zone 4. The lowest surface water $\delta^{15}N\text{-}NO_3$ values were often found after rain events. In Nobel Creek and San Gorgonio Creek, $\delta^{15}N\text{-}NO_3$ values were -0.58‰ and 0.26‰ respectively. Water samples collected from SWP recharge ponds had significantly higher $\delta^{15}N\text{-}NO_3$ (8.9±0.2, n=4) values (Table 7, Figure 27) in comparison with groundwater $\delta^{15}N\text{-}NO_3$, however nitrate-nitrogen concentrations in SWP recharge water were only 0.3 mg/L.

The $\delta^{18}O$ of nitrate provides additional information to determine nitrate sources and understand microbial processing of nitrate within aquifers (Kendall 1998). The variation $\delta^{18}O\text{-}NO_3$ within the Beaumont Basin groundwater was -0.85‰ to 9.4‰, with an average of 2.2±0.3‰ (n=55). About 85% of groundwater $\delta^{18}O\text{-}NO_3$ values were lower than 4‰ (Figure 26B). The highest groundwater $\delta^{18}O\text{-}NO_3$ values were observed along San Timoteo Creek,

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followed by groundwater in Edgar Canyon and Beaumont Cherry Valley (Table 7, Figure 28). The range of surface water $\delta^{18}O-NO_3$ was from -3.9‰ to 10.4‰ (Table 7). The SWP water had significantly lower $\delta^{18}O-NO_3$ values (-2.9±0.5‰, n=4) compared to other surface water sites (3.4±1.4‰) with $p = 0.016$ (Table 7).

The ratio of $\delta^{18}O-NO_3$ vs. $\delta^{15}N-NO_3$ could be an additional tool to distinguish sources of nitrate. Nitrate from human or animal waste may produce a ratio between about 1.0 and 4.0. Soil nitrate could produce a ratio of 0.2 to 2 while mineralization of reduce nitrogen fertilizer could produce a ratio of 0.6 to -1.3. Nitrate from precipitation will typically produce values of the ration < -0.5 or greater than 10. The ratio was mapped in Figure 29. Wells within Zone 4 typically had ratios between -0.4 and +0.3 which may nitrate derived from natural soil nitrogen or reduced nitrogen fertilizers. Wells in Zone 2 generally had ratios in the range of +0.4 to 1.0 which overlaps the ratios expected from natural soil nitrogen and fertilizer. Wells in Zone 3 generally had the highest ratios and in several cases the values overlapped the ratios expected from human or animal waste. The isotopes of nitrate in Zone 1 were strongly influenced by denitrification (see below) which tends to reduce the ratio therefore confounding its usefulness for tracing nitrate sources.

***Pharmaceutical and Personal Care Products (PPCPs)***

Samples were analyzed for 16 compounds, and 15 were identified above the detection limit in at least 1 of the 51 samples assayed (40 groundwater, 9 surface water and 2 recharge water). There were a total of 6 well water samples (12%) with no detections, and 7 (14%) samples with 1-3 detects of compounds with concentrations below the quantification limit (Table 8). PPCPs were identified above the detection limit in 34 of the 40 wells samples with an average detects per well of 2.3 compounds (range 0 to 7). PPCPs were detected in every surface water sample with an average detect of 4.2 compounds per site (range 1-13). However, some of these detects were below the limits of quantitation.

Diclofenac was not detected in any sample. Diuron (55%) and sulfamethoxazole (50%) were the most commonly detected compounds in groundwater samples, while diuron (89%), trimethoprim (78%) and gemfibrozil (67%) were most commonly found in surface waters. The two SWP recharge water site samples contained similar concentrations of the exact same compounds (meprobamate, diuron, carbamazepine and sulfamethoxazole). The most commonly detected compounds among all samples were diuron (63%) and sulfamethoxazole (49%).

The spatial distribution of PPCP detections within the BMZ was not homogenous. Generally, the highest concentrations and detections occurred in Zone 1 and the lowest concentrations and least detections occurred in Zone 4 (Figure 30).

To aid in statistical evaluation of PPCP data, we derived an equation based on PPCP concentrations and the number of detections. This equation provides an index, C, to judge the likelihood that water samples contain human waste.

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$$C = Ln\left[(\sum J \times 100)\ \frac{L}{L_i}\right] \qquad \text{(Equation 3)}$$

Where C is the PPCP contamination index, $\sum J$ is the sum concentration (ng $L^{-1}$) of all the detected analytes, $L$ is the number of compounds detected and $L_i$ is the total number of analytes in the method. Sites with highest probability of containing human waste are those with multiple compound detections at relatively higher concentrations. Sites with less human waste are those with few or no detects at lower concentrations. The highest C values were measured in surface and groundwater within Zone 1 (Figure 31). Lowest C values were measured in Zone 4 and Zone 2. Levels in Zone 3 were higher than in Zones 2 and 4, but overall were less than those in Zone 1. While diuron was examined and is discussed with PPCPs throughout the text, it was not used to calculate the PPCP contamination index. Diuron is an herbicide, and while it may be found in septic and wastewater effluents, it is also applied regularly in the environment and therefore not strictly associated with septic or wastewater effluents.

***Principal Components Analysis (PCA) of Environmental and Chemical Data***

Principal components analysis (PCA) was used to determine the major gradients in the water chemistry dataset, and to identify clusters of sites exhibiting similar water chemistry. PCA is a common ordination technique for linear indirect gradient analysis (ter Braak 1988), which is especially useful for visualizing large and complex data sets in reduced dimensions that are more interpretable. PCA identifies patterns in data and expresses the data in a way that highlights similarities and differences among samples and sample attributes.

Principal components analysis (PCA) was chosen based on initial data exploration using DCA (detrended correspondence analysis), which identified short lengths of gradients (lower than 1.5) in our dataset. Therefore the PCA was used to assess the overall variability. Environmental data was log (log+1, for data containing zeros), square root, or Box –Cox (Box and Cox 1964) transformed prior to analysis, to achieve normality and remove negative values. Because our variables were measured in different units (e.g. pH, DO, Conductivity etc.) we used center and standardize settings to better interpret distance between groups of samples. All ordinations were performed using CANOCO version 4.5 (ter Braak and Smilauer. 1998).

Principal components analysis (PCA with all groundwater environmental variables included) revealed that PPCPs, isotopic composition ($\delta^{15}N$ and $\delta^{18}O$), major ions (Cl, $SO_4$) and major water chemistry parameters (Conductivity, pH, DO, TN, DON and DOC) were the most significant environmental variables in explaining the variance in the wells sampled in our survey of groundwater in the BMZ (Figure 32). A significant portion of the variance in our data was explained by both Axis 1 and 2 (37.1 %). For large datasets such as ours, even less than 10% explained variance is considered normal. The first axis, which accounted for 22.8% of the variance within the well data, was strongly related to parameters associated with the ionic strength and nitrogen concentrations of groundwater. The second PCA axis is more directly influenced by PPCPs and isotopic values of nitrate. In Figure 32, the length of the arrow denotes the importance of that variable in explaining variability among the wells. The direction that the arrow points generally indicates a gradient of increasing values for each variable. For example, samples with high ionic strength (i.e., high specific conductance = COND) also tended to have high total nitrogen (TN). Similarly, samples with higher values of $\delta^{15}N\text{-}NO_3$ (.15N in figure) tend to be found in wells with higher PPCP concentrations (primidone, carbamazepine, meprobamate) and lower field dissolved oxygen (FDO).

We performed Pearson Product Moment Correlation (PPMC) to quantify relationships among some of the most important parameters identified in the PCA analysis. The following parameters were most strongly correlated to PPCP index values in groundwater of the BMZ ($p<0.01$):

- $\delta^{18}O\text{-}NO_3$: r = +0.76
- $\delta^{15}N\text{-}NO_3$: r = +0.75
- Boron: r = +0.72
- Sodium: r = +0.68
- Chloride: r = +0.65
- Dissolved oxygen: r = -0.64
- Sulfate: r = +0.57
- Total dissolved solids or: specific conductance r = +0.53

The following parameters were most strongly correlated to $\delta^{15}N\text{-}NO_3$ values in groundwater of the BMZ ($p<0.01$):

- $\delta^{18}O\text{-}NO_3$: r = +0.88
- PPCP index: r = +0.75
- Dissolved oxygen: r = -0.75
- Boron: r = +0.72
- Sodium: r = +0.71
- Chloride: r = +0.59
- Total dissolved solids or: specific conductance r = +0.39

The following parameters were most strongly correlated to total nitrogen (TN) concentrations in groundwater of the BMZ ($p<0.05$) (the strong positive correlations between TN and nitrate-nitrogen and DON are not presented):

- Total Dissolved Solids or: Specific Conductance r = +0.69
- Sulfate: r = +0.56
- Chloride: r = +0.48
- ANC or $HCO_3$: r = +0.47
- Sodium r = +0.35
- Boron: r = +0.32
- pH r = -0.27

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The correlation analysis demonstrates that a strong positive relationship exists between the two parameters we chose to identify contamination from human waste (PPCPs and isotopes of nitrate). Higher levels of PPCPs and enrichment of the nitrogen and oxygen isotopes of nitrate tended to occur in groundwater with lower dissolved oxygen and higher concentrations of salts which is consistent with expected water quality impacts from human waste. Higher total nitrogen concentrations were also associated with higher concentrations of salts which is consistent with influence from human waste. Total nitrogen was positively correlated with the PPCP index and $\delta^{15}N\text{-}NO_3$, but the r- and p-values did not reach the thresholds for statistical significance (r-values of +0.18 and +0.13 and p-values of 0.2 and 0.36, respectively). We did note a statistically significant positive correlation between TN and $\delta^{18}O\text{-}NO_3$ (r value of +0.38, p-value 0.004). We speculate that the lack of correlation among TN (or nitrate-nitrogen or DON) and the PPCP index and $\delta^{15}N\text{-}NO_3$ results from the non-conservative nature of nitrate in the vadose zone and in low oxygen environments.

The clustering of individual groundwater samples in the PCA is presented in Figure 33. In the figure, wells from Zones 1 through 4 and surface water are colored to show their grouping. Zone 4 wells formed the tightest cluster (blue diamonds) and constitute a chemically distinct group of wells based on general water chemistry, isotopes of nitrate and PPCP levels. The position of Zone 4 wells in the PCA indicates that they generally have the lowest ionic strength, lowest total nitrogen and lowest PPCP levels of all the wells sampled in the BMZ. The second tightest grouping was Zone 2 wells (red diamonds) and these wells are further down along the axis related to ionic strength and total nitrogen. While not as tightly clustered, many of the wells within Zone 1 plot away from the main clusters of wells and further along the axis related to higher PPCP concentrations and higher nitrogen and oxygen isotope values. Zone 3 groundwater formed a looser, less distinct cluster of wells. Compared to Zones 2 and 4, Zone 3 wells were often further along the axis indicating higher ionic strength and total nitrogen and further along the axis indicating higher PPCP levels and higher isotope values. Surface waters did not form a single tight cluster. The samples from the SWP formed a cluster in the upper left of the PCA owing to their low ionic strength and low total nitrogen levels relative to groundwater in the BMZ. In contrast samples of Cooper's Creek and lower San Timoteo Creeks plot into the upper right of the PCA indicating relatively high levels of PPCP, heavier isotopes, higher ionic strength and higher total nitrogen.

**Discussion**

The potable water supply in the BMZ is mainly supported by groundwater. Due to increases in urban and agricultural water demand, the water table level has dropped as much as 100 feet since 1920s in some areas of the BMZ (USGS, 2006). The total groundwater extraction in the BMZ increased from 1,630 acre-feet in 1936 to over 8,000 acre feet in 2005 (USGS 2006). Areal recharge, mountain-front recharge and general head boundary are the major natural sources of recharging groundwater, which accounted for ~100% of total inflow in 1960s, but decreased to about 40% of total inflow in current years (USGS 2006, Report by Wildermuth Environmental

Inc. 2010). Even though there is a significant amount of natural water recharge, artificial recharge is necessary to slow the decline of groundwater storage in the BMZ. There are several sources of artificial recharge to the basin including return flow from irrigation of crops, golf courses, and landscaping. Septic tank seepage and imported water from the State Water Project (SWP) also contribute to groundwater recharge within the BMZ. Artificial return flow of applied SWP and storm-flow water accounted for less than 1% of the local groundwater recharge in 1960s, but has increased to about 20% in recent years. Percolation of surface water (including artificial return flow) is estimated to take about 50-100 years to reach the water table (USGS 2006). However, infiltration of septic waste water and SWP water appears to be faster, taking 5-10 years to reach the water table, depending on local geology and depth to the water table (personal communication, Samantha Adams, Wildermuth Environmental Inc.).

Nitrate is the most frequently observed nutrient contaminant detected in groundwater of the United States and its concentration is regulated by the US Environmental Protection Agency. Sources of groundwater nitrate in the BMZ include oxidized and reduced forms of nitrogen in precipitation, naturally occurring pools of nitrogen in soils, and fertilizers applied to agricultural lands, golf courses, and residential landscaping. Human waste may also contribute to groundwater nitrate through discharge of effluent from wastewater treatment plants, private septic tanks and during groundwater recharge with SWP water. Human waste contains nitrogen in three forms: nitrate, ammonium and dissolved organic nitrogen (DON). Under oxic conditions, ammonium can be converted into nitrate via the microbial nitrification reactions:

$$NH_4^+ + \frac{1}{2}O_2 + 2H_2O \rightarrow NO_3^- + 8H^+ \qquad \text{(Equation 4)}$$

DON can be converted in ammonium via microbial mineralization and then nitrified to produce nitrate.

When water containing nitrate enters a zone of zero oxygen or biological oxygen demand in infiltrating groundwater exhausts all dissolved oxygen, the process of microbial denitrification can convert nitrate into nitrous oxide or di-nitrogen gas. Two potential electron donors can catalyze the denitrification reaction, reduced iron or organic matter:

$$14NO_3^- + \mathbf{5FeS_2} + 4H^+ \rightarrow 7N_2(g) + 10SO_4 + 5Fe^{2+} + 2H_2O \qquad \text{(Equation 5)}$$

$$4NO_3^- + \mathbf{5CH_2O} \rightarrow 2N_2 + 4HCO_3^- + CO_2 + 3H_2O$$

Because oxygen is usually plentiful in surface water and in soils within the vadose zone, most of the nitrogen that reaches the groundwater has undergone mineralization and nitrification. Denitrification occurs when groundwater migrates into a zone of zero oxygen which could occur in an aquifer, a septic tank or in a wastewater treatment plant. Successful application of nitrate isotopes for tracing sources requires an understanding of the effects of denitrification since it can obscure the original source signatures of nitrate (Figure 34). Denitrification leaves a geochemical fingerprint that can be interpreted as evidence for its occurrence and extent. The most obvious evidence for denitrification is the presence of a redox gradient that generates a series of

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oxidation-reduction reactions, including the reduction of nitrate in the appropriate position in the sequence. Hence, in a closed system without oxygen, denitrification occurs between the disappearance of dissolved $O_2$ by aerobic respiration and the appearance of $Mn^{2+}$ and $Fe^{2+}$ (Mariotti et al., 1988). Importantly, during denitrification, the $\delta^{15}N-NO_3$ and $\delta^{15}O-NO_3$ values of the residual nitrate increase in proportion to the logarithm of the residual nitrate fraction if the aquifer or treatment plant or septic tank acts as a closed system (Kendall, 1998). Because the kinetic isotope effect of denitrification acts more strongly on the nitrogen isotope of nitrate, the magnitude of fractionation for nitrogen is about 2-times the fractionation experienced by oxygen. When $\delta^{15}N-NO_3$ and $\delta^{15}O-NO_3$ are plotted on an X:Y graph ($\delta^{18}O$ on the y-axis and $\delta^{15}N$ on the x-axis), one can identify the occurrence of denitrification when samples fall along a line with a slope of about 0.5 (Figure 34) (Roadcap et al., 2002).

In Figure 34 we show typical source signatures for nitrate and the potential effect of denitrification on nitrate isotope composition. Atmospheric nitrate and nitrate fertilizer produced from atmospheric $N_2$ typically have $\delta^{15}N$ values between -5 and + 5 per mil and $\delta^{18}O$ values greater than about 20 per mil (typical range +20 to +80 per mil). Nitrate produced from reduced nitrogen fertilizers has a $\delta^{15}N$ that hovers around zero per mil and a $\delta^{18}O$ between 0 and 5 per mil. Nitrate produced by microbial mineralization and nitrification has a $\delta^{15}N$ that can range between 0 to about +5 per mil $\delta^{15}N$ and 0 and 5 per mil $\delta^{18}O$. Nitrate from human or animal waste typically has the highest $\delta^{15}N$ values, +5 to >20 per mil. Note that denitrification of fertilizer or soil N could produce high $\delta^{15}N$ values, but $\delta^{18}O$ values would also increase.

To better understand the sources of groundwater nitrate, the BMZ was divided into four zones (Figure 35a) based primarily on how human waste is handled and secondly on landuse within the BMZ. Zone 3 was further divided into Zones 3-1 and 3-2 (Figure 35b) based on differences between the isotopes of nitrate in Zone 3 sub-regions (see below). The results from the PCA and cluster analysis provide validation for separating the well data into these zones (Figure 33). These four zones have real differences in water quality, including parameters that are diagnostic of groundwater contamination with human waste (PPCPs, salts and isotopes of nitrate).

In the following sections we will describe the water quality within each of these four zones and discuss the likelihood that zonal groundwater is affected by human waste. Where appropriate, we will also describe the changes in water quality that occur as the water moves laterally within each zone to gain better understanding of processes that could be impacting groundwater chemistry (for example mixing of groundwater basins or denitrification of nitrate).

**Zone 1 – Region Influenced by Wastewater Treatment Plant Effluent**: Zone 1 occupies the southernmost area of the BMZ and is defined as surface water and groundwater sampling sites nearby Cooper's Creek and San Timoteo Creek. Water quality in Zone 1 is influenced by effluent from the City of Beaumont wastewater treatment plant (WWTP #1 in Figure 35a). About 1.8 MGD (million gallons per day) of tertiary treated wastewater from the City of Beaumont is discharged to support riparian habitat in Cooper's Creek and San Timoteo Creek. This recycled

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wastewater may take only a few years to reach the shallow water table in Zone 1 (USGS 2006). The groundwater in Zone 1 flows away from WWTP #1 in two directions (NW and SE), which is shown in Figure 35a. Several groundwater wells close to WWTP #1 had higher salt content, higher nitrate concentrations, and higher PPCP concentrations, compared with downstream sites and other sites in the BMZ (Figures 36 and 37). Based on ANOVA analysis, Zone 1 had significantly higher PPCP index values than zones 2 and 4 ($p < 0.001$), significantly higher nitrate concentrations than Zone 4 ($p<0.001$), significantly higher $\delta^{15}N$ and $\delta^{18}O$ of $NO_3$ than zones 2, and 4 ($p<0.001$) and significantly lower dissolved oxygen concentrations than zones 3 and 4 ($p < 0.001$).

Moving along a flowpath down-gradient from the WWTP, we observed marked changes in dissolved oxygen, nitrate and isotopes of nitrate (Figure 37). These changes are likely the result of microbial processes that consume oxygen and thereby generate conditions that favor denitrification. Alternatively, mixing of WWTP #1 with water in a deeper or adjacent aquifer could be driving the changes seen in Figure 37. Plots of nitrate isotope vs. nitrate concentration (Figure 38) were made for Zone 1 to distinguish between mixing ($\delta^{15}N$ vs. $1/[NO_3]$) or denitrification ($\delta^{15}N$ vs. $Ln[NO_3]$) and showed that both mixing and denitrification could be taking place and therefore did not say much regarding the relative importance of these two processes. However, a bi-plot of nitrate $\delta^{18}O$ vs. $\delta^{15}N$ provides strong evidence for denitrification within Zone 1 (Figure 39). The linear regression in Figure 39 produces an $R^2$ of >0.94 for all groundwater wells except 1208660 and the slope of this line, 0.43, is not significantly different from the slope of 0.5 expected from denitrification.

Extrapolation of the denitrification line in Figure 39 passes slightly above the position of the isotope values of Well 1208660 suggesting that Well 1208660 contains nitrate that is slightly different than that found in the other Zone 1 wells. Interestingly, one can draw a line through the two creek samples that passes through the isotope values for Well 1208660 which may indicate that nitrate in Well 1208660 is a mixture of more recently infiltrated nitrate from surface water and groundwater nitrate that has experienced substantial denitrification. At Well 1208660, six PPCP compounds were detected, including primidone (4.7 ng/L), meprobamate (3.0 ng/L), diuron (3.3 ng/L), carbamazepine (87.2 ng/L) and sulfamethoxazole (25.8 ng/L) (Table 8).

The water quality changes along the flowpath in Zone 1 tell a consistent story of nitrate inputs from a WWTP followed by microbial processes consuming oxygen, which produces conditions favorable for denitrification (Figure 37). During denitrification, nitrate is converted to $N_2$ gas which drives isotopic enrichment of the residual nitrate pool; this effect is clearly seen in the exponential reduction of nitrate concentrations and logarithmic increase in nitrate isotope values (Figure 37). Suitable conditions for denitrification, including depletion of DO (8.8 mg/L decreased to 0.3 mg/L) (Table 5 and Figure 37) and adequate supply of electron donors, such as iron and sodium (Table 6) were present along the water flowpath. Furthermore, $Fe^{2+}$ was detected in the low DO groundwater of Zone 1 (Table 5) which indicates that redox conditions were suitable for denitrification.

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The PPCP data provide additional evidence that much of the nitrate in Zone 1 comes from the WWTP effluent. Zone 1 had the highest frequency of PPCP detection, in both wells and surface water, of the BMZ (Figure 30). Five of the 10 wells located in Zone 1 contained 3 to 5 quantifiable concentrations of the target compounds. Two wells contained quantifiable concentrations of sulfamethoxazole and there were no compounds detected in the remaining three wells. The majority of the detections and highest concentrations were located along the NW flowpath of the WWTP 1 outfall. The concentration and detections of PPCPs in groundwater were lower along the SE flowpath.

The two surface water samples from the NW flowpath of the WWTP effluent contained 10-13 detectable PPCP compounds, which was more than any well sample. These two surface water samples also had PPCP index values 10.9 and 11.9, the highest measured in the BMZ (Table 7).. The concentrations of PPCP compounds decreased by 22 to 86% with increasing distance from the WWTP #1 outfall (when adjusted for evaporation using chloride as a conservative tracer). Carbamazepine (22%) and sulfamethoxazole (23%) were reduced the least, while trimethoprim (86%) and gemfibrozil (80%) concentrations were reduced the most. Diuron concentrations increased with distance from the WWTP #1. This compound is a commonly used herbicide, which would likely have sources other than effluent from the WWTP. Concentrations of PPCP in surface water of Zone 1 were greater in all instances than what was detected in the groundwater of Zone 1. This is likely due to sorption and degradation of PPCP compounds as they travel from the WWTP discharge and percolate into the ground. The PPCP index values in groundwater ranged from 9.1 to 1.1 and generally decreased along the NW flowpath of the WWTP effluent (Table 7). The only two wells in this zone that had index values of zero were wells 1006132 and 1220050, which were along the SE flowpath of groundwater. This is the opposite direction of where most of the WWTP discharge flows.

**Zone 2 – Wildland and Low Density Septic Disposal Region:** Zone 2 is defined as the area uphill of Edgar Canyon to the north of Cherry Valley (Figure 2). Groundwater in this mostly wildland area has lower temperatures than elsewhere in the BMZ (Figure 3) which may be a result of the temperature lapse rate with elevation or faster recharge of groundwater (Brink 2007). Zone 2 wells, overall, were oxic (Figure 6), and had low to moderate concentrations of TDS (Figure 9). In the wells at the top of Zone 2, nitrate-nitrogen concentrations ranged from about 1 to 2.5 mg/L while concentrations were slightly higher in wells at the lower elevations in Zone 2 (2 to 2.8 mg/L; Figure 35a). Moving along the flowpath, downhill, we noted changes in major ion chemistry (Figure 40) and a slight decrease in $\delta^{15}N$-$NO_3$ and increase in $\delta^{18}O$-$NO_3$ (Figure 41). The oxygen isotope of nitrate in Zone 2 wells may be reflecting the $\delta^{18}O$ value of water used in nitrification (Equation 4) which is lower at higher elevations (Fry 2006). Plots of $\delta^{15}N$ vs. 1/[$NO_3$]) and $\delta^{15}N$ vs. Ln[$NO_3$]) could not distinguish between isotope mixing or denitrification (Figure 42). A bi-plot of $\delta^{15}N$-$NO_3$ vs. $\delta^{18}O$-$NO_3$ reveals no evidence for denitrification of nitrate within Zone 2 or along the downhill flowpath (Figure 43). Overall, the isotopic values of nitrate in Zone 2 suggest that most of the nitrate in groundwater is derived from natural soil nitrogen and/or fertilizer nitrogen (Figure 34). Higher values of $\delta^{15}N-NO_3$ in the lower-elevation portions of Zone 2 may indicate a small, but increasing influence of inputs of nitrate from human or animal waste.

All of the wells sampled in Zone 2 contained PPCPs, however diuron was the only compound detected in two of the wells. While diuron may be associated with septic waste, it is also common in the environment due to its usage as an agricultural herbicide. Sulfamethoxazole was the most commonly detected pharmaceutical compound in Zone 2 (4 wells), with higher concentrations in the lower elevation groundwater samples. Carbamazepine was also detected in wells at lower elevations. Both sulfamethoxazole and carbamazepine are commonly detected in the environment and are relatively more persistent than other PPCPs. The presence of these two compounds as well as primidone, atorvastatin and fluoxetine indicate that some water emanating from septic systems is entering the groundwater in Zone 2, although concentrations of nitrate and isotopic values of nitrate observed in Zone 2 indicate lower levels of human/animal waste contamination relative to zones 1 and 3 (discussed below). Generally higher concentrations of sulfamethoxazole at lower elevation wells may indicate that groundwater receives greater amounts of human waste at lower elevations within Zone 2. The two wells with the highest PPCP index were BCVWD 4 and BCVWD 6 with values of 4.7 and 4.1 respectively. The two surface water samples from the top of the mountain were relatively clean, with only diuron and gemfibrozil being detected, but at concentrations less than the limits of quantitation, therefore their PPCP index values are zero.

**Zone 4 – Urban Region With Consolidate Sewer System:** Zone 4 encompasses the portion of Beaumont utilizing a municipal sewer system. All sewage from the City of Beaumont is transported to WWPT #1 for tertiary treatment (USGS 2006). As discussed above, water applied to the soil surface could take 50-100 years to reach water table due to localized geology and groundwater table depths. Therefore, it is possible that the groundwater in Zone 4 is currently receiving water applied to the land surface around the 1960s (USGS 2006). SWP water takes less time to reach groundwater through the recharge ponds (5-10 years), but has only been occurring at the BCVWD spreading basins since 2005. Zone 4 groundwater might not yet be receiving large amounts of SWP water due to the slow groundwater infiltration rates (USGS 2006).

Groundwater in Zone 4 is oxic, and has lower than BMZ-average specific conductance (Figure 7), lower than average nitrate concentration (Figure 14), and lower than average sulfate and chloride levels (Figures 17 and 18). ANOVA tests demonstrate that nitrate concentrations are significantly lower in Zone 4 compared to all other zones ($p < 0.001$) and that $\delta^{15}N-NO_3$ values are significantly lower in Zone 4 compared to zones 1 and 4 ($p < 0.001$). The $\delta^{15}N-NO_3$ and $\delta^{18}O-NO_3$ measured in Zone 4 groundwater cluster tightly around 2 to 3 per mil and 0 per mil, respectively (Table 7), which suggests the major sources are natural soil nitrate or oxidation of reduced nitrogen fertilizer (Figure 34). In 11 of the 14 wells sampled in Zone 4 there were no PPCP compounds detected or they were detected below the limits of quantitation (Figures 30 and 31). The PPCP concentrations detected were all less than 1 ng/L (except acetaminophen – 13.9

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ng/L and diuron – 2.1 ng/L). ANOVA tests indicate that PPCP index values in Zone 4 are significantly lower than in Zone 1 ($p < 0.001$) and Zone 3 ($p < 0.1$). Based on the major ion, nutrient, PPCP and isotope data, we conclude that the probability of human waste contamination is much lower in Zone 4 than in either zones 1 and 3 and similar to the contamination probability in Zone 2.

**Zone 3 – Urban Region With On-site Septic Disposal Systems:** Human waste from homes and businesses in Zone 3 is predominantly disposed of in on-site waste disposal systems. The groundwater within Zone 3 was well-oxygenated with the exception of the western-most well which had DO between 2 and 4 mg/L (Figure 6). Several wells within Zone 3 had higher than average levels of specific conductance and TDS (Figures 7 and 9). It is noteworthy that groundwater in Zone 3 contained higher nitrate concentrations than surface water and SWP recharge water (Figure 35a). Five wells within Zone 3 had nitrate-nitrogen concentrations greater than 5 mg/L (Figure 14); sulfate and chloride levels in these wells were higher than average for the BMZ. Six wells in Zone 3 had $\delta^{15}N\text{-}NO_3$ greater than 5 per mil (Figure 27) and PPCP index values higher than any well outside of Zone 1 (Figure 31). The $\delta^{15}N\text{-}NO_3$ values of groundwater in Zone 3 were significantly ($p<0.001$) higher compared to nitrate in zones 2 and 4 (Figure 27).

Groundwater flowpaths in Zone 3 were more difficult to define, so we attempted to discern gradients in water quality moving away from groundwater recharge sites using SWP inputs (Figure 44). A clear gradient in anion percentage was observed in Zone 3 with a weaker trend detectable in major cations (Figure 44). SWP water was characterized by relatively high values for $\delta^{15}N\text{-}NO_3$ (> +8 per mil), which suggests a higher contribution of nitrate from human or animal waste. However, nitrate-nitrogen concentrations in the SWP were only 0.32 mg/L. In water samples taken at the San Gorgonio Pass Water Agency and Beaumont Cherry Valley Water District spreading basins, carbamazepine, sulfamethoxazole, meprobamate and diuron were detected. The first three compounds are associated with human waste, while diuron is a herbicide. The concentrations of each of the four compounds were nearly identical between the two sampling sites, indicating homogeneity of water from the SWP. The index values for PPCP contamination in the SWP were both 5.3. The source waters for the SWP contain wastewater effluent discharge points (Loraine and Pettigrove 2006), therefore, the SWP may be influenced by anthropogenic sources of nitrate. Additionally, PPCPs have also been detected in the source water for the SWP (Loraine and Pettigrove 2006).

Water from Well 1007022 contained dilantin, diuron, primidone and sulfamethoxazole and a PPCP index value of 6.7 (the sixth highest index value within the BMZ). A nearby well (1206853) also contained sulfamethoxazole and had an index value of 3.6. While these two wells are in the BMZ, they are actually in the Singleton groundwater storage unit. The Singleton storage unit is separated from the Beaumont Basin by the Cherry Valley Fault to the South and Southeast. This fault likely impedes groundwater movement from the Singleton storage unit into the adjacent storage units. This may be one reason that we see a several detects within well 1007022.

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Three additional groundwater wells in Zone 3 contained sulfamethoxazole, albeit at lower concentrations than the two wells within the Singleton storage unit. Atorvastatin and diuron were also detected in two of the three wells, and the concentration of diuron in BCVWD Well 16 was 336 ng/L. These wells had index values for PPCP contamination from 1.9 to 3.5. Two wells had index values of zero. The surface water sample taken in San Gorgonio Creek, near San Gorgonio High School contained gemfibrozil (0.2 ng/L), trimethoprim (1.2 ng/L) and diuron (1061 ng/L) resulting in a PPCP index value of 2.9. The concentration of diuron in this sample was the highest of any compound in all of the samples examined. This sample was taken during a "first flush" rain event. Trimethoprim was also detected in the surface water sample taken from Noble Creek at Noble Avenue (C value of 1.2).

Zone 3 was further separated into two sub-regions to provide more information on groundwater quality within distinct parts of Cherry Valley that lie within Zone 3 (Figure 35b). Zone 3-1 represents wells sampled near the center of Cherry Valley and wells within Zone 3-2 generally lie around the periphery of Cherry Valley (see Table 1 for individual well classifications). Groundwater at the center of Cherry Valley in Zone 3-1 had significantly higher $NO_3$–N concentrations, higher $\delta^{15}$N-$NO_3$ values, higher PPCP index values and higher TDS than wells in Zone 3-2 and Zone 4 (Figure 45). The data in Figure 45 suggest that groundwater within Zone 3-1 has the highest probability of contamination by human waste in the BMZ outside of Zone 1. Furthermore, groundwater quality appears to improve markedly when moving in a direction southward out of Cherry Valley and into Zone 4 which is served by a sewage treatment plant.

**Apportioning Sources of Nitrate in Zone 3 Using Isotope Mixing Analysis:** Zone 3, due to its geographic position in the center of the BMZ, its varied landuse patterns and recharge program using SWP water, is perhaps the most complex zone within the BMZ to apportion groundwater nitrate inputs. A bi-plot of $\delta^{15}$N-$NO_3$ vs. $\delta^{18}$O-$NO_3$ reveals two clusters of points: Zone 3-1 plots further to the right and higher in the graph relative to Zone 3-2 (Figure 46). A linear regression fit to the Zone 3 data in Figure 46 produces an $R^2$ of 0.15 and slope of 0.31 indicating that the influence of denitrification on nitrate in Zone 3 is relatively low and that the isotope values faithfully record source signatures. In order to quantify the amount of nitrate contributed by various sources in Zone 3, we defined potential source endmembers and performed an isotope mixing analysis using the software program IsoSource.

Artificial recharge makes up about 20% of the annual groundwater recharge in the BMZ therefore it is a potential source for nitrate contamination in Zone 3 so it was considered in the isotope mixing analysis. We assigned nitrate in the SWP isotopic values of -2.74 per mil and +8.88 per mil for $\delta^{18}$O-$NO_3$ and $\delta^{15}$N-$NO_3$, respectively (i.e. the average of the points labeled SWP in Figure 46). Because of the relatively high density of septic tanks in Zone 3, we included an endmember representative of nitrate from human waste. We set this endmember value to equal the isotopic composition of nitrate discharged at the City of Beaumont Wastewater Treatment Plant with $\delta^{18}$O-$NO_3$ and $\delta^{15}$N-$NO_3$ values of 5.36‰ and 11.8‰ respectively (i.e., the

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average of the points labeled Septic Waste in Figure 46). Because of Zone 3's location downhill from Zone 2, we included an endmember with $\delta^{18}O\text{-}NO_3$ and $\delta^{15}N\text{-}NO_3$ of 3.01‰ and 3.02‰ respectively, which was the average isotopic composition of wells in the lower portions of Zone 2 (i.e., the average of the points labeled Zone 2 in Figure 46) Lastly, we included an endmember representative of uncontaminated natural groundwater and used the average isotopic composition of nitrate in Zone 4 to approximate its isotope values: $\delta^{18}O\text{-}NO_3$ and $\delta^{15}N\text{-}NO_3$ equal to -0.31‰ and 2.46‰ respectively (i.e., the average of the points labeled Native Groundwater in Figure 46).

IsoSource uses the isotope composition of nitrate of the endmembers to compute all possible mixtures of sources that can produce observed values of $\delta^{18}O\text{-}NO_3$ and $\delta^{15}N\text{-}NO_3$ in Zone 3 groundwater. We used the software to separately predict the source contributions to zones 3-1 and 3-2 using their mean isotopic values to guide the mixing computations. Note that IsoSource does not compute a single source contribution for each endmember but a range of possible contributions. If the isotope mixing model is not well constrained by the available data, then mixing contributions can span wide ranges and not provide much useful information. In many cases, IsoSource solutions allow one to estimate a minimum or maximum endmember contribution which can be very useful.

The results for central Cherry Valley groundwater (Zone 3-1) are graphed in Figure 47. Natural groundwater contributes from zero to 36% of the nitrate in central Cherry Valley groundwater, and SWP recharge could contribute from zero to 15%. Contributions from lateral movement of Zone 2 groundwater and septic systems are better constrained. Based on the IsoSource model, lateral transport of nitrate from Zone 2 is likely the single largest source of nitrate in Zone 3-1 with a contribution ranging from 33 to 69%. Contributions of nitrate from septic systems could potentially supply between 18 to 30% of the nitrate in groundwater of Zone 3-1, suggesting that human waste is an important source of nitrate in central Cherry Valley. Based on this model, extension of sewer service to central Cherry Valley could result in a 30% decrease in groundwater nitrate concentrations over time.

IsoSource mixtures for Zone 3-2 (Figure 48) indicate that natural groundwater is the single largest sources and could potentially supply between 51 to 81% of the groundwater in peripheral areas of Cherry Valley. Lateral movement of Zone 2 groundwater is the next largest source with possible contributions of between 12 to 39%. Both the SWP and septic systems contribute a maximum of about 9 to 10% of the nitrate in Zone 3-2 groundwater. Based on our IsoSource mixing analysis, extension of sewer service to peripheral areas of Cherry Valley could lead to a 9% reduction in groundwater nitrate concentrations given current population density.

**Apportioning Sources of Nitrate in the BMZ Using Mass Balance Analysis:** If one assumes that groundwater in the BMZ can be modeled as a mixed reactor, then it is possible to construct simple water and mass budgets based on annual fluxes of water and nitrate. If one can estimate the volume of groundwater in the BMZ and one can quantify recharge pathways and water withdrawals it is possible to assign nitrate concentrations to these pools and fluxes and construct a mass balance for nitrate in the BMZ. We utilized recent estimates of groundwater pools and

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groundwater fluxes computed by Wildermuth Environmental and nitrate concentrations from our study and Wildermuth Environmental to compute an annual nitrate mass balance for the BMZ (Table 9).

In the mass balance, the nitrate concentration for total groundwater storage is the average of all wells sampled during our study, including duplicates. Nitrate concentrations for the State Water Project are the average of four measurements made at the BCVWD recharge basins during our study. The natural surface water nitrate value is the average nitrate concentration in all surface water samples collected during our study. Nitrate in mountain-front groundwater was computed as the average nitrate value for all Zone 2 wells. The nitrate concentration for well pumpage is the average of nitrate values measured in large volume wells operated by the BCVWD within the entire BMZ. Wastewater treatment plant effluent volume was estimated to be 1.8 million gallons per day which equals 2016 acre-feet per day. The nitrate concentration for WWTP effluent was set to 6 mg/L based on the information offered by California State Water Boards (Dr. Cindy Li, personal communication). Denitrification was estimated based on the relative reduction of nitrate (change from 16 to 14.5 mg/L = 90.6% nitrate reduction) observed along the flowpath in Zone 1 and the average concentration of nitrate in effluent from the City of Beaumont Wastewater Treatment Plant(Figure 37). Negative signs in the table indicate that BMZ aquifer is losing either water or nitrate-nitrogen.

Groundwater storage in the BMZ is estimated to be almost 190,000 acre feet (AF) and based on our study, it has a mean nitrate-nitrogen concentration of 3.49 mg/L which yields a total groundwater nitrate-nitrogen pool of about 815,000 kg (Table 9). The largest sources of nitrate to the BMZ are effluent from the City of Beaumont WWTP and septic waste, which add about 15,000 kg each year respectively. However, denitrification occurring along the flowpath in Zone 1 (see Figure 37) removes a large amount of the WWTP nitrate (Table 9). Pumpage of groundwater represents another large loss of nitrate from the aquifers within the BMZ and is on the order of -47,000 kg per year (we assumed that the nitrate in pumpage was completely assimilated by vegetation during landscape irrigation with the remainder accounted for in septic waste and WWTP effluent).

Mountain-front drainage, primarily from Zone 2, contributes about 10,000 kg of nitrate-nitrogen per year. Despite representing 8,000 AF of water, the SWP adds only about 3,200 kg of nitrate-nitrogen owing to its very low nitrate concentration. Lastly recharge by natural surface water adds about 5,200 kg of nitrate-nitrogen to the groundwater within the BMZ.

On an annual basis we estimate that the BMZ is near a steady state in terms of water storage, however without groundwater recharge with SWP water, there would be an overdraft of about 8,000 AF per year or about 4% of the groundwater pool. We estimate that there is currently net removal of nitrate from groundwater in the BMZ on the order of -12,500 kg per year. This decrease in nitrate-nitrogen storage would translate into a 0.05 mg/L/yr decline in groundwater nitrate concentrations. A complete phase-out of septic systems over time would increase the rate of nitrate-nitrogen decline to 0.12 mg/L/yr under current conditions.

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The nitrate mass balance underscores an important point. Most of the nitrogen added to the BMZ is derived from human waste and its ultimate source lies in food imported into the region. Currently the human population within the BMZ produces 2,016 + 341 = 2,356 AF of sewage per year with a weighted nitrate-nitrogen concentration of 10.2 mg/L. This waste adds 29,642 kg of nitrogen per year to the groundwater within the BMZ which is equal to about 3.4% of the current mass of nitrate-nitrogen held in the BMZ aquifers. However, the large majority of nitrate discharged by the City of Beaumont WWTP is effectively removed from the basin through the process of denitrification in Zone 1. In contrast, current septic system designs do not produce large reductions in nitrate-nitrogen concentrations. We estimate that if sewer service was extended to all homes and businesses within the BMZ, nitrate-nitrogen loading to the groundwater would be reduced by 341 x (35-6) x 0.906 = 8,959 kg per year.

However, groundwater quality improvements from a phase-out of septic systems could be negated to some extent if the region increases the use of treated wastewater for irrigation of landscaping. Current projections estimate that 642 AF of recycled water per year could be applied within the BMZ with an expected average nitrate-nitrogen concentration of 10.79 mg/L (Wildermuth Environmental). This represents a diversion of 8,542 kg/yr of nitrate-nitrogen from the riparian zone in Zone 1 where there is efficient removal of nitrogen via denitrification. While some of the nitrate in the irrigation water will be utilized by plants, we speculate that the majority will infiltrate below the rooting zone and eventually add to the load of nitrate to the BMZ aquifers. It is possible that nitrogen additions from the use of recycled WWTP effluent could substantially offset nitrate decrease expected from a phase-out of septic systems within the BMZ.

**Can We Answer the Questions Posed at the Beginning of This Report?**

In the Introduction to this report we posed three main questions regarding groundwater quality within the Beaumont Management Zone. We will know attempt to answer them using the results of our 2011 water quality investigation.

**1. Can different groundwater regions within the BMZ be defined using isotope, PPCP and general chemical parameters?**

*Based on the principal components and cluster analyses we were able to delineate four statistically distinct groundwater sub-zones within the BMZ. The first of these regions, Zone 1, was characterized by relatively high levels of PPCPs, isotopes of nitrate that were indicative of human waste contamination and major ion chemistry that supported the supposition that discharge from the City of Beaumont wastewater treatment plant is affecting wells along the Cooper's Creek and San Timoteo Creek drainages. Our data suggest that this region has the highest likelihood for nitrate contamination from human waste. Within Zone 1, nitrate behaves in a non-conservative manner likely owing to high biological oxygen and groundwater*

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*conditions that favor denitrification. Thus, a substantial proportion of the nitrate exiting the WWTP is being converted to gaseous nitrogen forms.*

*In the northern part of the BMZ we identified a region of mainly wildlands with some low-density urban development served by septic systems. This region, Zone 2, had detectable levels of some PPCPs, but nitrate concentrations and isotopes suggest that septic inputs to the groundwater are relatively minor. Overall, the groundwater nitrate in Zone 2 appeared to originate from natural soil nitrogen and/or nitrate from oxidation of reduced nitrogen fertilizers. However, there was evidence for greater contributions from human waste in the lower-elevation areas of Zone 2 that bordered a higher density urban region.*

*In the central part of the BMZ we identified a region, Zone 3, with several wells showing clear signs of contamination by septic systems. The groundwater within the central part of Cherry Valley appeared to be more strongly affected by septic systems than groundwater on the periphery of Cherry Valley. Several wells within Zone 3 had relatively high concentrations of PPCPs and major anions and cations suggesting septic waste was entering the groundwater system. Nitrogen isotope values of nitrate in several Zone 3 wells fell in a range consistent with human or animal waste and, when combined with the PPCP data, led us to conclude that groundwater within Zone 3 has a moderate to high probability of contamination by human waste.*

*Between zones 3 and 1 we identified a region, Zone 4, with groundwater showing the fewest signs of contamination by human waste. Most homes and businesses in Zone 4 are serviced by a consolidated sewer system that discharges treated wastewater into Zone 1. In Zone 4 we observed the fewest detections of PPCPs, relatively low concentrations of nitrate and the isotopic composition of nitrate suggested that the major inputs were natural soil nitrate and/or nitrate produced from nitrification of reduced nitrogen fertilizer.*

1A. Do areas with septic systems have different chemistry than areas with sewers?

*Our data suggest there are statistically significant differences between groundwater in areas with septic systems and groundwater in areas where sewer service is available. ANOVA tests revealed that Zone 4, with sewer service, had significantly lower nitrate concentrations and significantly lower* $\delta^{15}N\text{-}NO_3$ *values than groundwater in Zone 3 (septic systems). To underscore these differences, we performed t-tests on wells from zones 2, 3 and 4 wherein we classified each well as to whether it was in a region serviced by septic systems or sewer; we excluded wells from Zone 1 which are influenced by treated wastewater from the City of Beaumont Plant. We observed the following significant differences* ($p < 0.05$) *between the chemistry of wells in regions using septic tanks vs. wells in regions using sewers:*

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*PPCP concentrations were significantly higher in areas with septic systems than in areas with sewer service (mean 2.3 ng/L vs. 0.46 ng/L)*

*TDS was significantly higher in areas with septic systems than in areas with sewer service (mean 308 mg/L vs. 243 mg/L)*

*Nitrate-nitrogen was significantly higher in areas with septic systems than in areas with sewer service (mean 10.4 mg/L vs. 6.1 mg/L)*

*The sum of base cations (Ca, Ng, Na, K) was significantly higher in areas with septic systems than in areas with sewer service (mean 82.3 mg/L vs. 67.4 mg/L)*

*Boron was significantly higher in areas with septic systems than in areas with sewer service (mean 9.7 µg/L vs. 8.6µg/L)*

*$\delta^{18}O\text{-}NO_3$ was significantly higher in areas with septic systems than is areas with sewer service (mean 1.96 per mil vs. -0.21 per mil)*

*$\delta^{58}N\text{-}NO_3$ was significantly higher in areas with septic systems than is areas with sewer (mean 3.78 per mil vs. 2.48 per mil)*

1B. Do areas where groundwater is recharged with water from the State Water Project or wastewater treatment plant effluent have different chemistry from other areas?

*The SWP recharge basins tended to produce more dilute groundwater in their immediate vicinity. Nitrate concentrations in the SWP water were much lower than groundwater in the BMZ. However, detections of PPCPs and the isotopic composition of nitrate in the SWP suggested that the SWP is contaminated with human waste prior to entering the BMZ. Zone 1 is a region where riparian ecosystems are supported by treated wastewater. We detected strong evidence for nitrate deriving from human waste in Zone 1 as well as strong biological attenuation of nitrate transported in groundwater.*

**2. What sources contribute nitrate to groundwater of the BMZ?**

2A. Do different regions within the BMZ have different sources of nitrate?

2B. Do regions of the BMZ with different types of human waste disposal (i.e., septic vs. sewer) have different sources of nitrate?

2C. What areas of the BMZ, if any, have nitrate that appears to come from animal or human waste?

*In Figure 49 we have created bi-plots of the oxygen and nitrogen isotopic composition of groundwater nitrate in each of the four groundwater zones within the BMZ. In zones 2 and 4, the isotopic composition of nitrate overlaps the expected values for soil nitrate and nitrate produced from nitrification of ammonia fertilizers (Figure 34). It is noteworthy that no wells sampled within zones 2 and 4 had a $\delta^{15}N\text{-}NO_3$ value greater*

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*than 5 per mil, hence we can constrain the range of $\delta^{15}N$ values for soil nitrate shown in Figure 34 to a range of between 0 and +5 per mil in the BMZ. In Zone 1, we observed several sites where the $\delta^{15}N$ and $\delta^{18}O$ values of nitrate overlap those expected for human or animal waste; in all Zone 1 samples, $\delta^{15}N\text{-}NO_3$ values were greater than 5 per mil. In several wells within Zone 3, the $\delta^{15}N$ values of nitrate were greater than 5 per mil and suggest a high probability of inputs of nitrate from human or animal waste. The presence of PPCPs in most of these samples demonstrates the possibility that septic systems are contaminating groundwater within the central part of Cherry Valley.*

**3. How much nitrate from human waste is making its way into the groundwater of the BMZ?**

3A. Can models based on isotopes and mass balances be used to estimate septic inputs?

3B. How much would nitrate concentrations decline if sewer service was extended to regions within the BMZ currently using septic tanks?

*This is a challenging question to answer but we have data to make an approximate answer. Isotope mixing analysis for groundwater in Zone 3 shows that we cannot produce a mixture of nitrate sources to match the $\delta^{15}N$ and $\delta^{18}O$ of nitrate in central Cherry Valley groundwater without the additions of isotopically heavy nitrate from human waste. The mixing model suggests that between 18 to 30% of the nitrate in central Cherry Valley groundwater is derived from septic systems. These results suggest that if septic systems were completely phased out, nitrate concentrations in central Cherry Valley groundwater could decline by 30% once a steady state condition is achieved. It is difficult to estimate how long nitrate concentrations will take decline once septic systems are phased out, however, we would note that the residence time of groundwater in Zone 3 may be shorter than in other portions of the BMZ owing to relatively high rates of recharge from the SWP which has very low concentrations of nitrate.*

*At a larger scale, our t-test analysis demonstrated that wells in regions with septic systems had an average nitrate-nitrogen concentration of 10.4 mg/L while wells in areas serviced by sewers had a mean nitrate-nitrogen concentration of 6.1. If a phase out of septic systems were to reduce nitrate levels in septic-influenced wells to that measured in wells in sewered areas, groundwater nitrate levels could decline by (10.4-6.1)/10.4 = 41.3% (similar to the results from the isotope mixing analysis).*

*Our mass balance computations show that nitrate-nitrogen inputs from septic tanks is one of the largest input of nitrogen to groundwater in the BMZ. If this waste were diverted to the City of Beaumont WWTP, about 90.6% of the nitrate would be consumed by denitrification in the riparian areas of Zone 1, effectively removing about 30% of the current input of nitrate to ground water from human waste.*

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**Table 1.Sampling sites for groundwater (40) and surface water (11) in the Beaumont Management Zone. All sites were sampled during the period between February-May 2011 (wet season), and locations marked withan * were re-sampled in July 2011 (dry season). Samples marked with an $^{\Delta}$ were collected in duplicate.**

| Surfacewater | UTM | | Zone # |
|---|---|---|---|
| | Easting | Northing | |
| Noble Cr@ Noble Ave$^{\Delta}$ | 502986 | 3759467 | 3 |
| Drainage @Sundance | 504880 | 3755558 | 4 |
| San Gorgonio Cr@HS | 502089 | 3758005 | 3 |
| Riley Farm | 505305 | 3765760 | 2 |
| Noble Cr below Powerline | 502089 | 3756679 | 4 |
| San Timoteo Creek | 492120 | 3759436 | 1 |
| Coopers Creek | 500092 | 3753745 | 1 |
| Little San Gorgonio Creek | 502089 | 3758005 | 3 |
| Stormwater recharge basin | 504688 | 3765191 | 2 |
| BCVWD pond* | 502388 | 3758655 | SWP |
| San Gorgonio Pond* | 502460 | 3759568 | SWP |

| Groundwater | UMT | | Zone # |
|---|---|---|---|
| | Easting | Northing | |
| 1002958 | 498094 | 3757277 | 4 |
| 1003072 | 495356 | 3759175 | 4 |
| 1004370 | 501475 | 3753148 | 1 |
| 1006132 | 501832 | 3753006 | 1 |
| 1007022 | 500029 | 3758878 | 3-1 |
| 1007025 | 500681 | 3756648 | 4 |
| 1201450 | 500978 | 3759867 | 3-2 |
| 1201486 | 498494 | 3757277 | 4 |
| 1201561 | 495985 | 3758865 | 4 |
| 1206853 | 500095 | 3758396 | 3-1 |
| 1206892 | 501810 | 3752753 | 1 |
| 1206995 | 497356 | 3756555 | 4 |
| 1206996 | 498779 | 3756714 | 4 |
| 1207012 | 498146 | 3759288 | 3-1 |
| 1207769 | 500337 | 3756840 | 4 |
| 1208432 | 499544 | 3753783 | 1 |
| 1208660*$^{\Delta}$ | 496948 | 3754946 | 1 |
| 1220050 | 503381 | 3753003 | 1 |
| 1221612 | 500417 | 3754357 | 1 |
| 1222079 | 494276 | 3757317 | 1 |
| 1222080 | 494276 | 3757317 | 1 |
| BCVWD Well#1* | 502724 | 3755313 | 4 |
| BCVWD Well#3 | 502908 | 3755205 | 4 |
| BCVWD Well#4* | 503225 | 3760400 | 2 |
| BCVWD Well#5* | 503554 | 3760837 | 2 |
| BCVWD Well#6* | 503431 | 3763011 | 2 |
| BCVWD Well#10* | 504647 | 3765018 | 2 |
| BCVWD Well#11 | 504860 | 3765116 | 2 |
| BCVWD Well#12* | 504997 | 3765249 | 2 |
| BCVWD Well#14* | 504254 | 3764826 | 2 |
| BCVWD Well#16$^{\Delta}$ | 502913 | 3759077 | 3-1 |
| BCVWD Well#19* | 504717 | 3764974 | 2 |
| BCVWD Well#20* | 504666 | 3764986 | 2 |
| BCVWD Well#21* | 503293 | 3757563 | 3-1 |
| BCVWD Well#23* | 502490 | 3757737 | 3-2 |
| BCVWD Well#24 | 500221 | 3757665 | 3-2 |
| BCVWD Well#25 | 504151 | 3756122 | 4 |
| BCVWD Well#26* | 503441 | 3755078 | 4 |
| BCVWD Well#28 | 502885 | 3756095 | 4 |
| BCVWD Well#29 | 498512 | 3758423 | 3-2 |

**Table 2. Water quality criteria used during collection of well samples.**

| Field Measurement | Stability Criteria^ |
|---|---|
| pH | ± 0.3 standard units |
| Temperature (T) | ± 0.4°C (Thermistor thermometer) |
| Conductivity ($\mu S\ cm^{-1}$ at 25°C) | ± 1.0% for SC ≤ 100 $\mu S\ cm^{-1}$ |
| | ± 0.5% for SC > 100 $\mu S\ cm^{-1}$ |
| Dissolved Oxygen ($mg\ L^{-1}$) | ± 0.5 $mg\ L^{-1}$ |

^*Allowable variation between 3 or more sequential field measurement values*

**Table 3. Summary of general water quality and isotopic constituents measured in water samples collected in the Beaumont Management Zone.**

| Analyte | Well Samples | Creek Samples | SWP | Analytical Method |
|---|---|---|---|---|
| **pH, Acid Neutralizing Capacity.** | X | X | X | pH Electrode and Meter |
| **Specific Conductance** | X | X | X | Meter and K=1 $cm^{-1}$ cell |
| **Major Anions** (Cl, PO4, $NO_2$, $NO_3$, $SO_4$,) | X | X | X | EPA Method 300.1 |
| **Major Cations** (Ca, Mg, Na, K, B, Al, Fe) | X | X | X | EPA Method 200.7 |
| **Nutrients** ($NO_3$, total dissolved N, organic N, total dissolved phosphate), | X | X | X | NaOH-Persulfate digestion, EPA 353.2 |
| **Dissolved Organic Carbon** | X | X | X | EPA Method 9060A |
| **$\delta^{15}N$ and $\delta^{18}O$ of Nitrate** | X | X | X | USGS Method (RSIL Lab Code 2900) |

**Table 4. Pharmaceutical and personal care products used as septic waste indicators in groundwater and surface water samples in the Beaumont Management Zone.**

| Compound | Use | Compound | Use |
|---|---|---|---|
| Acetaminophen | Analgesic | Meprobamate | Human Tranquilizer |
| Atenolol | Beta Blocker | Naproxen | Non-steroidal Anti-inflammatory |
| Atorvastatin | Statin | Primidone | Anticonvulsant |
| Carbamazepine | Anti-epileptic | Sulfamethoxazole | Antibiotic |
| Diazepam | Barbiturate | Trimethoprim | Antibiotic |
| Diclofenac | Non-steroidal Anti-inflammatory | | |
| Dilantin | Anti-epileptic | | |
| ^Diuron | Herbicide | | |
| Fluoxetine | Anti-depressant | | |
| Gemfibrozil | Fibrate | | |
| Ibuprofen | Non-steroidal Anti-inflammatory | | |

^ *Diuron was measured, but was not used in computation of the PPCP contamination index*

**Table 5. Field measurements of physical and chemical characteristics of surface water and groundwater in the Beaumont Management Zone. ANC = acid neutralizing capacity; TDS = total dissolved solids and DOC = dissolved organic carbon. Samples marked with an * were re-sampled in July 2011 and the samples marked with an Δ had duplicate samples collected. NA – not available.**

| | | Sampling Date | Field Temp. | pH | Field Dissolved Oxygen | Specific Cond. | A.N.C. | Total Dissolved Solid | DOC |
|---|---|---|---|---|---|---|---|---|---|
| | | | °C | | mg/L | µS/cm | µeq/l | ppm | mg/l |
| SurfaceWater | Noble Cr@Noble Ave | 02/19/11 | 11.7 | 7.31 | 9.90 | 496 | 4041.66 | 332.32 | 4.97 |
| | Noble Cr@Noble Ave[Δ] | 02/19/11 | 11.7 | 7.45 | 9.90 | 492 | 4021.08 | 329.64 | 4.93 |
| | Drainage@Sundance | 02/19/11 | 15.0 | 7.49 | 9.30 | 368 | 2431.24 | 246.56 | 7.25 |
| | San Gorgonio Cr@HS | 02/19/11 | 12.8 | 7.82 | 9.40 | 530 | 4211.93 | 355.10 | 8.31 |
| | Riley Farm | 02/19/11 | 10.5 | 7.21 | 10.00 | 407 | 3497.59 | 272.69 | 2.25 |
| | Noble Cr below Powerline | 02/19/11 | 9.6 | 6.91 | 9.10 | 227 | 1622.98 | 152.36 | 4.41 |
| | San Timoteo Creek | 03/03/11 | 17.0 | 8.18 | 8.59 | 912 | 5941.82 | 611.04 | 3.15 |
| | Coopers Creek | 03/03/11 | 16.6 | 7.84 | 7.33 | 725 | 4070.26 | 485.75 | 3.91 |
| | Little San Gorgonio Creek | 03/03/11 | 13.2 | 7.31 | 4.20 | 366 | 1181.92 | 245.22 | 2.31 |
| | Stormwater recharge basin | 03/03/11 | 8.5 | 7.85 | 10.22 | 382 | 3172.66 | 255.94 | 1.62 |
| | BCVWD pond | 05/11/11 | 17.4 | 6.89 | 9.26 | 250 | 1008.92 | 167.57 | 3.09 |
| | BCVWD pond* | 07/19/11 | 24.2 | 7.17 | 7.45 | 241 | 924.90 | 161.47 | 3.07 |
| | San Gorgonio Pond | 05/11/11 | 17.9 | 6.86 | 7.77 | 253 | 1029.97 | 169.71 | 2.13 |
| | San Gorgonio Pond* | 07/19/11 | 24.2 | 7.22 | 6.80 | 238 | 909.90 | 159.53 | 2.16 |
| Ground water | 1002958 | 03/02/11 | 18.8 | 7.45 | 7.54 | 396 | 3321.29 | 265.32 | 0.07 |
| | 1003072 | 03/01/11 | 19.4 | 7.23 | 6.92 | 420 | 3248.26 | 281.40 | 0.07 |
| | 1004370 | 03/01/11 | 19.2 | 7.15 | 6.80 | 433 | 2500.72 | 290.11 | 0.22 |
| | 1006132 | 03/17/11 | 20.7 | 7.50 | 6.48 | 560 | 2924.85 | 375.20 | 0.20 |
| | 1007022 | 03/02/11 | 19.4 | 7.32 | 9.13 | 624 | 3444.29 | 418.08 | 0.33 |

| | | Sampling Date | Field Temp. | pH | Field Dissolved Oxygen | Specific Cond. | A.N.C. | Total Dissolved Solid | DOC |
|---|---|---|---|---|---|---|---|---|---|
| | | | °C | | mg/L | µS/cm | µeq/l | ppm | mg/l |
| Groundwater | 1007025 | 03/02/11 | 21.3 | 7.55 | 6.35 | 348 | 2936.56 | 233.16 | 0.08 |
| | 1201450 | 03/17/11 | 20.8 | 7.57 | 8.27 | 490 | 3528.61 | 328.30 | 0.16 |
| | 1201486 | 03/02/11 | 18.6 | 7.62 | 8.00 | 385 | 3213.34 | 257.95 | 0.07 |
| | 1201561 | 03/17/11 | 20.2 | 7.62 | 7.43 | 397 | 3296.29 | 265.99 | 0.07 |
| | 1206853 | 03/02/11 | 19.0 | 7.41 | 7.54 | 485 | 2873.70 | 324.95 | 0.14 |
| | 1206892 | 03/17/11 | 19.2 | 7.68 | 8.83 | 435 | 3036.81 | 291.45 | 0.13 |
| | 1206995 | 03/31/11 | NA | 7.83 | 10.63 | 335 | 2461.57 | 224.45 | 0.04 |
| | 1206996 | 03/31/11 | 19.5 | 7.43 | 7.98 | 362 | 2857.72 | 242.54 | 0.06 |
| | 1207012 | 03/17/11 | 20.1 | 7.03 | 3.63 | 965 | 5784.13 | 646.55 | 1.73 |
| | 1207769 | 03/02/11 | 21.1 | 7.56 | 6.60 | 333 | 2705.68 | 223.11 | 0.04 |
| | 1208432 | 03/03/11 | 19.1 | 7.40 | 1.41 | 1147 | 5329.29 | 768.49 | 0.82 |
| | 1208660 | 03/17/11 | 19.2 | 7.59 | 0.71 | 708 | 4114.09 | 474.36 | 0.32 |
| | 1208660* | 07/18/11 | 20.8 | 7.80 | 1.75 | 567 | 3261.02 | 379.89 | 0.19 |
| | 1208660*$^{\Delta}$ | 07/18/11 | 20.8 | 7.80 | 1.75 | 567 | 3261.02 | 379.89 | 0.19 |
| | 1220050 | 03/01/11 | 19.5 | 7.24 | 6.52 | 517 | 3764.77 | 346.39 | 0.19 |
| | 1221612 | 03/03/11 | 21.9 | 7.78 | 2.14 | 578 | 3706.83 | 387.26 | 0.20 |
| | 1222079 | 07/18/11 | 21.1 | 8.70 | 0.35 | 382 | 2181.28 | 255.94 | 0.09 |
| | 1222080 | 07/18/11 | 21.9 | 9.28 | 0.29 | 355 | 2030.25 | 237.85 | 0.08 |
| | BCVWD Well# 1 | 05/10/11 | 17.9 | 7.43 | 7.64 | 383 | 3214.27 | 256.61 | 0.06 |
| | BCVWD Well#1* | 07/19/11 | 20.6 | 7.60 | 10.17 | 352 | 3072.78 | 235.84 | 0.03 |
| | BCVWD Well # 3 | 05/10/11 | 18.3 | 7.50 | 7.08 | 361 | 2994.36 | 241.87 | 0.04 |
| | BCVWD Well # 4 | 05/10/11 | 15.2 | 7.33 | 5.92 | 579 | 3695.32 | 387.93 | 0.21 |
| | BCVWD Well#4* | 07/19/11 | 19.3 | 7.36 | 6.00 | 590 | 3756.86 | 395.30 | 0.20 |
| | BCVWD Well # 5 | 05/10/11 | 15.1 | 7.35 | 7.50 | 463 | 3165.51 | 310.21 | 0.22 |
| | BCVWD Well#5* | 07/19/11 | 18.1 | 7.45 | 8.32 | 460 | 3126.97 | 308.20 | 0.15 |

| | | Sampling Date | Field Temp. | pH | Field Dissolved Oxygen | Specific Cond. | A.N.C. | Total Dissolved Solid | DOC |
|---|---|---|---|---|---|---|---|---|---|
| | | | °C | | mg/L | µS/cm | µeq/l | ppm | mg/l |
| Groundwater | BCVWD Well # 6 | 05/10/11 | 14.0 | 7.30 | 7.63 | 456 | 3464.62 | 305.52 | 0.17 |
| | BCVWD Well#6* | 07/19/11 | 16.4 | 7.36 | 8.44 | 447 | 3412.56 | 299.49 | 0.14 |
| | BCVWD Well#10 | 05/10/11 | 13.1 | 7.14 | 7.20 | 424 | 3395.67 | 284.08 | 0.21 |
| | BCVWD Well#10* | 07/19/11 | 15.7 | 7.25 | 6.26 | 424 | 3298.76 | 284.08 | 0.20 |
| | BCVWD Well#11 | 05/11/11 | 13.5 | 7.28 | 8.22 | 454 | 3579.01 | 304.18 | 0.34 |
| | BCVWD Well#12 | 05/11/11 | 13.7 | 7.08 | 6.78 | 416 | 3193.09 | 278.72 | 0.39 |
| | BCVWD Well#12* | 07/19/11 | 14.3 | 7.11 | 7.31 | 408 | 3125.63 | 273.36 | 0.30 |
| | BCVWD Well#14 | 05/11/11 | 15.3 | 7.58 | 7.72 | 478 | 3782.09 | 320.26 | 0.25 |
| | BCVWD Well#14* | 07/19/11 | 16.6 | 7.59 | 8.20 | 477 | 3811.73 | 319.59 | 0.21 |
| | BCVWD Well#16 | 05/26/11 | 16.8 | 7.47 | 8.74 | 620 | 3578.01 | 415.40 | NA |
| | BCVWD Well#16[Δ] | 05/26/11 | 16.8 | 7.52 | 8.74 | 612 | 3484.38 | 410.04 | NA |
| | BCVWD Well#19 | 05/10/11 | 11.6 | 7.01 | 6.00 | 462 | 3687.87 | 309.54 | 0.51 |
| | BCVWD Well#19* | 07/19/11 | 17.5 | 7.22 | 6.82 | 439 | 3541.88 | 294.13 | 0.35 |
| | BCVWD Well#20 | 05/10/11 | 12.8 | 7.07 | 6.72 | 451 | 3608.32 | 302.17 | 0.28 |
| | BCVWD Well#20* | 07/19/11 | 15.7 | 7.25 | 8.25 | 440 | 3454.11 | 294.80 | 0.19 |
| | BCVWD Well#21 | 05/11/11 | 18.1 | 7.36 | 9.13 | 475 | 2692.43 | 318.25 | 0.13 |
| | BCVWD Well#21* | 07/19/11 | NA | 7.61 | 9.02 | 480 | 3139.85 | 321.60 | 0.07 |
| | BCVWD Well#23 | 05/11/11 | 16.5 | 7.51 | 8.86 | 458 | 3526.00 | 306.86 | 0.20 |
| | BCVWD Well#23* | 07/19/11 | 19.2 | 7.74 | 8.96 | 429 | 3449.38 | 287.43 | 0.05 |
| | BCVWD Well#24 | 05/11/11 | 17.0 | 7.49 | 8.53 | 365 | 2971.99 | 244.55 | 0.09 |
| | BCVWD Well#25 | 05/11/11 | 17.3 | 7.55 | 8.40 | 402 | 3254.46 | 269.34 | 0.04 |
| | BCVWD Well#26 | 05/10/11 | 19.6 | 7.54 | 7.08 | 348 | 2813.89 | 233.16 | 0.06 |
| | BCVWD Well#26* | 07/19/11 | NA | 7.78 | 8.06 | 346 | 2810.48 | 231.82 | 0.06 |
| | BCVWD Well#28 | 05/11/11 | 16.5 | 7.47 | 9.40 | 408 | 3421.64 | 273.36 | 0.04 |
| | BCVWD Well#29 | 05/11/11 | 17.3 | 7.58 | 8.80 | 396 | 3130.64 | 265.32 | 0.08 |

**Table 6. Major and trace ion concentrations for surface water and groundwater in the Beaumont Management Zone Samples marked with an * were re-sampled in July 2011 and the samples marked with an Δ had duplicate samples collected. Charge balance error = (Σ positive charge – Σ negative charge) / Σ positive charge * 100%**

| | | $NO_3$-N | $HCO_3$ | $SO_4$ | Cl | F | $PO_4$ | $NO_3$ | Ca | Mg | Na | K | Al | B | Fe | P | Charge Balance Error |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mg/L | | | | | | | mg/L | | | | | | | | % |
| SurfaceWater | Noble Cr@Noble Ave | 0.70 | 246.0 | 47.50 | 13.43 | 0.64 | 0.09 | 3.11 | 49.19 | 22.90 | 21.77 | 1.89 | 0.000 | 0.012 | 0.001 | 0.05 | -1.3 |
| | Noble Cr@Noble Ave[Δ] | 0.70 | 244.6 | 47.50 | 13.41 | 0.64 | 0.08 | 3.11 | 49.22 | 22.82 | 21.32 | 1.86 | 0.000 | 0.012 | 0.001 | 0.04 | -1.3 |
| | Drainage@Sundance | 1.23 | 147.8 | 48.01 | 15.45 | 0.26 | 0.95 | 5.47 | 36.23 | 11.03 | 20.38 | 3.77 | 0.000 | 0.024 | 0.013 | 0.35 | -3.0 |
| | San Gorgonio Cr@HS | 1.06 | 255.2 | 57.38 | 15.40 | 0.62 | 0.31 | 4.68 | 53.11 | 23.13 | 26.85 | 3.82 | 0.000 | 0.020 | 0.000 | 0.09 | -0.7 |
| | Riley Farm | 1.31 | 213.0 | 37.25 | 4.48 | 0.59 | 0.02 | 5.80 | 46.55 | 16.84 | 10.42 | 2.83 | 0.000 | 0.009 | 0.000 | 0.01 | -3.2 |
| | Noble Cr below Powerline | 1.03 | 98.9 | 19.84 | 6.99 | 0.10 | 0.68 | 4.57 | 25.31 | 6.36 | 9.29 | 2.46 | 0.000 | 0.018 | 0.002 | 0.24 | -0.8 |
| | San Timoteo Creek | 1.08 | 357.0 | 88.64 | 80.44 | 0.49 | 1.16 | 4.77 | 69.16 | 19.52 | 87.94 | 6.24 | 0.004 | 0.172 | 0.000 | 0.42 | -4.9 |
| | Coopers Creek | 0.92 | 246.6 | 65.99 | 64.63 | 0.38 | 2.50 | 4.05 | 43.17 | 13.24 | 70.74 | 13.10 | 0.004 | 0.182 | 0.007 | 0.93 | -3.9 |
| | Little San Gorgonio Creek | 1.26 | 71.9 | 47.16 | 47.34 | 0.04 | 0.26 | 5.59 | 18.91 | 8.49 | 33.51 | 2.55 | 0.000 | 0.098 | 0.002 | 0.10 | -5.7 |
| | Stormwater recharge basin | 1.50 | 192.1 | 38.89 | 4.06 | 0.47 | 0.02 | 6.65 | 42.80 | 15.09 | 9.77 | 2.06 | 0.000 | 0.008 | 0.000 | 0.02 | -4.3 |
| | BCVWD pond | 0.32 | 61.5 | 24.26 | 23.32 | 0.08 | 0.17 | 1.44 | 14.24 | 6.32 | 19.45 | 1.83 | 0.001 | 0.104 | 0.000 | 0.07 | -0.9 |
| | BCVWD pond* | 0.32 | 56.3 | 18.47 | 21.77 | 0.07 | 0.15 | 1.42 | 14.14 | 5.88 | 21.76 | 1.54 | 0.006 | 0.092 | 0.006 | 0.08 | 6.3 |
| | San Gorgonio Pond | 0.32 | 62.8 | 24.05 | 23.15 | 0.07 | 0.19 | 1.43 | 14.14 | 6.28 | 21.55 | 1.82 | 0.006 | 0.104 | 0.004 | 0.07 | 0.7 |
| | San Gorgonio Pond* | 0.32 | 55.4 | 18.25 | 21.50 | 0.07 | 0.00 | 1.42 | 14.31 | 5.91 | 21.81 | 1.60 | 0.008 | 0.090 | 0.008 | 0.08 | 7.4 |
| Groundwater | 1002958 | 1.31 | 202.0 | 23.16 | 6.75 | 0.45 | 0.61 | 5.80 | 39.93 | 14.66 | 18.01 | 1.96 | 0.000 | 0.007 | 0.000 | 0.23 | -0.6 |
| | 1003072 | 2.05 | 197.8 | 24.48 | 13.24 | 0.36 | 0.03 | 9.07 | 44.89 | 15.15 | 17.81 | 1.43 | 0.000 | 0.006 | 0.000 | 0.02 | 0.2 |
| | 1004370 | 11.10 | 152.3 | 22.28 | 16.51 | 0.38 | 0.11 | 49.15 | 48.44 | 8.46 | 23.50 | 1.50 | 0.000 | 0.010 | 0.000 | 0.05 | -0.7 |
| | 1006132 | 15.86 | 177.8 | 24.66 | 30.86 | 0.68 | 0.03 | 70.23 | 51.16 | 16.27 | 31.18 | 3.31 | 0.000 | 0.012 | 0.003 | 0.01 | -1.2 |
| | 1007022 | 11.52 | 209.7 | 70.67 | 32.28 | 0.54 | 0.29 | 51.02 | 51.00 | 25.77 | 32.13 | 0.92 | 0.000 | 0.028 | 0.000 | 0.10 | -4.4 |
| | 1007025 | 1.38 | 178.5 | 16.53 | 7.82 | 0.31 | 0.04 | 6.13 | 32.36 | 8.79 | 24.25 | 1.53 | 0.000 | 0.010 | 0.000 | 0.03 | -2.4 |
| | 1201450 | 2.17 | 214.4 | 52.92 | 20.86 | 0.57 | 0.13 | 9.61 | 45.43 | 17.39 | 28.10 | 1.24 | 0.000 | 0.018 | 0.000 | 0.04 | -4.1 |
| | 1201486 | 1.69 | 195.2 | 21.34 | 7.36 | 0.36 | 0.00 | 7.48 | 35.71 | 14.89 | 20.46 | 1.46 | 0.000 | 0.006 | 0.000 | 0.03 | -0.6 |
| | 1201561 | 1.71 | 200.2 | 25.30 | 8.88 | 0.25 | 0.04 | 7.59 | 43.90 | 11.77 | 21.34 | 1.76 | 0.000 | 0.007 | 0.000 | 0.01 | -0.7 |
| | 1206853 | 8.71 | 174.8 | 34.09 | 23.16 | 0.67 | 0.06 | 38.59 | 42.90 | 16.54 | 26.07 | 1.38 | 0.000 | 0.013 | 0.000 | 0.04 | -2.1 |
| | 1206892 | 3.99 | 184.4 | 9.26 | 25.25 | 0.62 | 0.07 | 17.65 | 37.78 | 10.80 | 33.11 | 1.88 | 0.000 | 0.015 | 0.000 | 0.02 | 0.3 |
| | 1206995 | 1.44 | 149.1 | 12.96 | 15.09 | 0.66 | 0.06 | 6.37 | 13.57 | 4.56 | 47.90 | 1.19 | 0.006 | 0.020 | 0.000 | 0.02 | -1.6 |
| | 1206996 | 1.87 | 173.8 | 17.41 | 10.27 | 0.53 | 0.10 | 8.29 | 28.31 | 12.57 | 25.18 | 1.34 | 0.000 | 0.010 | 0.000 | 0.03 | -1.1 |
| | 1207012 | 21.31 | 352.4 | 61.48 | 51.37 | 0.35 | 0.03 | 94.37 | 65.77 | 35.32 | 74.44 | 0.55 | 0.000 | 0.071 | 0.000 | 0.01 | -3.0 |
| | 1207769 | 1.46 | 164.4 | 11.74 | 9.54 | 0.42 | 0.06 | 6.48 | 31.06 | 8.52 | 23.28 | 1.61 | 0.000 | 0.010 | 0.000 | 0.03 | -0.3 |
| | 1208432 | 10.79 | 324.3 | 73.14 | 146.71 | 0.42 | 0.26 | 47.80 | 89.59 | 31.97 | 84.69 | 3.73 | 0.000 | 0.189 | 0.000 | 0.11 | -3.6 |
| | 1208660 | 2.43 | 250.0 | 78.67 | 57.63 | 0.42 | 0.01 | 10.77 | 59.92 | 16.13 | 60.35 | 1.78 | 0.000 | 0.113 | 0.008 | 0.01 | -3.7 |
| | 1208660* | 1.61 | 197.7 | 25.79 | 47.59 | 0.42 | 0.00 | 7.12 | 35.78 | 9.57 | 68.43 | 1.53 | 0.000 | 0.088 | 0.000 | 0.00 | 3.2 |
| | 1208660*[Δ] | 1.59 | 197.7 | 25.42 | 47.06 | 0.42 | 0.00 | 7.04 | 35.91 | 9.75 | 67.86 | 1.46 | 0.001 | 0.089 | 0.003 | 0.00 | 3.4 |
| | 1220050 | 5.20 | 229.2 | 20.74 | 22.51 | 0.42 | 0.04 | 23.01 | 58.79 | 13.97 | 24.44 | 2.16 | 0.000 | 0.016 | 0.000 | 0.02 | -0.1 |
| | 1221612 | 6.09 | 224.7 | 42.05 | 30.35 | 0.42 | 0.01 | 26.95 | 34.17 | 14.88 | 60.94 | 3.82 | 0.000 | 0.029 | 0.000 | 0.01 | -1.6 |
| | 1222079 | 1.03 | 126.6 | 17.81 | 22.42 | 0.42 | 0.00 | 4.55 | 5.35 | 0.48 | 77.74 | 0.77 | 0.050 | 0.061 | 0.034 | 0.02 | 6.0 |
| | 1222080 | 0.99 | 103.4 | 17.26 | 18.83 | 0.42 | 0.00 | 4.38 | 1.81 | 0.09 | 76.31 | 0.70 | 0.039 | 0.040 | 0.009 | 0.01 | 11.2 |
| | BCVWD Well# 1 | 1.11 | 195.5 | 9.49 | 9.78 | 0.42 | 0.06 | 4.93 | 39.10 | 12.92 | 19.76 | 1.49 | 0.000 | 0.007 | 0.000 | 0.03 | 1.9 |
| | BCVWD Well#1* | 0.60 | 186.7 | 10.44 | 6.23 | 0.42 | 0.00 | 2.66 | 36.81 | 10.95 | 22.42 | 1.53 | 0.000 | 0.009 | 0.001 | 0.00 | 3.4 |
| | BCVWD Well # 3 | 1.04 | 182.1 | 11.37 | 9.16 | 0.42 | 0.07 | 4.59 | 36.39 | 8.96 | 24.42 | 1.57 | 0.000 | 0.009 | 0.000 | 0.02 | 1.3 |

| | | $NO_3$-N | $HCO_3$ | $SO_4$ | Cl | F | $PO_4$ | $NO_3$ | Ca | Mg | Na | K | Al | B | Fe | P | Charge Balance Error |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | mg/L | | | | | | | % |
| Groundwater | BCVWD Well # 4 | 2.10 | 224.9 | 49.12 | 26.20 | 0.47 | 0.04 | 9.29 | 61.93 | 20.24 | 22.99 | 1.58 | 0.000 | 0.010 | 0.000 | 0.01 | -6.8 |
| | BCVWD Well#4* | 2.06 | 228.6 | 46.19 | 24.29 | 0.37 | 0.00 | 9.13 | 64.82 | 21.30 | 21.81 | 1.79 | 0.000 | 0.011 | 0.001 | 0.00 | 3.7 |
| | BCVWD Well # 5 | 2.86 | 192.7 | 33.75 | 13.37 | 0.47 | 0.03 | 12.66 | 51.09 | 15.81 | 18.13 | 1.49 | 0.000 | 0.009 | 0.000 | 0.01 | 2.4 |
| | BCVWD Well#5* | 2.46 | 190.2 | 29.52 | 12.09 | 0.39 | 0.00 | 10.91 | 50.40 | 15.94 | 19.36 | 1.71 | 0.000 | 0.011 | 0.000 | 0.00 | 13.0 |
| | BCVWD Well # 6 | 2.81 | 210.9 | 24.55 | 8.13 | 0.36 | 0.03 | 12.44 | 49.89 | 16.18 | 16.67 | 1.15 | 0.000 | 0.008 | 0.000 | 0.01 | 1.8 |
| | BCVWD Well#6* | 2.41 | 207.7 | 22.54 | 6.45 | 0.30 | 0.00 | 10.66 | 49.37 | 16.38 | 18.77 | 1.47 | 0.000 | 0.009 | 0.000 | 0.00 | 5.0 |
| | BCVWD Well#10 | 1.59 | 206.8 | 24.41 | 5.48 | 0.33 | 0.02 | 7.03 | 47.58 | 15.41 | 12.35 | 1.64 | 0.000 | 0.008 | 0.001 | 0.00 | 0.5 |
| | BCVWD Well#10* | 2.07 | 200.9 | 19.79 | 4.94 | 0.32 | 0.00 | 9.16 | 48.64 | 16.12 | 13.89 | 1.74 | 0.000 | 0.010 | 0.001 | 0.00 | 4.9 |
| | BCVWD Well#11 | 2.43 | 217.9 | 25.22 | 5.65 | 0.41 | 0.04 | 10.76 | 51.02 | 17.01 | 12.05 | 2.06 | 0.000 | 0.008 | 0.000 | 0.00 | 0.9 |
| | BCVWD Well#12 | 2.48 | 194.5 | 25.16 | 5.06 | 0.41 | 0.07 | 11.00 | 46.50 | 15.20 | 11.62 | 1.73 | 0.000 | 0.007 | 0.000 | 0.01 | 0.9 |
| | BCVWD Well#12* | 1.67 | 190.4 | 22.97 | 3.95 | 0.34 | 0.00 | 7.41 | 46.05 | 15.42 | 12.92 | 1.93 | 0.000 | 0.008 | 0.001 | 0.00 | 4.4 |
| | BCVWD Well#14 | 1.71 | 229.8 | 30.28 | 5.25 | 0.34 | 0.00 | 7.59 | 55.37 | 16.55 | 16.76 | 1.09 | 0.000 | 0.008 | 0.000 | 0.00 | 2.1 |
| | BCVWD Well#14* | 1.56 | 231.6 | 26.79 | 4.25 | 0.27 | 0.00 | 6.90 | 55.89 | 17.23 | 18.53 | 1.38 | 0.000 | 0.010 | 0.001 | 0.00 | 4.7 |
| | BCVWD Well#16 | 5.71 | 217.6 | 60.03 | 21.10 | 0.76 | 0.08 | 25.30 | 54.78 | 20.25 | 35.92 | 1.32 | 0.000 | 0.023 | 0.000 | 0.04 | 1.3 |
| | BCVWD Well#16[Δ] | 5.70 | 211.8 | 60.09 | 21.02 | 0.76 | 0.10 | 25.24 | 54.59 | 20.31 | 35.29 | 1.29 | 0.000 | 0.023 | 0.000 | 0.04 | 1.8 |
| | BCVWD Well#19 | 2.35 | 224.7 | 27.96 | 5.66 | 0.43 | 0.04 | 10.41 | 52.63 | 17.92 | 11.59 | 2.03 | 0.000 | 0.008 | 0.000 | 0.01 | 0.5 |
| | BCVWD Well#19* | 1.15 | 215.7 | 22.00 | 4.15 | 0.37 | 0.00 | 5.08 | 50.70 | 17.59 | 11.74 | 2.43 | 0.000 | 0.010 | 0.000 | 0.00 | 3.9 |
| | BCVWD Well#20 | 2.21 | 219.8 | 25.61 | 5.51 | 0.39 | 0.03 | 9.79 | 52.50 | 17.36 | 11.40 | 1.77 | 0.000 | 0.009 | 0.000 | 0.00 | 1.4 |
| | BCVWD Well#20* | 1.82 | 210.3 | 23.03 | 4.62 | 0.32 | 0.00 | 8.07 | 51.69 | 17.67 | 12.74 | 1.93 | 0.000 | 0.010 | 0.005 | 0.00 | 4.9 |
| | BCVWD Well#21 | 8.65 | 163.9 | 30.97 | 16.38 | 0.72 | 0.07 | 38.32 | 44.54 | 15.03 | 24.58 | 1.43 | 0.000 | 0.016 | 0.000 | 0.02 | 1.4 |
| | BCVWD Well#21* | 4.46 | 190.7 | 28.04 | 13.60 | 0.47 | 0.00 | 19.77 | 47.30 | 17.27 | 25.63 | 1.70 | 0.005 | 0.019 | 0.007 | 0.01 | 5.5 |
| | BCVWD Well#23 | 1.12 | 214.4 | 11.08 | 9.89 | 0.38 | 0.14 | 4.97 | 39.51 | 16.77 | 17.44 | 1.28 | 0.000 | 0.006 | 0.000 | 0.03 | 0.3 |
| | BCVWD Well#23* | 1.68 | 209.2 | 15.99 | 8.02 | 0.31 | 0.00 | 7.46 | 45.17 | 14.27 | 23.32 | 1.73 | 0.000 | 0.011 | 0.000 | 0.01 | 4.3 |
| | BCVWD Well#24 | 2.64 | 180.7 | 20.28 | 12.43 | 0.41 | 0.14 | 11.68 | 48.56 | 17.09 | 18.85 | 1.41 | 0.000 | 0.009 | 0.000 | 0.03 | 8.6 |
| | BCVWD Well#25 | 1.48 | 197.8 | 11.32 | 6.58 | 0.42 | 0.08 | 6.55 | 38.17 | 12.28 | 17.97 | 1.39 | 0.000 | 0.007 | 0.000 | 0.03 | -0.7 |
| | BCVWD Well#26 | 1.01 | 171.0 | 12.71 | 9.17 | 0.26 | 0.09 | 4.49 | 42.20 | 13.11 | 21.35 | 1.54 | 0.000 | 0.009 | 0.000 | 0.03 | 9.9 |
| | BCVWD Well#26* | 0.90 | 170.4 | 8.56 | 7.79 | 0.28 | 0.00 | 4.00 | 32.43 | 9.27 | 26.09 | 1.74 | 0.000 | 0.009 | 0.000 | 0.01 | 4.4 |
| | BCVWD Well#28 | 1.09 | 208.1 | 9.87 | 9.05 | 0.31 | 0.07 | 4.82 | 32.77 | 9.38 | 24.68 | 1.51 | 0.000 | 0.010 | 0.000 | 0.03 | -5.9 |
| | BCVWD Well#29 | 1.80 | 190.2 | 11.68 | 12.86 | 0.34 | 0.08 | 7.98 | 41.20 | 14.21 | 16.84 | 1.56 | 0.000 | 0.008 | 0.000 | 0.03 | 1.7 |

**Table 7. Oxygen and nitrogen isotopes of nitrate (units are per mil: ‰), their ratio and PPCP indexof surface water and groundwater in Beaumont Management Zone. Samples marked with an * were re-sampled in July 2011 and the samples marked with an Δ had duplicate samples collected.**

| Surfacewater | $\delta^{18}O\text{-}NO_3$ ‰ | $\delta^{15}N\text{-}NO_3$ ‰ | $\delta^{18}O/\delta^{15}N$ | PPCP Index |
|---|---|---|---|---|
| Noble Cr @Noble Ave | 1.90 | -0.46 | -4.17 | 1.3 |
| Noble Cr @Noble Ave^Δ | 1.75 | -0.70 | -2.52 | 1.2 |
| Drainage @Sundance | 10.41 | 6.92 | 1.50 | 4.6 |
| San Gorgonio Cr@HS | 9.62 | -0.26 | -37.63 | 2.9 |
| Riley Farm | 1.22 | 5.76 | 0.21 | 0.0 |
| Noble Cr below Powerline | 2.50 | 6.03 | 0.41 | 1.1 |
| San Timoteo Creek | 4.34 | 15.60 | 0.28 | 10.9 |
| Coopers Creek | -3.88 | 5.38 | -0.72 | 11.9 |
| Little San Gorgonio Creek | -3.30 | 9.36 | -0.35 | 0.0 |
| Stormwater recharge basin | 2.30 | 6.31 | 0.36 | 0.0 |
| BCVWD pond | 0.21 | 0.15 | 1.36 | - |
| BCVWD pond* | -1.49 | 8.39 | -0.18 | - |
| San Gorgonio Pond | -3.00 | 8.96 | -0.33 | 5.3 |
| San Gorgonio Pond* | -3.18 | 8.81 | -0.36 | 5.3 |

| Groundwater | $\delta^{18}O\text{-}NO_3$ ‰ | $\delta^{15}N\text{-}NO_3$ ‰ | $\delta^{18}O/\delta^{15}N$ | PPCP Index |
|---|---|---|---|---|
| 1002958 | -0.21 | 2.45 | -0.09 | 0.0 |
| 1003072 | 0.52 | 3.36 | 0.15 | 0.0 |
| 1004370 | 3.89 | 9.87 | 0.39 | 1.1 |
| 1006132 | 5.05 | 8.72 | 0.58 | 0.0 |
| 1007022 | 3.58 | 5.86 | 0.61 | 6.7 |
| 1007025 | -0.12 | 2.31 | -0.05 | 0.0 |
| 1201450 | 1.33 | 3.85 | 0.35 | 2.1 |
| 1201486 | -0.60 | 2.02 | -0.30 | 0.0 |
| 1201561 | 0.17 | 2.27 | 0.08 | 0.0 |
| 1206853 | 1.26 | 7.17 | 0.18 | 3.6 |
| 1206892 | 2.32 | 5.16 | 0.45 | 3.0 |
| 1206995 | 1.79 | 3.31 | 0.54 | -0.1 |
| 1206996 | -0.56 | 2.68 | -0.21 | 2.4 |
| 1207012 | 3.05 | 2.44 | 1.25 | 0.0 |
| 1207769 | -0.05 | 2.56 | -0.02 | 0.0 |
| 1208432 | 5.36 | 11.84 | 0.45 | 9.1 |
| 1208660 | 9.43 | 21.08 | 0.45 | 9.1 |
| 1208660* | 8.27 | 20.19 | 0.41 | 8.1 |
| 1208660*^Δ | 8.76 | 20.49 | 0.43 | 8.1 |
| 1220050 | 3.35 | 7.39 | 0.45 | 0.0 |
| 1221612 | 4.44 | 9.52 | 0.47 | 7.5 |
| 1222079 | 5.77 | 10.43 | 0.55 | 4.5 |
| 1222080 | 5.67 | 13.39 | 0.42 | 4.8 |
| BCVWD Well# 1 | -0.48 | 2.61 | -0.19 | - |
| BCVWD Well#1* | -0.60 | 2.14 | -0.28 | 0.0 |
| BCVWD Well # 3 | -0.37 | 3.28 | -0.11 | 0.0 |
| BCVWD Well # 4 | 3.42 | 2.90 | 1.18 | - |
| BCVWD Well#4* | 3.21 | 3.39 | 0.95 | 4.7 |
| BCVWD Well # 5 | 2.84 | 3.40 | 0.84 | - |
| BCVWD Well#5* | 2.74 | 3.03 | 0.91 | 0.0 |
| BCVWD Well # 6 | 2.70 | 2.79 | 0.97 | - |
| BCVWD Well#6* | 3.16 | 2.59 | 1.22 | 4.1 |
| BCVWD Well#10 | 1.58 | 4.48 | 0.35 | - |
| BCVWD Well#10* | 2.56 | 3.08 | 0.83 | 0.0 |
| BCVWD Well#11 | 1.88 | 4.29 | 0.44 | 0.0 |
| BCVWD Well#12 | 2.23 | 3.12 | 0.71 | - |
| BCVWD Well#12* | 2.04 | 3.78 | 0.54 | 1.7 |
| BCVWD Well#14 | 1.75 | 2.98 | 0.59 | - |
| BCVWD Well#14* | 1.61 | 3.26 | 0.49 | -0.4 |
| BCVWD Well#16 | 3.42 | 5.20 | 0.66 | 3.4 |
| BCVWD Well#16^Δ | 3.16 | 5.12 | 0.62 | 3.3 |
| BCVWD Well#19 | 1.91 | 4.16 | 0.46 | - |
| BCVWD Well#19* | 2.20 | 4.21 | 0.52 | 0.2 |
| BCVWD Well#20 | 1.34 | 3.78 | 0.35 | - |
| BCVWD Well#20* | 1.62 | 3.79 | 0.43 | 0.8 |
| BCVWD Well#21 | 1.78 | 6.84 | 0.26 | - |
| BCVWD Well#21* | 1.77 | 5.79 | 0.31 | 3.5 |
| BCVWD Well#23 | -0.85 | 2.29 | -0.37 | - |
| BCVWD Well#23* | 0.84 | 3.57 | 0.24 | 1.9 |
| BCVWD Well#24 | 1.04 | 3.97 | 0.26 | 0.0 |
| BCVWD Well#25 | -0.05 | 2.31 | -0.02 | 0.0 |
| BCVWD Well#26 | -0.20 | 2.48 | -0.08 | - |
| BCVWD Well#26* | -0.49 | 2.34 | -0.21 | 4.5 |
| BCVWD Well#28 | -0.53 | 2.50 | -0.21 | 0.0 |
| BCVWD Well#29 | 0.86 | 3.08 | 0.28 | 0.0 |

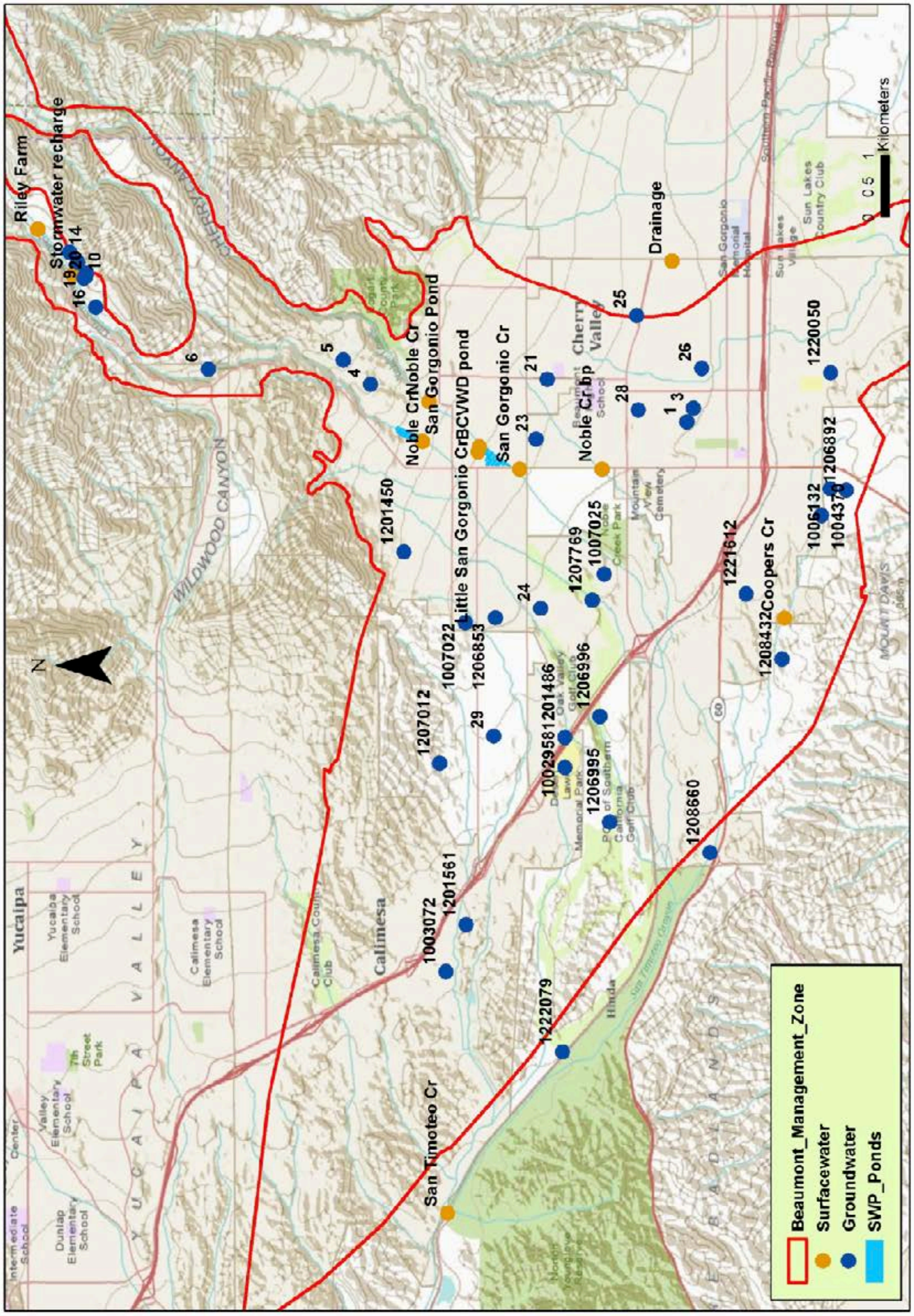
**Table 8. PPCP detections in groundwater, surface water and SWP recharge water, including concentration range, average quantifiable concentration and percentage of total detected compounds. LOQ – limit of quantitation.**

| | Concentration Range (ng/L) | | | Avg.Quantifiable Concentration (ng/L) | | | Groundwater | Surface Water | Recharge Water | Total Detects |
|---|---|---|---|---|---|---|---|---|---|---|
| | Groundwater | Surface Water | Recharge Water | Groundwater | Surface Water | Recharge Water | n = 40 | n = 9 | n = 2 | n = 51 |
| **Acetaminophen** | 13.9 | ND | ND | ND | ND | ND | 3% | ND | ND | 2% |
| **Primidone** | <LOQ - 8.5 | 5.5 - 9.4 | ND | 2.3 (n=7) | 7.5 (n=2) | ND | 20% | 22% | ND | 20% |
| **Meprobamate** | <LOQ -10.3 | 72.4 - 213.7 | 2.6 - 2.8 | 6.8 (n=2) | 143.0 (n=2) | 2.7 (n=2) | 8% | 22% | 100% | 14% |
| **Diuron** | <LOQ -359.3 | <LOQ - 1061.3 | 50.7 - 52.3 | 23.5 (n=18) | 354.2 (n=6) | 51.5 (n=2) | 55% | 89% | 100% | 63% |
| **Carbamazepine** | <LOQ -304.0 | <LOQ -545.5 | 1.8 | 81.6 (n=6) | 445.1 (n=2) | 1.8 (n=2) | 23% | 33% | 100% | 27% |
| **Dilantin** | <LOQ - 1.3 | 4.7 - 12.4 | ND | 0.7 (n=4) | 8.5 (n=2) | ND | 18% | 22% | ND | 18% |
| **Sulfamethoxazole** | <LOQ - 40.5 | <LOQ - 495.9 | 5.4 - 5.6 | 7.8 (n=17) | 401.2 (n=2) | 5.5 (n=2) | 50% | 33% | 100% | 49% |
| **Atenolol** | ND | 26.4 - 69.6 | ND | ND | 48.0 (n=2) | ND | ND | 22% | ND | 4% |
| **Diazepam** | <LOQ | <LOQ - 1.1 | ND | ND | ND | ND | 8% | 22% | ND | 10% |
| **Trimethoprim** | ND | 0.5 - 93.7 | ND | ND | 15.4 (n=7) | ND | ND | 78% | ND | 14% |
| **Fluoxetine** | <LOQ - 0.1 | <LOQ | ND | ND | ND | ND | 5% | 11% | ND | 6% |
| **Atorvastatin** | <LOQ - 0.8 | 3.3 | ND | 0.3 (n=4) | ND | ND | 23% | 11% | ND | 20% |
| **Ibuprofen** | <LOQ | ND | ND | ND | ND | ND | 3% | ND | ND | 2% |
| **Naproxen** | ND | <LOQ | ND | ND | ND | ND | ND | 11% | ND | 2% |
| **Diclofenac** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| **Gemfibrozil** | <LOQ - 0.1 | <LOQ - 924.8 | ND | ND | 269.3 (n=4) | ND | 18% | 67% | ND | 25% |

Table 9. Annual mass balance of nitrate – nitrogen for groundwater in the Beaumont Management Zone. The groundwater storage and recharge volumes are from Wildermuth Environmental. Nitrate-nitrogen concentrations used in the computations are based on our current study except for the nitrate value for septic waste which is from Wildermuth Environmental and the nitrate value for wastewater treatment plant effluent which is from the State Water Resources Control Board. The nitrate concentration for total groundwater storage is the average of all wells sampled during our study, including duplicates. Nitrate concentrations for the State Water Project are the average of four measurements made at the BCVWD recharge basins during our study. The natural surface nitrate value is the average nitrate concentration in all surface water samples collected during our study. The nitrate concentration for mountain-front groundwater was computed as the average nitrate value for all Zone 2 wells. The nitrate concentration for well pumpage is the average of nitrate values measured in large-volume wells operated by the BCVWD throughout the entire BMZ. Denitrification was estimated based on the relative reduction of nitrate (90.6%) observed along the flowpath in Zone 1 and the average concentration of nitrate in effluent from the City of Beaumont Wastewater Treatment Plant (6 mg/L; Dr. Cindy Li personal communication). Negative signs indicate that BMZ aquifer is losing either water or nitrate-nitrogen.

| | Beaumont MZ | | |
|---|---|---|---|
| | **Volume AF** | **$NO_3$-N mg/L** | **N Pool or Flux kg** |
| **Total Groundwater Storage** | 189,482 | 3.49 | 815,704 |
| **Mountain-front Groundwater** | 4,023 | 2.10 | 10,421 |
| **State Water Project** | 8,000 | 0.32 | 3,158 |
| **Septic Waste** | 341 | 35 | 14,722 |
| **Natural Surface Water** | 3,900 | 1.08 | 5,196 |
| **Wastewater Treatment Plant Effluent** | 2,016 | 6.00 | 14,920 |
| **Pumpage** | -18,219 | 2.11 | -47,418 |
| **Denitrification** | | | -13,518 |
| **Gain or Loss** | 61 | -0.05 | -12,520 |

# Sampling locations, Beaumont Management Zone




**44**

Figure 1. Sampling locations within and adjacent to the Beaumont Management Zone, with sample ID labeled. Surface water – yellow; groundwater – blue.

## Groundwater Zones, Beaumont Management Zone

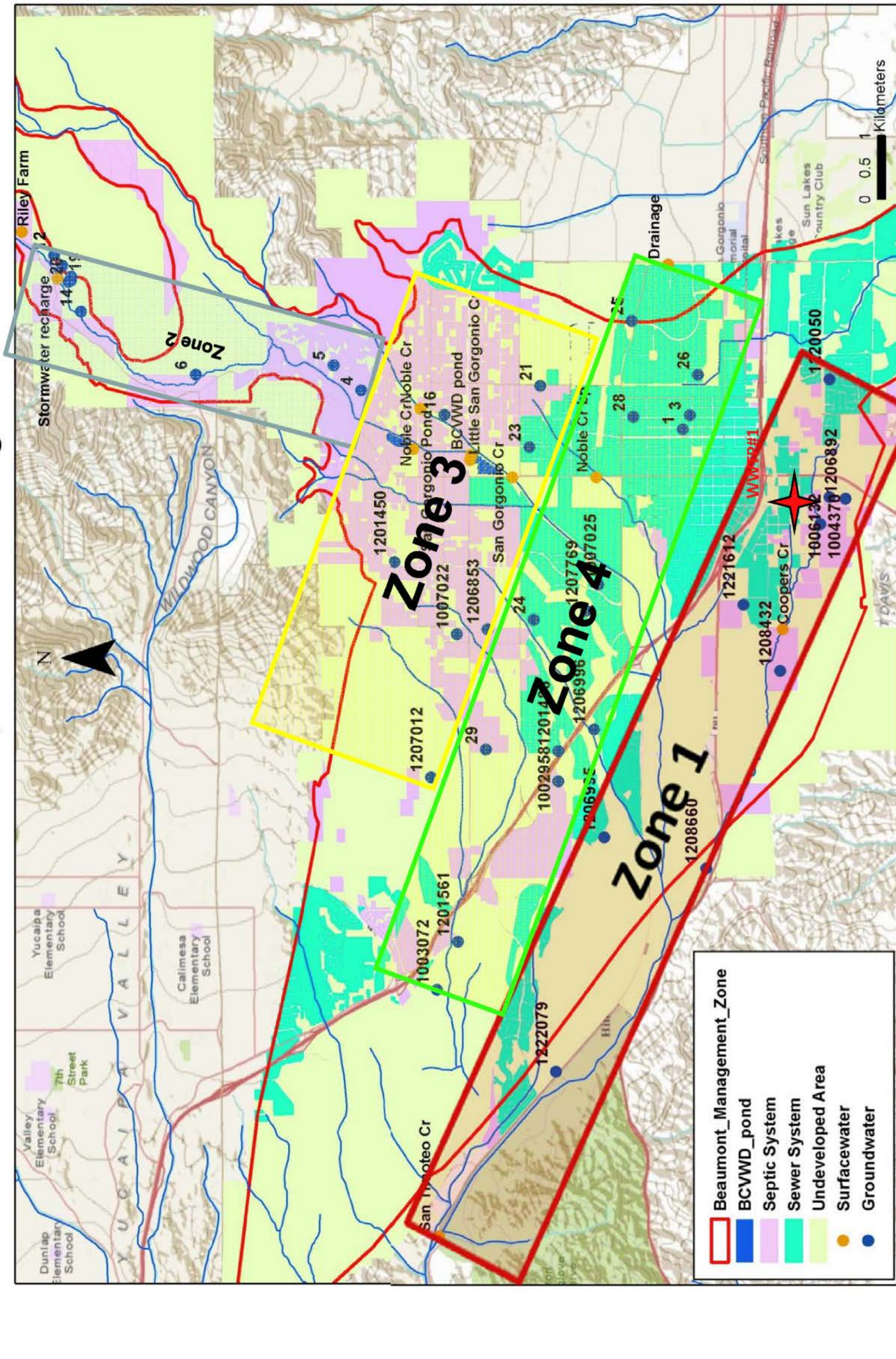



Figure 2. Delineation of groundwater zones within and adjacent to the Beaumont Management Zone. Zone 1 – Area affected by infiltration of wastewater treatment plant effluent; Zone 2 – Percolation of mountain-front flow; Zone 3 – Area with high concentration of on-site waste disposal systems; Zone 4 – Area with sewer service. WWTP #1 – City of Beaumont waste water treatment plant #1.

45

## Water Temperature, Beaumont Management Zone

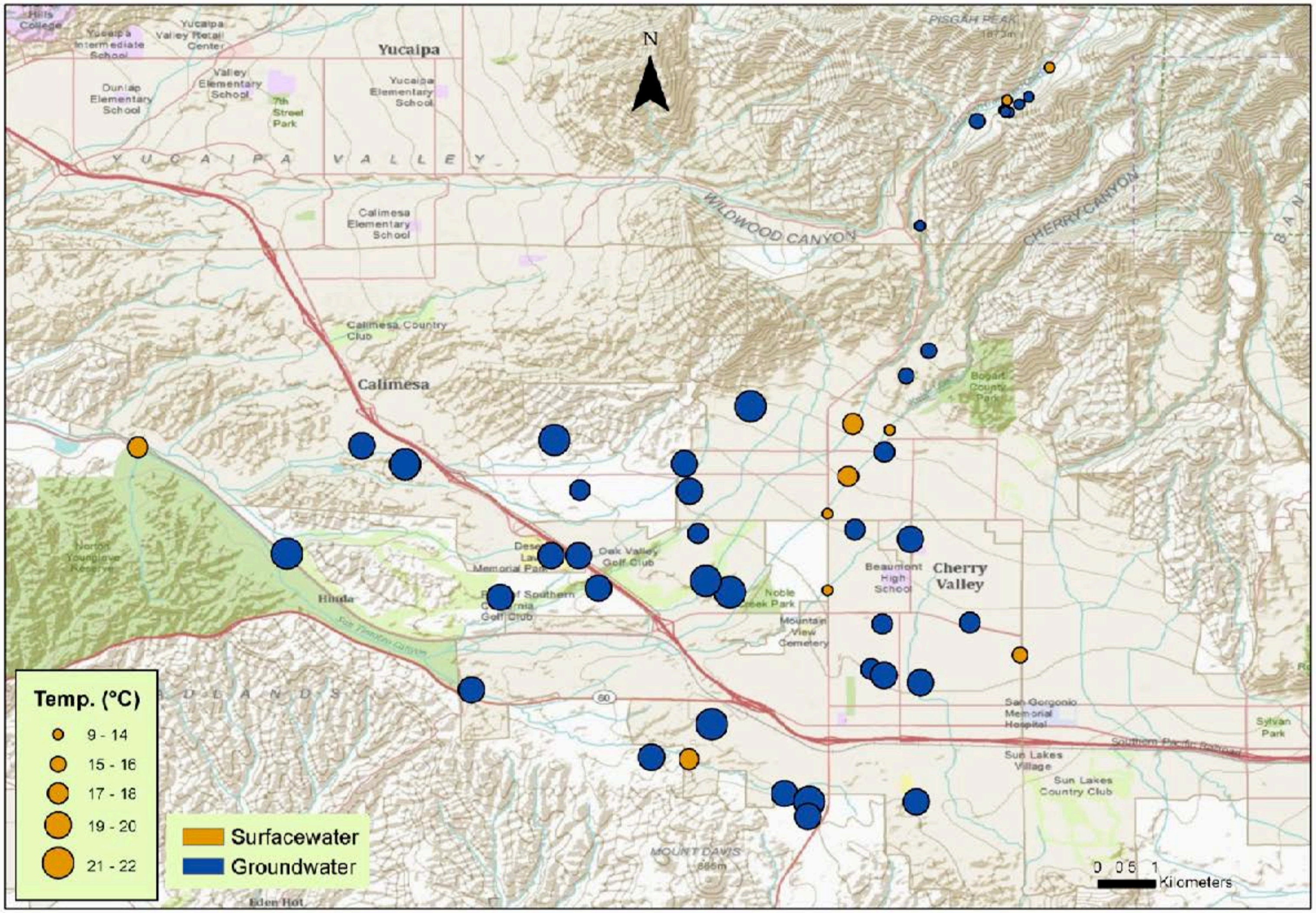



Figure 3. Water temperature in surface water and groundwater within and adjacent to the Beaumont Management Zone.

46

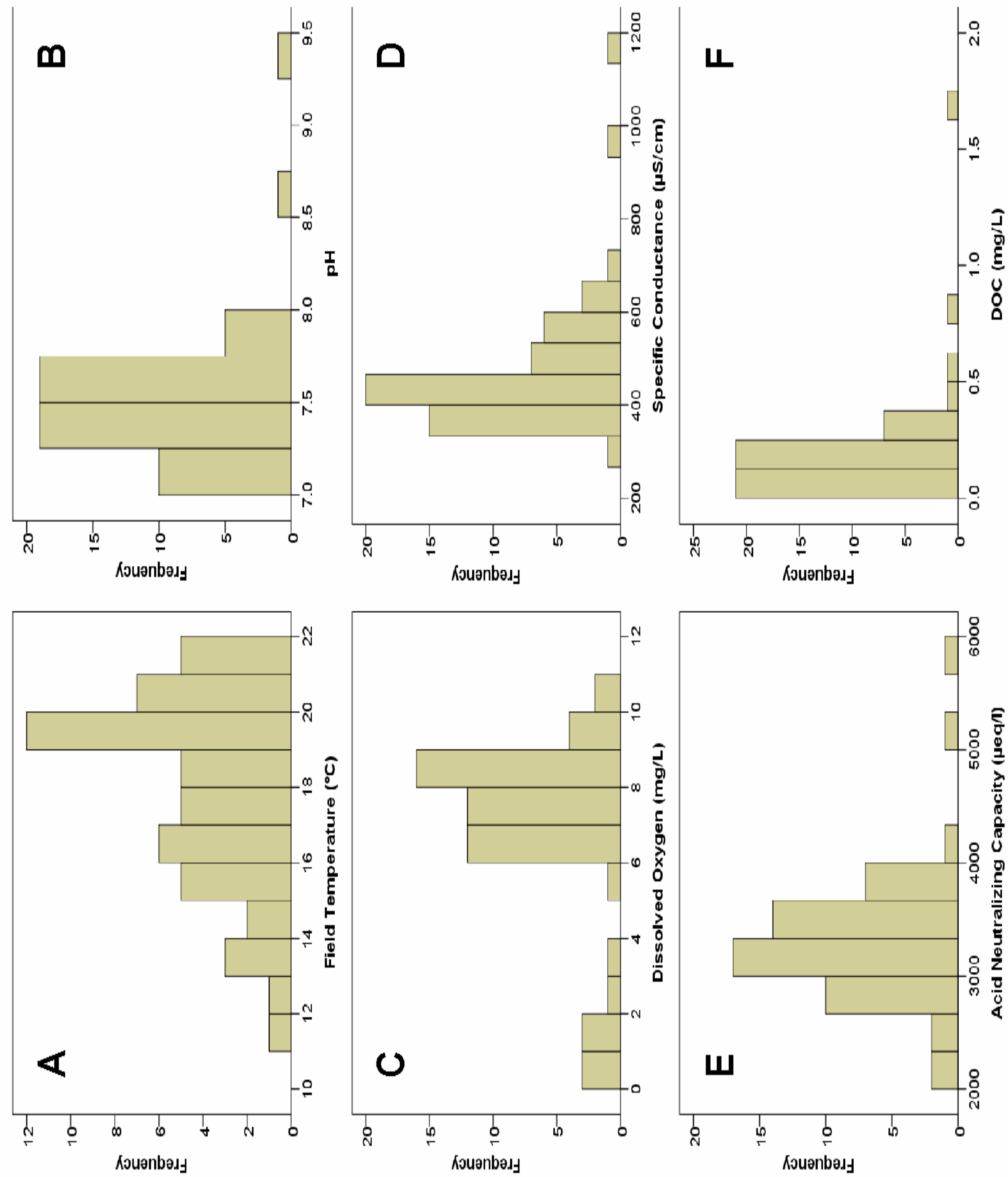



Figure 4. Histograms of physical and chemical characteristics of groundwater for A: field temperature; B: pH; C: dissolved oxygen; D: specific conductance; E: acid neutralizing capacity; F: dissolved organic carbon (F).

## pH, Beaumont Management Zone

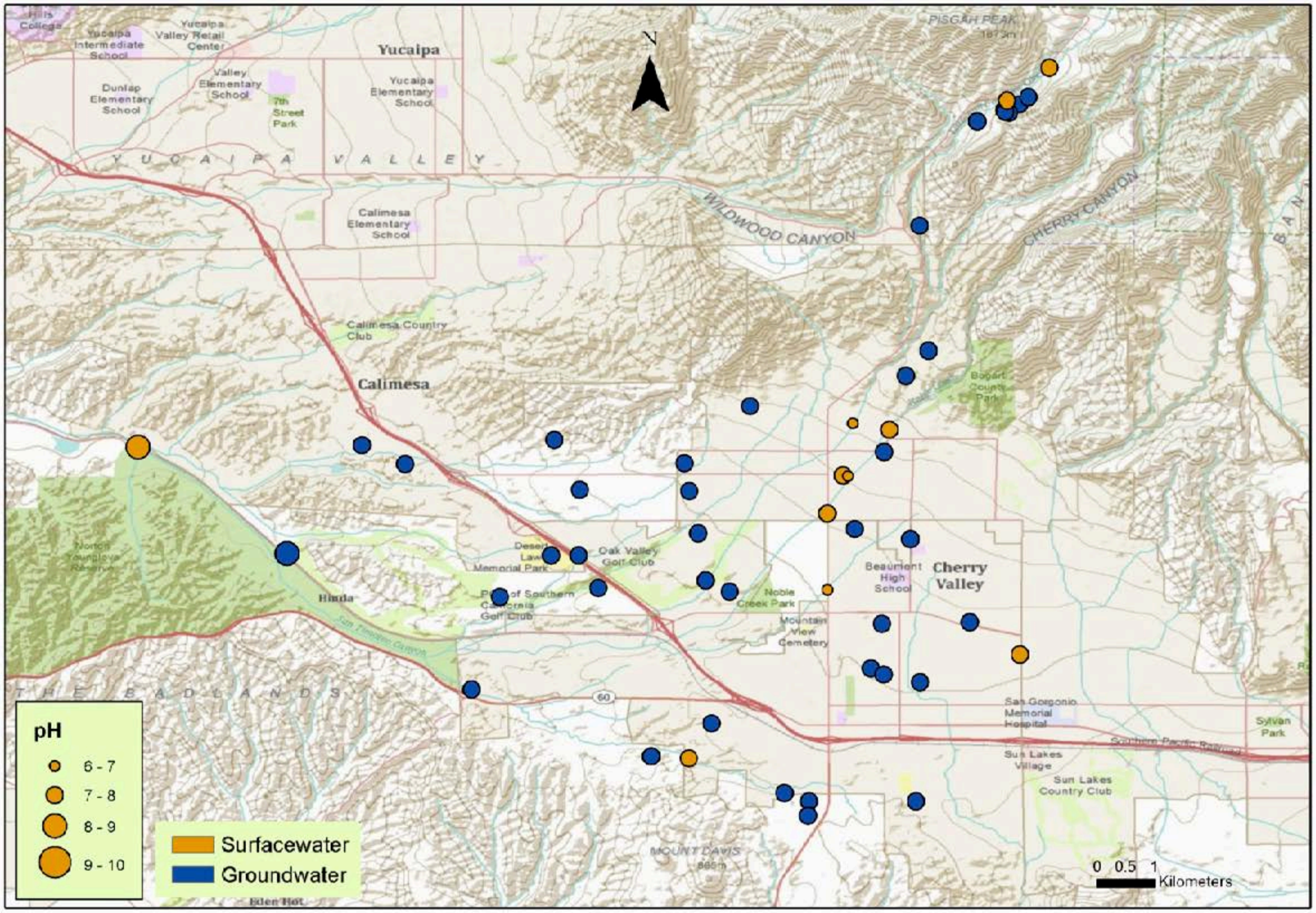



Figure 5. pH distribution in both surface water and groundwater within and adjacent to the Beaumont Management Zone.

48

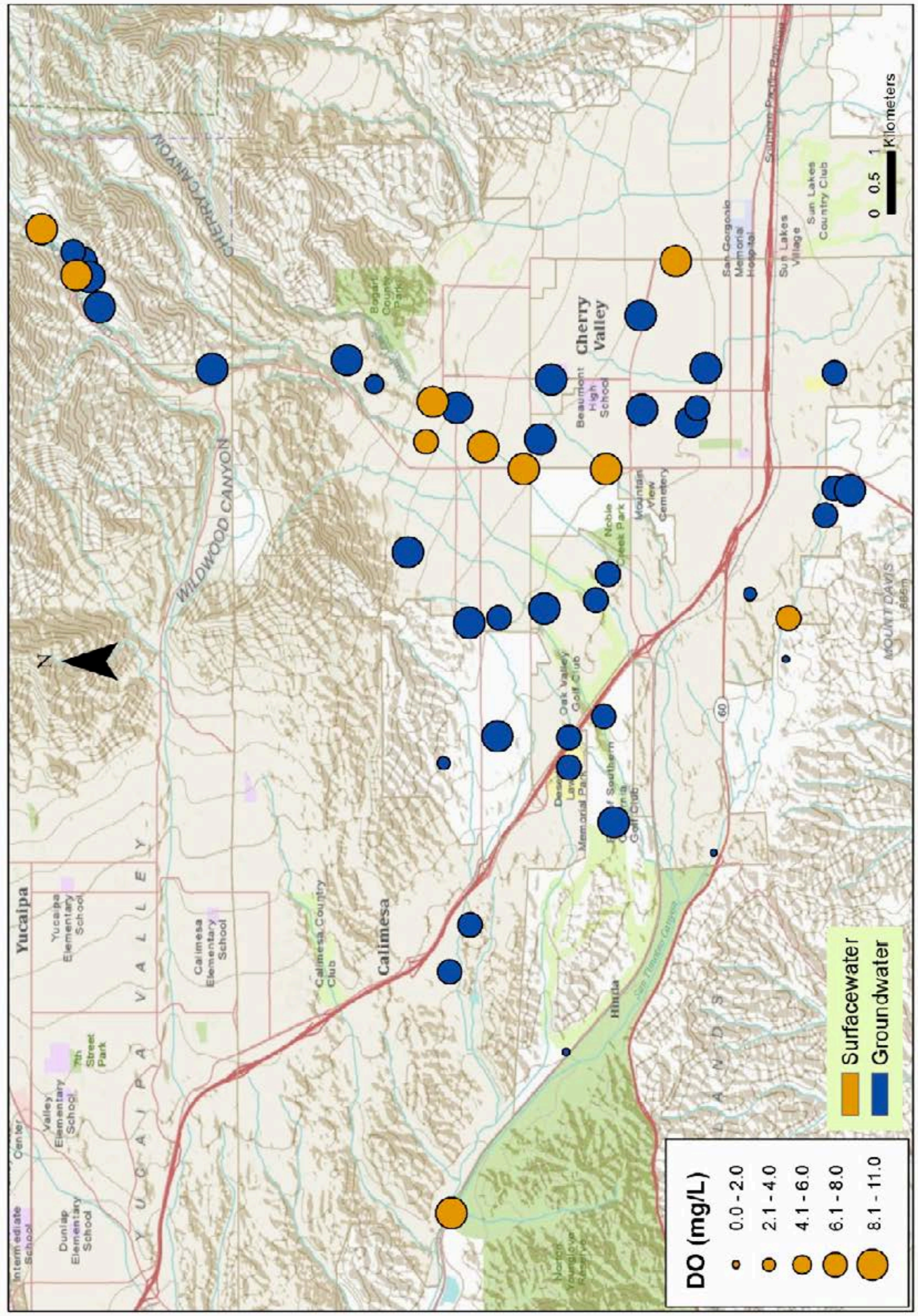



Figure 6. Dissolved oxygen (DO) of surface water and groundwater within and adjacent to the Beaumont Management Zone.

49

## Specific Conductance, Beaumont Management Zone

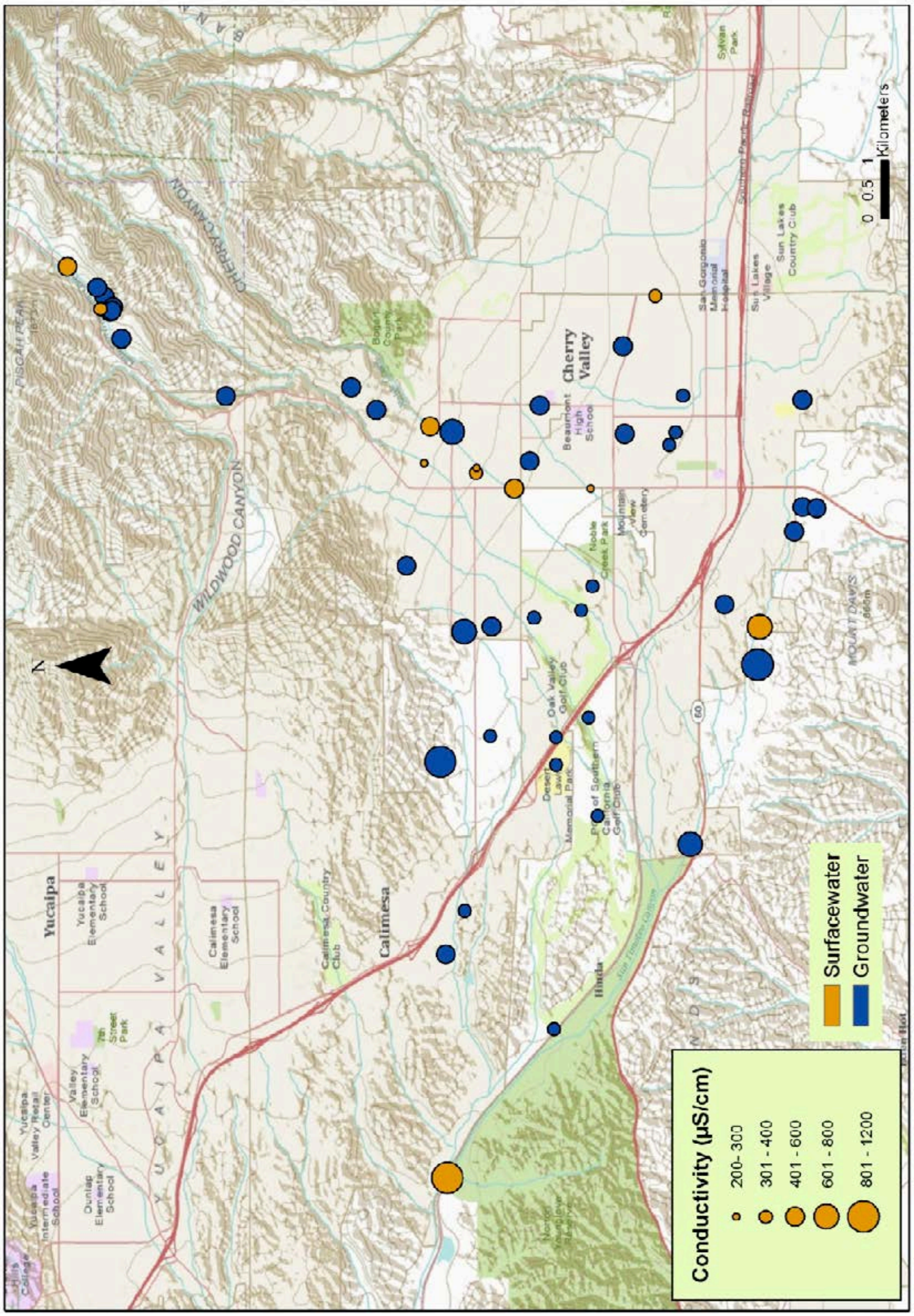



Figure 7. Specific conductance of surface water and groundwater within and adjacent to the Beaumont Management Zone.

50

## Acid Neutralizing Capacity, Beaumont Management Zone

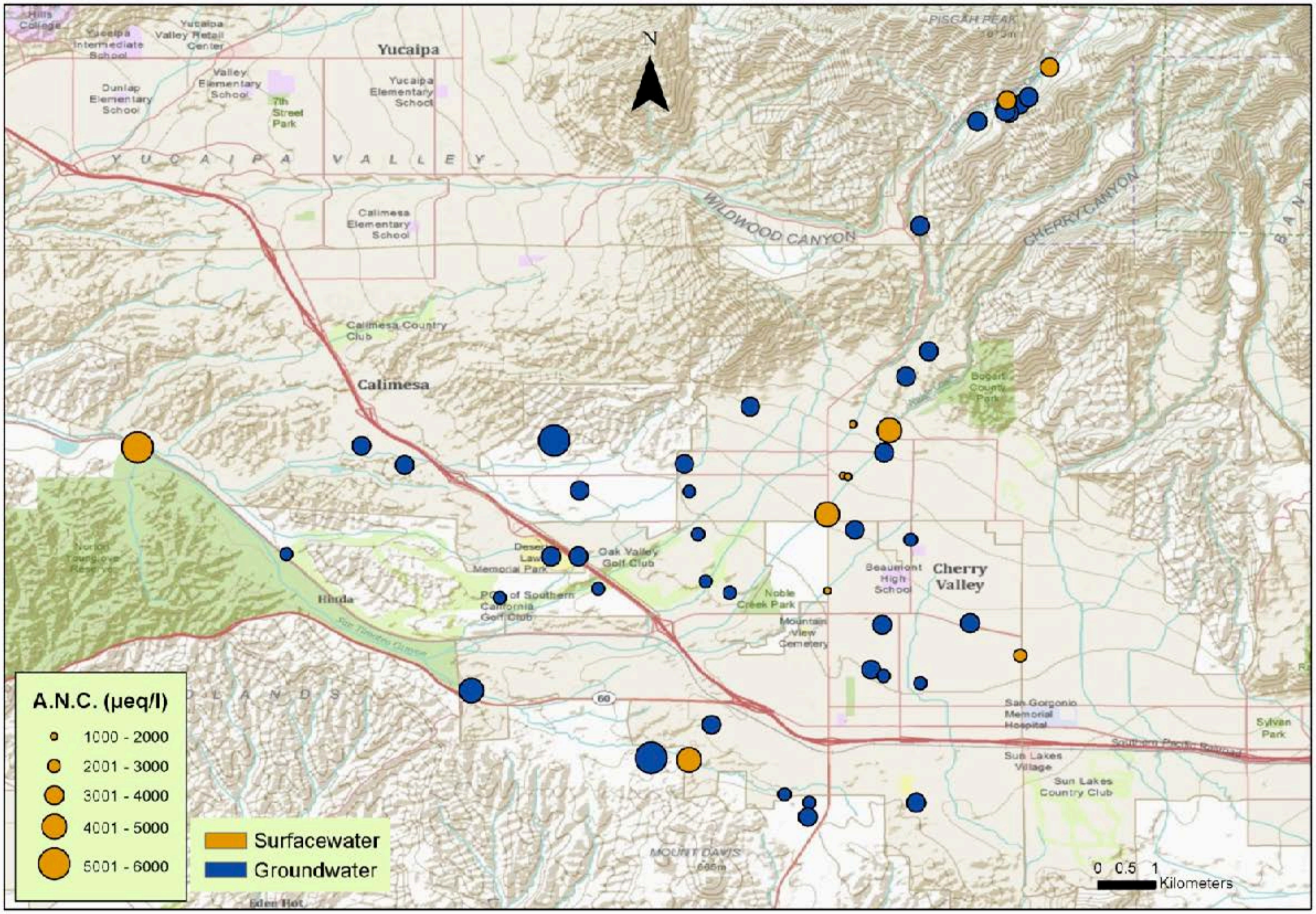



Figure 8. Acid neutralizing capacity (A.N.C.) of surface water and groundwater within and adjacent to the Beaumont Management Zone.

51

## Total Dissolved Solids, Beaumont Management Zone

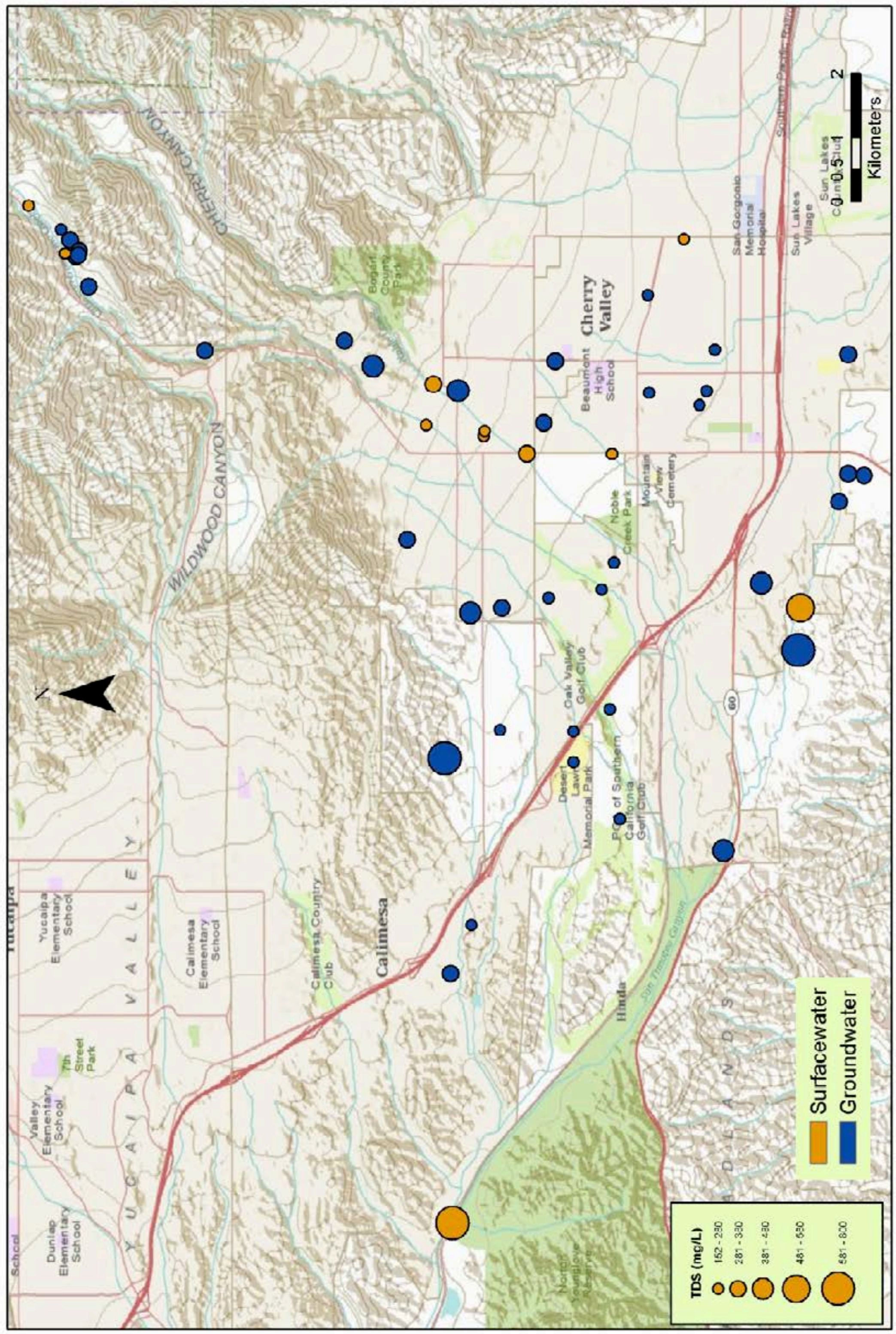



Figure 9. Total Dissolved Solids (TDS) of surface water and groundwater within and adjacent to the Beaumont Management Zone.

52

## Dissolved Organic Carbon, Beaumont Management Zone

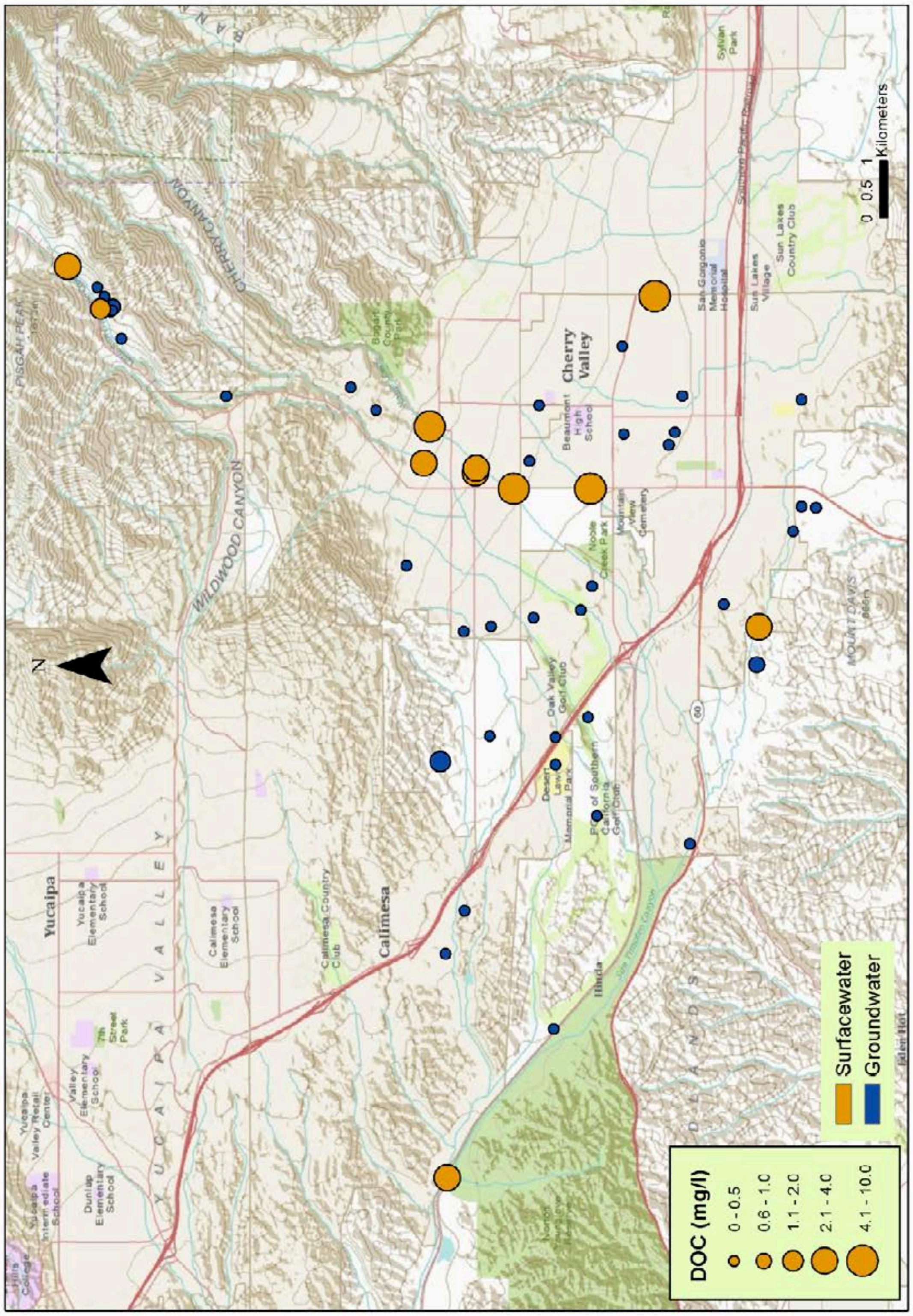



Figure 10. Dissolved organic carbon (DOC) of surface water and groundwater within and adjacent to the Beaumont Management Zone.

53

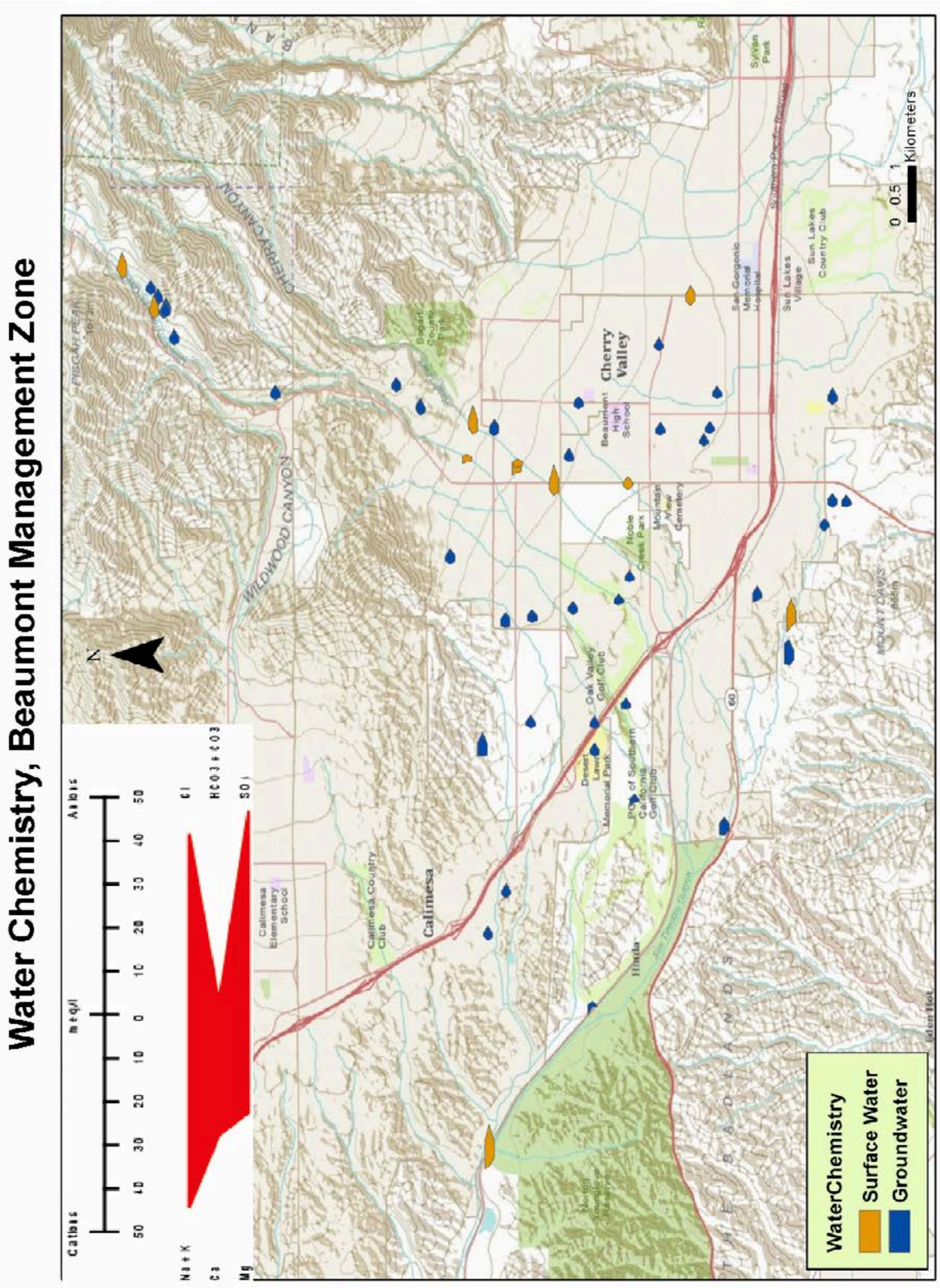



Figure 11. Geostiff diagram for major cations and anions of surface water and groundwater within and adjacent to the 54 Beaumont Management Zone.

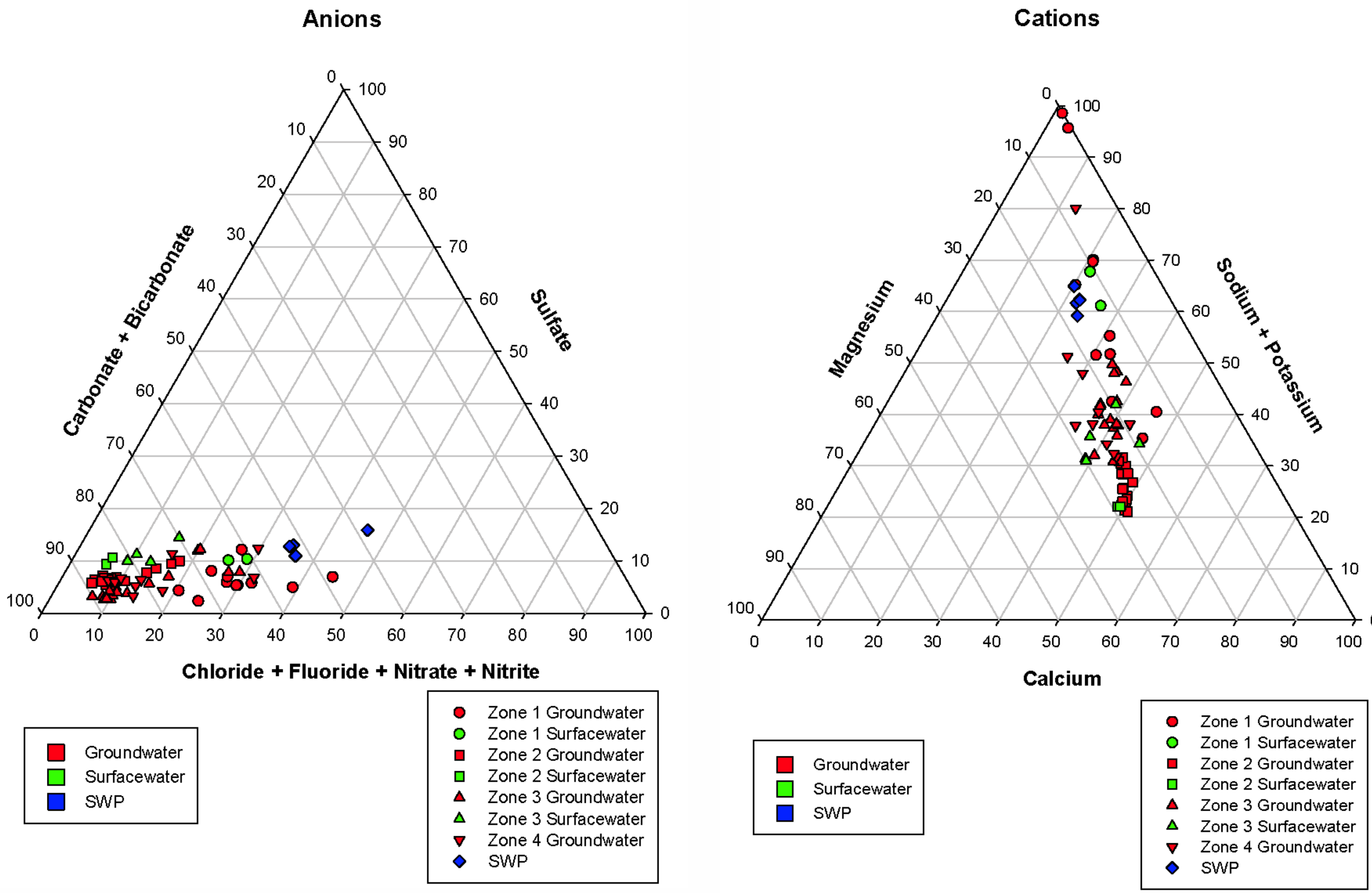



Figure 12. Percentages of major cations and anions in both surface water and groundwater. Red – groundwater; Green – surface water; Blue – state water project water; Circle – Zone 1; Square – Zone 2; Triangle – Zone 3; Inverted triangle – Zone 4. Zone delineation is described in Figure 2.

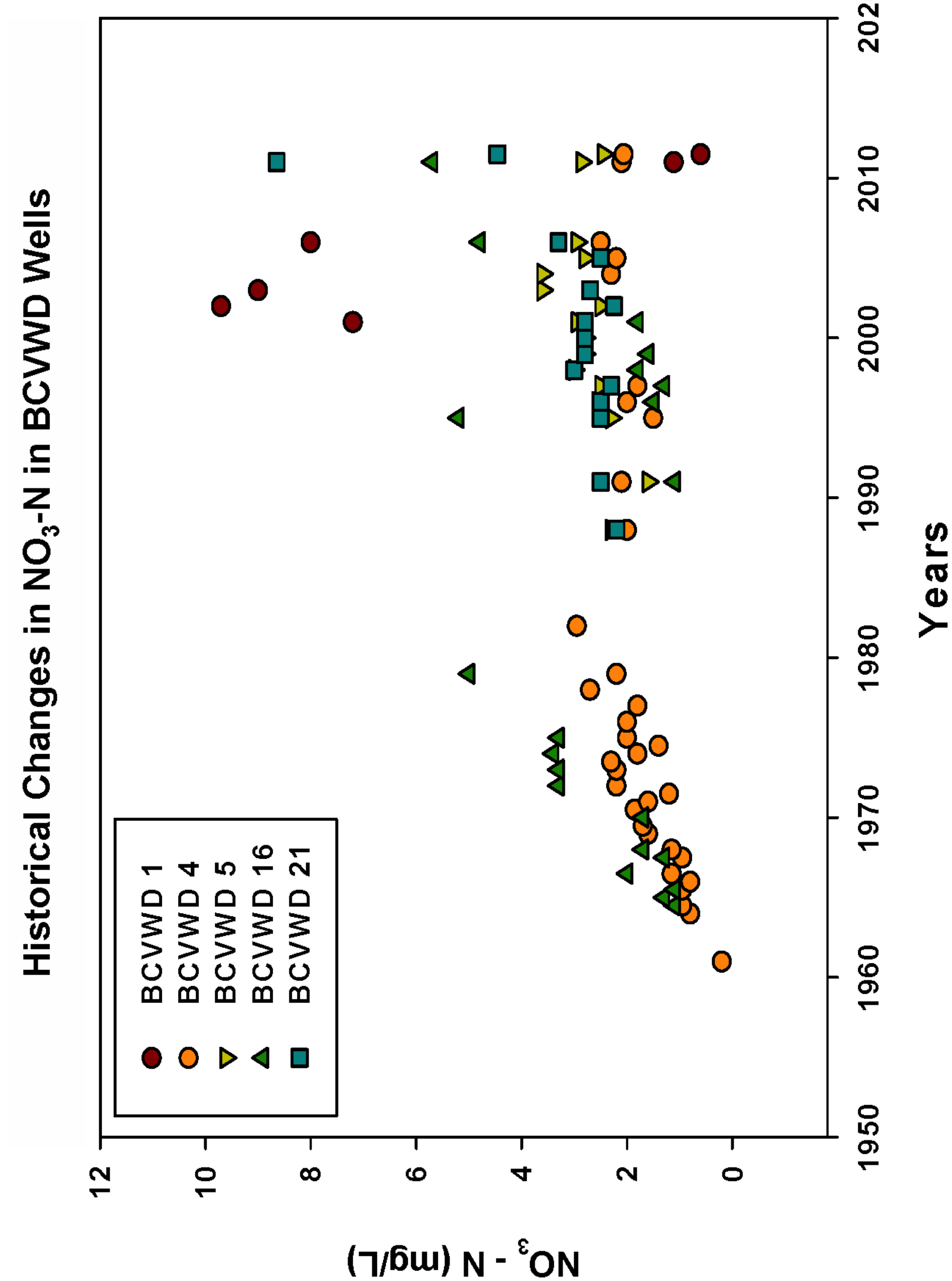



Figure 13. Historical changes in nitrate-nitrogen of wells operated by the Beaumont Cherry Valley Water District (BCVWD) Data are from EPA and the present study.

56

## Nitrate-Nitrogen Concentration, Beaumont Management Zone

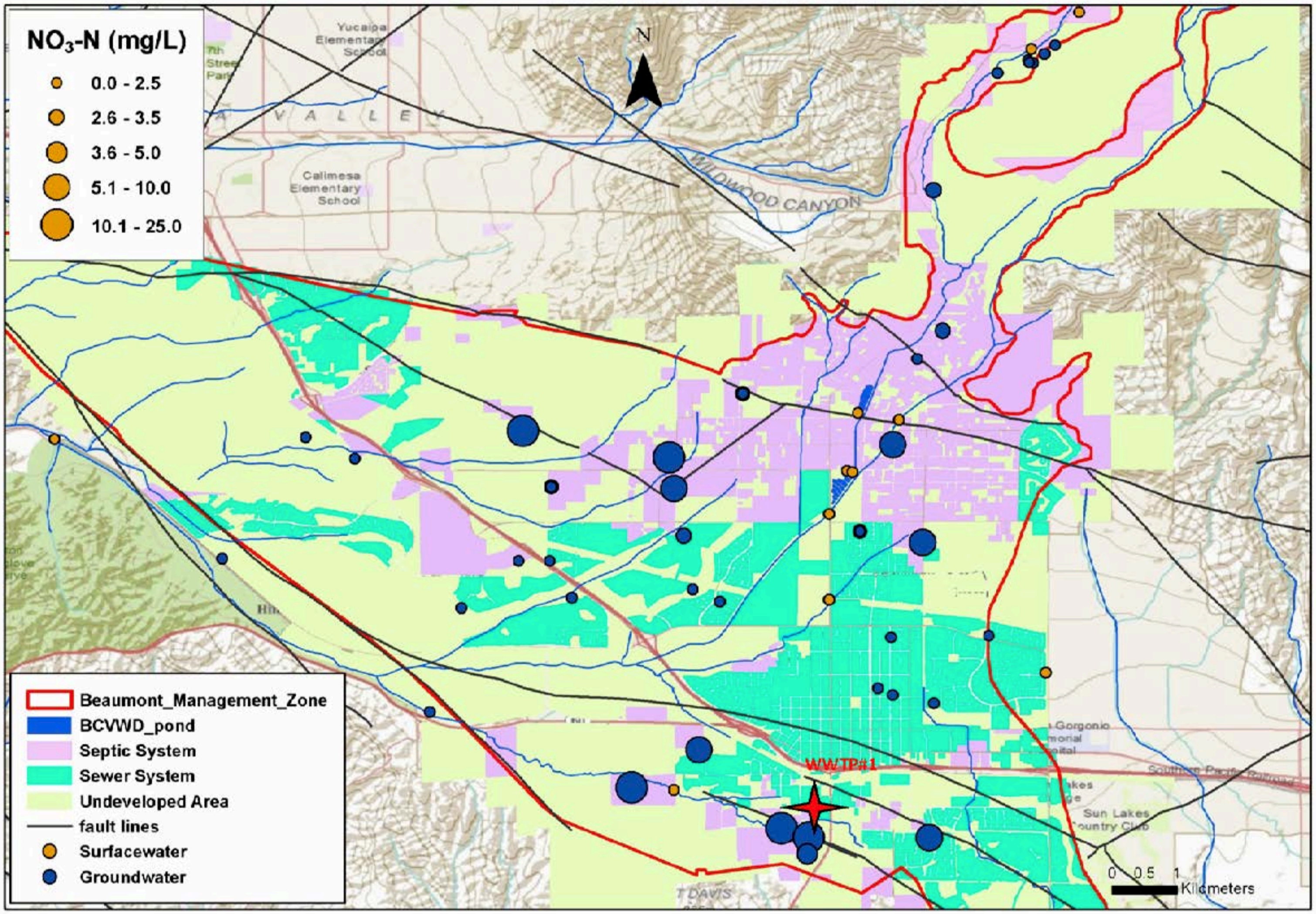



Figure 14. Nitrate-nitrogen concentration of surface water and groundwater within and adjacent to the Beaumont Management Zone. The overlaid blue lines are stream courses, brown lines are roads and the black lines are geologic faults.

57

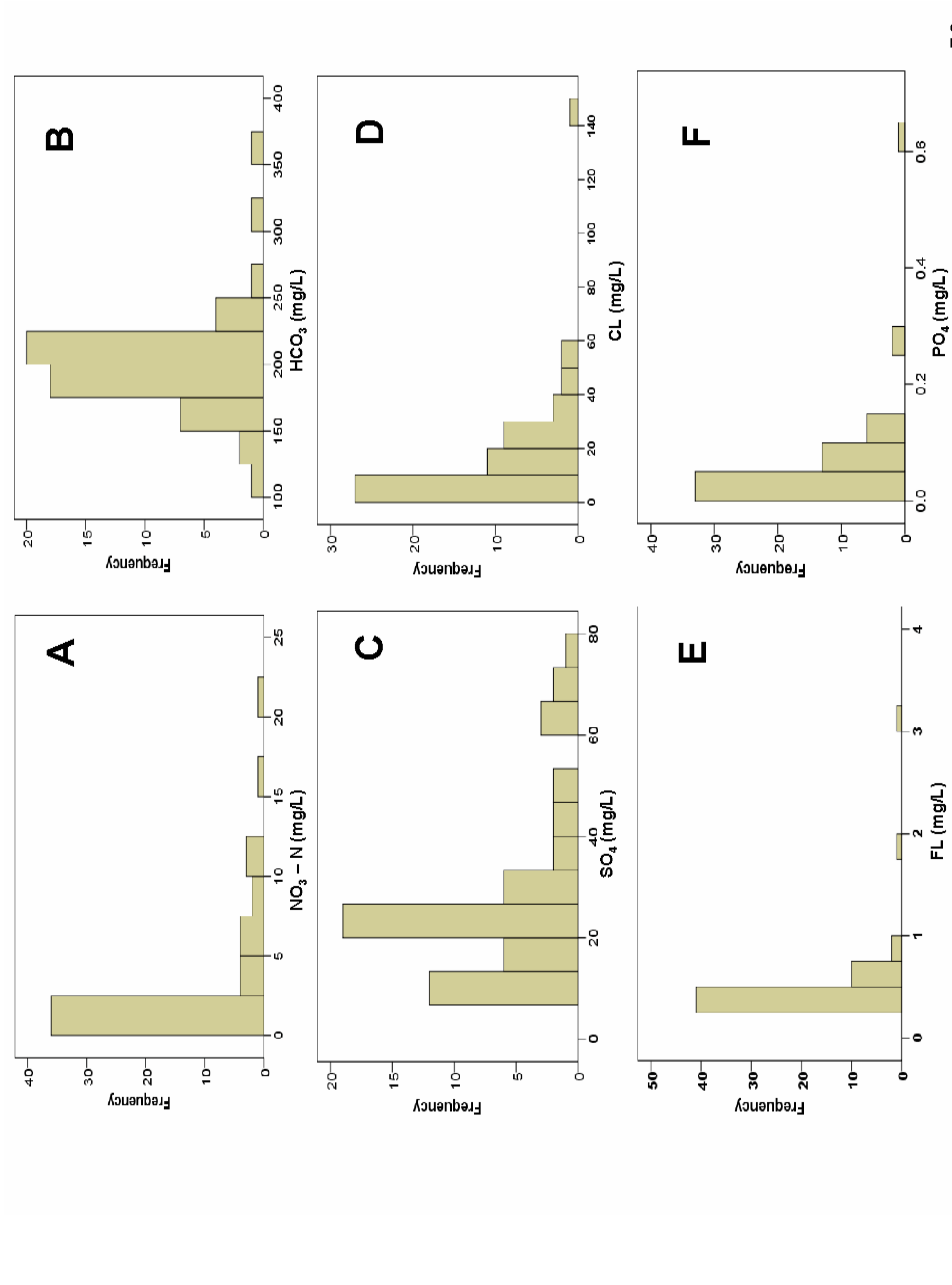



Figure 15. Histograms of major anions in groundwater within and adjacent to the Beaumont Management Zone. A[58]: nitrate; B: bicarbonate; C: sulfate; D: chloride; E: fluoride; F:phosphate.

## Bicarbonate, Beaumont Management Zone

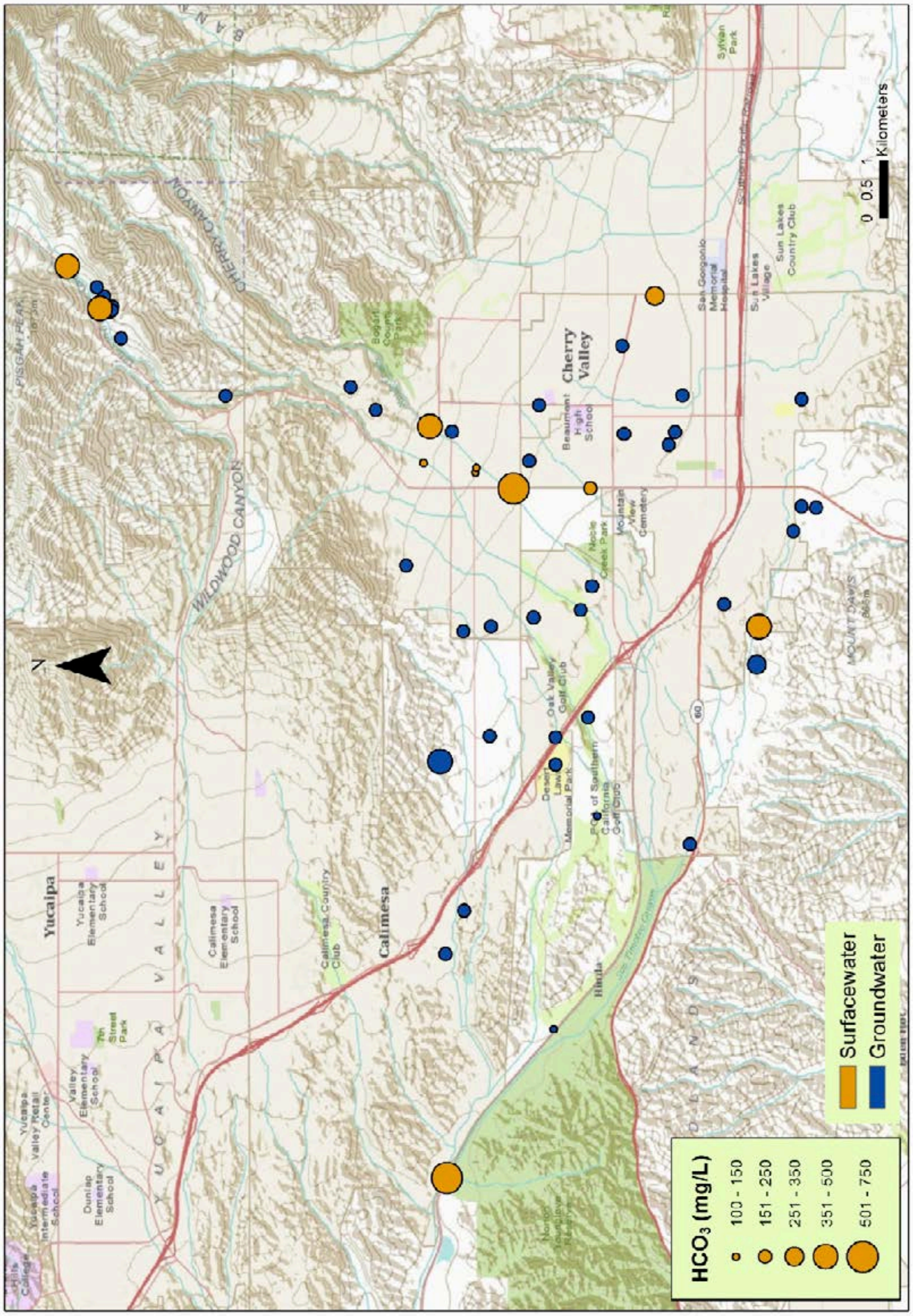
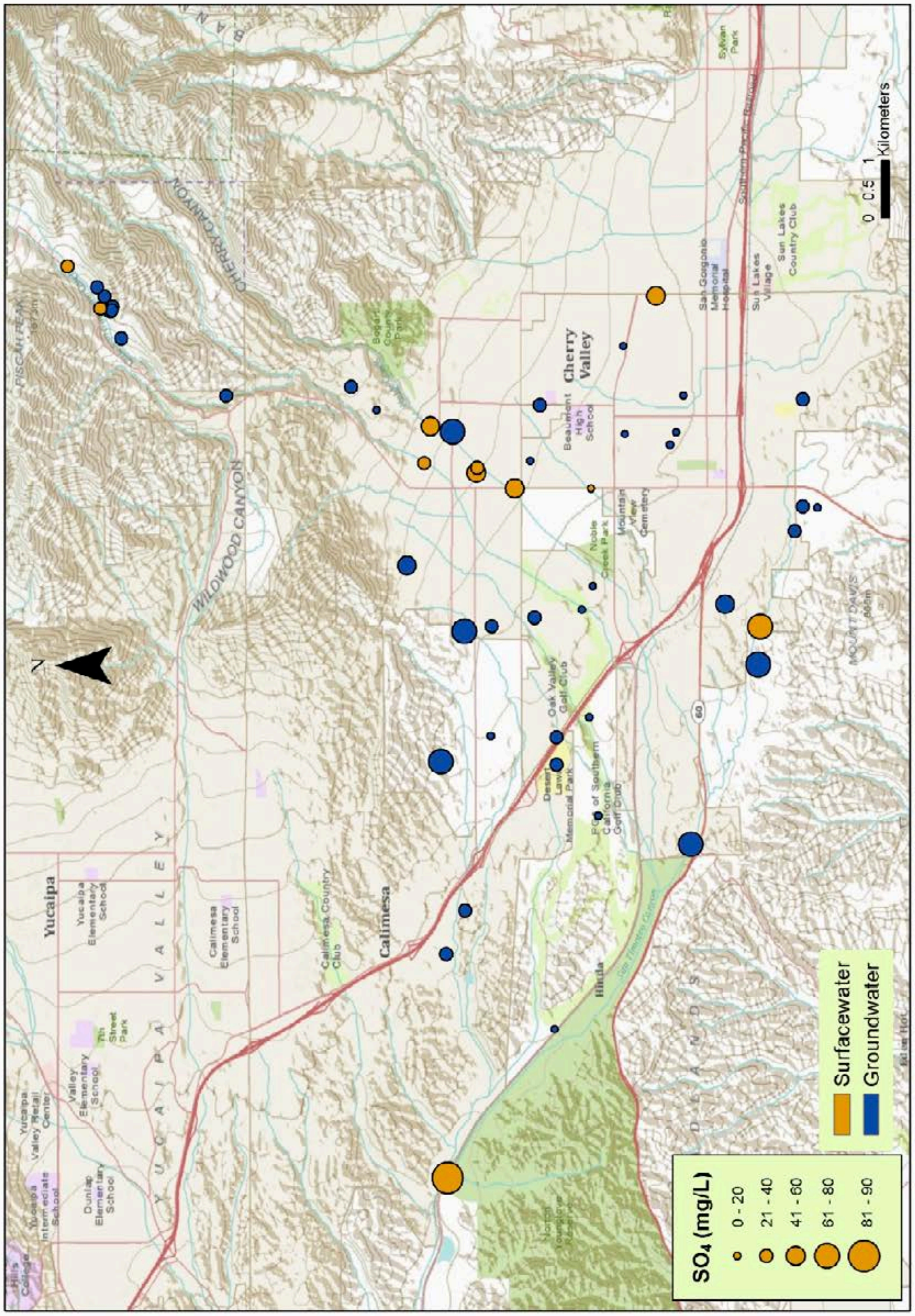



Figure 16. Bicarbonate ion concentration of surface water and groundwater within and adjacent to the Beaumont Management Zone.

59

# Sulfate, Beaumont Management Zone




60

Figure 17. Sulfate concentration of surface water and groundwater within and adjacent to the Beaumont Management Zone.

## Chloride, Beaumont Management Zone

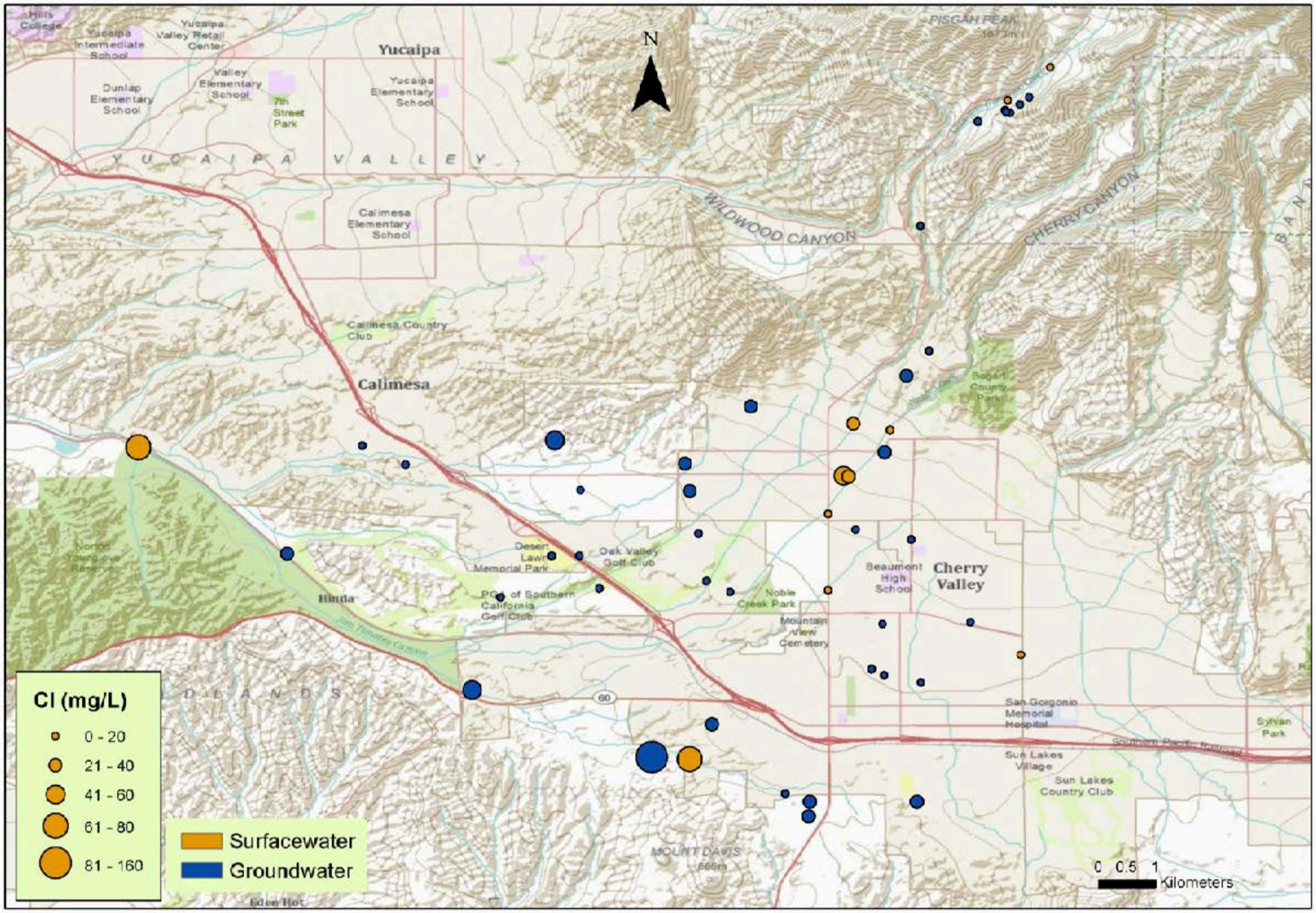



Figure 18. Chloride concentration of surface water and groundwater within and adjacent to the Beaumont Management Zone.

61

## Fluoride, Beaumont Management Zone

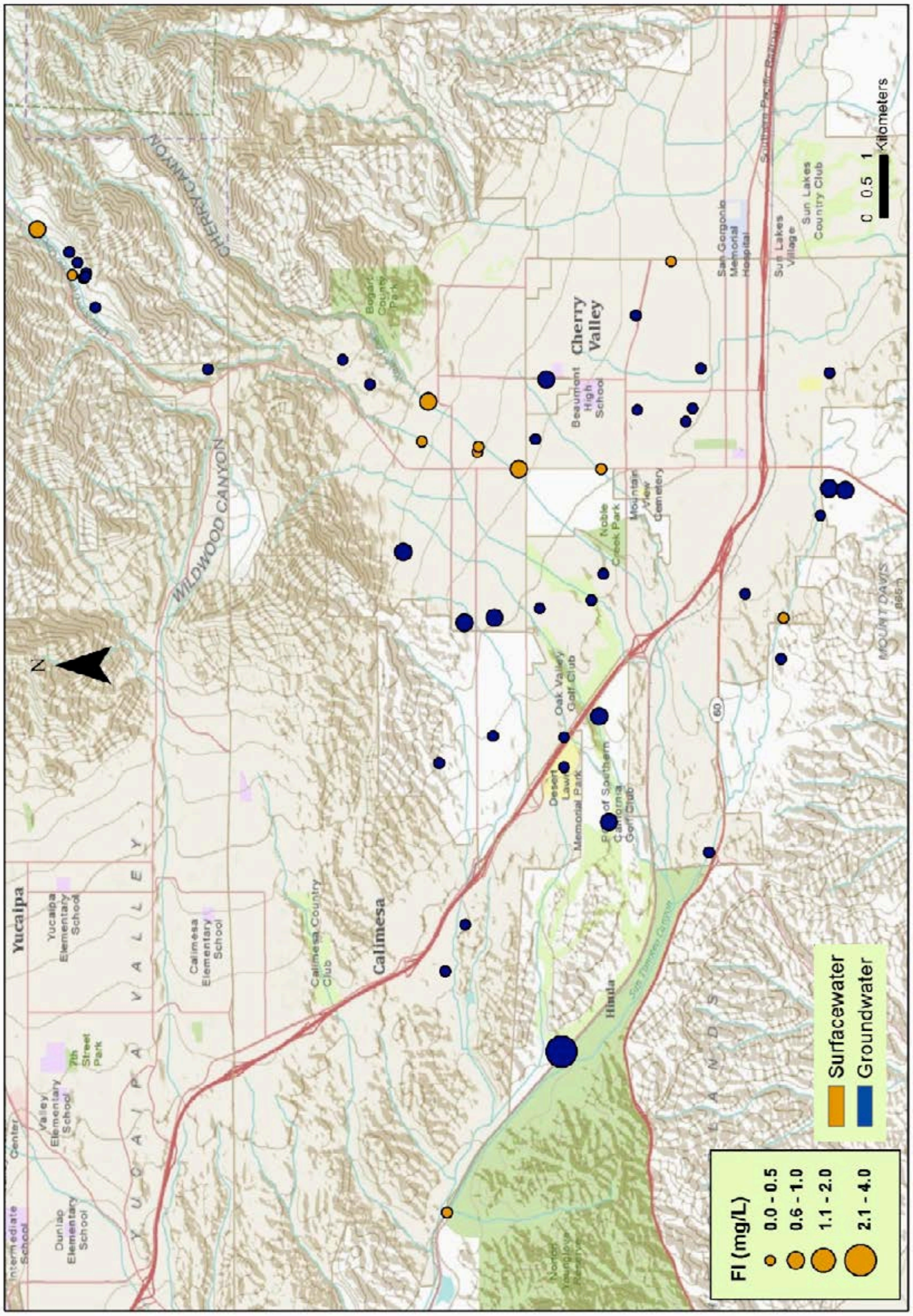



Figure 19. Fluoride concentration of surface water and groundwater within and adjacent to the Beaumont Management Zone.

62

## Phosphate, Beaumont Management Zone

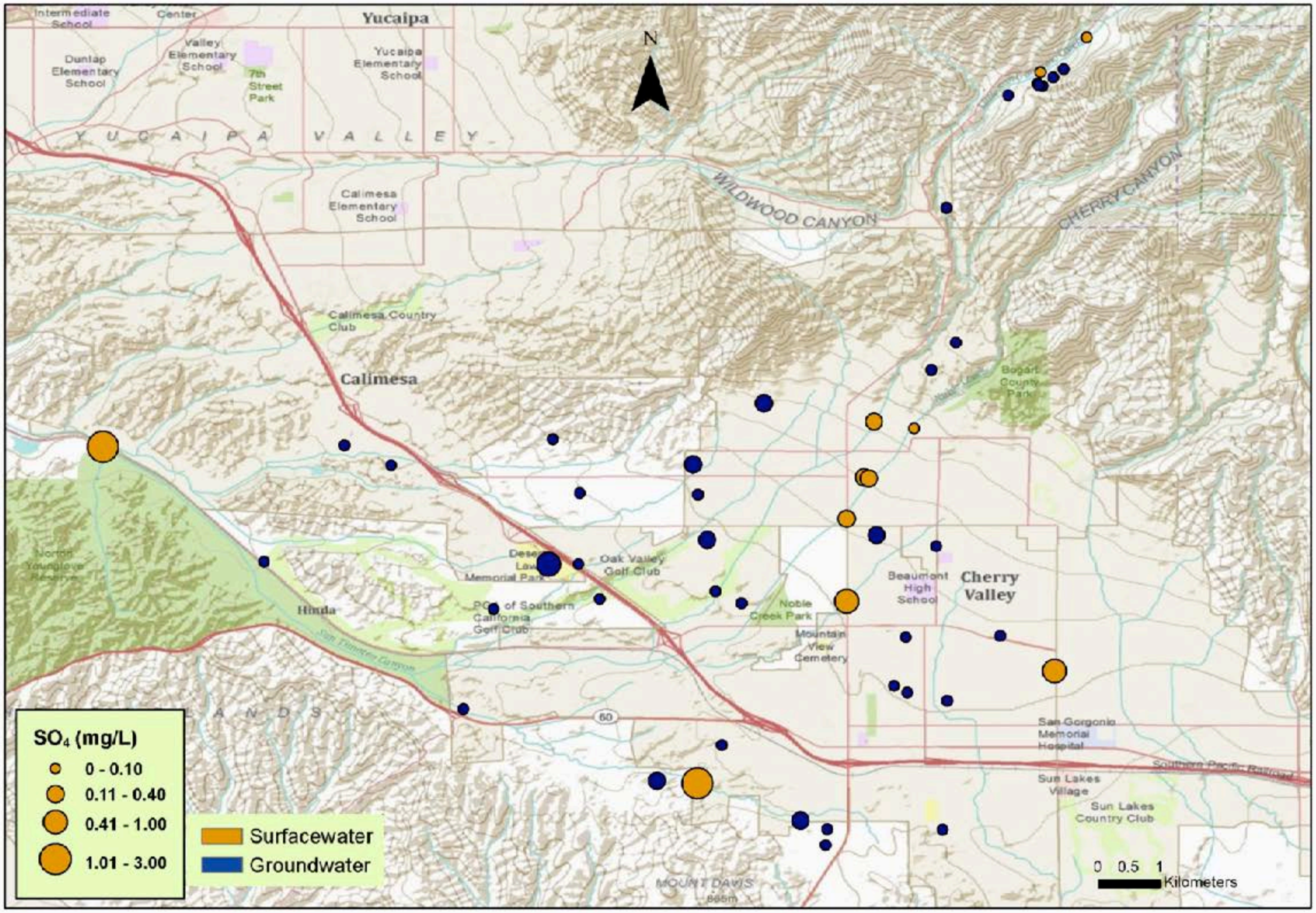



Figure 20. Phosphate concentrations of surface water and groundwater within and adjacent to the Beaumont Management Zone.

63

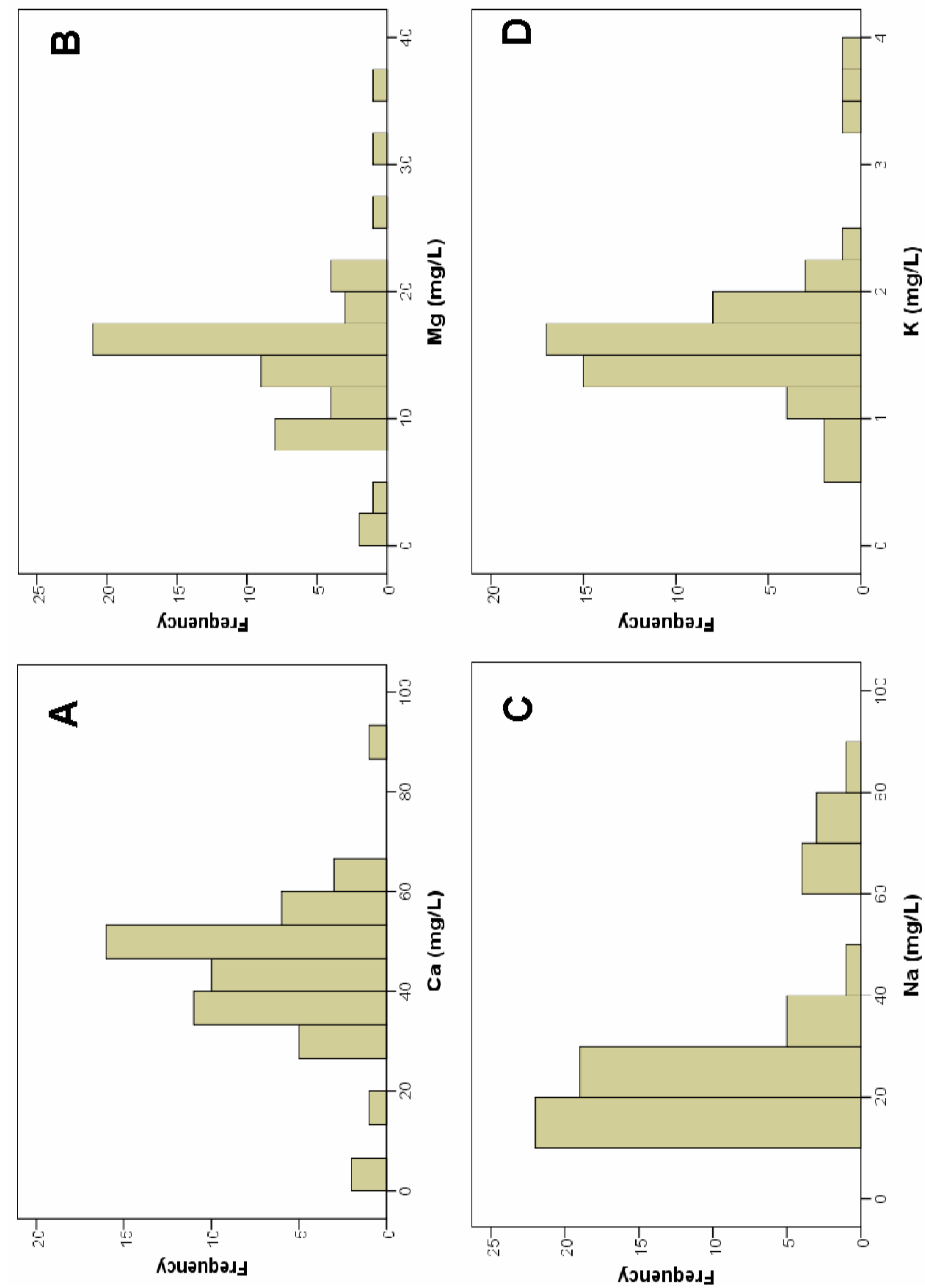



Figure 21. Histograms of major cations in groundwater within and adjacent to the Beaumont Management Zone. A: calcium; B: magnesium; C: sodium; D: potassium.

64

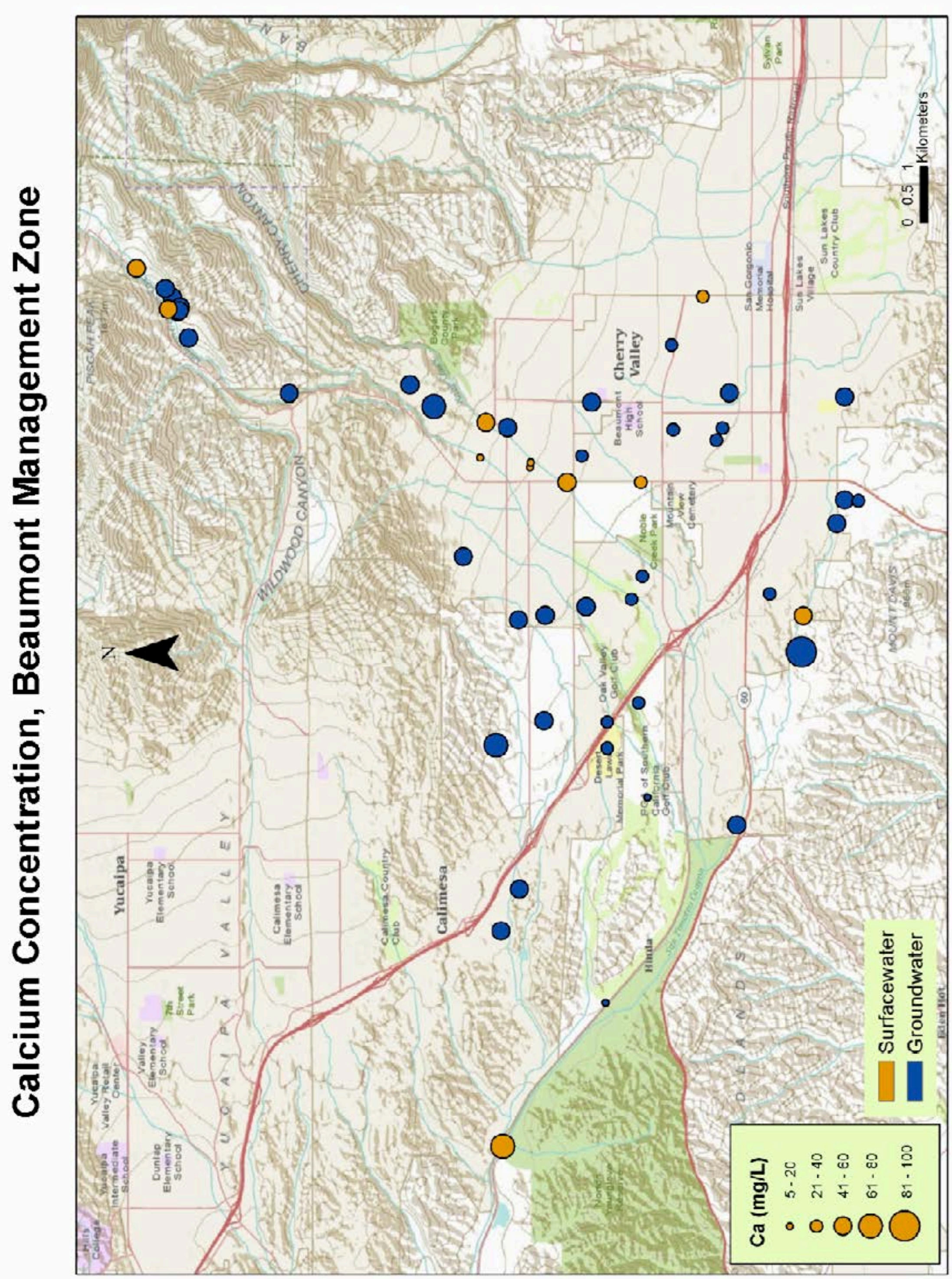



Figure 22. Calcium concentration of surface water and groundwater within and adjacent to the Beaumont Management Zone.

65

## Magnesium Concentration, Beaumont Management Zone

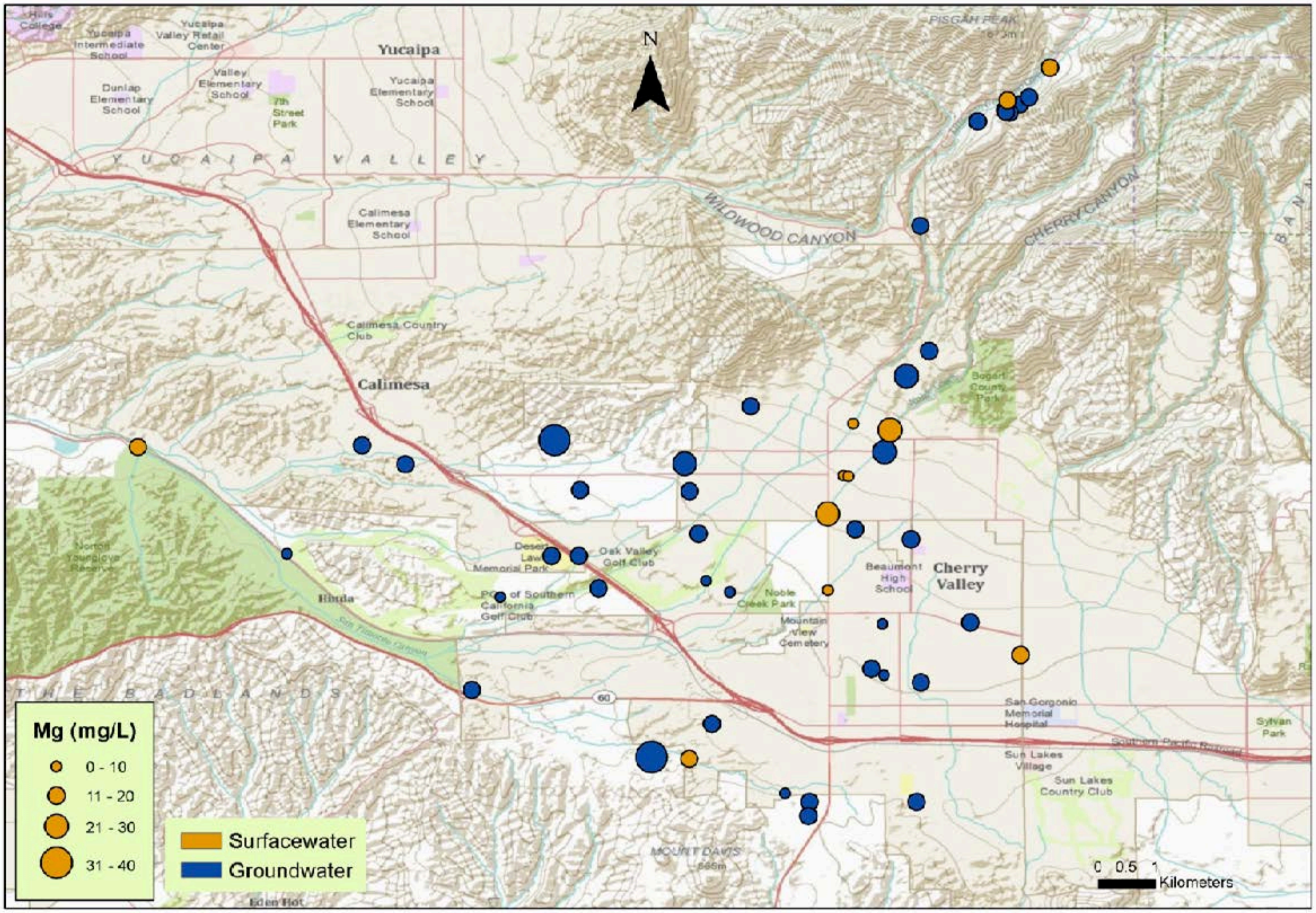



Figure 23. Magnesium concentration of surface water and groundwater within and adjacent to the Beaumont Management Zone.

66

# Sodium Concentration, Beaumont Management Zone

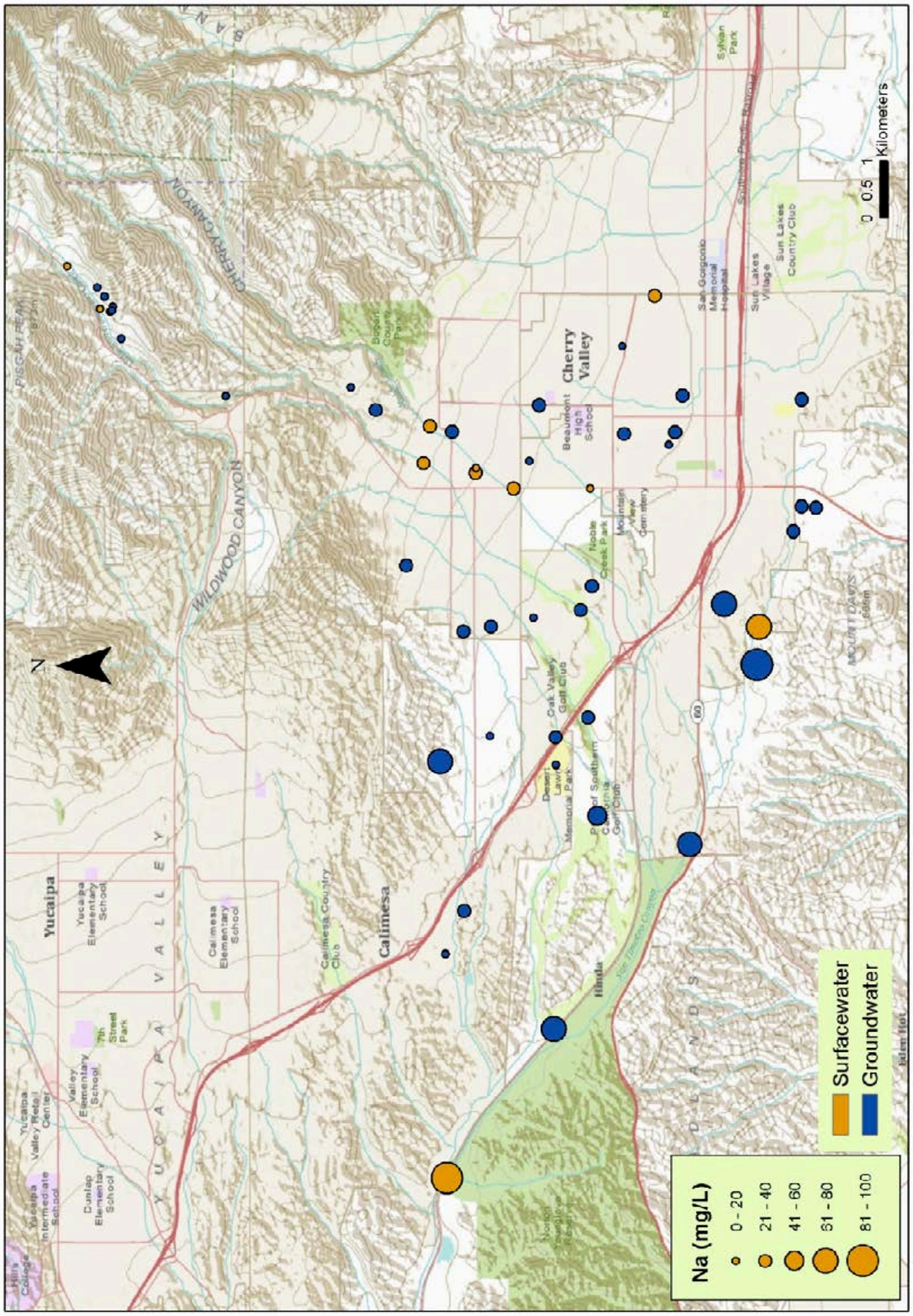



Figure 24. Sodium concentration of surface water and groundwater within and adjacent to the Beaumont Management Zone.

67

## Potassium Concentration, Beaumont Management Zone

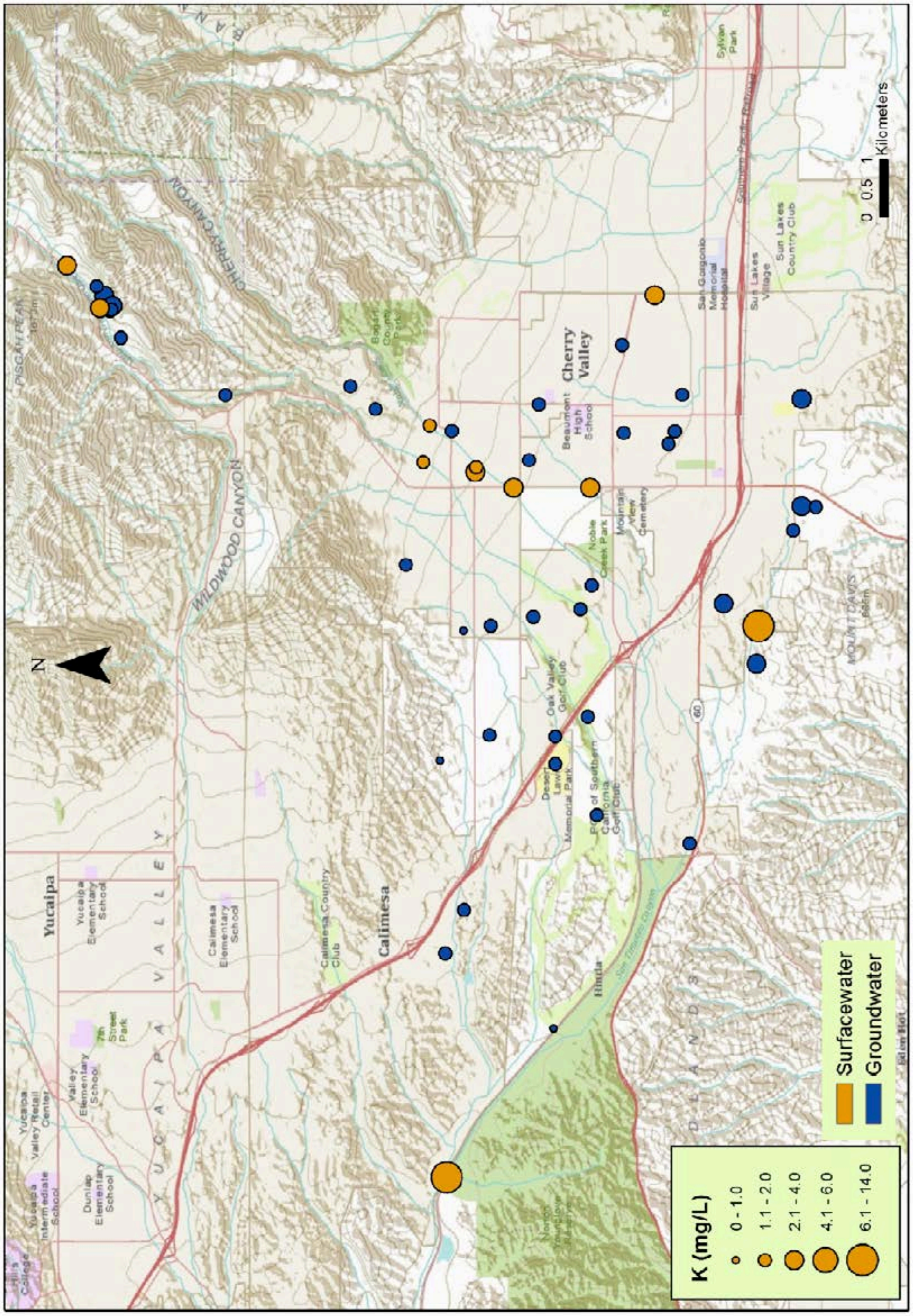



Figure 25. Potassium concentration of surface water and groundwater in Beaumont management zone.

68

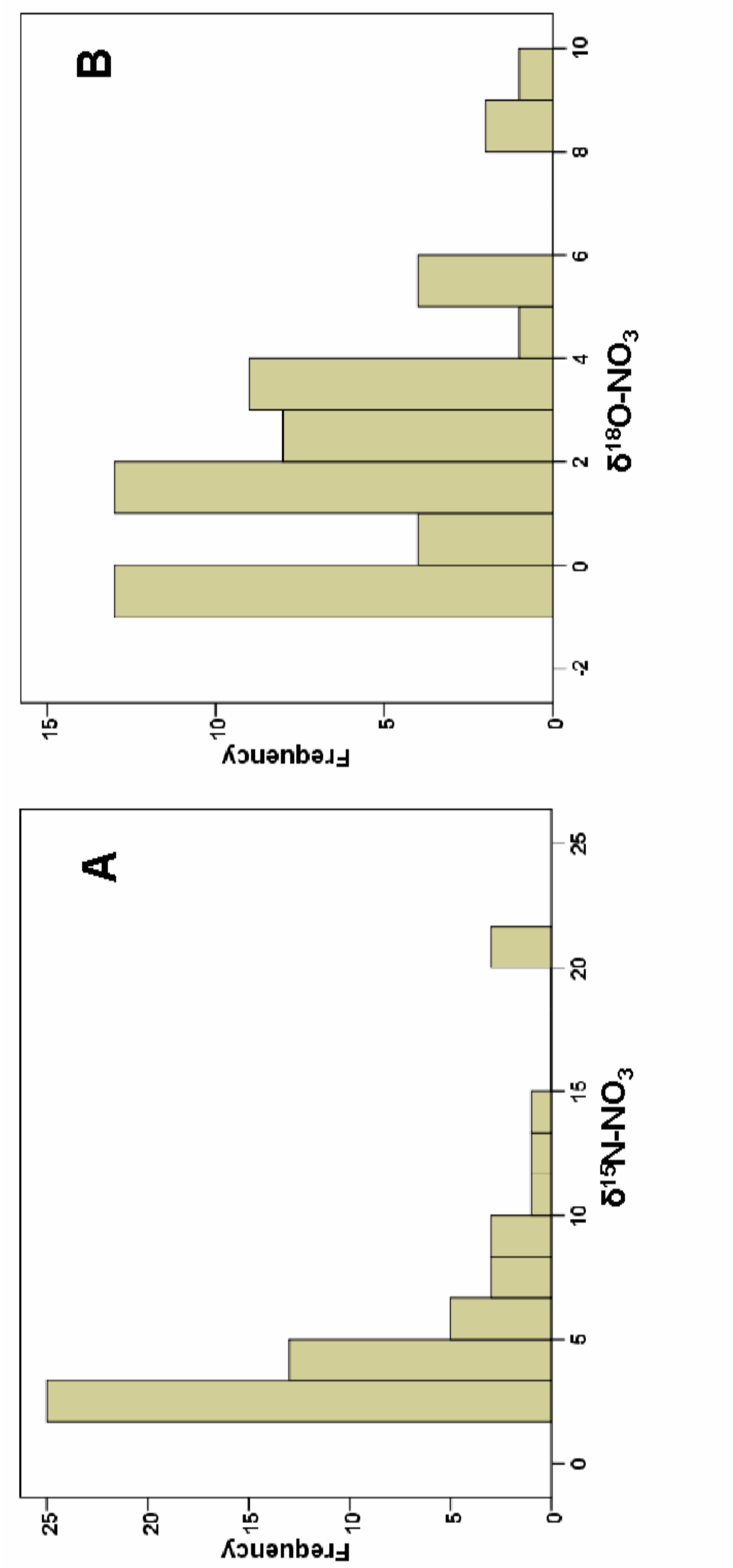



Figure 26. Histograms of isotopes of nitrate of groundwater within and adjacent to the Beaumont Management Zone. A: nitrogen isotope of nitrate; B: oxygen isotope of nitrate. Units are per mil.

Nitrogen Isotope, Beaumont Management Zone

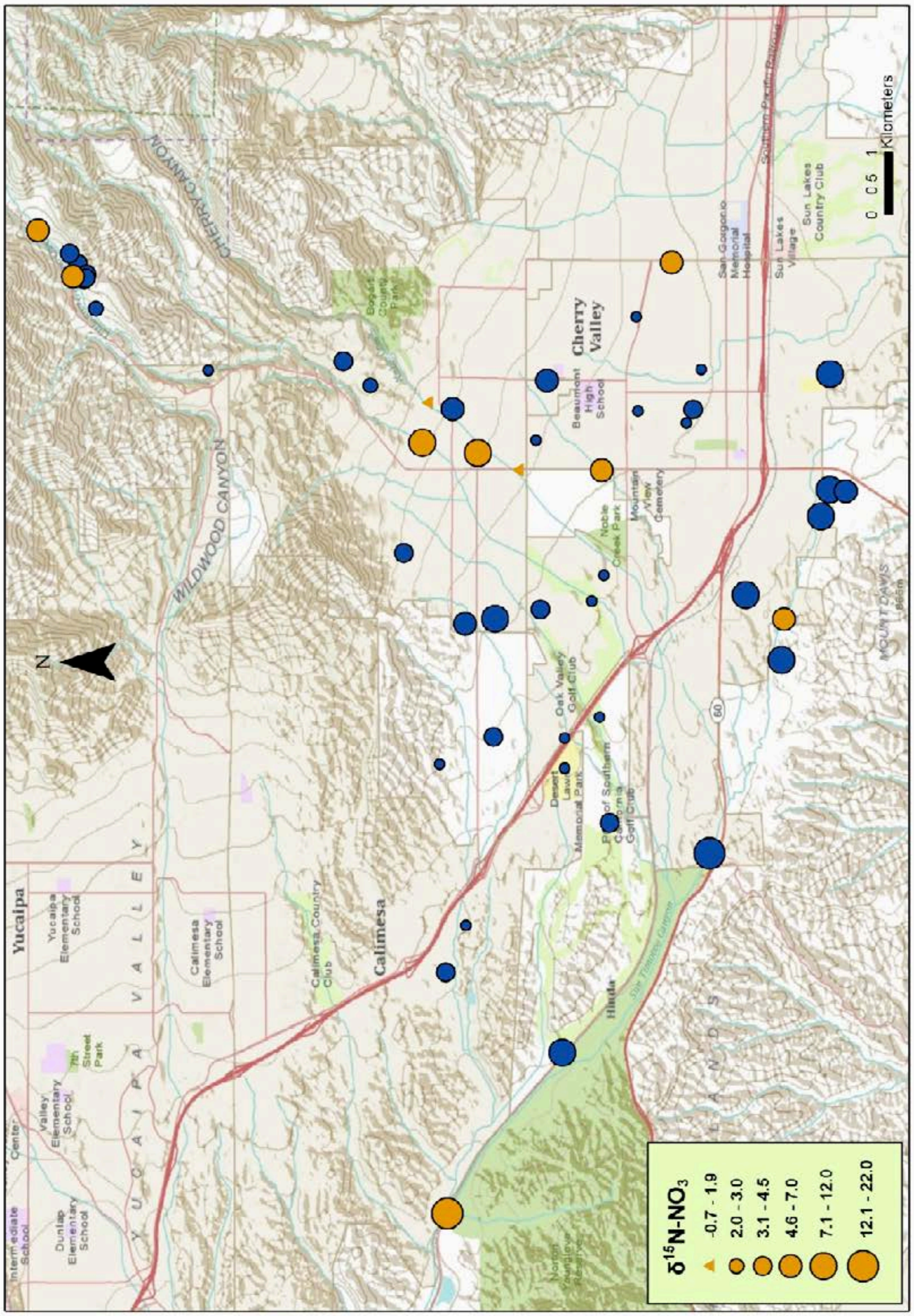



Figure 27. Nitrogen isotope composition of nitrate of surface water and groundwater within and adjacent to the Beaumont Management Zone. Units are per mil. Blue circles are groundwater, yellow circles are surface water.

70

Oxygen Isotope, Beaumont Management Zone

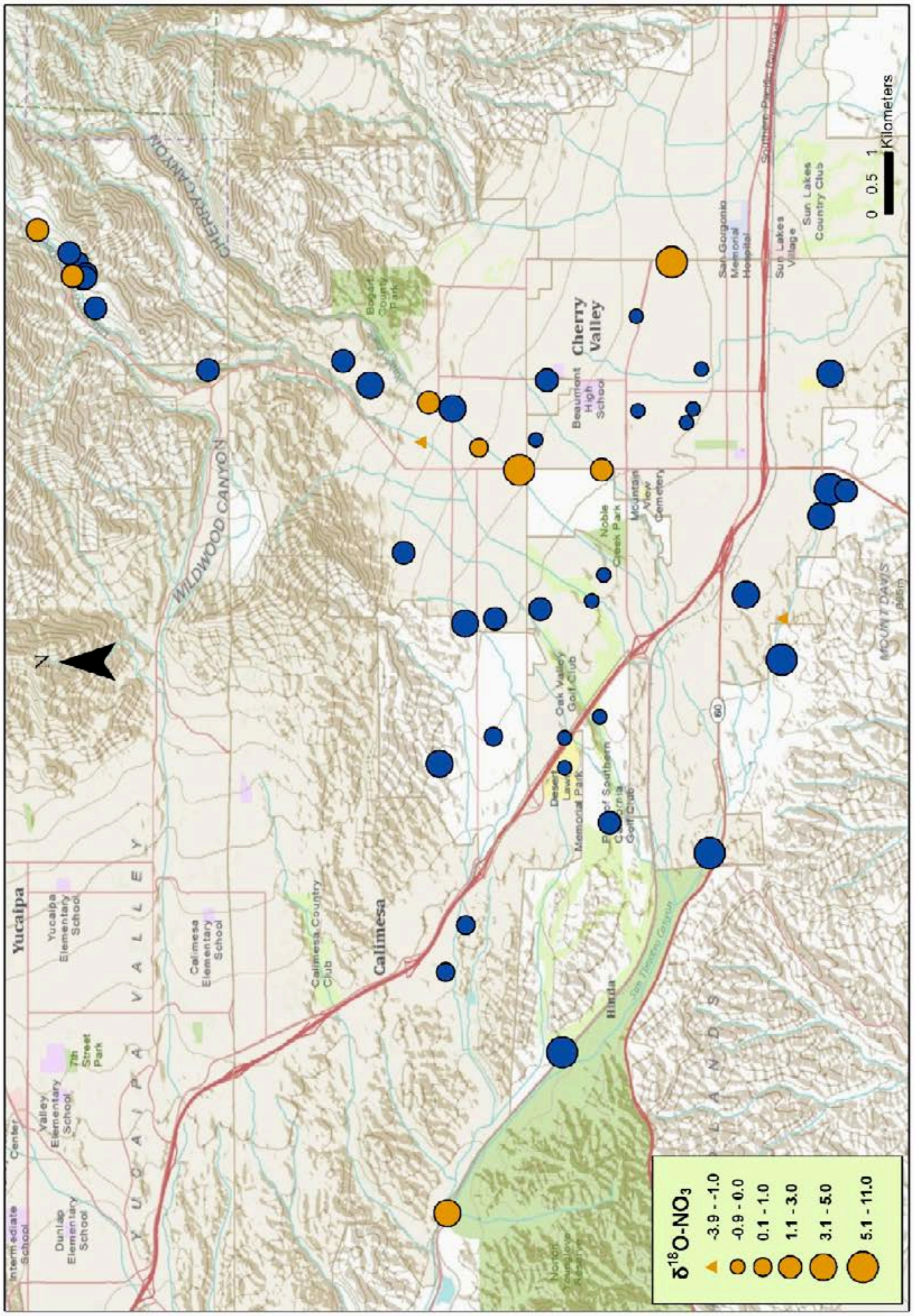



Figure 28. Oxygen isotope composition of nitrate of surface water and groundwater within and adjacent to the Beaumont Management Zone. Units are per mil. Blue circles are groundwater, yellow circles are surface water.

71

## Ratio of δ18O : δ15N of nitrate, Beaumont Management Zone

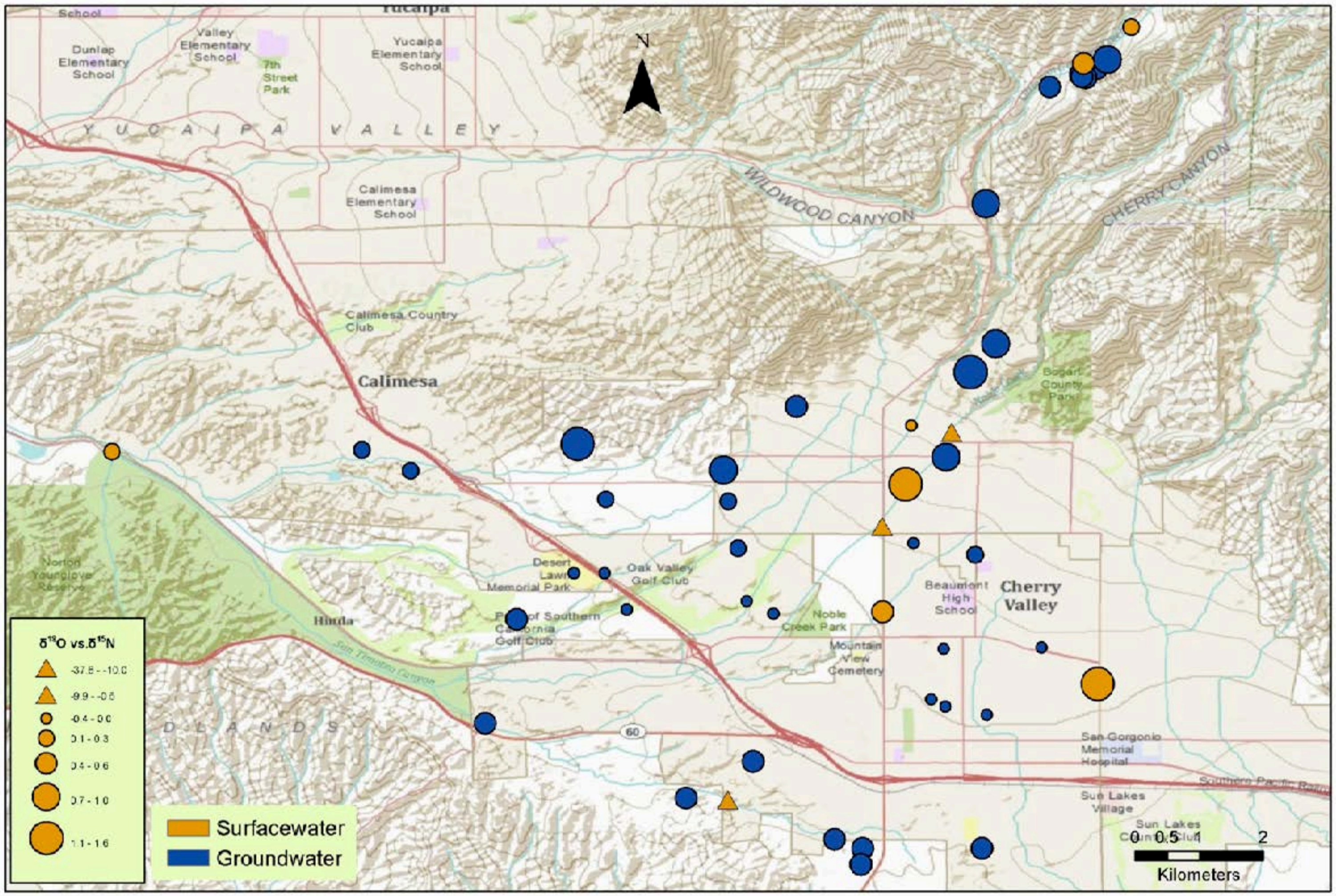



Figure 29. Ratio of δ18O : δ15N of nitrate of surface water and groundwater within and adjacent to the Beaumont Management Zone. Units are dimensionless. 72

## Groundwater PPCP, Beaumont Management Zone

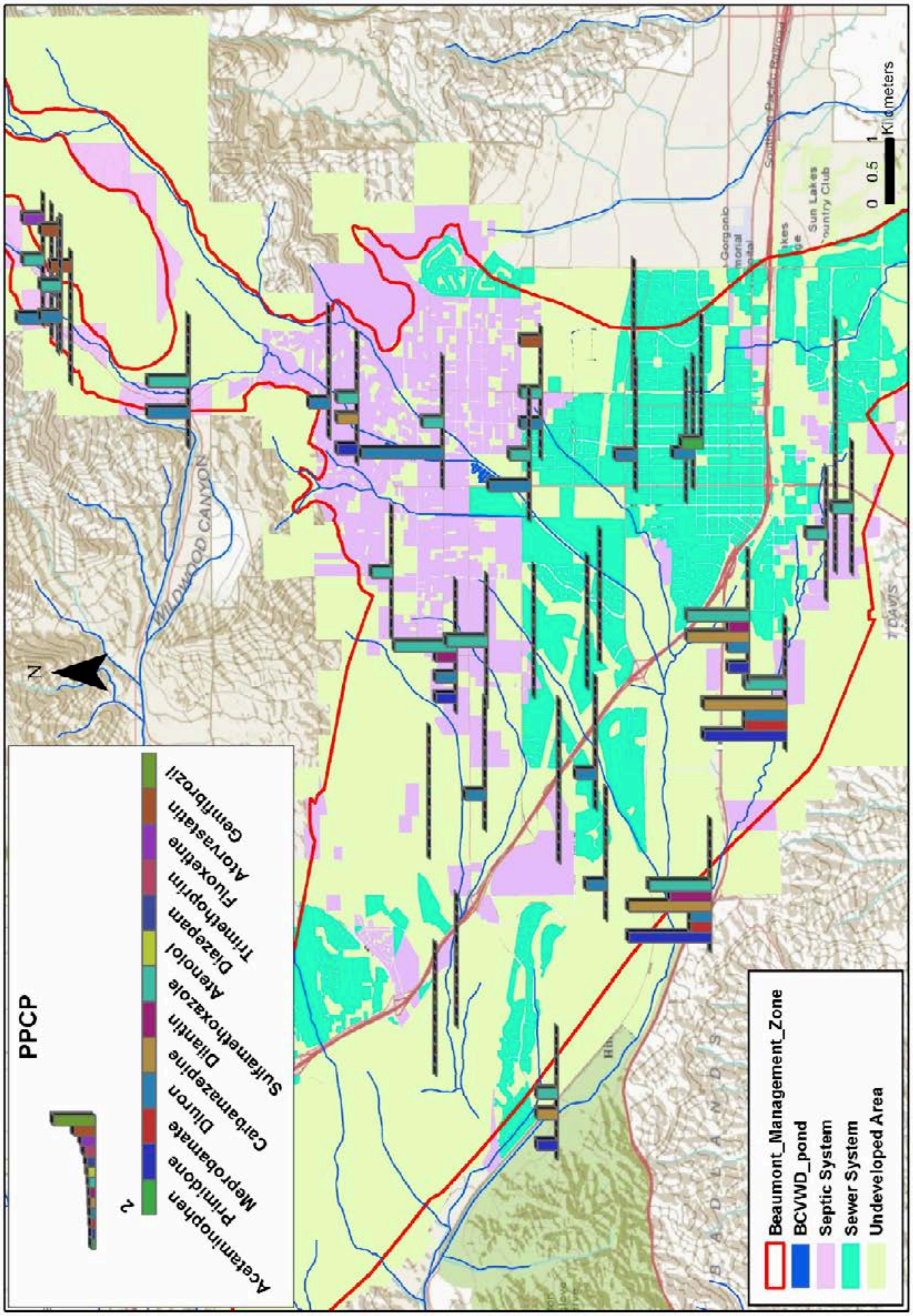



Figure 30. Concentrations of pharmaceutical and personal care products (PPCPs) of groundwater within and adjacent to the Beaumont Management Zone. Different colors indicate different PPCP compounds and the bar scale indicates the rank of PPCP concentration (0-4).

73

## PPCP Index, Beaumont Management Zone

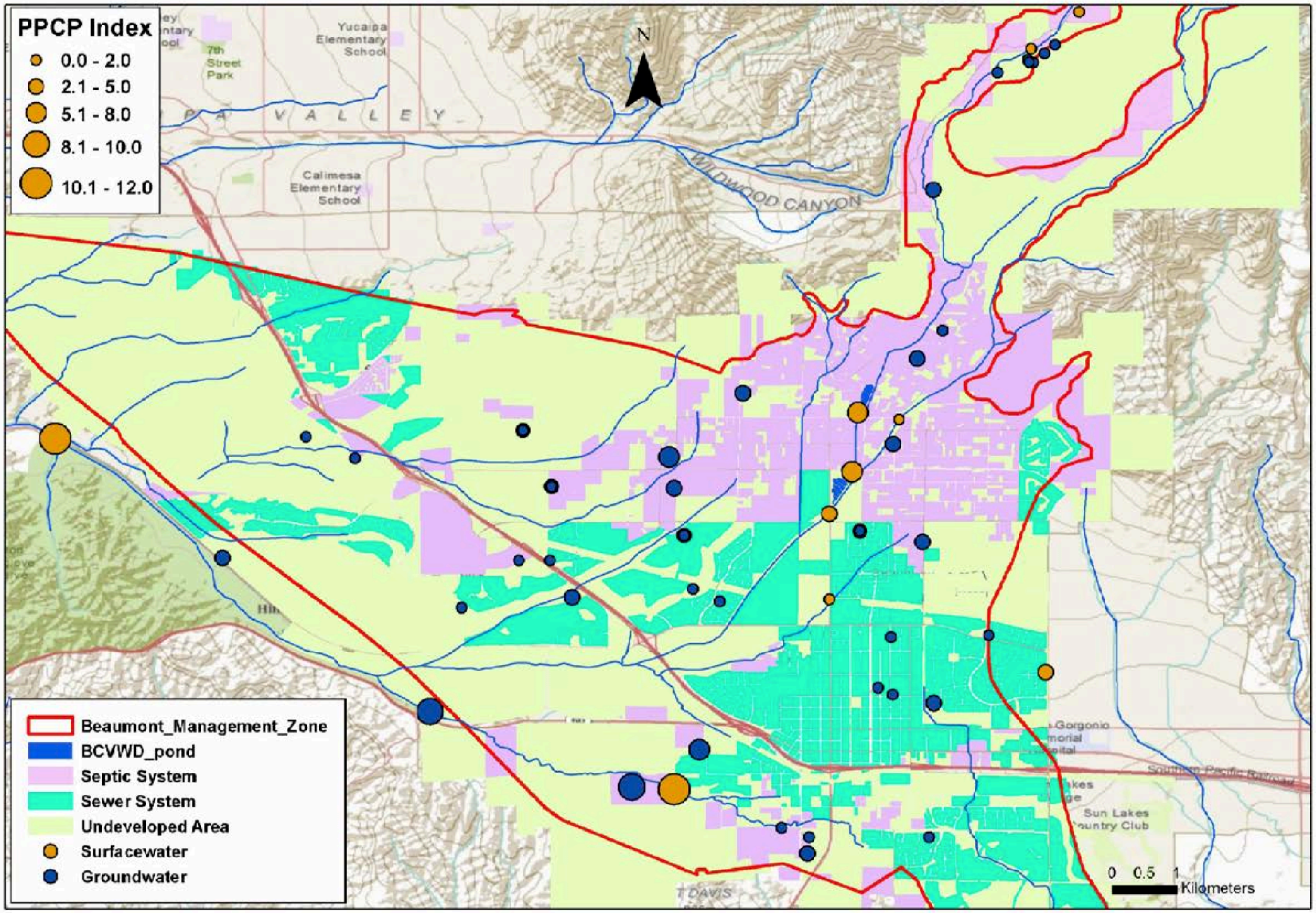



Figure 31. Index of pharmaceutical and personal care products (PPCPs) of groundwater within and adjacent to the Beaumont Management Zone. The higher the index value the higher the probability of groundwater contamination by human waste. Blue symbols denote groundwater and gold symbols are surface water.

74

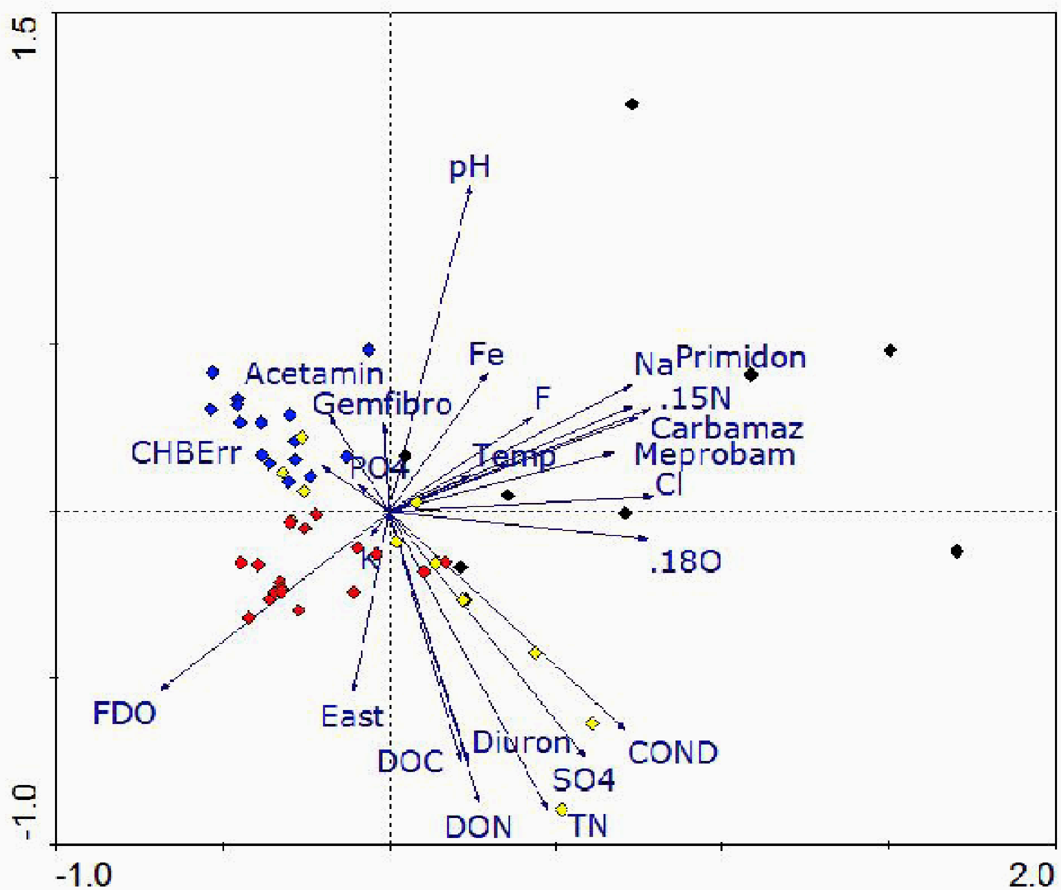



Figure 32. Principal component analysis (PCA) analysis of groundwater within and adjacent to the Beaumont Management Zone. This PCA represents measured environmental variables (arrows) in our dataset after removal of autocorrelated variables. Each arrow points in the direction of increasing values for the corresponding variable. The length of arrow is a measure of that variable's importance in explaining chemical variation among the sampling sites. Black diamond – Zone 1; Red diamond – Zone 2; Yellow diamond – Zone 3; Blue diamond – Zone 4.

| env var code | description |
|---|---|
| E or East | Easting |
| N or North | Northing |
| T or Temp | Field Temp |
| FDO | Field Dissolved Oxygen |
| pH | pH |
| SC | Specific Cond. |
| A.N.C. | A.N.C. |
| TDS | TDS (total dissolved solid) |
| DOC | DOC |
| $HCO_3$ | $HCO_3$ |
| F | F |
| Cl | Cl |
| $NO_2$ | $NO_2$ |
| $NO_3$ | $NO_3$ |
| $PO_4$ | $PO_4$ |
| $SO_4$ | $SO_4$ |
| $NO_3$-N | $NO_3$-N |
| TN | TN |
| DON | DON |
| Ca | Ca |
| Mg | Mg |
| Na | Na |
| K | K |
| Al | Al |
| B | B |
| Fe | Fe |
| P | P |
| CHBErr | Charge balance error |
| $\delta^{18}O$ | $\delta^{18}O$ |
| $\delta^{15}N$ | $\delta^{15}N$ |
| $\delta^{18}O/\delta^{15}N$ | $\delta^{18}O/\delta^{15}N$ |
| Acetamino | Acetaminophen |
| Primidone | Primidone |
| Meprobam | Meprobamate |
| Diuron | Diuron |
| Carbamaze | Carbamazepine |
| Dilantin | Dilantin |
| Sulfametho | Sulfamethoxazole |
| Atenolol | Atenolol |
| Diazepam | Diazepam |
| Trimethopri | Trimethoprim |
| Fluoxetine | Fluoxetine |
| Atorvastatin | Atorvastatin |
| Ibuprofen | Ibuprofen |
| Naproxen | Naproxen 75 |
| Diclofenac | Diclofenac |
| Gemfibrozil | Gemfibrozil |

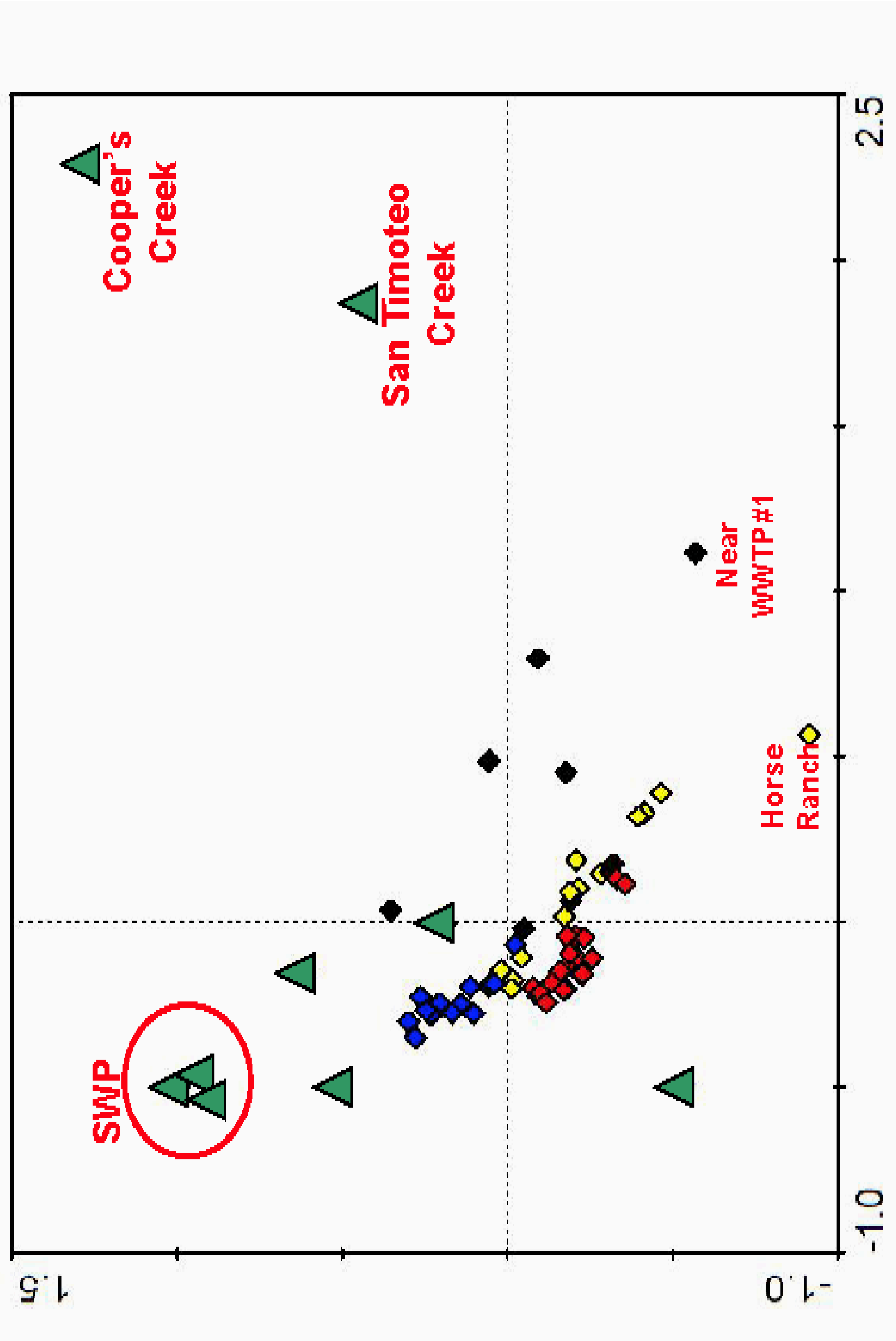



Figure 33. Cluster analysis of groundwater and surface water in Beaumont management zone. Black diamonds – Zone 1 groundwater; Red diamonds – Zone 2 groundwater; Yellow diamonds – Zone 3 groundwater; Blue diamonds – Zone 4 groundwater; Green triangles – Surface water.

76

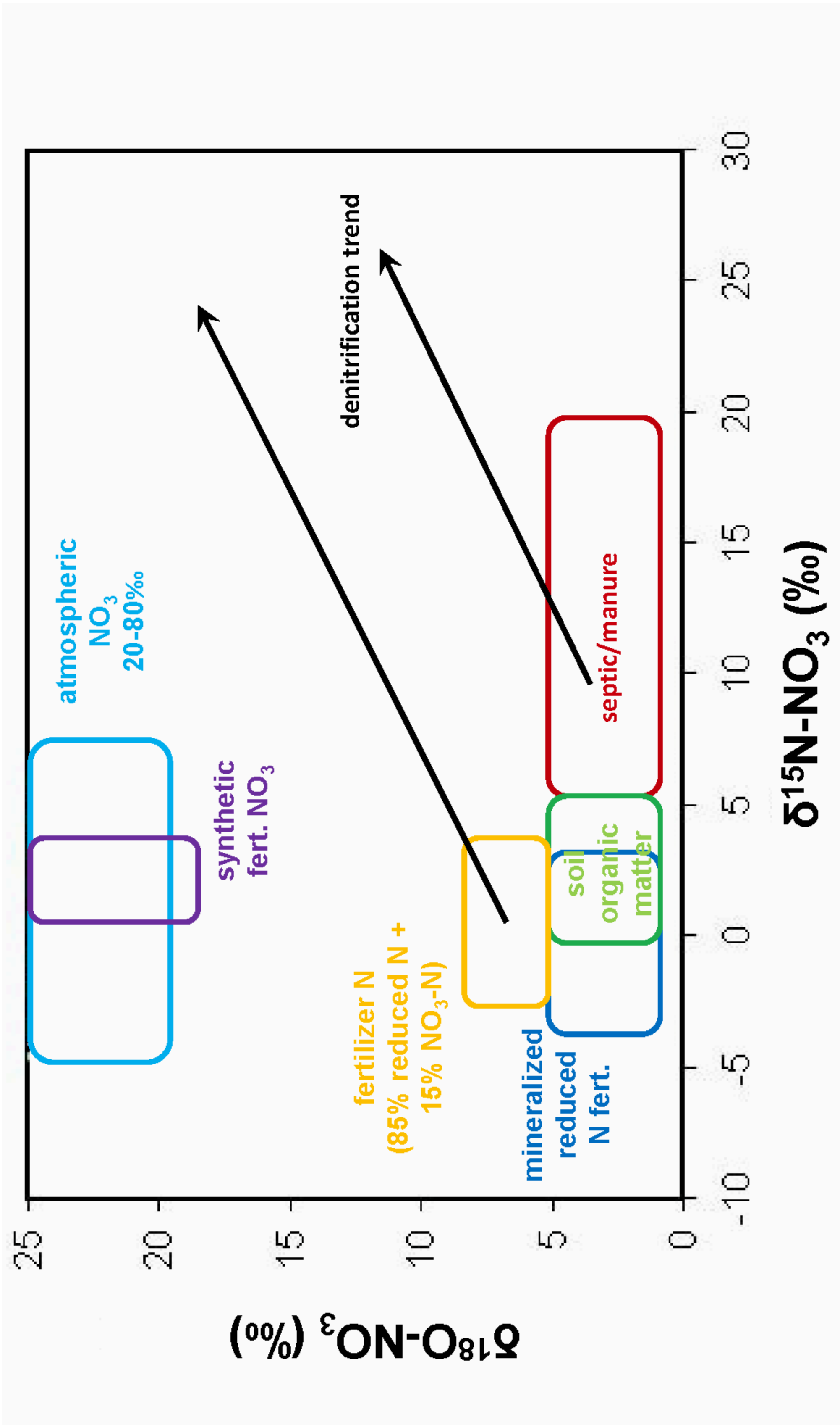



Figure 34. Crossplot of typical $\delta^{18}O-NO_3$ and $\delta^{15}N-NO_3$ values for different nitrate sources and the trend of isotopic compositions caused by denitrification (estimated based on Roadcap et al. 2002, Kendall and McDonnell 1998 and data in this study)

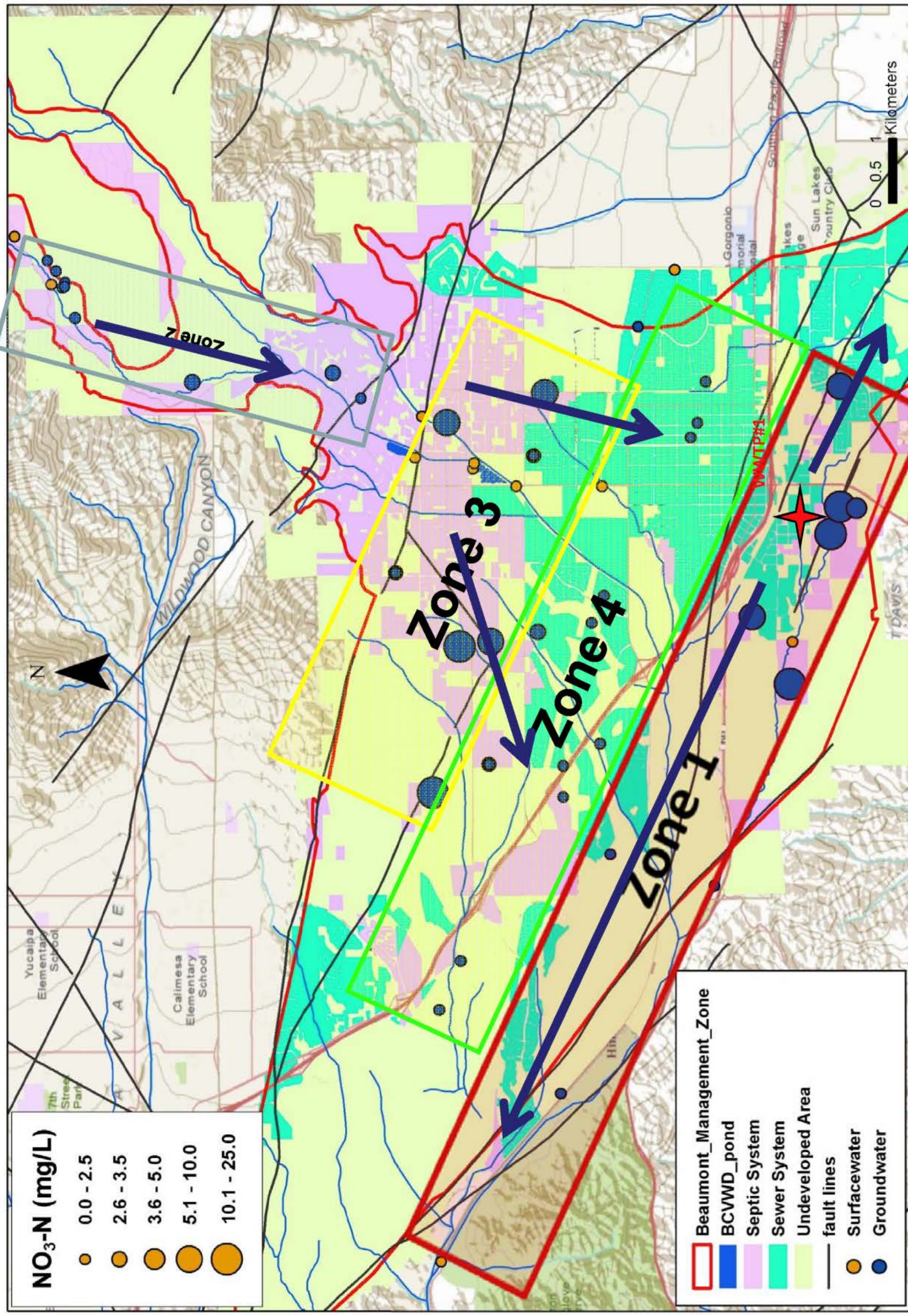



Figure 35a. Nitrate-nitrogen concentration corresponding with different zones in Beaumont Basin. The blue arrows indicate general horizontal flow paths for groundwater. 78

## Nitrate-Nitrogen Concentration, Beaumont Management Zone 3

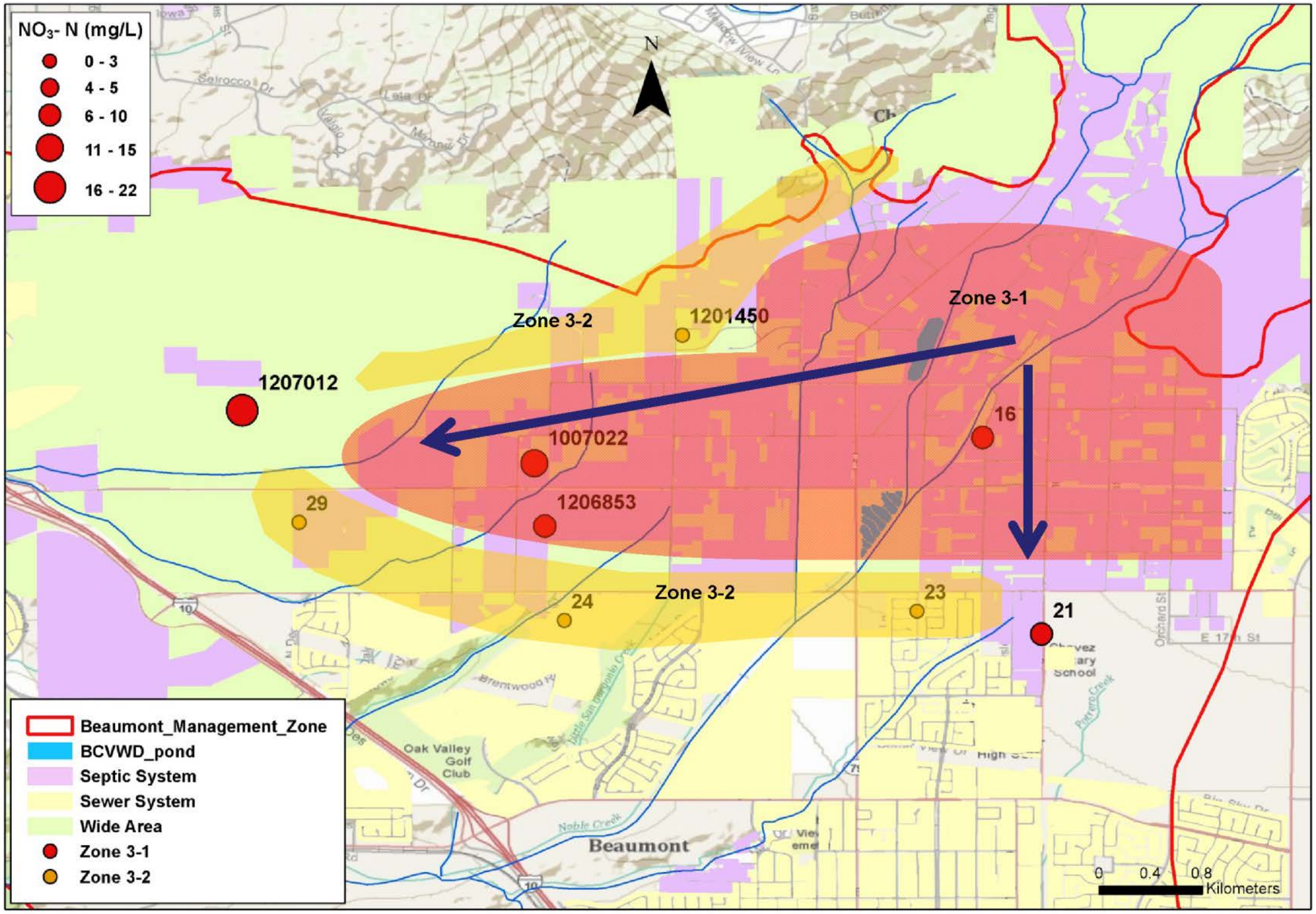



Figure 35b. Nitrate-nitrogen concentration of Zone 3 in Beaumont Basin. The blue arrows indicate general horizontal flow paths for groundwater.

79

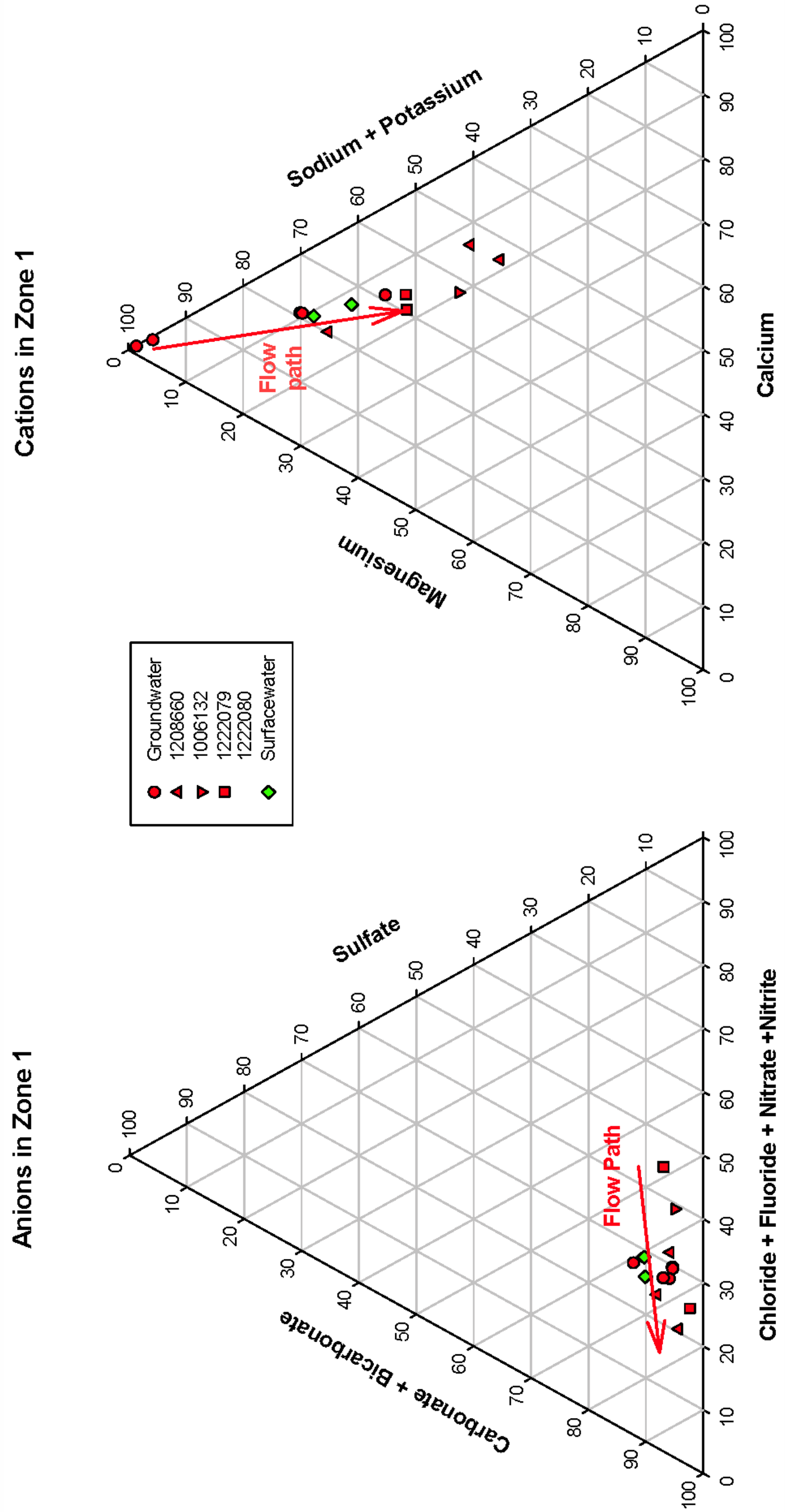



Figure 36. Variation of major ions along the general flow path in Zone 1.

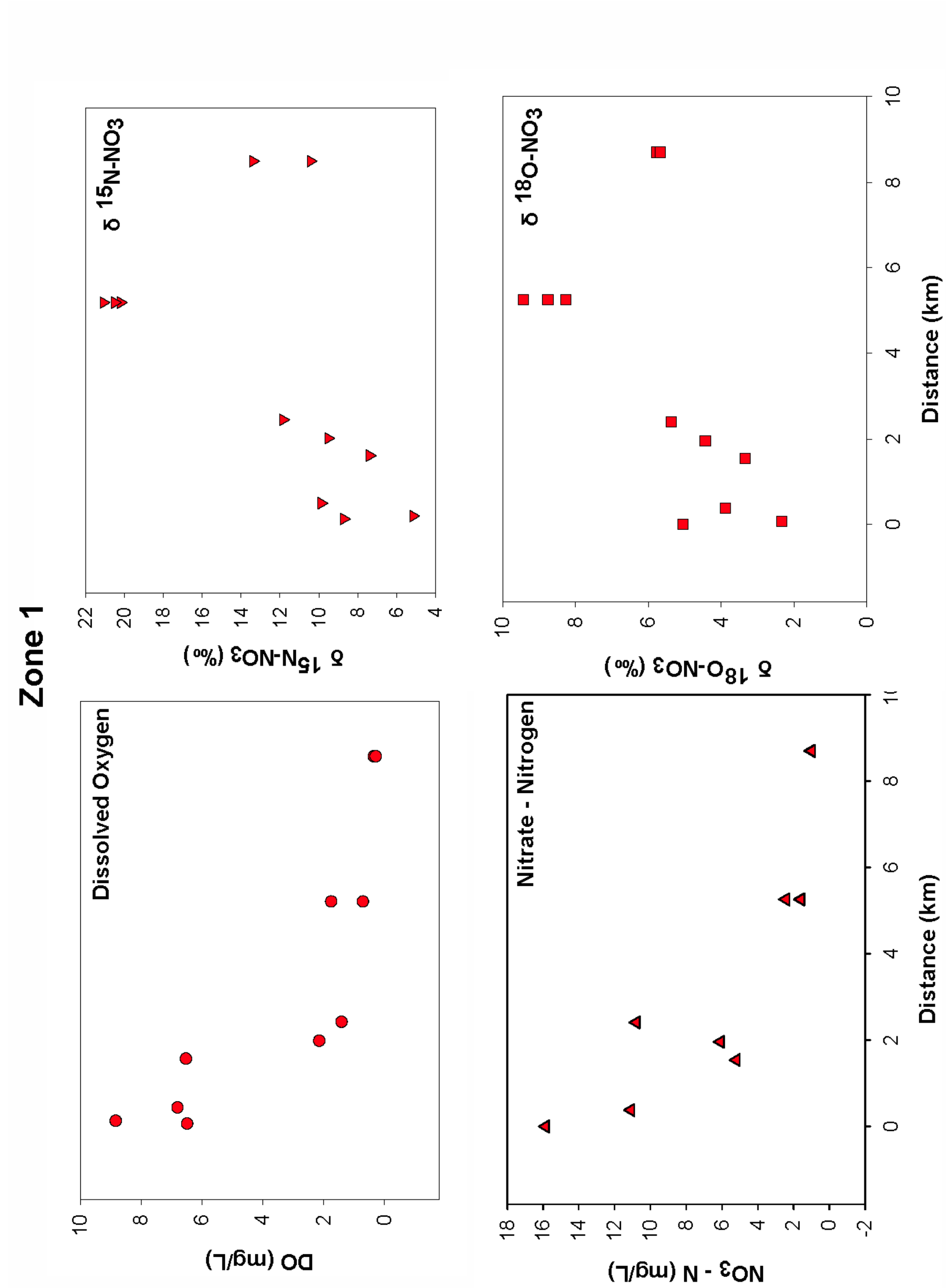



Figure 37. Variation of dissolved oxygen, nitrate concentration and isotopes along the general flow path in Zone 1

81

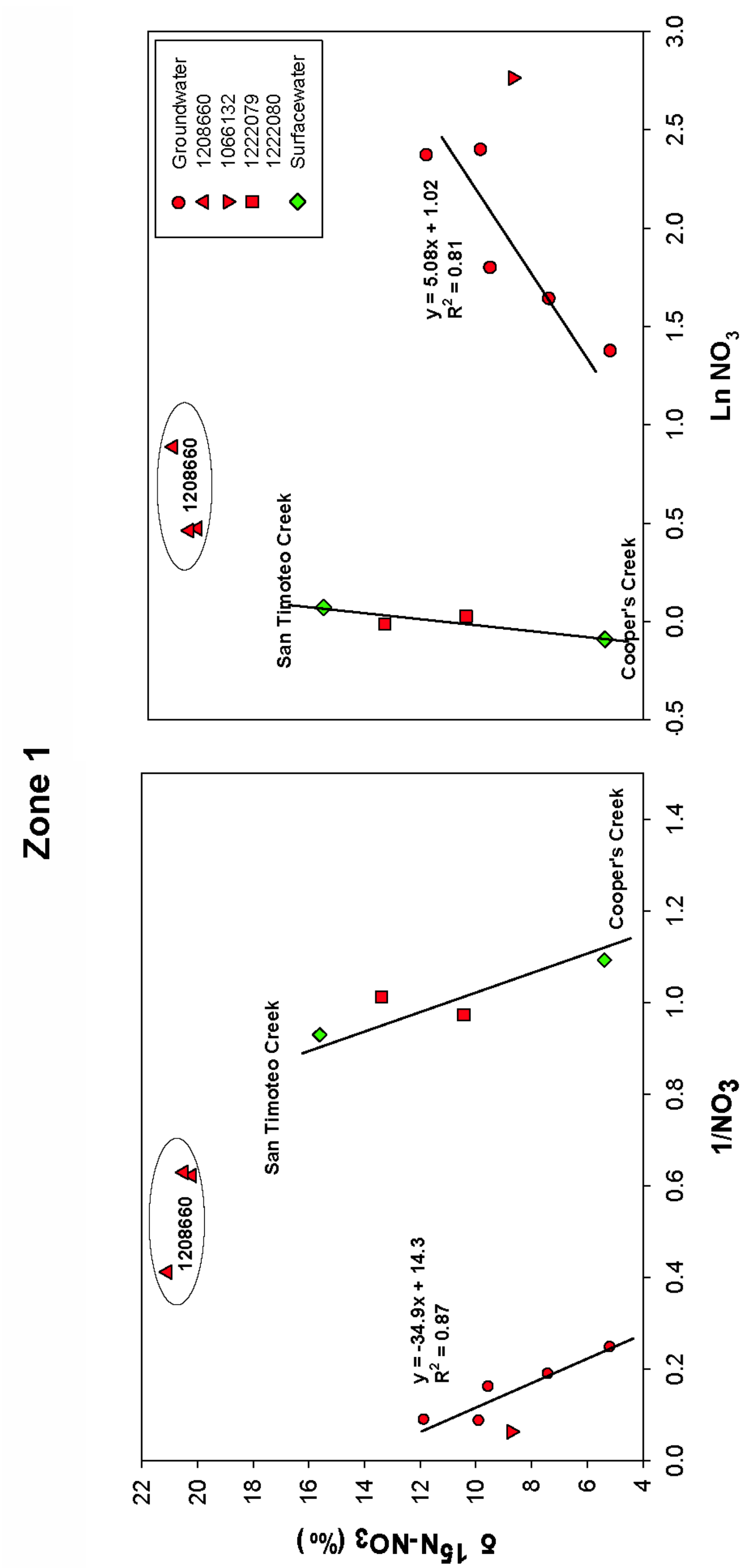



Figure 38. Relationships between $\delta^{15}N$ of nitrate and nitrate concentrations in Zone 1.

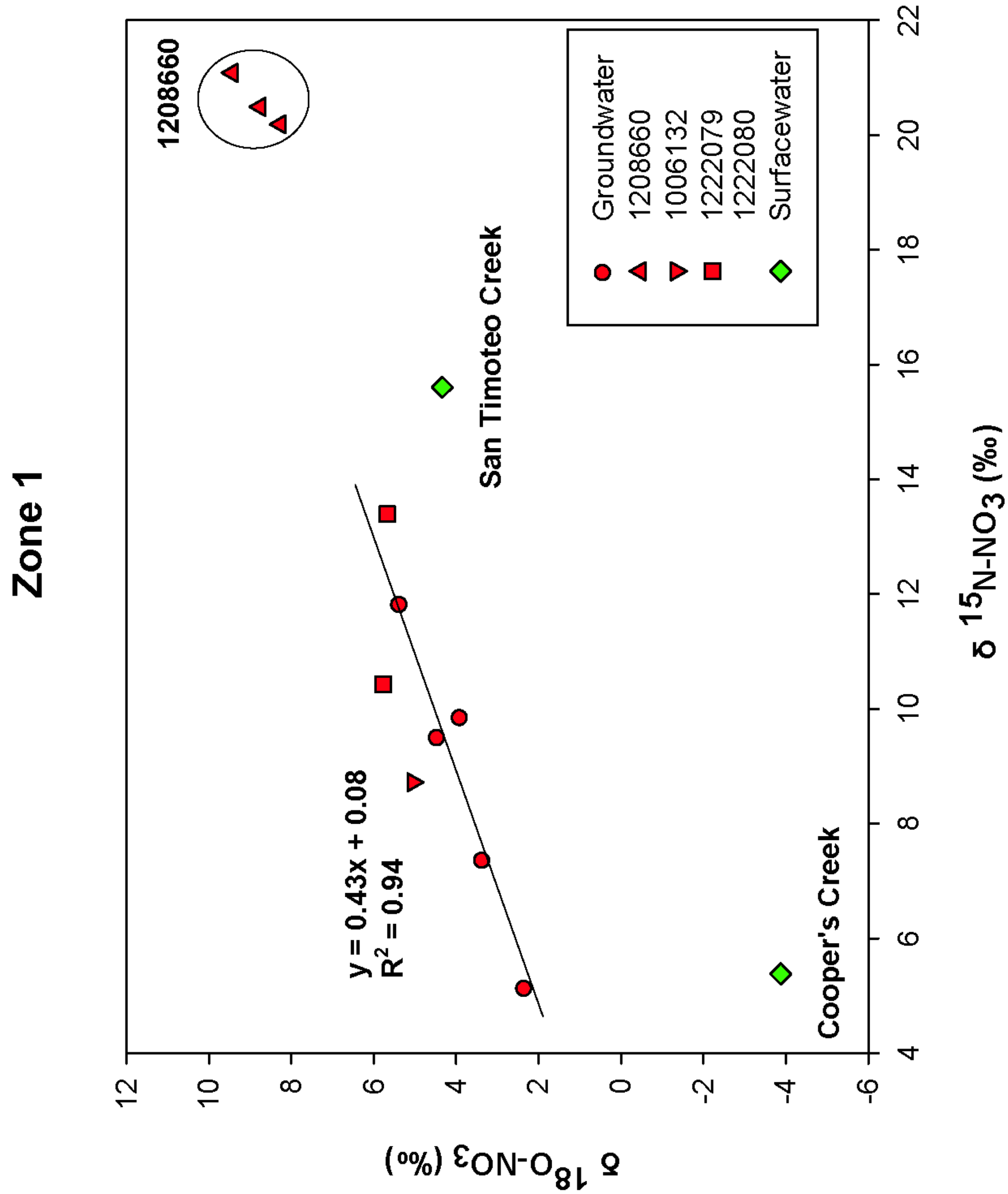



Figure 39. Relationship between $\delta^{15}N$ and $\delta^{18}O$ of nitrate in Zone 1.

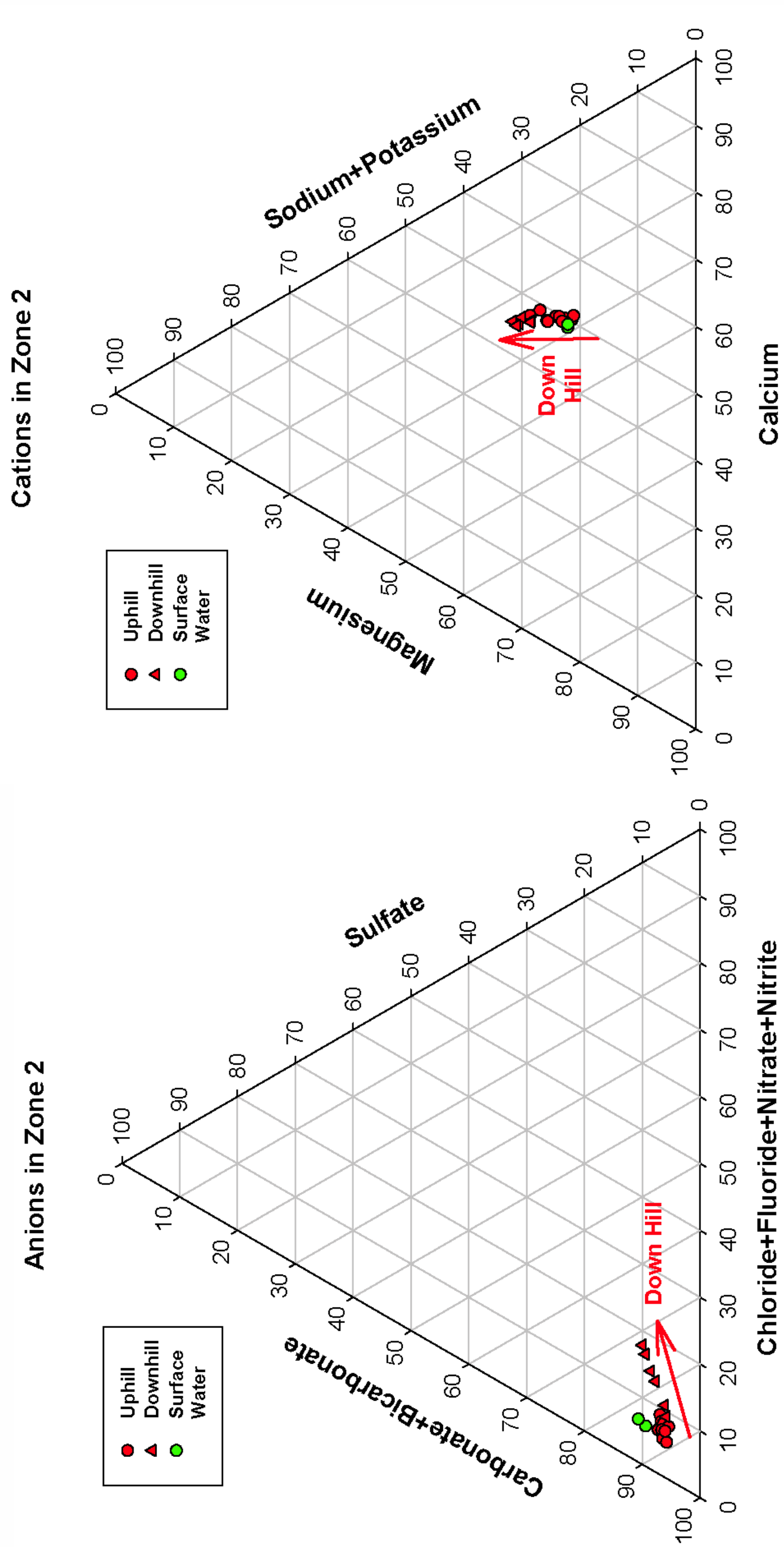



Figure 40. Variation of major ions moving along the general flow path in Zone 2.

84

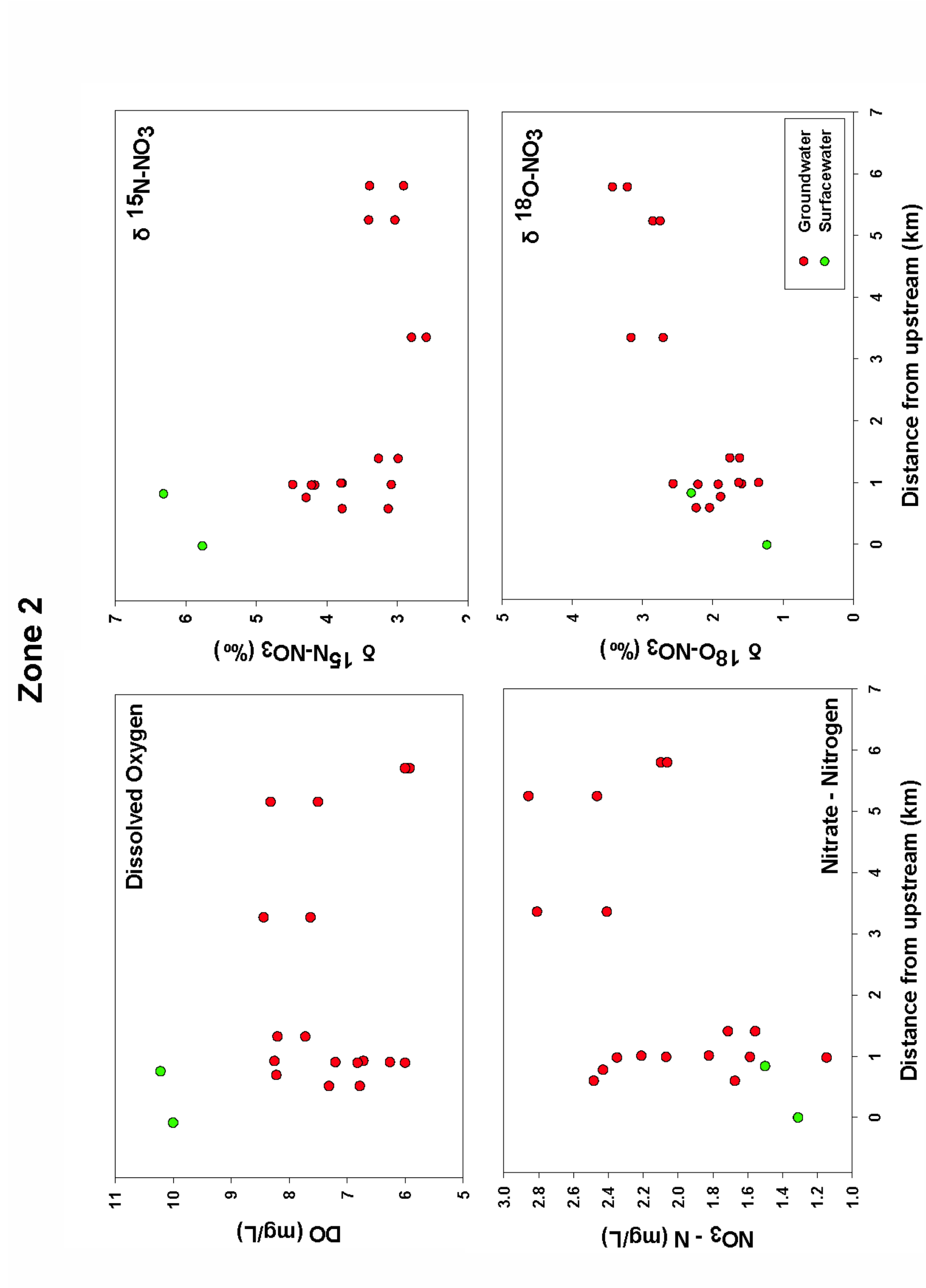



Figure 41. Variation of dissolved oxygen, nitrate concentration and isotopes moving along the general flow path in Zone 2.

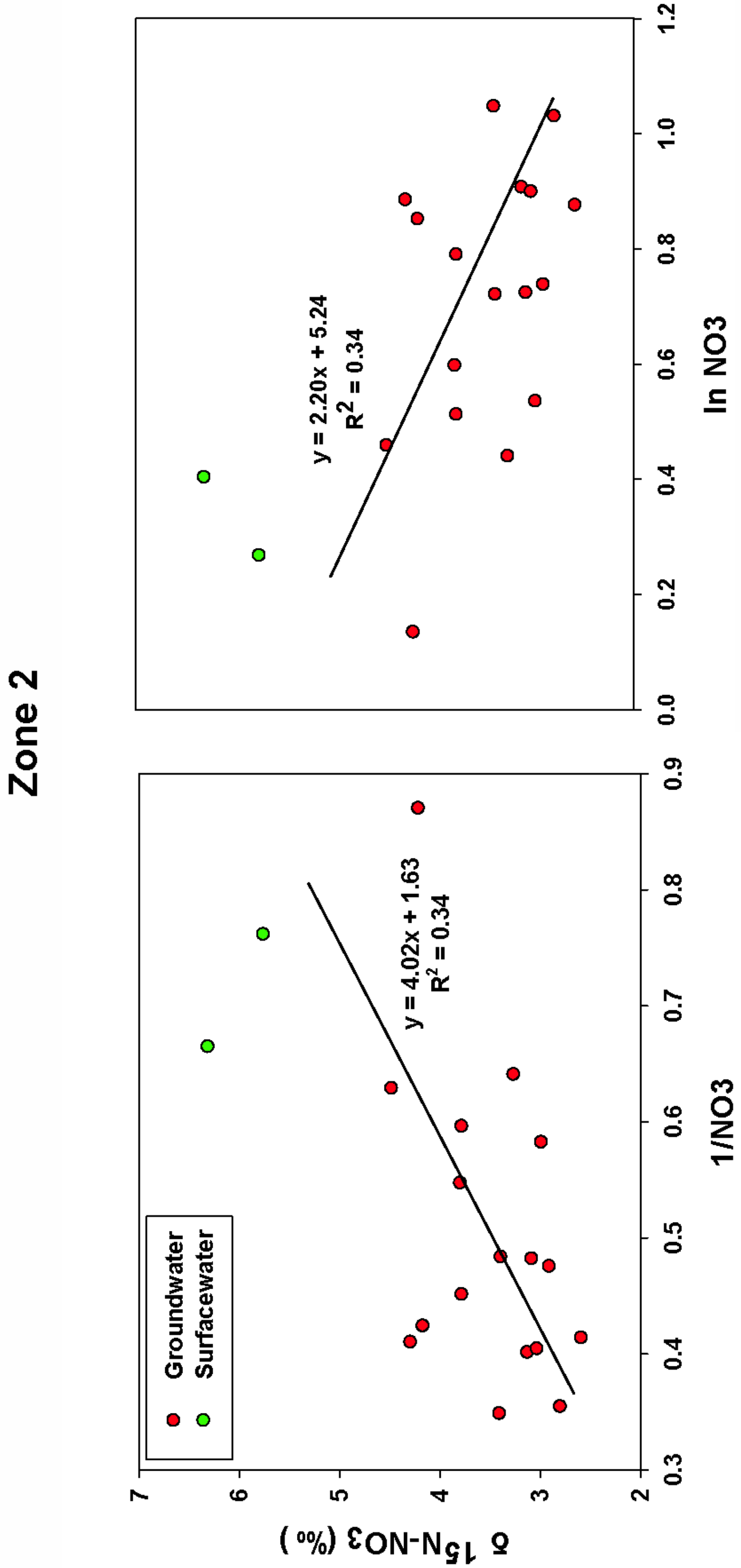



Figure 42. Relationships between $\delta^{15}N$ of nitrate and nitrate concentrations in Zone 2.

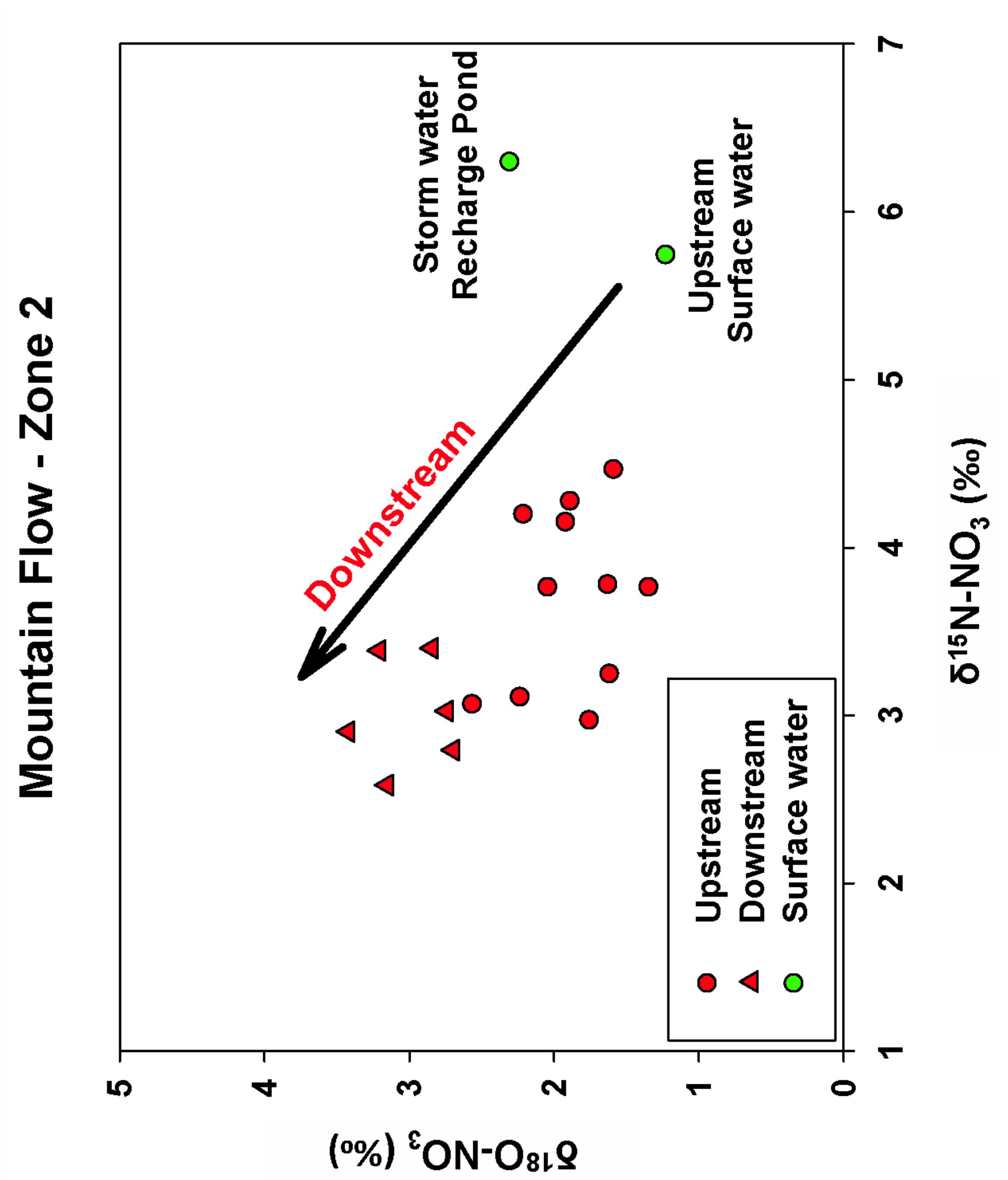



Figure 43. Relationship between $\delta^{15}N$ and $\delta^{18}O$ of nitrate in Zone 2.

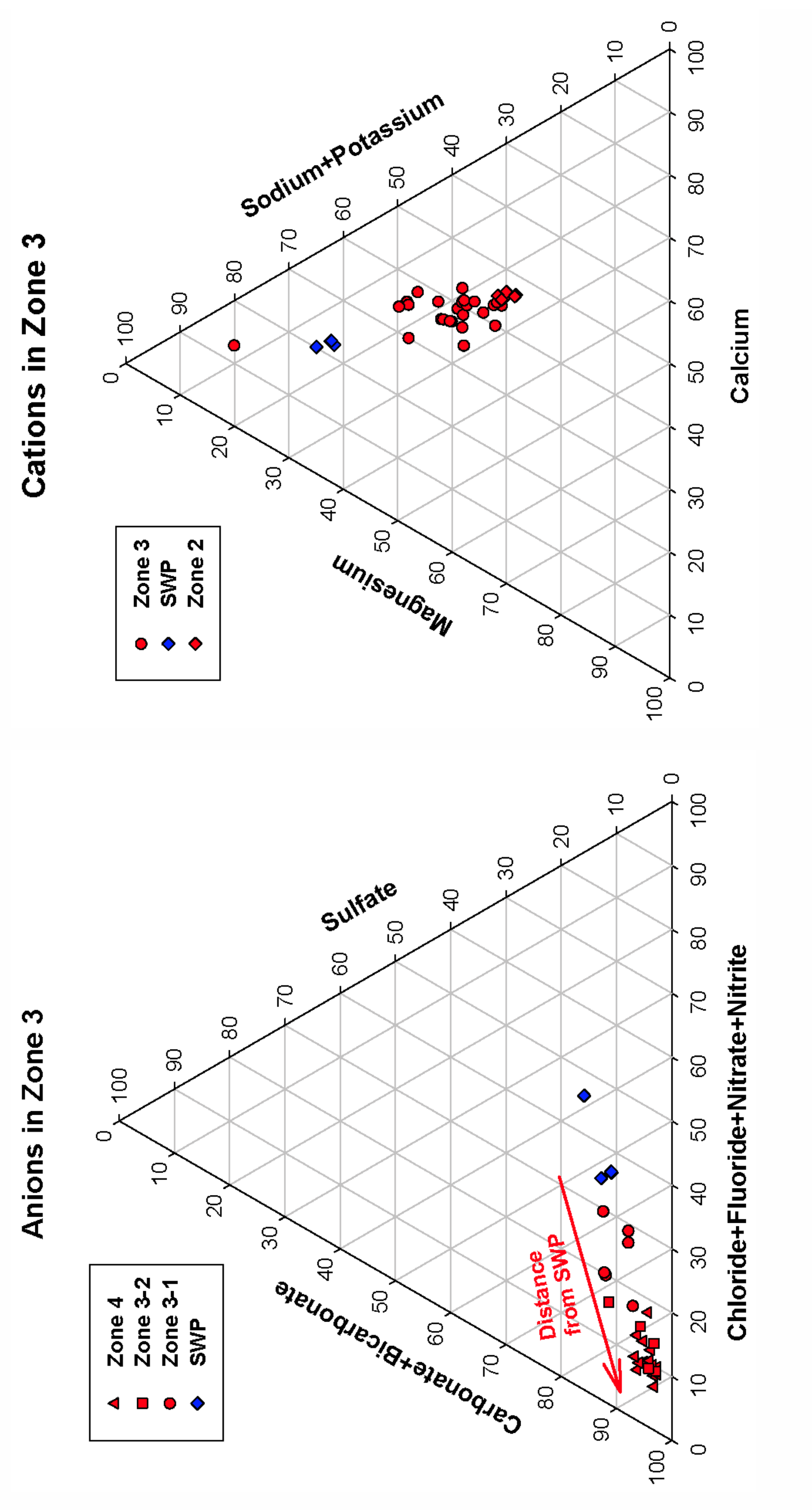



Figure 44. Variation of major ions moving away from groundwater recharge sites in Zone 3.

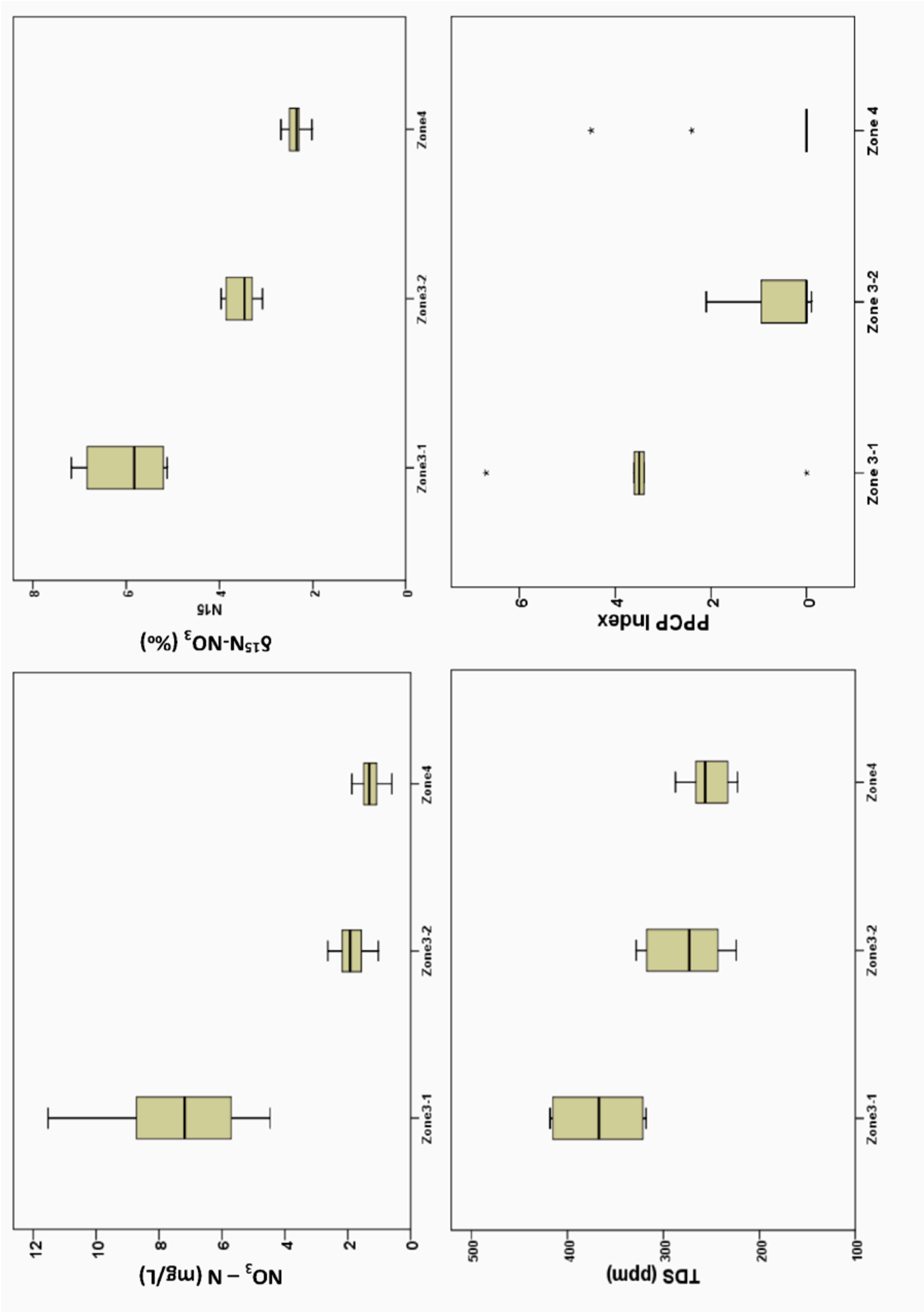



Figure 45. Comparison of groundwater nitrate concentration, nitrogen isotope, total dissolved solids and PPCP index in Zone 3-1, Zone 3-2 and Zone 4.

89

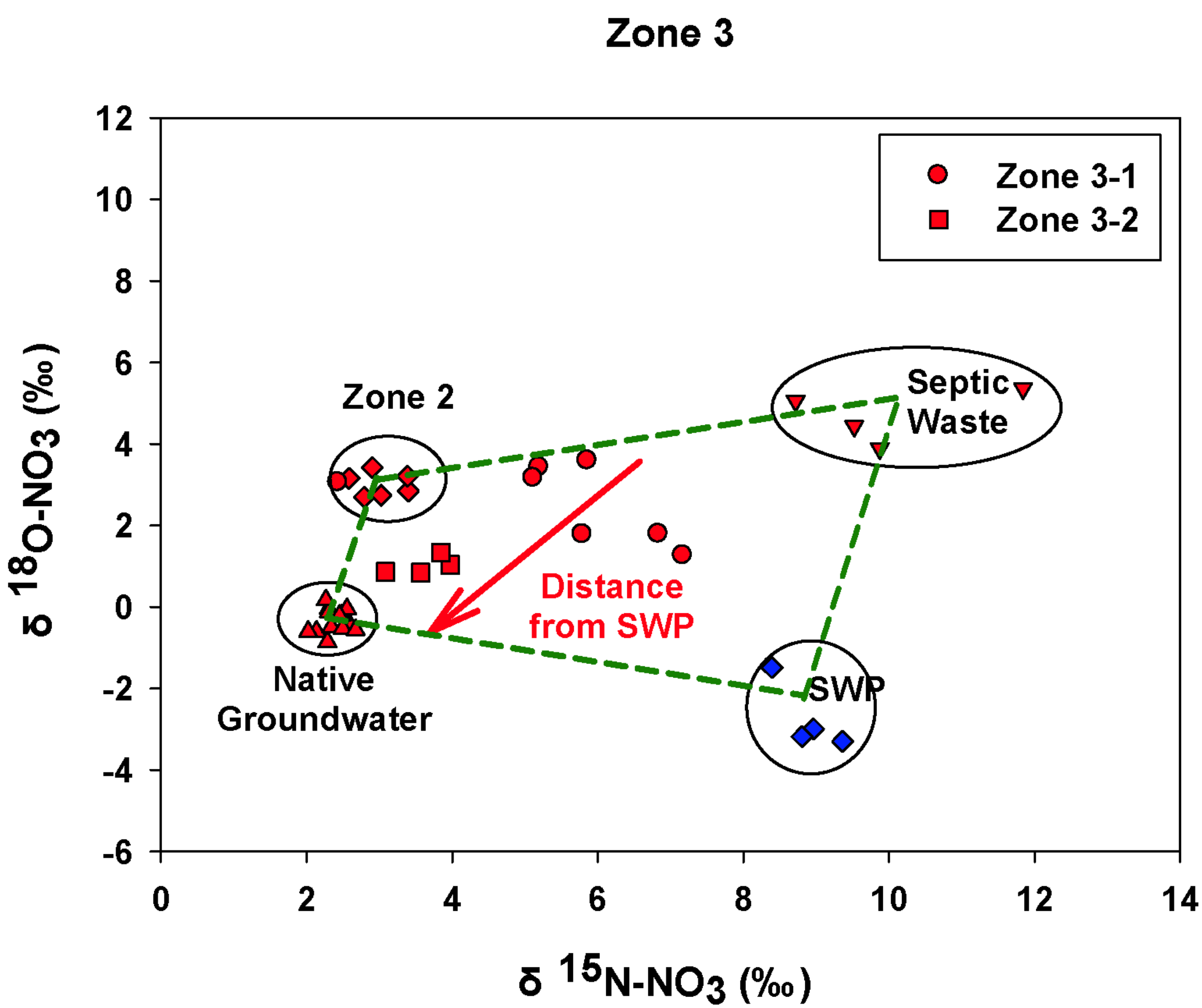



Figure 46. Relationship between $\delta^{15}N$ and $\delta^{18}O$ of nitrate in Zone 3. The septic waste endmember was estimated to be equal to WWTP #1 effluent measured in Zone 1. The green box denotes the 2-dimensional space defined by the four end members used in the isotope mixing analyses (Figures 47 and 48).

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# Zone 3-1

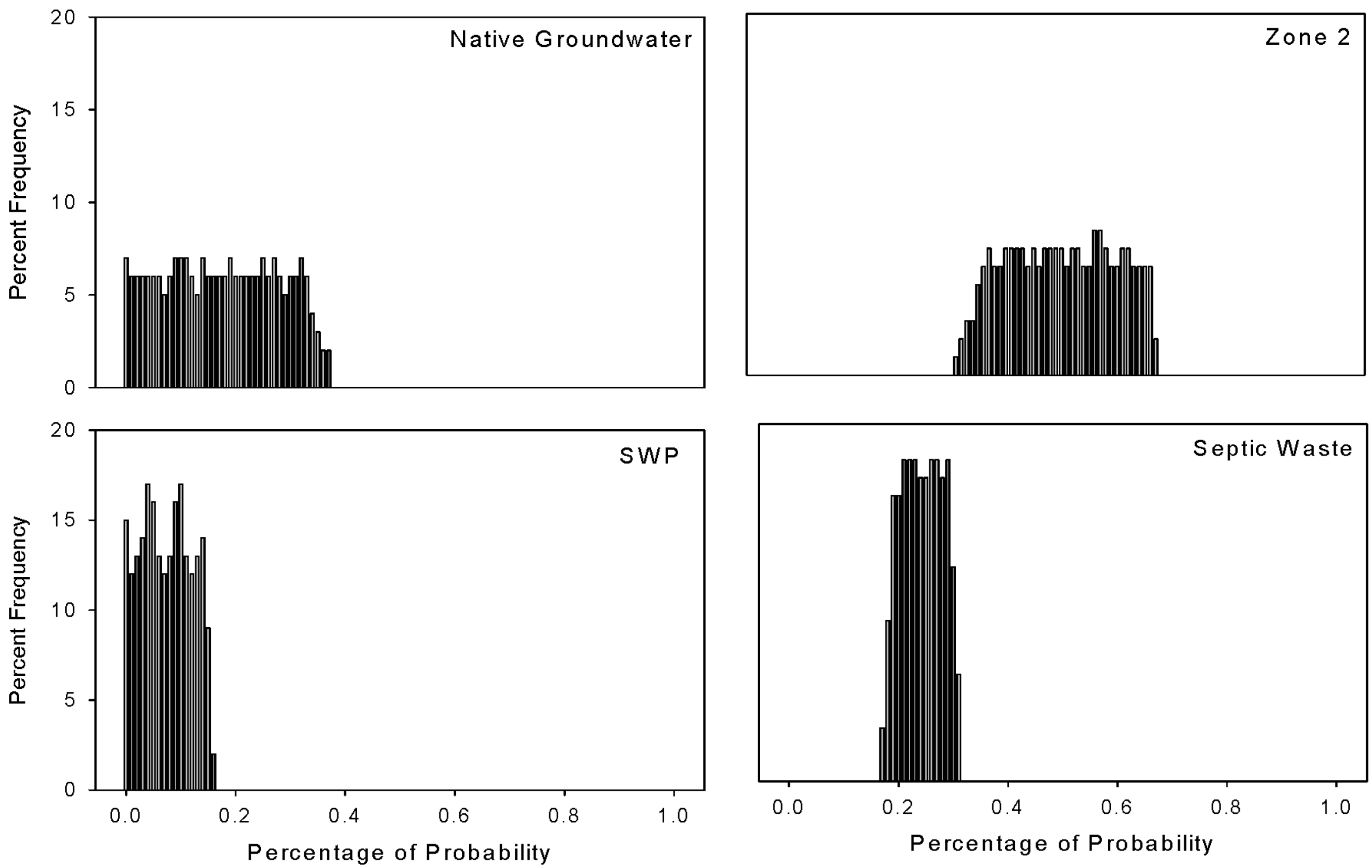


Figure 47. Nitrate contribution by different water sources in Central Cherry Valley, Zone 3-1: native groundwater; (estimated from Zone 4), mountain-front flow groundwater (estimated from Zone 2); SWP recharge; and septic waste (estimated to equal the isotopic composition of nitrate discharged from the City of Beaumont Wastewater Treatment Plant).

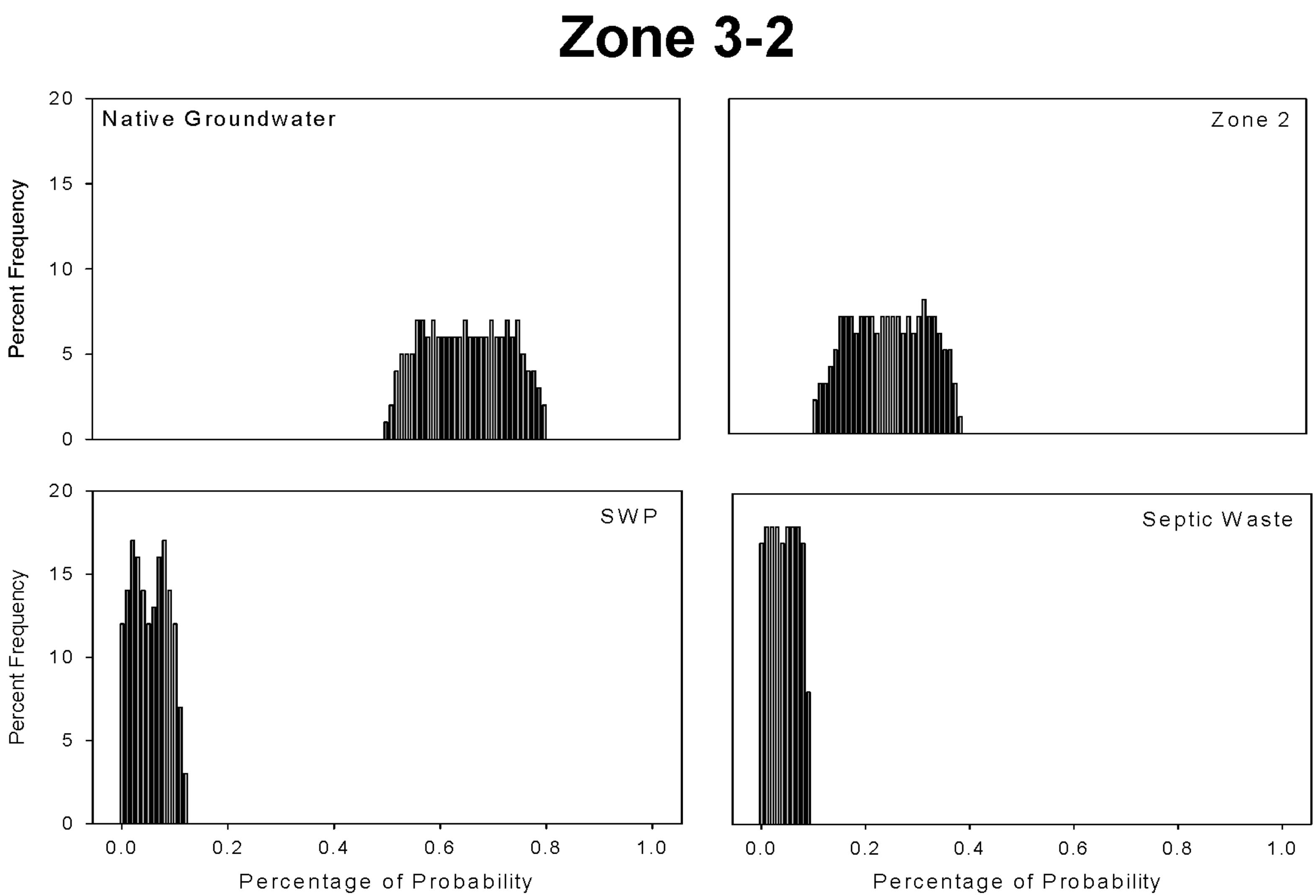


Figure 48. Nitrate contribution by different water sources in well peripheral to Cherry Valley, Zone 3-2: natural groundwater; (estimated from Zone 4), mountain-front flow groundwater (estimated from Zone 2); SWP recharge; and septic waste (estimated to equal the isotopic composition of nitrate discharged from the City of Beaumont Wastewater Treatment Plant).

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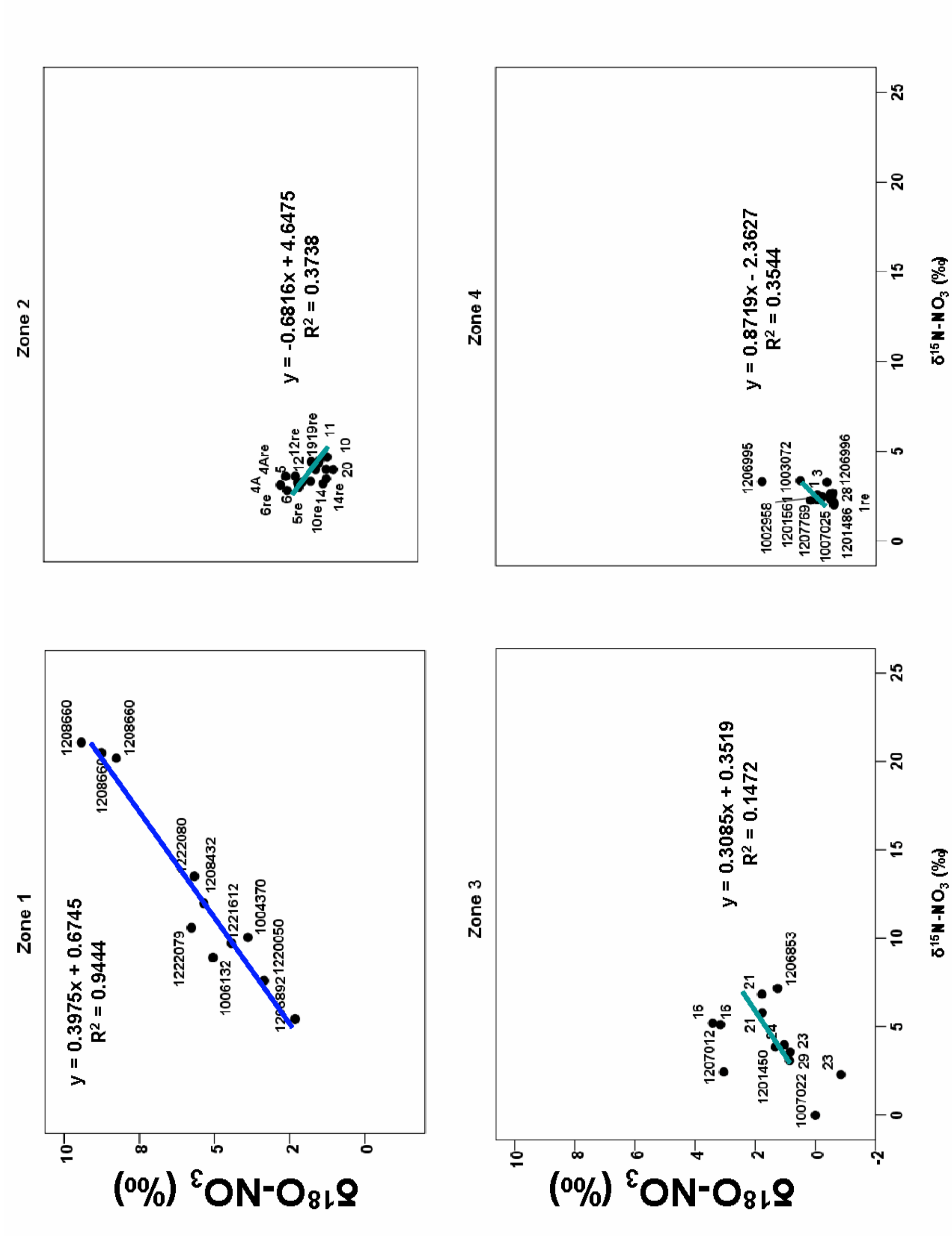


Figure 49. Summary of bi-plots of the isotopes of nitrate measured in groundwater zones within the BMZ. Labeled with sample ID.

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Yucaipa Valley Water District

# Workshop Memorandum 12-034

**Date:** **February 28, 2012**

**Subject:** **2011 Draft Delivery Reliability Report for the State Water Project**

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The Department of Water Resources has released the State Water Project Draft Delivery Reliability Report for 2011. This report assists State Water Project contractors and retail water agencies, like the Yucaipa Valley Water District, determine the adequacy of their imported water supply sources.

Overall, the report finds that future reliability of the State Water Project will continue to be affected by two significant factors: (1) operational restrictions on Delta pumping to protect species; and (2) climate change. The report notes that under existing conditions, the average annual amount of water exported from the Delta has decreased 12% since 2005.

At the board workshop, the District staff will provide an overview of the report and discuss specific implications related to our service area.

Comments on the draft report are due by March 12, 2012.

Additional Resources:

- Draft State Water Project Delivery Reliability Report 2011 (PDF - 19 MB):
- Draft State Water Project Delivery Reliability Report 2011 - Technical Addendum (PDF - 7 MB):
- View the input and output information for the CalSim-II studies described in the Draft State Water Project Delivery Reliability Report 2011 and Technical Addendum.

The State Water Project

# DRAFT Delivery Reliability Report 2011

January 2012

State of California
Natural Resources Agency
Department of Water Resources

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**Prepared by AECOM**

# Director's Message

The *State Water Project Delivery Reliability Report 2011* (2011 Report) is the latest update to a biannual report that describes the existing and future conditions for State Water Project (SWP) water supply that are expected if no significant improvements are made to convey water past the Sacramento–San Joaquin Delta (Delta) or to store the more variable runoff that is expected with climate change.

This report is presented in a different format than previous versions. The four previous reports were written for a dual audience—both the general public and those interested in a greater level of technical detail, such as the SWP contractors. By contrast, this report is written primarily with the public in mind. As a result, it not only provides updated information about the SWP's water delivery reliability, but is also designed to educate Californians about the SWP and its operations. This report presents a concise description of the historical events leading to the construction of the SWP and describes the SWP's facilities and operations. It then defines and explains the concept of water delivery reliability and the types of SWP water available to contractors, and describes various factors that affect the reliability of water deliveries. Because of the public interest in water project pumping from the Delta and the dependence of SWP water supply on Delta pumping, a new chapter has been added that focuses specifically on SWP pumping (exports) at the Harvey O. Banks Pumping Plant in the Delta.

The 2011 Report shows that the SWP continues to be subject to reductions in deliveries similar to those contained in the *State Water Project Delivery Reliability Report 2009* (2009 Report), caused by the operational restrictions of biological opinions (BOs) issued in December 2008 and June 2009 by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) to govern SWP and Central Valley Project operations. Federal court decisions have remanded the BOs to USFWS and NMFS for further review and analysis. We expect that the current BOs will be replaced sometime in the future. The operational rules defined in the 2008 and 2009 BOs, however, continue to be legally required and are the rules used for the analyses supporting the 2011 Report.

The following "Summary" includes key findings of the analyses in the 2011 Report. A technical addendum is also available which provides detail on the assumptions of the analyses and the results for the 2011 Report. The results of the studies, as presented in this report and the technical addendum, are designed to assist water planners and managers in updating their water management and infrastructure development plans. These results emphasize the need for local agencies to develop a resilient and robust water supply, and a distribution and management system to maximize the efficient use of our variable supply. They also illustrate the urgent need to improve the method of conveying water past the Delta in a more sustainable manner that meets the dual goals of increasing water delivery reliability and improving conditions for endangered and threatened fish species.

Mark Cowin
Director
California Department of Water Resources
January 2012

# Summary

This report is intended to inform the public about key factors important to the operation of the SWP and the reliability of its water deliveries.

California faces a future of increased population growth coupled with the potential for water shortages and pressures on the Delta. For many SWP water contractors, water provided by the SWP is a major component of all the water supplies available to them. SWP contractors include cities, counties, urban water agencies, and agricultural irrigation districts. These local utilities and other public and private entities provide the water that Californians use at home and work every day and that helps to nourish the state's bountiful crops. Thus, the availability of water to the SWP becomes a planning issue that ultimately affects the amount of water that local residents and communities can use.

The availability of these water supplies may be highly variable. A wet water year may be followed by a dry or even critical year. Knowing the probability that they will receive a certain amount of SWP water in a given year—whether it be a wet water year, a critical year, or somewhere in between—gives contractors a better sense of the degree to which they may need to implement increased conservation measures or plan for new facilities.

The Delta is the key to the SWP's ability to deliver water to its agricultural and urban contractors. All but three of the 29 SWP contractors receive water deliveries from the Delta (pumped by either the Harvey O. Banks or Barker Slough Pumping Plant).

Yet the Delta faces numerous challenges to its long-term sustainability. Among these are continued subsidence of Delta islands, many of which are already below sea level, and the related threat of a catastrophic levee failure as water pressure increases on fragile levees. Climate change poses the threat of increased variability in floods and droughts, and sea level rise complicates efforts to manage salinity levels and preserve water quality in the Delta so that the water remains suitable for urban and agricultural uses.

Protection of endangered and threatened fish species, such as the delta smelt, is also an important factor of concern for the

Delta. Ongoing regulatory restrictions, such as those imposed by federal biological opinions on the effects of SWP and CVP operations on these species, also contribute to the challenge of determining the SWP's water delivery reliability.

The analyses in this report factor in all of the regulations governing SWP operations in the Delta and upstream, and assumptions about water uses in the upstream watersheds.

Modeling was conducted that considered the amounts of water that SWP contractors use and the amounts of water they choose to hold for use in a subsequent year.

Many of the same specific challenges to SWP operations described in the *State Water Project Delivery Reliability Report 2009* (2009 Report) remain in 2011. Most notably, the effects on SWP pumping caused by issuance of the 2008 and 2009 federal biological opinions, which were reflected in the 2009 Report, continue to affect SWP delivery reliability today. The analyses in this report factor in climate change and the effects of sea level rise on water quality, but do not incorporate the probability of catastrophic levee failure. The resulting differences between the 2009 and 2011 Reports can be attributed primarily to updates in the modeling assumptions and inputs.

As noted in the discussion of SWP exports in Chapter 5 of this report, Delta exports (that is, SWP water of various types pumped by and transferred to contractors from the Banks Pumping Plant) have decreased since 2005, although the bulk of the change occurred by 2009 as the federal BOs went into effect, restricting operations. These effects are also reflected in the SWP delivery estimates provided in Chapters 6 and 7 of this report. Chapters 6 and 7 characterize the SWP's water delivery reliability under existing conditions and future conditions, respectively. The following are a few of the key points from Chapters 5, 6, and 7:

- Estimates of average annual SWP exports under conditions that exist for 2011 are 2,607 taf, 350 taf or 12% less than the estimate under 2005 conditions.
- The estimated average annual SWP exports decrease from 2,607 taf/year to 2,521 taf/year (86 taf/year or about 3%) between the existing- and future-conditions scenarios.
- Under existing conditions, the average annual delivery of Table A water estimated for this 2011 Report is 2,524 taf/year, 41 taf (2%) more than the 2,483 taf/year estimated for the 2009 Report.
- Under future conditions, the average annual delivery of Table A water estimated for this 2011 Report is 2,466 taf/year, about 1% less than the 2,487-taf/year estimate for the future-conditions scenario presented in the 2009 Report.
- The likelihood of SWP Article 21 deliveries (supplemental deliveries to Table A water) being equal to or less than 20 taf/year has increased relative to that estimated in the 2009 Report. However, both this report and the 2009 Report show a high likelihood that Article 21 water deliveries will be equal to or less than 20 taf/year, ranging between 71% and 78% for both existing and future conditions.

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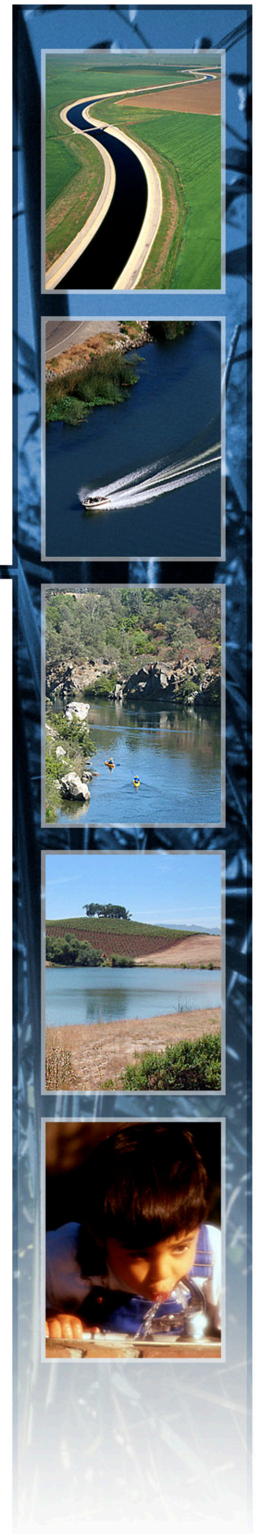

# Tables

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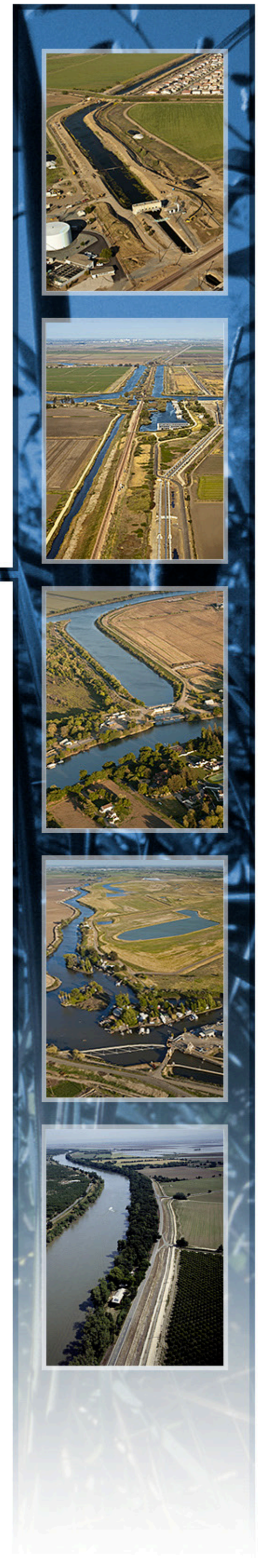


# Chapter 1

## Water Delivery Reliability: A Concern for Californians

California's water supplies are crucial to maintaining a high quality of life for the state's residents. The State Water Project (SWP), operated by the California Department of Water Resources (DWR), is an integral part of the effort to ensure that business and industry, urban and suburban residents, and farmers throughout much of California have sufficient water at all times. This *State Water Project Delivery Reliability Report 2011* describes the expected existing and future SWP water deliveries.

The term "water delivery reliability," as used in this report, is defined as the annual amount of SWP water that can be expected to be delivered with a certain frequency. To put this another way: What is the likelihood, or probability, that a certain amount of water will be delivered by the SWP in a year?

### Reasons to Assess SWP Water Delivery Reliability

Let's look at two important factors that underscore the importance of assessing the SWP's water delivery reliability: the effects of population growth on California's water supply, and State legislation intended to help maintain a reliable water supply.

#### Population Growth, Land Use, and Water Supply

Water and development have had a close yet complex relationship since California's early days. Indeed, the SWP was established in the wake of a second economic "gold rush" that began after the end of World War II. Increased statewide population and commerce made it clear to water managers that local water supplies (including groundwater) would not be sufficient to meet their communities' future needs.

Population growth and resulting development in California since World War II have been substantial, fueling the need for increased water supply.

California's population has grown rapidly in recent years, with resulting changes in land use. This growth is expected to continue. From 1990 to 2005, California's population increased from about 30 million to about 36.5 million. Based on this trend, California's population has been projected to be more than 47.5 million by 2020. The "current trends" scenario depicted in the *California Water Plan 2009* for year-2050 conditions assumed a population of nearly 60 million—double the 1990 population.

The amount of water available in California—or in different parts of the state—can vary greatly from year to year. Some areas may receive 2 inches of rain a year, while others are deluged with 100 inches or more. As land uses have changed, population centers have grown up in many locations where there is not a sufficient local water supply. Thus, Californians have always been faced with the problem of how best to conserve, control, and move water from areas of abundant water to areas of water need and use.

To help assure that their water supply is sufficient to meet their demands, water districts develop "water management portfolios" that reflect diversity in water sources and locations. Components of a sustainable water portfolio include conservation, improved efficiency in use, rainwater and runoff capture, use of groundwater aquifers for storage and treatment, improved water treatment, desalination, and a water recycling program.

## Legislation on Ensuring a Reliable Water Supply

The laws described below impose specific requirements on both urban and agricultural water suppliers. These laws increase the importance to water suppliers of estimates of SWP water delivery reliability.

### California Urban Water Management Planning Act

The California Urban Water Management Planning Act was enacted in 1983. As amended, this law (California Water Code, Sections 10610–10656) requires urban water suppliers to adopt water management plans every 5 years and submit those plans to DWR. Adoption of the most recent (2010) round of urban water management plans was required by July 1, 2011; the plans were due to DWR by August 1, 2011.

In their water management plans, urban water suppliers must assess whether their current and planned water supplies will be enough to meet the water demands expected during the next 20 years. The plans also consider various drought scenarios and the proper ways to respond in case of an unexpected water shortage.

DWR is required to review local water management plans and report on the status of these plans. DWR published a guidebook to preparing urban water management plans in March 2011. Guidance documents are available at http://www.water.ca.gov/urbanwatermanagement.

### Water Conservation Act

The Water Conservation Act of 2009 (Senate Bill X7.7, Steinberg), enacted in November 2009, includes distinct requirements related to both urban and agricultural water use.

This law requires that the State of California reduce urban per capita water use statewide by 10% by the end of 2015 and 20% by the end of 2020. DWR is required to report on progress toward meeting these urban per capita water use goals.

In addition, agricultural water suppliers must adopt agricultural water management plans by the end of 2012, then update the plans by the end of 2015 and every 5 years thereafter.

Through its Agricultural Water Management Planning & Implementation Program (http://www.water.ca.gov/wateruseefficiency/agricultural/agmgmt.cfm), DWR helps water districts develop agricultural water management plans and implement cost-effective, efficient water management practices. DWR is currently preparing a guidebook for developing agricultural water management plans.

## Background of This Report

This *State Water Project Delivery Reliability Report 2011* is the fifth in a series of reports on the SWP's water delivery reliability. DWR is legally required to prepare and distribute this report every 2 years to all SWP contractors (recipients of SWP water), city and county planning departments, and regional and metropolitan planning departments in the SWP's service area. Reports were previously produced for 2002, 2005, 2007, and 2009.

The requirement for a biennial water delivery reliability report was established in a settlement agreement among the Planning and Conservation League, DWR, SWP contractors, and others that was approved by the 3rd Circuit Court of Appeals in May 2003. The settlement agreement was reached in the aftermath of the "Monterey Amendments" case, which resolved a dispute about the environmental analysis of amendments to the long-term water supply contracts for the SWP that were entered into by DWR and most of the SWP contractors in the 1990s. The terms of the SWP contracts were amended after water shortages during the 1987–1992 drought drastically reduced SWP water deliveries to SWP contractors in the San Joaquin Valley and Southern California.

Attachment B to the settlement agreement specifies that each SWP delivery reliability report must include all of the following information:

- the overall water delivery capacity of the SWP facilities at the time of the report;
- the allocation of that SWP water to each SWP contractor;
- a discussion of the range of hydrologic conditions, which must include the historic extended dry cycle and long-term average; and
- the total amount of SWP water delivered to all contractors and the amount of SWP water delivered to each contractor during each of the 10 years immediately preceding the report.

DWR's water delivery reliability reports are used by various entities for water planning purposes. The reports must be presented in a format understandable by the public. The information presented in the reports is intended to help local agencies, cities, and counties that use SWP water to develop adequate, affordable water supplies for their communities.

## Contents and Use of This Report

The following topics are addressed in this *State Water Project Delivery Reliability Report 2011*:

- The Summary at the front of this report briefly summarizes the updated findings on water delivery reliability detailed in previous chapters.
- Chapter 1, "Water Delivery Reliability: A Concern for Californians," summarizes important issues (including selected State legislation) that underlie the need to assess the SWP's water delivery reliability, provides background on DWR's water delivery reliability reports, and defines key terms.
- Chapter 2, "A Closer Look at the State Water Project," describes the SWP's purpose, background, and facilities. This chapter also introduces factors that interact in the Sacramento–San Joaquin Delta (Delta) to affect SWP operations: precipitation and snowmelt patterns, variable river inflows, operations of the federal Central Valley Project (CVP), Delta water quality concerns, regulatory requirements, and the Delta's physical conditions.
- Chapter 3, "SWP Contractors and Water Contracts," lists the SWP water contractors and shows where they are located, and describes the different types of SWP water allocations.
- Chapter 4, "Factors that Affect Water Delivery Reliability," explains generally how water delivery reliability is calculated. The chapter then describes a variety of factors that make forecasting water delivery

reliability inherently challenging. Among these complicating factors are climate change, environmental and policy planning efforts pertaining to the Delta, and the potential for levee breaches in the Delta.

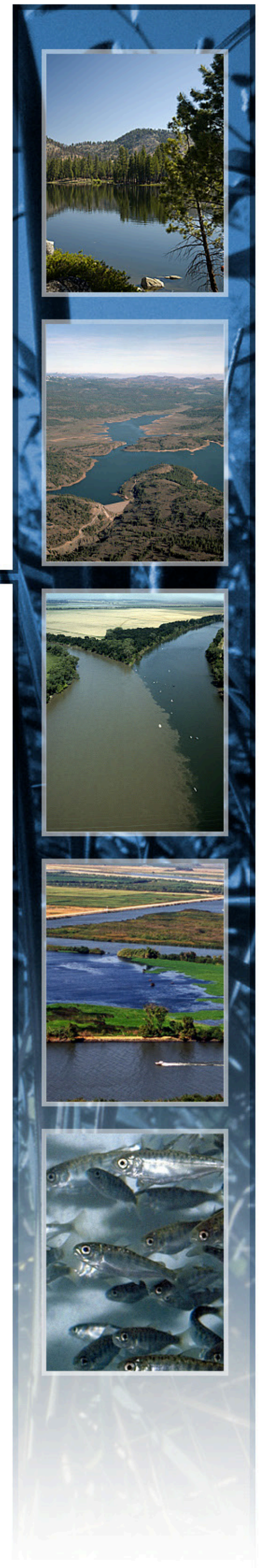
- Chapter 5, "SWP Exports," discusses how the delivery estimates for the SWP have been reduced as a result of more restrictive operational rules. This chapter also presents the results of DWR's modeling of SWP exports from the Harvey O. Banks Pumping Plant for existing conditions (2011) and future conditions (2031).
- Chapter 6, "Existing SWP Water Delivery Reliability (2011)," estimates the SWP's delivery reliability for existing conditions (2011) and compares these estimates with the existing-condition results presented in the *State Water Project Delivery Reliability Report 2009*.
- Chapter 7, "Future SWP Water Delivery Reliability (2031)," estimates the SWP's delivery reliability for conditions 20 years in the future (2031), reflecting potential hydrologic changes that could result from climate change. This chapter also compares these estimates with the future-condition results presented in the *State Water Project Delivery Reliability Report 2009*.
- Appendix A, "Historical SWP Delivery Tables for 2001–2012," presents the historical deliveries for SWP contractors over the last 10 years.

In addition, a technical addendum has been prepared for this report and includes more specific details of the technical analyses and results. Urban and agricultural water suppliers can use the information in this report and the technical addendum when they prepare or amend their water management plans. These details will help them decide whether they need new facilities or programs to meet future water demands. The technical addendum is available upon request and is posted online, along with this report, at http://baydeltaoffice.water.ca.gov.

Urban water suppliers can also use this information when, as required by the California Environmental Quality Act, they analyze whether enough water is available for proposed subdivisions or development projects.

# Chapter 2

## A Closer Look at the State Water Project



Northern California typically receives abundant rainfall and runoff from mountain snow pack. However, a larger percentage of California's population lives in Southern California and most irrigated farmland lies in Central California. These regions are mostly arid, and local water suppliers cannot fully meet the needs of many of their communities. These areas rely on additional imported water, especially to meet shortages during dry years and the demands of increasing populations. The SWP was constructed to help meet these needs.

### Purpose and Background of the SWP

The SWP is the largest state-built, multipurpose, user-financed water project in the United States. More than two-thirds of California's residents—25 million people—receive at least part of their water from the SWP. Project water also supplies thousands of industries and irrigates about 750,000 acres of California farmland. Of the SWP's contracted water supply, 70% goes to urban users and 30% goes to agricultural users.

The primary purpose of the SWP is to provide a water supply—that is, to divert and store water during wet periods in Northern and Central California and distribute it to areas of need in Northern California, the San Francisco Bay area, the San Joaquin Valley, the Central Coast, and Southern California. Other SWP purposes include flood control, power generation, recreation, fish and wildlife enhancement, and water quality improvement in the Delta.

These purposes have been discussed at length for many decades. The concept of a statewide water development project was first raised in 1919 when Lt. Robert B. Marshall of the U.S. Geological Survey proposed transporting water from the Sacramento River system to the San Joaquin Valley, then moving it over the Tehachapi Mountains into Southern California.

In the 1930s, State Engineer Edward Hyatt proposed the "State Water Plan," which identified the facilities needed and economic means to transfer water from north to south. The California Legislature authorized the project in the Central Valley Act of 1933, and a $170 million bond act was approved by California voters in December 1933. However, the Great Depression precluded the State from obtaining the necessary funding. The U.S. government funded the construction of major components of the plan, which became the federal CVP. (See "The Central Valley Project and Its Relationship to the SWP" later in this chapter.)

As California's population grew after World War II, investigations of statewide water resources resumed. In 1945, DWR's predecessor, the Division of Water Resources of the Department of Public Works, conducted a variety of studies that culminated in the Feather River Project, presented to the State Legislature in 1951 by State Engineer A. D. Edmonston. A revised project proposal was presented in 1955. The Legislature appropriated funds for detailed studies of the Feather River Project, which evolved to become the SWP.

In 1959, the Legislature passed the California Water Resources Development Bond Act. This law, also known as the Burns-Porter Act, authorized $1.75 billion in bonds to build the SWP's initial facilities, contingent on voter approval. After California voters approved the Burns-Porter Act in November 1960, construction of the SWP by DWR began in the early 1960s, with water deliveries following.

## SWP Facilities

Today, the SWP includes 33 storage facilities, 21 reservoirs and lakes, 20 pumping plants, four pumping-generating plants, five hydroelectric power plants, and about 700 miles of canals and pipelines. Figure 2-1 shows the primary SWP facilities.

### Facilities North of the Delta

The SWP's watershed encompasses the mountains and waterways around the Feather River in Plumas County. Rain and melting snow run off mountainsides and into waterways that flow into Lake Oroville, where the SWP officially begins. With a capacity of about 3.5 million acre-feet, Lake Oroville is the SWP's largest storage facility. The water management facilities of Lake Oroville are designed to maximize energy production and include six power generating units and six pumping/generating units. Three hydroelectric power plants operate at Oroville.

Oroville Dam.

When water is needed, Oroville Dam releases water into the Feather River, which converges with the Sacramento River north of the city of Sacramento. Releases from Shasta and Folsom Reservoirs, facilities of the federal CVP, also flow into the Sacramento River. The Sacramento River flows into the Delta, where it mixes with water from the San Francisco Bay and is influenced by the tides. From the Delta, some of this water is pumped by the Barker Slough Pumping Plant into the North Bay Aqueduct for municipal use by Napa and Solano Counties.


Figure 2-1. Primary State Water Project Facilities

### Facilities in the Delta and Central California

The SWP's primary pumping plant, the Harvey O. Banks Pumping Plant, is located in the south Delta in Alameda County. The pumps at the Banks Pumping Plant lift Delta water stored in the Clifton Court Forebay into the California Aqueduct, which at 444 miles long is the longest water conveyance system in California. At Bethany Reservoir, some SWP water is diverted from the California Aqueduct into the South Bay Aqueduct, which serves urban and agricultural uses in Alameda and Santa Clara Counties.

Harvey O. Banks Pumping Plant.

Water in the California Aqueduct flows into the San Luis Joint-Use Complex located in Merced County, which is jointly owned by the SWP and the CVP. Among the facilities at the complex is San Luis Reservoir, which is the world's largest offstream reservoir, with storage space for more than 2 million acre-feet of water. (An "offstream reservoir" is a water body that does not impede and store natural flows directly within a stream course, but instead is located "offstream"; stored water is diverted elsewhere and conveyed to the offstream reservoir by a pipeline or aqueduct.) Generally, water is pumped into San Luis Reservoir from late fall through early spring and is stored temporarily before being released back to the California Aqueduct to meet the higher summertime water demands of SWP (and CVP) contractors.

### Facilities in the San Joaquin Valley and Southern California

After leaving the San Luis Joint-Use Complex, water travels through the central San Joaquin Valley via a jointly owned federal/State portion of the California Aqueduct. Along the way, deliveries are made to San Joaquin Valley contractors of both the SWP and the CVP. Near Kettleman City in Kings County, the SWP's Coastal Branch Aqueduct branches off to serve SWP contractors in San Luis Obispo and Santa Barbara Counties. The California Aqueduct continues southeast until, at the base of the Tehachapi Mountains, it reaches the A. D. Edmonston Pumping Plant, the SWP's largest pumping station.

A. D. Edmonston Pumping Plant.

The Edmonston Pumping Plant, located in Kern County, is an engineering marvel. It is the highest single-lift pumping plant in the world. The 14 pumps at this facility, each weighing more than 400 tons and powered by 80,000-horsepower motors, raise water from the California Aqueduct 1,926 feet—more than one and one-half times the height of New York's Empire State Building—to enter 10 miles of tunnels and siphons that cross the Tehachapi Mountains.

After crossing the mountains, the water splits into two branches, the West Branch and East Branch, and is delivered to SWP contractors in Southern California. The southernmost SWP facility, located at the end of the East Branch, is Lake Perris in Riverside County.

## The Delta and Factors Affecting SWP Operations and Deliveries

The Delta forms the eastern portion of the San Francisco estuary. It is composed of 738,000 acres of land interlaced with hundreds of miles of waterways that receive runoff from about 40% of the state's land area. The Delta is one of the few estuaries in the world that is used as a major source of drinking water supply. The Delta is important not only to SWP operations, but to California's economy. About $400 billion of California's $1.5 trillion economy is supported by water from the Delta, as noted by DWR and the California Department of Fish and Game (DFG) in the 2008 report, *Risks and Options to Reduce Risks to Fishery and Water Supply Uses of the Sacramento/San Joaquin Delta*.

Numerous competing demands converge in the Delta—especially the need to provide water for both agricultural and urban uses and the desire to protect habitat for endangered species.

In the SWP conveyance system, the Delta is the critical link between the water supplies in the Sacramento Valley and the water demands of, and deliveries to, the rest of the Central Valley and Southern California. Physically, the Delta is the focal point for water distribution in California because most of the SWP contractors are located at points south of the Delta.

However, the Delta has long been an area of numerous competing demands; for example, the Delta provides water for millions of Californians, but also serves as important habitat for hundreds of animal, plant, and fish species, some of which are listed under the federal Endangered Species Act (ESA) and/or California Endangered Species Act (CESA) as threatened or endangered. It also supports a local population of more than 500,000 and millions of visitors who use the Delta's recreational areas, navigable waterways, and marinas. Further, not only do SWP and CVP contractors use Delta water for agriculture, but local farmers within the Delta itself use its water to irrigate their crops planted on the numerous Delta islands.

The SWP's ability to pump water from the Delta is not affected only by the physical size and capacity of the pumps at the Banks Pumping Plant. As described below, the Delta is affected by numerous factors that interact to affect SWP operations and water deliveries:

- Delta inflows (i.e., the combined total of water flowing into the Delta from the Sacramento River, San Joaquin River, and other rivers and waterways),
- beneficial uses and water rights,
- Delta water quality standards,
- regulatory requirements,
- concurrent CVP operations and pumping, and
- physical factors.

### Delta Inflows

Delta inflow varies considerably from year to year. Levels of development upstream of the Delta along the rivers and their watersheds—in the areas from which the water originates—affect Delta inflows. In an average year, 85% of the total Delta inflow comes from the Sacramento River, 10% to 15% comes from the San Joaquin River, and the rest comes from three eastside Delta tributaries (the Mokelumne, Cosumnes, and Calaveras Rivers) (Figure 2-2).

The type of water year is also an important factor affecting the volume of Delta inflows. When hydrology is analyzed, water years are designated by DWR as "wet," "above normal," "below normal," "dry," or "critical" based on the amount of rain and snow that fell during the preceding period of October 1–September 30. DWR hydrologists and meteorologists measure snowpack in the northern Sierra Nevada on or about the first of January, February, March, April, and May, in the watersheds where most of the state's water supply originates, to forecast snowmelt runoff—and thus available water supply—for the coming spring and summer.

All other factors (such as upstream development) being equal, much less water will flow into the Delta during a dry or critical water year—that is, during a drought—than during a wet or above normal water year. Fluctuations in inflows are a substantial overall concern for the Delta, and a specific concern for the SWP; such fluctuations affect Delta water quality and fish habitat, which in turn trigger regulatory requirements that constrain SWP Delta pumping. For example:

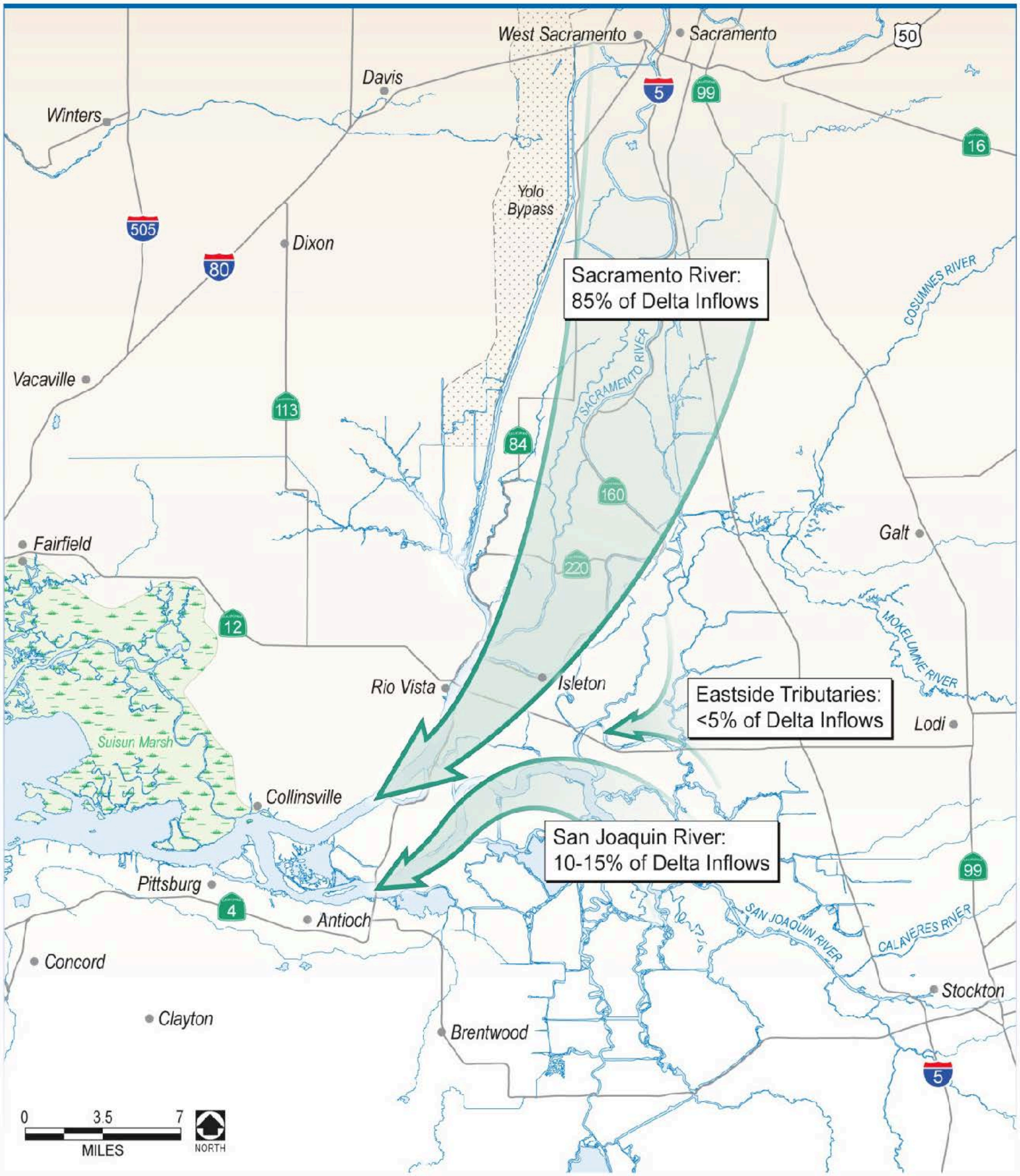
- As discussed below under "Delta Water Quality Standards," lower inflows can cause Delta water to become increasingly saline and trigger additional upstream reservoir releases and/or reduced Delta pumping to meet regulatory requirements.
- Conditions for fish in the Delta are less suitable in drier years, as seen during California's 1987–1992 drought, which can also trigger regulatory requirements that reduce SWP pumping.

Delta inflows will also vary by time of year because the amount of precipitation varies by season. About 80% of annual precipitation occurs between November and March, and very little rain typically falls from June through September. A seasonal mismatch of water supply and demand typically exists; runoff is greatest in winter and spring, but water demands peak in summer. Upstream reservoirs dampen this variability by reducing flood flows and storing water to be released later in the year to meet water demands and flow and water quality requirements.

### Delta Water Quality Standards

Water quality standards for the Delta also affect SWP operations. The Porter-Cologne Water Quality Control Act (Division 7 of the California Water Code) defines "beneficial uses" of waters of the State (both surface water and groundwater) that must be protected against quality degradation. These beneficial uses include domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. The criteria based on those uses, called "water quality objectives," are found in the water quality control plans adopted by the State Water Resources Control Board and the nine regional water quality control boards. The SWP and CVP must meet specific criteria for salinity during certain times of the year at various locations in the Delta, as described further under "Factors that Can Influence the SWP's Water Delivery Reliability" in Chapter 4.

Salinity levels can be affected by the water year type: Inflows into the Delta decline in dry and




Source: DWR 2011a

Figure 2-2. Origins of Delta Inflows

critical water years, but daily tidal inflow of salty water into the Delta from the Pacific Ocean remains generally the same, thus increasing Delta salinity. Excessive salinity may adversely affect crop yields and require more water for salt leaching, may require additional municipal and industrial treatment, may increase salinity levels in agricultural soils and groundwater, and is the primary water quality constraint to recycling wastewater. Salty water is both undrinkable and unusable for irrigation (and thus unsuitable for SWP and CVP contractors and farmers in the Delta), and is harmful to fish inhabiting the Delta, including endangered and threatened species. Climate change is also causing sea level rise, which is projected to substantially increase Delta salinities. Generally, Delta water quality is best during winter and spring and poorer through the summer irrigation season and early fall.

SWP operations are closely regulated by the water quality standards contained in State Water Resources Control Board Water Right Decision 1641 (D-1641). D-1641 was issued in December 1999 (with a revised version issued in March 2000) to implement the 1995 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta* (1995 WQCP). The 1995 WQCP established beneficial uses of Delta water, associated water quality objectives for the reasonable protection of beneficial uses, and an implementation program to achieve the water quality objectives.

D-1641 assigned primary responsibility for meeting many of the water quality objectives established in the 1995 WQCP to the SWP (thus, to DWR) and the CVP (thus, to Reclamation). To meet these objectives, D-1641 limits or curtails SWP and CVP pumping operations in certain parts of the year. For example, D-1641 imposed limits on the ratio of SWP and CVP exports to total inflow into the Delta. This "export-inflow ratio" varies by time of year.

## Regulatory Requirements

The Delta provides important habitat for fish species listed as threatened or endangered under either the federal ESA or the CESA, or both. Several resource agencies have taken actions under their authorities to protect these species. Regulatory requirements based on recent biological opinions (BOs) issued by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) for CVP and SWP operations are a particularly important factor affecting SWP operations. DFG also regulates the protection of species under the CESA, and has issued consistency determinations in the past when it has found federal BOs to be consistent with CESA for State-listed species.

Delta smelt.

A BO is a determination by USFWS or NMFS on whether a proposed federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of designated critical habitat. If jeopardy is determined, certain actions are required to protect species of concern. Usually BOs apply specifically to federal actions, but DWR coordinates with Reclamation in the agencies' operation of the SWP and federal CVP. Since the passage of the federal ESA in 1973, various BOs have been issued by USFWS and NMFS for the effects on federally listed endangered species of these coordinated operations.

NMFS administers the ESA for marine fish species, including anadromous salmonids (those that spend a part of their life cycle in the sea and return to freshwater streams to spawn), such as

Central Valley steelhead, winter-run and spring-run Chinook salmon, and green sturgeon. USFWS administers the ESA for nonanadromous and nonmarine fish species, such as delta smelt and longfin smelt. Both anadromous and nonanadromous fish species are found in the Delta and are federally listed under the ESA.

If USFWS or NMFS finds that a proposed action is likely to jeopardize a listed species or adversely modify its critical habitat, the agency is required to identify "reasonable and prudent alternatives" (defined in Title 50, Section 402.02 of the Code of Federal Regulations) that it has determined would enable the project to go forward in compliance with the ESA.

Especially important to the SWP are the BOs issued by USFWS and NMFS in 2008 and 2009, respectively, for the coordinated operations of the CVP and SWP. Both of these BOs, which DFG found consistent with the CESA for State-listed species, have directly and substantially affected SWP operations and pumping levels in recent years: They incorporate terms that directly or indirectly limit the amount of CVP and SWP Delta pumping under certain conditions. Relative to prior years, SWP water deliveries estimated in the *State Water Project Delivery Reliability Report 2009*—the last edition of this report—were, in general, reduced by the operational restrictions of these BOs.

### Concurrent Central Valley Project Operations and Pumping

CVP operations also affect the Delta as Reclamation diverts water for agricultural and urban uses. To make the most efficient use of the common water supply available to the CVP and SWP, Reclamation and DWR must work as closely as possible to coordinate their respective reservoir releases and Delta pumping operations.

Subsidence (sinking) of islands in the Delta places even more pressure on already fragile Delta levees.

The two projects share some of their facilities in the San Joaquin Valley—most notably the San Luis Unit, for which the major storage reservoir is San Luis Reservoir, and more than 100 miles of the California Aqueduct. In addition, the CVP and SWP are allowed to use each other's export pumping facilities in the south Delta—to pump water for each other—when operation of one set of pumps is affected by facility maintenance, capacity limitations, or fish protection requirements. Use of this "joint point of diversion" is subject to an operations plan that protects fish and wildlife and other legal users of water.

### Physical Factors

The stability and reliability of SWP water deliveries can be threatened by physical factors affecting facilities or water quality anywhere in the SWP system. The Delta is particularly vulnerable. Delta islands have been subsiding and in some places the land has sunk to 20 feet below sea level. This places extra pressure on the Delta's levees because it means they must hold back water constantly rather than only during peak-flow periods.

Climate change is causing sea level to rise, increasing pressure on Delta levees even further. Delta levees are also vulnerable because they were built 150 years ago and could be affected if an earthquake were to strike anywhere near the Delta.

## THE CENTRAL VALLEY PROJECT AND ITS RELATIONSHIP TO THE SWP

The federal Central Valley Project, operated by the U.S. Bureau of Reclamation, was originally conceived as a State of California project to protect the Central Valley from water shortages and floods. During the Great Depression, however, the State was unable to sell bonds to finance project construction, and beginning in the late 1930s, the U.S. government constructed the CVP as a public works project.

The CVP operates 18 dams and reservoirs, 11 powerplants, and 500 miles of canals and other facilities between the Cascade Range near Redding and the Tehachapi Mountains near Bakersfield. It serves agricultural, municipal, and industrial needs in the Central Valley and urban centers in parts of the San Francisco Bay Area, and is the primary water source for many Central Valley wildlife refuges. In an average year the CVP delivers about 7 million acre-feet of water for agriculture, urban, and wildlife use, irrigating about one-third (3 million acres) of California's agricultural lands and supplying water for nearly 1 million households (Reclamation 2009).

The CVP and SWP share some of their facilities, especially the San Luis Unit, and their respective operations staffs work closely together. The Coordinated Operations Agreement between the CVP and SWP, signed in 1986, outlines the shared responsibilities of each project to meet Delta water quality and flow objectives and provides for equitable sharing of surplus water that enters the Delta.

# Chapter 3

## SWP Contractors and Water Contracts

During the 1960s, as the SWP was created, long-term contracts were signed by DWR and 29 urban and agricultural water suppliers in various locations within California. The contracts are essentially uniform and will expire in 2035. These urban and agricultural water suppliers are referred to in this report as the "SWP contractors" or "contractors." This chapter introduces the SWP contractors, explains the basics of SWP water contracts, and describes the various types of project water, especially "Table A" water. The discussion also outlines some of the factors that influence delivery of Table A water.

### About the SWP Contractors

The SWP contractors are located in the south San Francisco Bay Area, along the Central Coast, in the San Joaquin Valley, and in Southern California. They include cities, counties, urban water agencies, and agricultural irrigation districts. Most contractors use the project water they receive for municipal purposes; a few use the water for agriculture. The SWP contractors mostly use project water to supplement local supplies, including groundwater, or other imported water. The 29 SWP contractors are listed below and their locations are shown in Figure 3-1.

#### Upper Feather River Area Contractors

- Butte County
- Yuba City
- Plumas County Flood Control and Water Conservation District

#### North Bay Area Contractors

- Napa County Flood Control and Water Conservation District
- Solano County Water Agency

#### South Bay Area Contractors

- Alameda County Flood Control and Water Conservation District, Zone 7
- Alameda County Water District
- Santa Clara Valley Water District

#### San Joaquin Valley Area Contractors

- Dudley Ridge Water District
- Empire West Side Irrigation District
- Kern County Water Agency
- Kings County
- Oak Flat Water District
- Tulare Lake Basin Water Storage District

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Figure 3-1. State Water Project Contractors

#### Central Coastal Area Contractors

- San Luis Obispo County Flood Control and Water Conservation District
- Santa Barbara County Flood Control and Water Conservation District

#### Southern California Area Contractors

- Antelope Valley–East Kern Water Agency
- Castaic Lake Water Agency
- Coachella Valley Water District
- Crestline–Lake Arrowhead Water Agency
- Desert Water Agency
- Little Rock Creek Irrigation District
- Metropolitan Water District of Southern California
- Mojave Water Agency
- Palmdale Water District
- San Bernardino County Municipal Water District
- San Gabriel Valley Municipal Water District
- San Gorgonio Pass Water Agency
- Ventura County Flood Control District

## How Water Contracts Work

Under the terms of their long-term water supply contracts with DWR, the 29 SWP contractors receive specified amounts of water from the SWP each year, called "annual allocations."

The SWP's long-term water supply contracts define the terms and conditions governing water delivery and repayment of project costs. In return for the allocated water, the SWP contractors repay principal and interest on both the bonds that initially funded construction of the SWP and the bonds that paid for additional facilities. The contractors also pay all costs, including labor and power, to maintain and operate project facilities. They also pay transportation charges based on the distance between the Delta and each contractor's water delivery point.

In addition, recreational facilities at many SWP reservoirs (such as Lake Oroville and San Luis Reservoir) are funded by SWP contractors. The contractors also contribute mitigation costs for any environmental impacts of SWP operations on fish and wildlife.

## "Table A" Water

Table A is an exhibit to the SWP's water supply contracts. This section explains Table A water and outlines the primary factors that influence the amount of such water actually delivered to SWP contractors.

### What Is Table A Water?

The water supply–related costs of the SWP are paid for by SWP contractors. All water contracts signed in the 1960s included an estimate of the date that SWP water would first be delivered and a schedule of the amount of water the contractor could expect to be delivered annually. That amount of water, known as the contractor's annual Table A amount, was designed to increase gradually until the designated maximum for that SWP contractor was reached.

The total combined maximum Table A amount for all SWP contractors was initially 4,230 thousand acre-feet per year (taf/year), assuming full development of the SWP. At that time, this amount was referred to as the "maximum project yield." As a result of amendments to the water supply contracts in the 1990s, the current combined maximum Table A amount is 4,173 taf/year. Of this amount, 4,133 taf/year is the maximum Table A water available for delivery from the Delta. It is recognized that deliveries will be less than the established maximum Table A amount in some years and more than this amount in other years.

The maximum Table A amount is the basis for apportioning water supply and costs to the SWP contractors. Once the total amount of water to be delivered is determined for the year, all available water is allocated in proportion to each contractor's annual maximum SWP Table A amount. To reiterate, however, in some years the SWP cannot deliver the maximum amount of 4,133 taf from the Delta, but in other years, project supply exceeds that amount. In years when the project supply from the Delta exceeds 4,133 taf, contractors may also receive other classifications of water from the SWP, such as Article 21 water and turnback pool water. (See "Other Types of SWP Water" later in this chapter.)

The established maximum Table A amounts for the 29 SWP contractors vary widely (Table 3-1). The median is 42 taf; thus, the maximum allocations of Table A water for half of the SWP contractors exceed this amount, and for the other half they are less. As shown in Table 3-1, the largest Table A amount is held by the Metropolitan Water District of Southern California at 1,911,500 acre-feet; the smallest is held by the Little Rock Creek Irrigation District at 2,300 acre-feet.

The maximum Table A amount listed in any particular contract should not be read as a guarantee that the SWP contractor will receive that amount. Rather, the maximum Table A amount is the tool in an allocation process that defines an individual contractor's "slice of the pie" (and a factor in allocating each contractor's share of the SWP's costs).

SWP contractors will receive a certain percentage of the maximum Table A amounts in their contracts. As discussed below, the water year type and the contractors' demand levels are among the factors involved in determining the amount of Table A water that will be delivered by DWR to each contractor. At various times of the year, DWR issues projections of anticipated Table A allocations based on then-current conditions, and updates those projections as warranted. The deliveries of Table A water to each of the SWP contractors in the last 10 years are shown in Appendix A.

## Factors Influencing Percentages of Table A Water Delivery Amounts

The percentage of its maximum Table A amount that an SWP contractor will receive in any given year will vary depending on a variety of factors. The discussion below presents basic questions underlying these factors, which are described in greater detail later in this report.

Winter snowpack is an important factor determining annual Table A water deliveries.

### Physical Availability of Water from Precipitation and Runoff

The amount and timing of precipitation and ensuing runoff to streams are important in determining how much water will be physically available to the SWP to pump and export from the Delta. The type of precipitation matters as well, along with anticipated patterns of use and consumption of the source water by entities other than the SWP.

The answers to the following questions influence the amount of water delivered to contractors each year:

- How much rain and snow fell within the last year?
- Which parts of California received the precipitation, and how much runoff resulted?
- Did rain come as a short intense storm or a long wet spell?
- Was snowmelt fast or gradual, and when did the bulk of the runoff occur?

Table 3-1. Maximum Annual SWP Table A Water Delivery Amounts for SWP Contractors

| Contractor | Maximum Table A Delivery Amounts (acre-feet) |
|---|---|
| **Upper Feather River Area Contractors** | |
| Butte County | 27,500 |
| Yuba City | 9,600 |
| Plumas County Flood Control and Water Conservation District | 2,700 |
| **Subtotal** | **39,800** |
| **North Bay Area Contractors** | |
| Napa County Flood Control and Water Conservation District | 29,025 |
| Solano County Water Agency | 47,756 |
| **Subtotal** | **76,781** |
| **South Bay Area Contractors** | |
| Alameda County Flood Control and Water Conservation District, Zone 7 | 80,619 |
| Alameda County Water District | 42,000 |
| Santa Clara Valley Water District | 100,000 |
| **Subtotal** | **222,619** |
| **San Joaquin Valley Area Contractors** | |
| Dudley Ridge Water District | 57,343 |
| Empire West Side Irrigation District | 3,000 |
| Kern County Water Agency | 998,730 |
| Kings County | 9,305 |
| Oak Flat Water District | 5,700 |
| Tulare Lake Basin Water Storage District | 95,922 |
| **Subtotal** | **1,170,000** |
| **Central Coastal Area Contractors** | |
| San Luis Obispo County Flood Control and Water Conservation District | 25,000 |
| Santa Barbara County Flood Control and Water Conservation District | 45,486 |
| **Subtotal** | **70,486** |
| **Southern California Area Contractors** | |
| Antelope Valley–East Kern Water Agency | 141,400 |
| Castaic Lake Water Agency | 95,200 |
| Coachella Valley Water District | 121,100 |
| Crestline–Lake Arrowhead Water Agency | 5,800 |
| Desert Water Agency | 50,000 |
| Little Rock Creek Irrigation District | 2,300 |
| Metropolitan Water District of Southern California | 1,911,500 |
| Mojave Water Agency | 75,800 |
| Palmdale Water District | 21,300 |
| San Bernardino Valley Municipal Water District | 102,600 |
| San Gabriel Valley Municipal Water District | 28,800 |
| San Gorgonio Pass Water Agency | 17,300 |
| Ventura County Flood Control District | 20,000 |
| **Subtotal** | **2,593,100** |
| **TOTAL TABLE A AMOUNTS** | **4,172,786** |

For example, if substantial snowfall occurs late in the wet season, Sierra Nevada rivers can be full of melting snow later than usual in the year, as occurred in 2011. This allows the SWP's Delta pumping to continue at or near capacity for an extended duration, increasing the percentage of Table A water delivered. Conversely, if rain falls on snow early in the year, the resulting early snowmelt results in less water available for Delta pumping later in the year. Other factors affecting SWP delivery reliability are discussed in Chapter 4.

### Local Facilities and Demands

A contractor's local diversion, storage, and conveyance facilities are important considerations in receiving water and in storing the water it receives. A contractor's water demands can also be affected by local weather patterns and water conservation measures. In some years, some contractors may rely more on water from sources such as groundwater or the Colorado River, while in other years they may rely more on the SWP.

The pattern of water demand on a water system can greatly affect the system's reliability. For example, if the demand occurs for only 3 months in summer, a water system with sufficient annual supply but insufficient water storage may not be able to reliably meet its customers' demands. If, however, the demand is distributed over the year, the system can more easily meet the demand because the need for water storage is reduced or storage could be increased.

## Other Types of SWP Water

Regardless of water year type, Table A water is given first priority for delivery over other types of SWP water. Contractors have several options for what to do with the water that is allocated to them: use it, store it for later use, or transfer it to another contractor. Each long-term water contract describes several types of SWP water that are available to SWP contractors to supplement Table A water: "Article 21" water, carryover water, and turnback pool water. These other types of project water are discussed below and the related deliveries that occurred in each of the last 10 years are shown in Appendix A.

### Article 21 Water

Article 21 water (so named because it is described in Article 21 of the water contracts) is surplus water that SWP contractors may receive on a short-term basis in addition to their Table A water, if they request it. Article 21 water is available to an SWP contractor only if the following conditions are met:

- "Excess water" is flowing through the Delta—that is, when releases from SWP and CVP reservoirs and unregulated flows into the Delta exceed Sacramento Valley water diversions, Delta exports, and flows needed to meet Delta water quality and flow requirements. If this scenario occurs, it is usually during December through May.
- The contractor is able to use the surplus water, such as by offsetting the use of groundwater that would otherwise occur, or can store it in its own system. (That is, the water will not be stored in an SWP facility, such as San Luis Reservoir.)
- Delivering this water would not interfere with Table A allocations, other SWP deliveries, or SWP operations.

SWP contractors requesting Article 21 water receive this water in the same proportion as their Table A water. Article 21 water becomes available only during wet months of the year, generally December through March. Unless the SWP contractor has facilities to routinely store or manage the Article 21 water it receives, such water is not likely to contribute significantly to local water supply reliability.

### Carryover Water

"Carryover water" is SWP water that is allocated to an SWP contractor and approved for delivery to that contractor in a given year, but not used by the end of the year. (Note that SWP water deliveries are managed by calendar year, January 1–December 31, while hydrology is measured by water year, October 1–September 30.) This water is exported from the Banks Pumping Plant, but instead of being delivered to the contractor, it is stored in the SWP's share of San Luis Reservoir, when space is available, for the contractor to use in the following water year.

Carryover water is like a water savings account that allows water managers flexibility in tough times—such as if the next year is a drought year and the contractor's allocation of SWP water is small. Carryovers were designed to encourage the most effective and beneficial use of water and to avoid obligating the contractors to use or lose the water by December 31 of each year.

With advance notice, SWP contractors can carry over water when they submit their initial request for Table A water, or within the last 3 months of the delivery year. They might do this for various reasons, such as local wet conditions and exchange and transfer arrangements. Storage for carryover water no longer becomes available to the contractors if it interferes with storage of SWP water for project needs.

Carryover water is stored in San Luis Reservoir.

### Turnback Pool Water

SWP contractors may offer the portion of their allocated Table A water that exceeds their needs in a "turnback pool," where another contractor may purchase this water. DWR sets the price for water offered in turnback pools, which are established in February and March. Contractors that sell their extra Table A water in a turnback pool are charged less for the water they receive, and contractors that buy water through the turnback pool pay extra.

## Historical SWP Deliveries (2001–2010)

Please see Appendix A for tables listing annual historical deliveries from the Delta by various water classifications for each SWP contractor for 2001–2010. Similar delivery tables for years 1999–2008 are included in the 2009 Report.

Figure 3-2 shows that deliveries of SWP Table A water from the Delta for 2001–2010 range from an annual minimum of 1,049 taf to a maximum of 2,963 taf, with an average of 2,087 taf. Historical deliveries of SWP Table A water from the Delta over this 10-year period are less than the maximum of 4,133 taf/year.

Total historical SWP deliveries from the Delta, including Table A, Article 21, turnback pool, and carryover water, range from 1,236 to 3,727 taf/year, with an average of 2,524 taf/year for the period of 2001–2010 (Figure 3-3).

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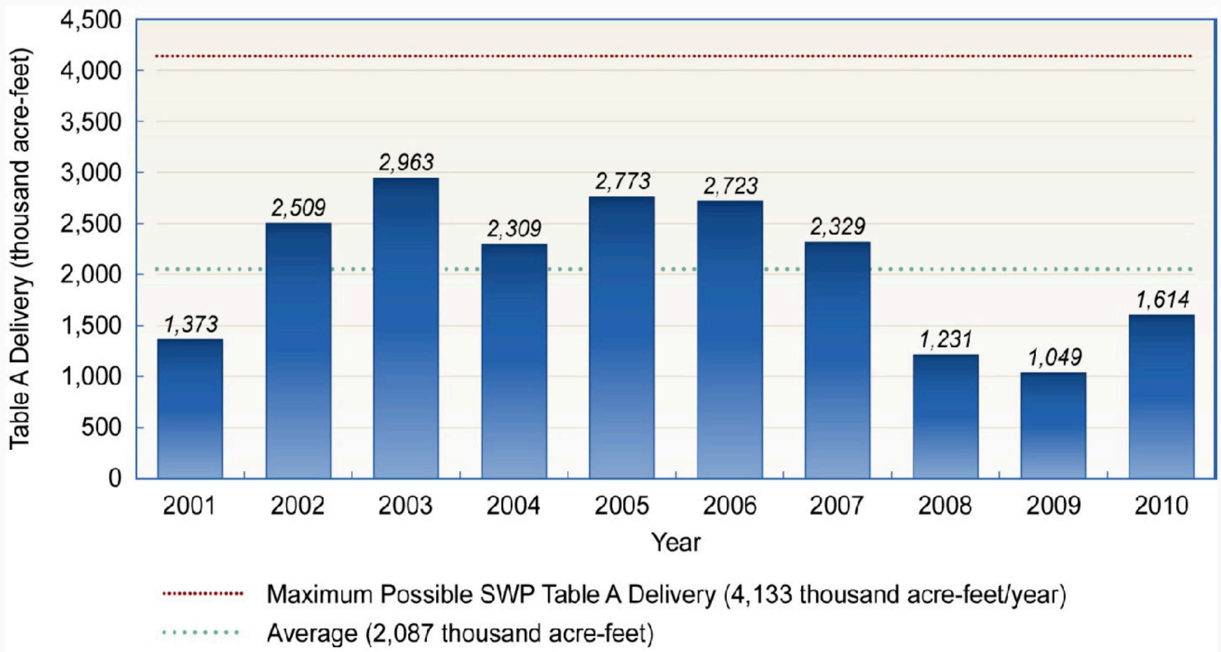
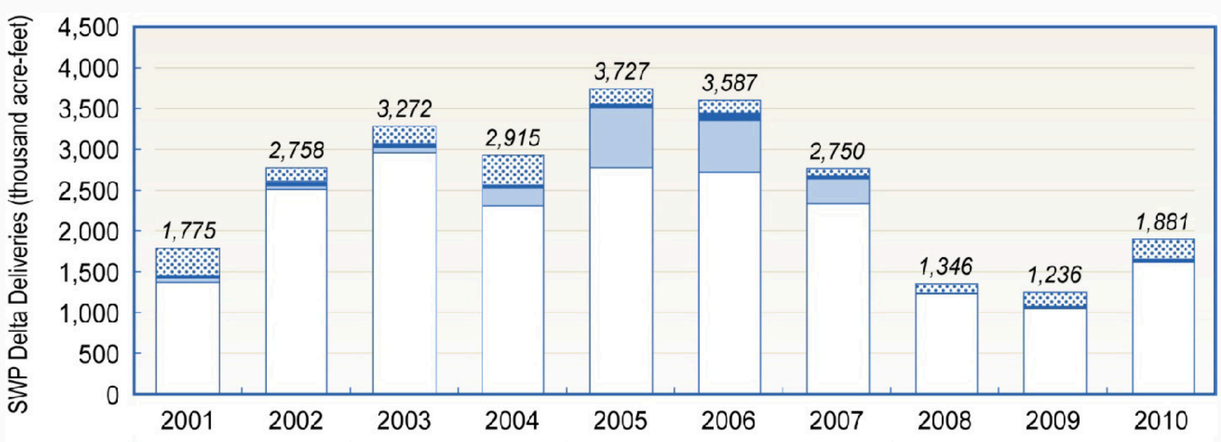


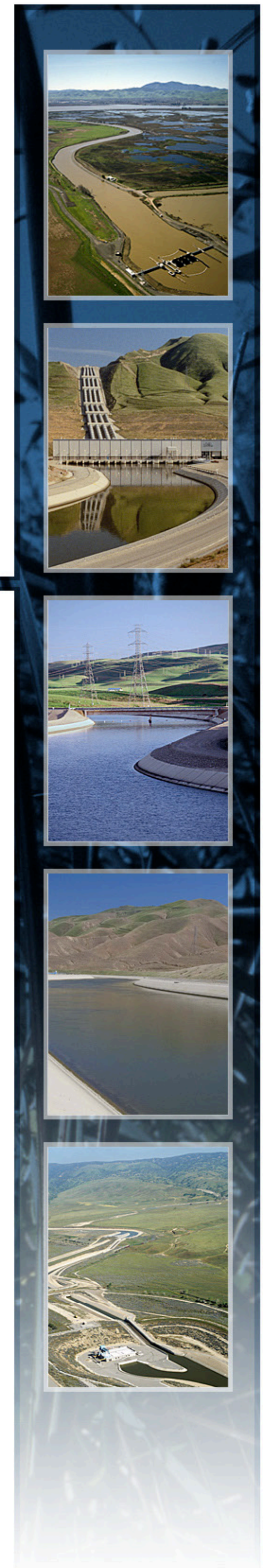

Figure 3-2. Historical Deliveries of SWP Table A Water from the Delta, 2001–2010




| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Carryover | 335 | 161 | 220 | 370 | 185 | 160 | 94 | 110 | 180 | 248 |
| Turnback | 18 | 45 | 30 | 17 | 38 | 73 | 16 | 3 | 2 | 11 |
| Article 21 | 48 | 43 | 60 | 218 | 731 | 631 | 310 | 3 | 6 | 8 |
| Table A | 1,373 | 2,509 | 2,963 | 2,309 | 2,773 | 2,723 | 2,329 | 1,230 | 1,049 | 1,614 |

*Note: Due to rounding, the total delivery may not equal the sum of individual delivery type line items.*

Figure 3-3. Total Historical SWP Deliveries from the Delta, 2001–2010 (by Delivery Type)



# Chapter 4

## Factors that Affect Water Delivery Reliability

This chapter explains the concept of SWP water delivery reliability and how it is calculated by DWR. Some of the factors that influence the percentages of SWP Table A deliveries were introduced in Chapter 3, "SWP Contractors and Water Contracts." This chapter builds on that discussion, describing the most important factors that combine to affect SWP water delivery reliability. Among these natural and human-created factors are the availability of source water, regulatory restrictions on SWP operations, and the effects of climate change.

Uncertainty also exists because of the potential for an emergency such as an earthquake striking in or near the Delta, which, if substantial enough, could interrupt SWP exports from the Delta. This chapter describes various statewide efforts by DWR and other agencies to reduce risks to the Delta and enhance emergency response capabilities.

### What Water Delivery Reliability Means to SWP Contractors

Water delivery reliability is the annual amount of SWP water that can be expected to be delivered to SWP contractors with a certain frequency. But what does that actually mean in practice?

In essence, it is a matter of probability—specifically, the likelihood that a contractor will receive a certain amount of water from the SWP in a particular year. From the contractor's perspective, water delivery reliability indicates an acceptable or desirable level of dependability of water deliveries to the people receiving the water. This information is vitally important to SWP contractors for their water planning and operations. Will farmers have the amount of water they will need to plant and grow crops and avoid fallowing their fields? Will urban and suburban water districts have sufficient water to serve current and planned future development, or will they need to call for greater conservation measures by residents and businesses? These are examples of critical questions to which SWP contractors must have answers on an annual basis to serve their customers.

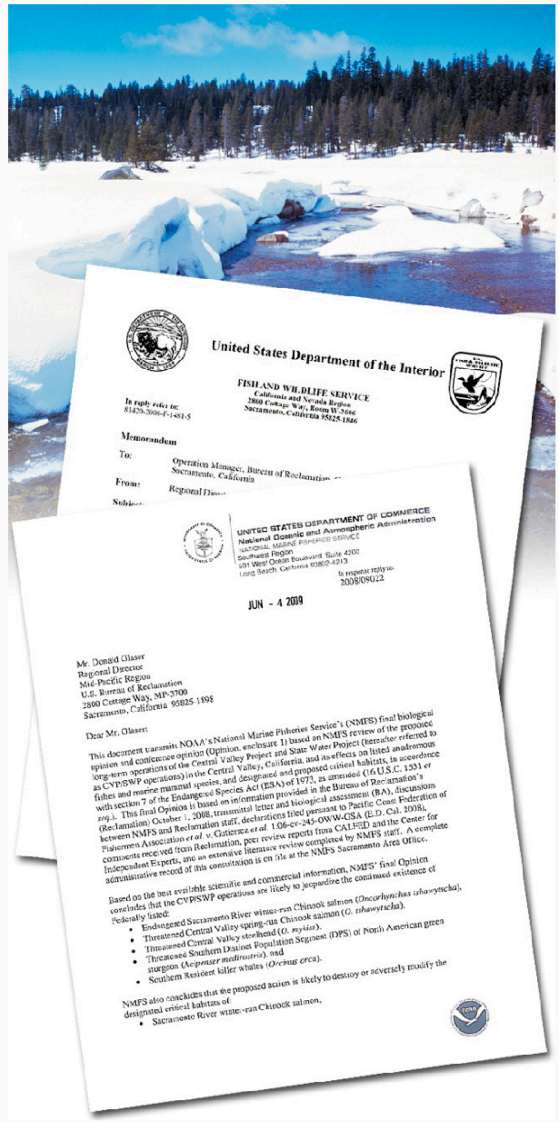
Usually, a local water agency, in coordination with the public it serves, determines the level of water delivery reliability that it considers acceptable. The water agency then plans for new facilities, programs, or additional sources of water to meet or maintain this level of reliability.

## Calculating SWP Water Delivery Reliability

DWR calculates the water delivery reliability of the SWP using the CalSim-II computer model, which simulates existing and future operations of the SWP. No model or tool can predict what actual, natural water supplies will be for any year or years, but a system of probability can be used to calculate water delivery reliability. The analyses of SWP delivery reliability contained in Chapters 6 and 7 of this report are based on modeling conducted using 82 years of historical data (water years 1922–2003) for rainfall and runoff. Those data were adjusted to reflect current and future levels of development in the source areas. The resulting data were then used to forecast the amount of water available to the SWP under current and future conditions (with the effects of climate change factored into the modeling for future conditions). The annual amounts of estimated SWP water deliveries are ranked from smallest to largest and the probability that various quantities of SWP Table A water will be delivered to each SWP contractor is estimated.

## Factors that Can Influence the SWP's Water Delivery Reliability

Forecasting water delivery reliability is a difficult task because California is such a large state with numerous microclimates. In a typical year, some areas receive as little as 2 inches of rain, while others receive more than 100 inches. In addition, the determinants of water delivery for a specific water supply system continually change over time and can be difficult to determine and/or model. For example, water use in Sacramento River watersheds has increased over time. The historical data upon which a water supply forecast is based must be adjusted to reflect the current and, if necessary, future use in these watersheds.




Natural factors such as snowmelt and human influences such as federal biological opinions can both influence the SWP's water delivery reliability.

The following factors affect the ability to estimate existing and especially future water delivery reliability:

- water availability at the source,
- water rights with priority over the SWP,
- regulatory restrictions on SWP Delta exports (imposed by federal biological opinions [BOs] and State water quality plans),
- climate change,

- ongoing environmental and policy planning efforts, and
- Delta levee failure.

### Water Availability at the Source

This factor affects the SWP's water delivery reliability because it is inherently variable; availability of water at the source depends on the amount and timing of rain and snow that fall in any given year, the amount and timing of runoff, and the level of development (that is, the use of water) in the SWP's source areas. The location, amount, and form of precipitation in California in any given year cannot be accurately predicted, introducing the greatest uncertainty to the availability of future SWP source water and hence future SWP deliveries.

Generally, during a single dry year or two, surface water and groundwater storage can supply most water deliveries, but dry years can result in critically low water reserves.

DWR measures the water content of snowpack in the northern Sierra Nevada to forecast snowmelt runoff.

Greater reliance on groundwater during dry years results in high costs for many users and increases groundwater overdraft. Further, the ability of some contractors to use local groundwater may be limited; some groundwater basins may be contaminated by toxins such as methyl tertiary butyl ether (commonly known as MBTE), an ingredient in gasoline, and other aquifers may be too deep to reach economically. This makes the availability of the SWP's surface water to contractors especially important.

DWR manually measures snowpack in the northern Sierra Nevada monthly between early January and early May to forecast snowmelt runoff. These surveys and real-time electronic measurements taken throughout the winter measure the snowpack's water content. The size of the snowpack in the Feather River watershed on April 1—when snowpack water content normally is at its peak before the spring runoff—and the storage in Lake Oroville are key components of the SWP's delivery capabilities from April through September.

However, in some years, even measurements taken in the northern Sierra Nevada earlier in the year can demonstrate an apparent trend in water delivery reliability for the rest of the year (assuming that the weather follows typical patterns in spring). For example, manual readings conducted by DWR on December 28, 2010, off U.S. Highway 50 near Echo Summit showed snow-water equivalents in the state's northern mountains at 169% of normal for that date and 57% of the normal value for April 1. By contrast, the readings taken on the same date in 2009 had indicated snow-water equivalents in the northern mountains at 77% of normal for the date and 26% of the normal value for April 1. These findings indicated the potential for SWP deliveries in 2011 to increase relative to deliveries that occurred in 2010, a below-normal water year.

## Water Rights with Priority Over the SWP

California's water rights system affects the SWP indirectly. There are two types of legally protected rights to surface water in California:

- *Appropriative* water rights allow the user to divert surface water for beneficial use. The user must first have obtained a permit from the State Water Resources Control Board (State Water Board), unless the appropriative water right predates 1914. Appropriative water rights may be lost if the water has gone unused for 5 years. The SWP diverts water from the Delta under appropriative water rights.
- *Riparian* water rights apply to lands traversed by or bordering on a natural watercourse. No permit is required to use this water, which must be used on riparian (adjacent) land and cannot be stored for later use.

Generally, the priority of an appropriative water right in California is "first in time, first in right"; therefore, an appropriative water right is subordinate to all prior water rights, whether appropriative or riparian. This means that if another entity with a prior water right increases its use of one of the SWP's sources of water supply—the Delta, the upstream Sacramento or San Joaquin River, or a tributary to either river—the overall amount of water available to the SWP will decrease. Thus, water users with prior water rights are assigned top priority for water in DWR's modeling of the SWP's water delivery reliability, even ahead of SWP Table A water deliveries.

## Regulatory Restrictions on SWP Delta Exports

Multiple needs converge in the Delta: the need to protect a fragile ecosystem, to support Delta recreation and farming, and to provide water for agricultural and urban needs throughout much of California. Various regulatory requirements are placed on the SWP's Delta operations to protect special-status species such as delta smelt and spring- and winter-run Chinook salmon. As a result, as described below, restrictions on SWP operations imposed by State and federal agencies contribute substantially to the challenge of accurately determining the SWP's water delivery reliability in any given year.

### Biological Opinions on Effects of Coordinated SWP and CVP Operations

Several fish species listed under the federal Endangered Species Act (ESA) as endangered or threatened are found in the Delta. The continued viability of populations of these species in the Delta depends in part on Delta flow levels. For this reason, the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have issued several BOs since the 1990s on the effects of coordinated SWP/CVP operations on several species.

These BOs affect the SWP's water delivery reliability for two reasons. Most obviously, they include terms that specifically restrict SWP pumping levels in the Delta at certain times under certain conditions. In addition, the BOs' requirements are based on physical and biological phenomena that occur daily while DWR's water supply models are based on monthly data.

The first BOs on the effects of SWP (and CVP) operations were issued in February 1993 (NMFS BO on effects of project operations on winter-run Chinook salmon) and March 1995 (USFWS BO on project effects on delta smelt and splittail). Among other things, the BOs contained requirements for Delta inflow, Delta outflow, and reduced export pumping to meet specified incidental take limits. These fish protection requirements imposed substantial constraints on Delta water supply operations. Many were incorporated into the 1995 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta* (1995 WQCP), as described in the "Water Quality Objectives" section later in this chapter.

The terms of the USFWS and NMFS BOs have become increasingly restrictive in recent years. In December 2008, USFWS issued a new BO covering effects of the SWP and CVP on delta smelt, and in June 2009, NMFS issued a BO covering effects on winter-run and spring-run Chinook salmon, steelhead, green sturgeon, and killer whales. These BOs replaced BOs issued earlier by the federal agencies.

The USFWS BO includes additional requirements in all but 2 months of the year. The BO calls for "adaptively managed" (adjusted as necessary based on the results of monitoring) flow restrictions in the Delta intended to protect delta smelt at various life stages. USFWS determines the required target flow, with the reductions accomplished primarily by reducing SWP and CVP exports. Because this flow restriction is determined based on fish location and decisions by USFWS staff, predicting the flow restriction and corresponding effects on export pumping with any great certainty poses a challenge. The USFWS BO also includes an additional salinity requirement in the Delta for September and October in wet and above-normal water years, calling for increased releases from SWP and CVP reservoirs to reduce salinity. Among other provisions included in the NMFS BO, limits on total Delta exports have been established for the months of April and May. These limits are mandated for all but extremely wet years.

The 2008 and 2009 BOs were issued shortly before and shortly after the Governor proclaimed a statewide water shortage state of emergency in February 2009, amid the threat of a third consecutive dry year. NMFS calculated that implementing its BO would reduce SWP and CVP Delta exports by a combined 5% to 7%, but DWR's initial estimates showed an impact on exports closer to 10% in average years, combined with the effects of pumping restrictions imposed by BOs to protect delta smelt and other species. The 2008 USFWS and 2009 NMFS BOs have been subject to considerable litigation. Recent decisions by U.S. District Judge Oliver Wanger changed specific operational rules for the fall/ winter of 2011–2012, and both the USFWS BO and NMFS BO have been remanded to the agencies for further review and analysis. However, the operational rules specified in the 2008 and 2009 BOs continue to be legally required and are the rules used in the analyses presented in Chapters 5, 6, and 7 of this report. Chapter 5 presents a comparison of monthly Delta exports as estimated for this 2011 Report with those estimated for the 2005 Report, illustrating how the 2008 and 2009 BOs have affected export levels from the Delta.

The California Department of Fish and Game (DFG) issued consistency determinations for both BOs under Section 2080.1 of the California Fish and Game Code. The consistency determinations stated that the USFWS BO and the NMFS BO would be consistent with the California Endangered Species Act (CESA). Thus, DFG allowed incidental take of species listed under both the federal ESA and CESA to occur during SWP and CVP operations without requiring DWR or the U.S. Bureau of Reclamation to obtain a separate State-issued permit.

Specific restrictions on Delta exports associated with the USFWS and NMFS BOs and their effects on SWP pumping levels are described further in Chapter 5, "SWP Exports," of this report.

### Water Quality Objectives

Because the Delta is an estuary, salinity is a particular concern. In the 1995 WQCP, the State Water Board set water quality objectives to protect beneficial uses of water in the Delta and Suisun Bay. The objectives must be met by the SWP (and federal CVP), as specified in the water right permits issued to DWR and the U.S. Bureau of Reclamation. Those objectives—minimum Delta outflows, limits on SWP and CVP Delta exports, and maximum allowable salinity levels—are enforced through the provisions of the State Water Board's Water Right Decision 1641 (D-1641), issued in December 1999 and updated in March 2000.

DWR and Reclamation must monitor the effects of diversions and SWP and CVP operations to ensure compliance with existing water quality standards. Monitoring stations are shown in Figure 4-1.

Among the objectives established in the 1995 WQCP and D-1641 are the "X2" objectives. D-1641 mandates the X2 objectives so that the State Water Board can regulate the locations of the Delta estuary's salinity gradient during the months of February–June. X2 is the position in the Delta where the electrical conductivity (EC) level, or salinity, of Delta water is 2 parts per thousand. The location of X2 is used as a surrogate measure of Delta ecosystem health. For the X2 objective to be achieved, the X2 position must remain downstream of Collinsville in the Delta (shown in Figure 4-1) for the entire 5-month period, and downstream of other specific locations in the Delta on a certain number of days each month from February through June. This means that Delta outflow must be at certain specified levels at certain times—which can limit the amount of water the SWP may pump at those times at its Harvey O. Banks Pumping Plant in the Delta. Because of the relationship between seawater intrusion and interior-Delta water quality, meeting the X2 objective also improves water quality at Delta drinking-water intakes; however, meeting the X2 objectives can require a relatively large volume of water for outflow during dry months that follow months with large storms.

The 1995 WQCP and D-1641 also established an export/inflow (E/I) ratio. The E/I ratio, presented in Table 3 of the 1995 WQCP (SWRCB 1995:18–22), is designed to provide protection for the fish and wildlife beneficial uses in the Bay-Delta estuary (SWRCB 1995:15). The E/I ratio limits the fraction of Delta inflows that are exported. When other restrictions are not controlling, Delta exports are limited to 35% of total Delta inflow from February through June and 65% of inflow from July through January.

## Climate Change

The *California Water Plan Update 2009* identified climate change as a key consideration in planning for the State's water management. California's reservoirs and water delivery systems were developed based on historical hydrology; future weather patterns have long been assumed to be similar to those in the past. However, as climate change continues to affect California, past hydrology is no longer a reliable guide to future conditions. This section discusses effects on the SWP that could result from specific aspects of climate change.

### Decreased Water Availability with Reduced Snowpack

As the effects of climate change continue, mean temperatures are predicted to increase, both globally and regionally. Climate projections used to assess the reliability of California's future water supply forecast average air temperature increases for the Sacramento region of 1.3 to 4.0 degrees Fahrenheit by the middle of the 21st century and 2.7 to 8.1 degrees by the end of the century (California Climate Change Center 2009a:8). Climate change is anticipated to bring warmer storms that result in less snowfall at lower elevations, reducing total snowpack. Loss of snowpack is projected to be greater in the northern Sierra Nevada—and thus closer to the Feather River watershed, the origin of SWP water—than in the southern Sierra Nevada because of the relative proportions of land at low and middle elevations.

Snowmelt provides an average of 15 million acre-feet of water for California per year, slowly released from about April to July each year (DWR 2006:2-22). Much of the state's water infrastructure, including the SWP, was designed to capture slow spring runoff and deliver it during the drier summer and fall months. However, during the 20th century, the average early-spring


Figure 4-1. Delta Salinity Monitoring Locations of Importance to the SWP

snowpack in the Sierra Nevada decreased by about 10%, resulting in the loss of 1.5 million acre-feet of snowpack storage (DWR 2008:3). Using historical data and modeling, DWR projects that by 2050 the Sierra snowpack will be reduced from its historical average by 25% to 40% (DWR 2008:4). Increased precipitation falling as rain instead of snow during winter could result in a larger number of "rain-on-snow" events. This would cause the snow to melt earlier in the year and over fewer days than historically, thus adversely affecting availability of water for pumping by the SWP during summer.

Such reductions in snowpack could have dire consequences. Under climate change and in some years, water levels in Lake Oroville, the SWP's main supply reservoir, could fall below the lowest release outlets, making the system vulnerable to operational interruption. DWR expects that a water shortage worse than the one during the 1977 drought could occur in 1 out of every 6–8 years by the middle of the 21st century and in 1 out of every 3–4 years at the end of the century (California Climate Change Center 2009a:46). In those years, it is estimated that an additional 575,000–850,000 acre-feet per year of water would be needed to meet current regulatory requirements and to maintain minimum system operations. This could preclude the SWP from pumping as much water as it would otherwise.

Climate change is also expected to reduce the SWP's median reservoir carryover storage. Carryover water is like a water savings account for water managers to use during shortage periods. Thus, a climate change–generated reduction in the amount of carryover water available to SWP contractors would reduce the system's flexibility during dry and critical water years.

### Increased SWP Water Demands

Even as water shortages may result from reduced snowpack, climate change may also cause water demand by SWP contractors to increase. Warmer temperatures may increase rates of evapotranspiration (loss of water from soil by evaporation and plant transpiration) and may extend growing seasons. A larger amount of water may be needed for irrigation of certain crops, urban landscaping, and environmental needs. Warmer temperatures will also increase evaporation from surface reservoirs. Reduced soil moisture and surface flow will disproportionately affect the environment and other water users that rely heavily on annual rainfall such as rainfed agriculture, livestock grazing on nonirrigated rangeland, and recreation.

### Sea Level Rise

During the last century, sea level rose 7 inches along California's coast. Estimates of future sea level rise range from 4 to 16 inches by the middle of the 21st century and 7–55 inches by 2100 (DWR 2009b:4-37). The increases in sea level that are expected to continue could affect SWP water delivery reliability in several ways:

- Most of the land in the Delta is below sea level—by as much as 20 feet—as a consequence of ongoing subsidence (Figure 4-2). Increases in sea level could place more pressure on the Delta's already fragile levee system and, as a consequence, cause levee breaches that could threaten SWP Delta exports.
- As salty water from the Pacific Ocean moves farther upstream into the Delta, DWR could be required to increase the amounts of freshwater released from Lake Oroville to maintain compliance with Delta water quality standards.
- Sea level rise is expected to cause salt water to flow farther inland. The resulting increase in saltwater intrusion into coastal aquifers would make increasing amounts of groundwater unsuitable for water supply or irrigation (California Climate Change Center 2009b:80–81). The reduced availability of groundwater would likely contribute to further increases in demands for surface water from the SWP, especially by the coastal SWP contractors.


Source: DWR 1995:28

Figure 4-2. Areas of the Delta that Have Subsided to Below Sea Level

### Adapting to Climate Change Effects in Forecasting Water Delivery Reliability

Chapter 7, "Future SWP Water Delivery Reliability (2031)," of this report estimates the SWP's delivery reliability for conditions 20 years in the future (2031), reflecting potential hydrologic changes that could result from climate change. Further details on these future projections are included in a technical addendum to this report (posted on the Internet and available upon request).

For purposes of this report and the technical addendum, the 2031 delivery estimates are based on a single median-impact future climate projection. To identify this projection, DWR analyzed the 12 climate projections for midcentury that were used in *Using Future Climate Projections to Support Water Resources Decision Making in California* (California Climate Change Center 2009a). The resulting water supply effects were examined to determine which one most closely represented the "central" or "median" projection. The analysis examined the following projected climate and hydrology variables and their effects on SWP exports: temperature, precipitation, total inflow to major reservoirs, shifts in timing of runoff, and Delta exports.

## Ongoing Environmental and Policy Planning Efforts

As discussed earlier, the Delta is an essential part of the conveyance system for the SWP. SWP pumping at the Banks Pumping Plant is regulated to protect the many uses of the Delta. However, today's uses in the Delta are not sustainable over the long term under current management practices and regulatory requirements. As discussed below, two large-scale plans for the Delta that are in development could affect SWP water delivery reliability: the Delta Plan and the Bay Delta Conservation Plan (BDCP).

### Delta Plan

After years of concern about the Delta amid rising water demand and habitat degradation, the Delta Stewardship Council was created in legislation to achieve State-mandated coequal goals for the Delta. As specified in Section 85054 of the California Water Code:

> "Coequal goals" means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.

The draft Delta Plan seeks to reduce reliance on Delta water supplies. In a series of policies and recommendations, the draft plan aims to encourage farms and cities to increase conservation and become more self-sufficient, particularly in the event of a disaster in the Delta. It calls for agricultural water agencies to change pricing to encourage conservation. It also urges the State Water Board to set enforceable flow objectives for the Delta and its tributaries that take into account wildlife and habitat needs. In the future, government projects in the Delta must prove they are consistent with the Delta Plan.

The Delta Stewardship Council is preparing the draft Delta Plan and environmental impact report. Scheduled for adoption and implementation in 2012, the Delta Plan is intended to serve as California's guiding policy document for the Delta and Suisun Marsh for the next 88 years (that is, through the year 2099), with frequent updates.

### Bay Delta Conservation Plan

The BDCP is being prepared by a group of local water agencies, environmental and conservation organizations, State and federal agencies, and other interest groups. An outgrowth of the CALFED Bay-Delta Plan's Ecosystem Restoration Program Conservation Strategy, the BDCP has been in development since 2006. The heart of the BDCP is a long-term conservation strategy that sets forth actions needed for a healthy Delta. The BDCP would do all of the following:

- identify conservation strategies to improve the overall ecological health of the Delta;
- identify ecologically friendly ways to move freshwater through and/or around the Delta;
- address toxic pollutants, invasive species, and impairments to water quality; and
- establish a framework and funding to implement the plan over time.

A draft environmental impact report is planned to be released for public review in mid-2012. The report is targeted to be final in 2013, after which a decision to proceed with the program would be made. Upon adoption, the BDCP would provide the basis for issuance of endangered species permits for the continued operation of the SWP and CVP. The plan would be implemented over a 50-year period.

### Delta Levee Failure

The fragile Delta faces a multitude of risks that could affect millions of Californians. Foremost among those risks, as they could affect the SWP's water delivery reliability, are the potential for levee failure and the ensuing flooding and water quality issues.

The Delta Risk Management Strategy (DRMS) was initiated in response to Assembly Bill 1200 (2005), which directed DWR to use 50-, 100-, and 200-year projections to evaluate the potential impacts on Delta water supplies associated with continued land subsidence, earthquakes, floods, and climate change. The discussions below describe DRMS Phase 1, which evaluated the risks, and DRMS Phase 2, which is proposing various solutions. Also discussed are other efforts currently being undertaken by DWR and other agencies to reduce risks to the Delta, enhance emergency response capabilities, and reduce the risk of interruption of Delta water exports by the SWP and CVP.

#### Effects of Emergencies on Water Supplies: Delta Risk Management Strategy, Phase 1

Phase 1 of the DRMS, completed in 2008, assessed the performance of Delta and Suisun Marsh levees under various stressors and hazards and evaluated the consequences of levee failures to California as a whole.

The Delta is protected by levees built about 150 years ago. The levees are vulnerable to failure because most original levees were simply built with soils dredged from nearby channels, and were never engineered. Most islands in the Delta have flooded at least once over the past 100 years. For example, on June 3, 2004, a huge dry-weather levee failure occurred without warning on Upper Jones Tract in the south Delta, inundating 12,000 acres of farmland with about 160,000 acre-feet of water. Because many Delta islands are below sea level, deep and prolonged flooding could occur during a levee failure event, which could disrupt the quality and use of Delta water.

Levee failure can result from the combination of high river inflows, high tide, and high winds; however, levees can also fail in fair weather—even in the absence of a flood or seismic event—in a so-called "sunny day event." Damage caused by rodents, piping (in which a pipe-like opening develops below the base of the levee), or foundation movement could cause sunny-day levee breaches.

Many vulnerable Delta levees require installation of rock revetments, riprap, or other engineered structures along eroding banks to reduce erosion and protect levee foundations.

A breach of one or more levees and island flooding may affect Delta water quality and SWP operations. Depending on the hydrology and the size and locations of the breaches and flooded islands, a large amount of salt water may be pulled into the interior Delta from Suisun and San Pablo Bays. When islands are flooded, DWR may need to drastically decrease or even cease SWP Delta exports to evaluate the distribution of salinity in the Delta and avoid drawing saltier water toward the pumps.

Delta levees are prone to failure, increasing risks to State water supplies.

An earthquake could also put Delta levees, and thus SWP water supplies, at risk. In 2008, the 2007 Working Group on California Earthquake Probabilities estimated a probability of 63% that a magnitude 6.7 or greater earthquake would strike the San Francisco Bay Area in the next 30 years (Working Group 2008:6). An earthquake could severely damage Delta levees, causing islands to flood with salty water. The locations most likely to be affected by an earthquake are the west and southwest portions of the Delta because these areas are closer to potential earthquake sources. Flooding of the west and southwest Delta is also more likely to interfere with conveyance of freshwater to export pumps (DWR 2007:17).

Modeling of the effects of earthquakes on Delta islands was conducted by DWR for the DRMS Phase 1 report. Described in the *California Water Plan Update 2009*, the assessment found a 40% probability that a major earthquake occurring between 2030 and 2050 would cause 27 or more islands to flood at the same time. If 20 islands were flooded as a result of a major earthquake, the export of freshwater from the Delta could be interrupted by about a year and a half (DWR 2009b:5-15). Water supply losses of up to 8 million acre-feet would be incurred by SWP (and CVP) contractors and local water districts.

### Managing and Reducing Risks: Delta Risk Management Strategy, Phase 2

The Phase 2 report for the DRMS, issued in June 2011, evaluates alternatives to reduce the risk to the Delta and the state from adverse consequences of levee failure (DWR 2011b). "Building blocks" (individual improvements or projects, such as improving levees or raising highways) and trial scenarios (various combinations of building blocks) were developed for the DRMS Phase 2 report. The building blocks fall into three main categories:

- conveyance improvements/ flood risk reduction and life safety,
- infrastructure risk reduction, and
- environmental risk mitigation.

The first of these categories is most relevant to the SWP in terms of reducing the risk of disruption of SWP Delta exports, but the environmental risk mitigation category includes a building block (Building Block 3.6) calling for reduction of water exports from the Delta.

Four trial scenarios were developed to represent a range of possible risk reduction strategies:

- *Trial Scenario 1—Improved Levees*: Improve the reliability of Delta levees against flood-induced failures by providing up to 100-year flood protection.
- *Trial Scenario 2—Armored Pathway (Through-Delta Conveyance)*: Improve the reliability of water conveyance by creating a route through the Delta that has high reliability and the ability to minimize saltwater intrusion into the south Delta.
- *Trial Scenario 3—Isolated Conveyance Facility*: Provide high reliability for conveyance of export water by building an isolated conveyance facility on the east side of the Delta.
- *Trial Scenario 4—Dual Conveyance*: Improve reliability and flexibility for conveyance of export water by constructing an isolated conveyance facility and a through-Delta conveyance. (This scenario would be much like a combination of Trial Scenarios 2 and 3.)

The findings of the DRMS Phase 2 report on these scenarios, as they apply to seismic risk and potential for disruption of SWP Delta exports, are as follows:

- Trial Scenario 1 (Improved Levees) would not reduce the risk of potential water export interruptions, nor would it change the seismic risk of most levees.
- Trial Scenario 2 (Armored Pathway [Through-Delta Conveyance]) would have the joint benefit of reducing the likelihood of levee failures from flood events and earthquakes and of significantly reducing the likelihood of export disruptions.
- The effects of Trial Scenario 3 (Isolated Conveyance) would be similar to those for the Armored Pathway scenario, but Trial Scenario 3 would not reduce the seismic risk of levee failure on islands that are not part of the isolated conveyance facility.
- Trial Scenario 4 (Dual Conveyance) would avoid the vulnerability of water exports associated with Delta levee vulnerability and would offer flexibility in water exports from the Delta and/or the isolated conveyance facility. However, seismic risk would not be reduced on islands not part of the export conveyance system or infrastructure pathway.

As noted in the discussion of the "enhanced emergency preparedness/response" building block in the DRMS Phase 2 report, analyses on resuming water exports after a levee failure were conducted by the Metropolitan Water District of Southern California, an SWP contractor. The studies found that a promising way to resume water exports would be to place structural barriers at selected channel locations in the Delta and complete strategic levee repairs, thus isolating an emergency freshwater conveyance "pathway" through channels that may be surrounded by islands flooded with saline water (Moffatt and Nichol 2007, cited in DWR 2011b:5-1).

### Delta Flood Emergency Preparedness, Response, and Recovery Program and Delta Multi-Hazard Coordination Task Force

In the last 5 years, DWR has worked to improve its ability to respond quickly and effectively to simultaneous levee failures on multiple islands within the Delta. The *Delta Emergency Operations Plan Concept Paper* released in April 2007 (DWR 2007) was the initial product of this effort. To enhance the State's ability to prepare for, respond to, and recover from a catastrophic Delta levee failure, DWR subsequently began development of the Delta Flood Emergency Preparedness, Response, and Recovery Program. This program is intended to supplement DWR's emergency operations plan. The goal is to protect lives, property, and critical infrastructure in the Delta while minimizing impacts on the ecosystem. The program consists of three components:

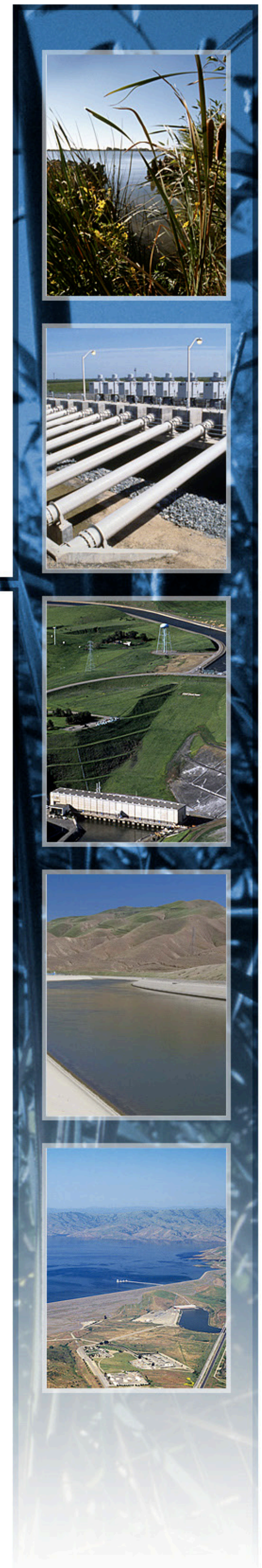
- develop DWR's Delta response and recovery plan,
- coordinate DWR's plan with other Delta flood emergency response agencies, and

- design and implement flood emergency response facilities within the Delta.

The flood emergency response plan for the Delta will describe the actions DWR will take before, during, and after a levee-endangering event or levee failure in the Delta. The Delta Flood Emergency Preparedness, Response, and Recovery Program is conducting an extensive effort to model water quality implications of levee failure and salinity changes associated with different levee repair strategies. DWR is coordinating this effort with the U.S. Army Corps of Engineers and expects to reach out to the five Delta counties during plan development.

DWR is also a member of the Sacramento–San Joaquin Delta Multi-Hazard Coordination Task Force, which was created in 2008 in the wake of passage of the Sacramento–San Joaquin Delta Emergency Preparedness Act of 2008. The task force is led by the California Emergency Management Agency (CalEMA); in addition to DWR, the Delta Protection Commission and representatives from each of the five Delta counties also participate in task force activities. An Emergency Preparedness and Response White Paper was prepared for the Delta Stewardship Council on November 8, 2010, describing the operations of this task force.

The Sacramento–San Joaquin Delta Multi-Hazard Coordination Task Force was created to make recommendations to CalEMA on creating a framework for an interagency unified command system, coordinate the development of a draft emergency preparedness and response strategy for the Delta region, and develop and conduct an all-hazards emergency response exercise in the Delta. The task force's draft emergency preparedness and response strategy includes a process for allocating scarce resources and a statement of priorities agreed to by the members of the task force. The original deadline for the task force's report has been legislatively extended to January 1, 2013.



# Chapter 5

## SWP Exports

The purpose of this chapter is to illustrate the effects of factors described in Chapter 4, "Factors that Affect Water Delivery Reliability," on SWP Delta exports from the Harvey O. Banks Pumping Plant in the south Delta. Past SWP delivery reliability reports characterized SWP deliveries in their entirety but did not focus specifically on Delta exports. This chapter describes SWP Delta exports to illustrate how regulatory requirements and climate change have affected or will affect the SWP's Delta water supplies, and to describe the general pattern of monthly SWP exports from the Delta.

This chapter focuses only on Delta exports that are associated with the SWP, not on CVP water that may have been exported through the Banks Pumping Plant via the CVP/SWP joint point of diversion.

This chapter briefly explains the difference between Delta exports and SWP deliveries, then describes trends in projected average annual exports and SWP Table A water deliveries under various recent existing-conditions scenarios. In addition, monthly exports estimated for this *State Water Project Delivery Reliability Report 2011* (2011 Report) are compared with those estimated for the *State Water Project Delivery Reliability Report 2005* (2005 Report) to illustrate the effect of regulatory restrictions.

This chapter also summarizes the primary factors influencing the SWP's Delta export operations and deliveries, presents estimates of exports for the existing-conditions and future-conditions scenarios, and characterizes the likelihood of such exports. Estimated SWP Delta exports by water year type are depicted relative to exports that were estimated for the existing-conditions and future-conditions scenarios in the *State Water Project Delivery Reliability Report 2009* (2009 Report).

### SWP Delta Exports versus SWP Deliveries

SWP Delta exports and SWP deliveries are characterized in separate chapters (this chapter for exports, Chapters 6 and 7 for SWP deliveries) because these two terms are not one and the same.

The amount of water pumped from the Delta is the only source of SWP supply for 24 of the 29 SWP water contractors listed in Chapter 3, "SWP Contractors and Water

Contracts." Delta exports are the water supplies that are transferred ("exported") to SWP contractors or San Luis Reservoir storage via the Banks Pumping Plant. SWP Delta exports do not include deliveries of SWP water to the two North Bay Area contractors, which receive SWP water pumped by the Barker Slough Pumping Plant and conveyed by the North Bay Aqueduct. (Water conveyed to the SWP's three Upper Feather River Area contractors, also not exported via the Banks Pumping Plant, is not the focus of this chapter or of Chapters 6 and 7.)

By contrast, SWP Table A water deliveries include both water pumped by the Banks Pumping Plant and conveyed by the California Aqueduct and water pumped by the Barker Slough Pumping Plant and conveyed by the North Bay Aqueduct. Thus, Table A water deliveries, as described in Chapters 6 and 7, also include deliveries to the two North Bay Area contractors, for a total of 26 SWP contractors.

SWP Delta exports include nearly all types of SWP water, not merely Table A water (see the explanation of SWP water types in Chapter 3). As allowed under the SWP's water supply contracts, the amount pumped from the Delta can be exported in the same year as Table A water, or can be exported as Article 21 (surplus) water if available. A contractor can opt to have exported Delta water held in San Luis Reservoir as carryover water—that is, as part of the contractor's supply for a subsequent year. Turnback pool water is included in the tabulation of Table A water.

## Recent Trends in SWP Delta Exports and Table A Deliveries

SWP Delta exports and Table A deliveries estimated for this 2011 Report are reduced by the operational restrictions imposed on the SWP by the biological opinions (BOs) issued by the U.S. Fish and Wildlife Service (USFWS) in December 2008 and the National Marine Fisheries Service (NMFS) in June 2009. This same scenario occurred in the 2009 Report. By contrast, the *State Water Project Delivery Reliability Report 2007* (2007 Report) incorporated interim, less restrictive operational rules established by U.S. District Judge Oliver Wanger in December 2007 while the USFWS and NMFS BOs were rewritten. The 2005 Report was based on much less restrictive operational rules contained in the BOs that had been issued in late 2004 and 2005.

Overall trends in both SWP Delta exports and Table A deliveries under existing conditions are summarized below. (For further detail on estimated SWP Table A deliveries for the existing-conditions and future-conditions scenarios, respectively, see Chapters 6 and 7.)

### Annual Exports and Table A Deliveries—2005–2011 Scenarios

Figure 5-1 illustrates the effect of the operational restrictions imposed by the USFWS and NMFS BOs on estimated average annual Delta exports and Table A water deliveries. The figure depicts the average values estimated for existing conditions in the 2005, 2007, 2009, and 2011 Reports.

As shown in Figure 5-1, estimated average annual Delta exports and SWP Table A water deliveries have generally decreased since 2005, when rules affecting SWP pumping operations began to become more restrictive. Under existing conditions, average annual Delta exports have decreased since 2005 from 2,958 thousand acre-feet per year (taf/year) to 2,607 taf/year in 2011, a decrease of 351 taf or 11.9%; average annual Table A deliveries have decreased since 2005 from 2,818 taf/year to 2,524 taf/year in 2011, a decrease of 294 taf or 10.4%. The reasons for these decreases are described under "Primary Factors Affecting SWP Delta Export Operations and Table A Water Deliveries," below.

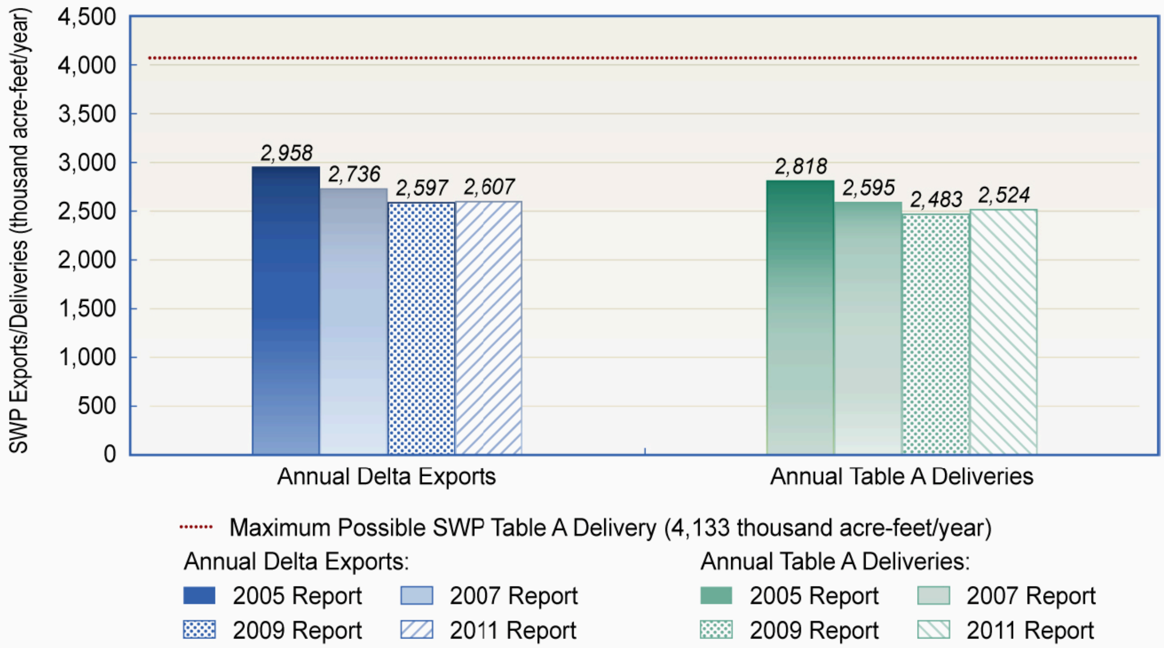



Figure 5-1. Trends in Estimated Average Annual Delta Exports and SWP Table A Water Deliveries (Existing Conditions)

### Monthly Delta Exports—2011 Scenario versus 2005 Scenario

Figure 5-2 illustrates the effects of the operational restrictions imposed by the BOs on SWP Delta exports since 2005 by comparing monthly existing-conditions exports estimated for this 2011 Report with those estimated for the 2005 Report. The bar charts show the average exports for each month under each scenario estimated for both reports.

As shown in Figure 5-2, average monthly SWP Delta exports estimated for the 2011 Report are lower than those estimated for the 2005 Report both in the first half of the year and from October through December. The reductions in exports for January through June are substantial, ranging from 22% in June to 58% in April. Exports for July and August as estimated for the 2011 Report exceed those estimated for the 2005 Report, but the increases (17% in August and approximately 45% in July) are generally smaller than the reductions seen earlier in the year.

Compiling the monthly average values for exports for the entire year under each scenario reveals that, as indicated previously in the description of annual exports, the average annual exports estimated for the 2011 Report are 11.9% less than those estimated for the 2005 Report.

## Primary Factors Affecting SWP Delta Export Operations and Table A Water Deliveries

Under current operational constraints on the SWP, maximum exports from the Banks Pumping Plant are generally limited to 6,680 cubic feet per second, except between December 15 and March 15, when exports can be increased by one-third of the San Joaquin River flow at the Vernalis gauge (when the Vernalis flow is greater than 1,000 cubic feet per second). As explained previously in Chapter 4, regulatory restrictions on the SWP's Delta operations have been among the major factors affecting SWP water delivery reliability. Several of those influence SWP exports from the Banks Pumping

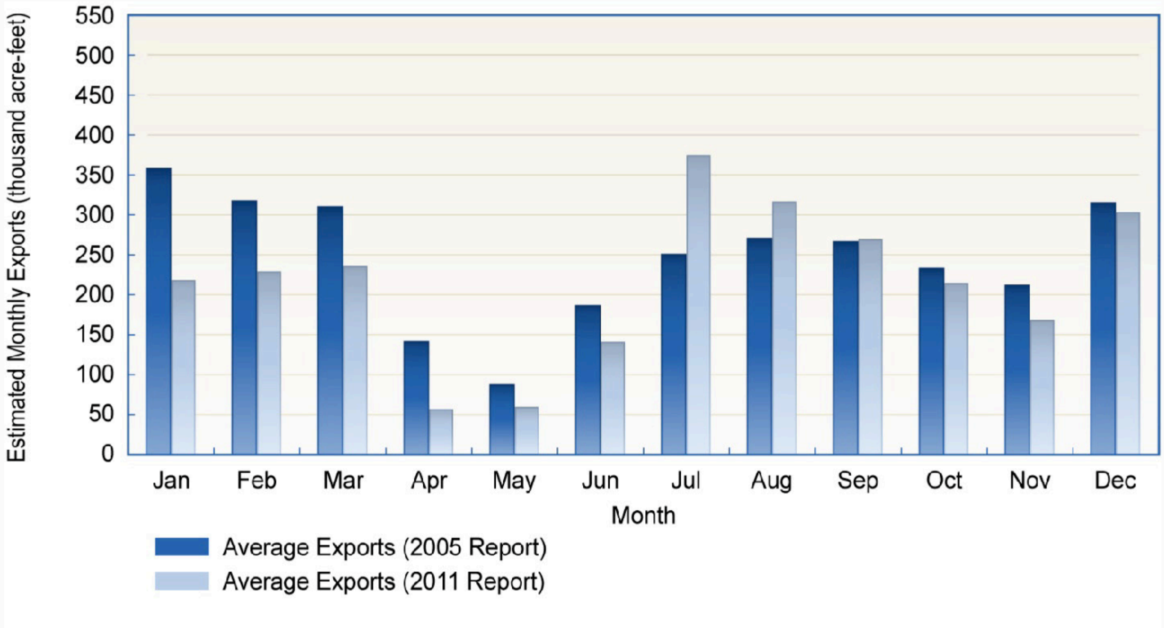



Figure 5-2. Estimated Monthly SWP Delta Exports (Existing Conditions), 2011 Scenario versus 2005 Scenario

Plant and, at times, impose particular limitations on exports. These limits are summarized here to illustrate how they affect the values shown in Figure 5-2:

- *2008 USFWS and 2009 NMFS BOs:* These BOs are much more restrictive than the BOs they replaced. The USFWS BO includes flow restrictions to protect delta smelt, with requirements in all but 2 months of the year. The NMFS BO contains similar limits for January through mid-June, but the greatest restriction imposes limits on total Delta exports in the months of April and May in most years to protect salmon and steelhead.
- *X2:* The "X2" objective mandated by the State Water Resources Control Board (State Water Board) regulates Delta salinity levels in the months of February–June. For the X2 position to be located in the appropriate location to achieve the State Water Board's salinity objective, Delta outflow must be at certain specified levels at certain times between February and June—which can constrain SWP pumping at the Banks Pumping Plant at those times.
- *Export/inflow ratio:* The 1995 *Water Quality Control Plan for the San Francisco Bay/ Sacramento–San Joaquin Delta* and State Water Board Decision 1641 (D-1641) limits Delta exports to 35% of total Delta inflow from February through June. Thus, even if substantial runoff occurs during those months (such as during a year with considerable rain-on-snow events, projected to be more likely as the effects of climate change increase), the SWP is limited in its ability to benefit from the availability of that extra water in the Delta by increasing its pumping beyond this limit. Allowable exports increase to 65% of inflow from July through January.
- *Spring Export Limitations:* Spring is an important time in the life cycles of fish protected by the USFWS and NMFS BOs. As a result, requirements for Delta exports exist in several places. D-1641 limits SWP and CVP exports to 100% of the base flow of the San Joaquin River for 31 days during the April/May period. The NMFS BO limits the combined exports during all of April and

May to a given percentage of the flow: 25% during above-normal and wet years to 100% in critical years. Finally, the previously mentioned flow requirements contained in the USFWS BO to protect delta smelt can also restrict exports during this time.

Figure 5-2 shows reductions in the values estimated for the 2011 Report during January through June and October through December that result from these restrictions. The period of July through September is the time when exports are less restricted. As a result—and to recover some of the water supply lost during the other months—the exports estimated for the 2011 Report for July–September are higher than those estimated for the 2005 Report.

Another factor described in Chapter 4, climate change, is expected to substantially affect the Delta—and SWP exports from the Banks Pumping Plant—under future conditions. The effects of climate change on SWP operations have been factored into DWR's modeling for future conditions.

## Estimated SWP Export Amounts—Existing Conditions and Future Conditions

This section provides estimates of average, maximum, and minimum annual Delta exports for both existing and future conditions. It also summarizes SWP Delta exports by month and by water year type, demonstrating the effects of the USFWS and NMFS BOs and other influencing factors on SWP Delta exports.

### Average, Maximum, and Minimum Annual Delta Exports

Figure 5-3 presents the estimated average, maximum, and minimum annual SWP Delta exports for the existing-conditions and future-conditions scenarios.

As shown in Figure 5-3, estimated maximum annual SWP exports increase by 40 taf/year (1%) under the future-conditions scenario, relative to existing conditions. However, the average export decreases by 86 taf/year (more than 3%) between the existing- and future-conditions scenarios, and the minimum export is 66 taf/year (7.6%) lower under future conditions.

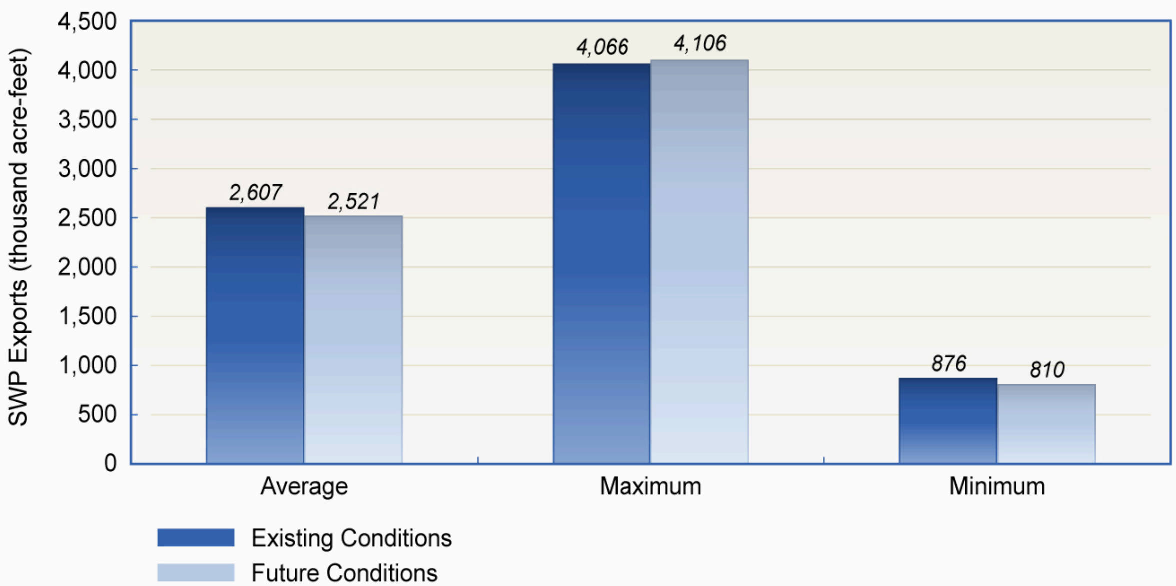



Figure 5-3. Estimated Average, Maximum, and Minimum Annual SWP Exports (Existing and Future Conditions)

### Exports by Month

Table 5-1 and Figures 5-4 and 5-5 show the range of estimated SWP exports from the Delta by month under existing and future conditions. The figures also depict the maximum and minimum estimated exports for each month under each scenario. (Please note that although the data in Figures 5-4 and 5-5 seem identical at first glance, they are not. As shown in Table 5-1, estimated existing and future SWP exports are generally similar, within 9% of each other in all months except October, but are not exactly the same.)

As shown in Figures 5-4 and 5-5 and Table 5-1, estimated SWP exports are highest on average in July, averaging 365 taf under existing conditions and 352 taf under future conditions. Exports are consistently lowest in April and May, averaging 60 taf in April and 65 taf in May for 2011, and 65 taf in April and 67 taf in May for 2031.

As shown in Table 5-1, in most months, the average estimated monthly SWP exports for future conditions are generally similar to or slightly lower than the estimated monthly exports for existing conditions. The most notable exceptions are in April and May. Under both existing and future conditions, the values for those months are essentially the same, reflecting the regulations in place during that time of the year.

Table 5-1. Average Estimated SWP Exports by Month (Existing and Future Conditions)

| Month | Estimated SWP Exports (thousand acre-feet) | | Difference, Existing vs. Future Conditions (thousand acre-feet and %) |
|---|---|---|---|
| | Existing | Future | |
| January | 214 | 217 | +4 (+2%) |
| February | 228 | 217 | -10 (-5%) |
| March | 232 | 228 | -5 (-2%) |
| April | 60 | 65 | +5 (+8%) |
| May | 65 | 67 | +2 (+4%) |
| June | 145 | 131 | -14 (-9%) |
| July | 365 | 352 | -12 (-3%) |
| August | 316 | 311 | -6 (-2%) |
| September | 268 | 271 | +3 (+1%) |
| October | 223 | 186 | -37 (-16%) |
| November | 174 | 169 | -5 (-3%) |
| December | 317 | 305 | -12 (-4%) |

### Exports by Water Year Type

Table 5-2 and Figure 5-6 compare SWP exports by water year type under existing conditions, as estimated for the 2009 Report and for this 2011 Report. As shown, the existing SWP exports estimated for this 2011 Report are roughly similar to the existing SWP exports estimated for the 2009 Report for most water year types. The largest difference is an increase in exports of about 2% in the critical-year scenario. Estimated exports in both years under existing conditions were found to be similar on average.

Table 5-2. Estimated SWP Exports by Water Year Type—Existing Conditions

| Water Year Type | Estimated Existing SWP Exports (thousand acre-feet) | | Difference, 2009 Report vs. 2011 Report (thousand acre-feet and %) |
|---|---|---|---|
| | 2009 Report | 2011 Report | |
| Wet | 3,233 | 3,210 | -23 (- <1%) |
| Above Normal | 2,774 | 2,784 | +10 (+ <1%) |
| Below Normal | 2,617 | 2,643 | +26 (+1%) |
| Dry | 2,290 | 2,320 | +30 (+1.3%) |
| Critical | 1,486 | 1,512 | +26 (+1.7%) |
| *Average* | *2,598* | *2,607* | *+9 (+ <1%)* |

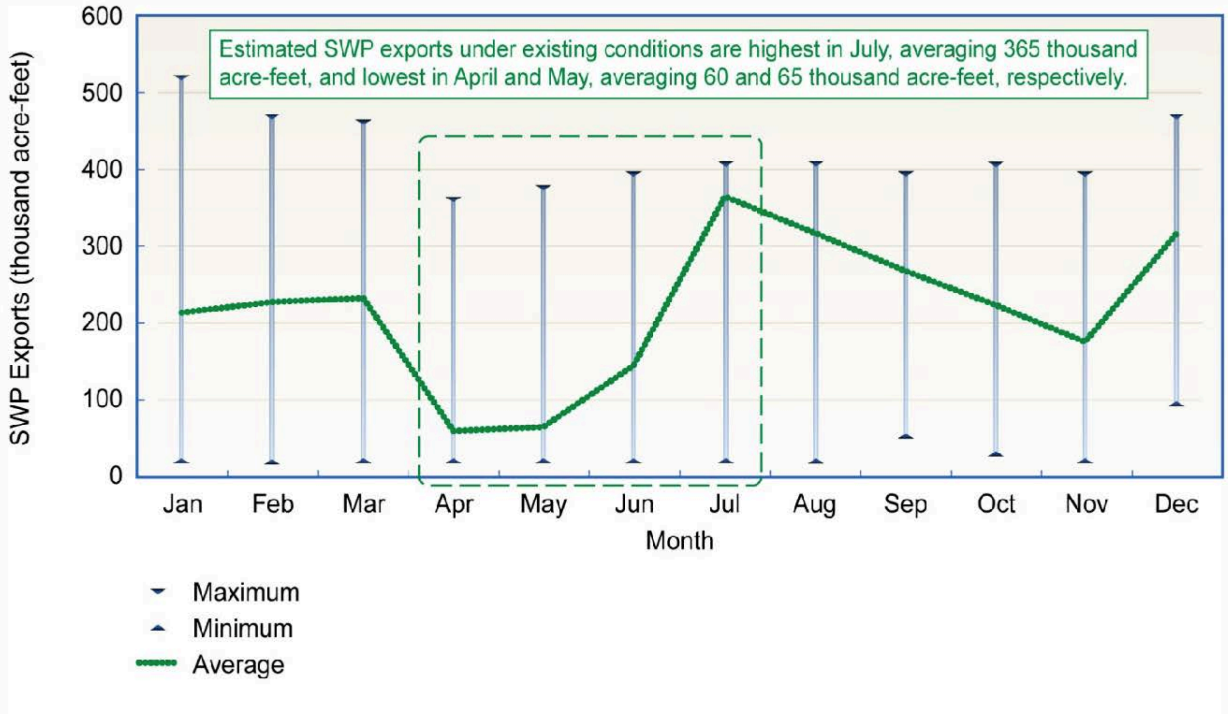



Figure 5-4. Monthly Range of Estimated SWP Exports (Existing Conditions)

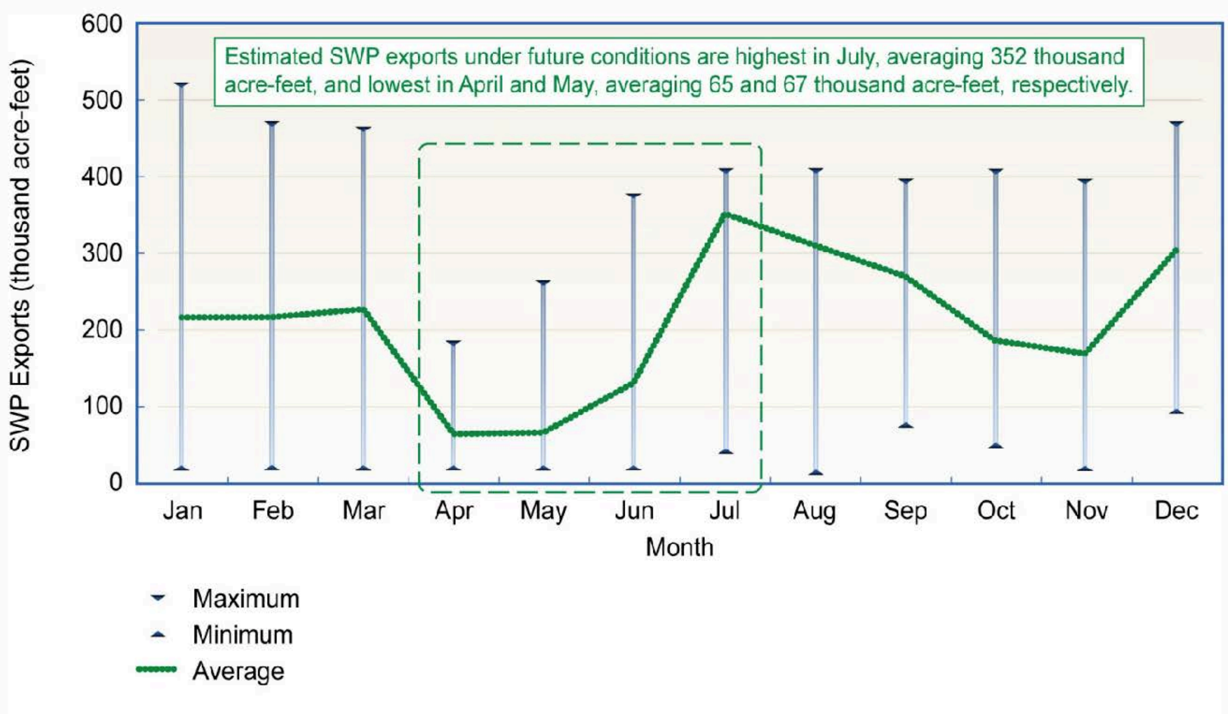



Figure 5-5. Monthly Range of Estimated SWP Exports (Future Conditions)

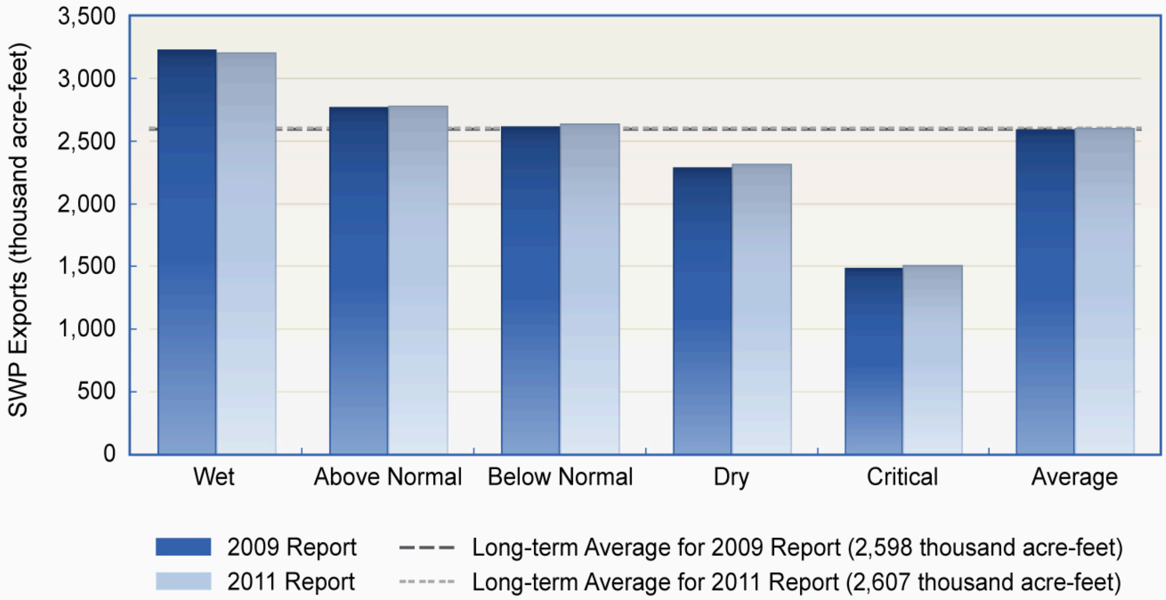



Figure 5-6. Comparison of Estimated SWP Exports by Water Year Type (Existing Conditions)

Table 5-3 and Figure 5-7 compare SWP exports by water year type under future conditions, as estimated for the 2009 Report and this 2011 Report. As shown, the future SWP exports estimated for this 2011 Report are roughly similar to or slightly (less than 7.5%) lower than the future exports estimated for the 2009 Report for all water year types, with the exception of the above-normal year scenario, where there is an increase in exports of about 0.7%. Future SWP exports estimated for this 2011 Report are slightly lower (about 1.1%) on average than future exports estimated for the 2009 Report.

Table 5-3. Estimated SWP Exports by Water Year Type—Future Conditions

| Water Year Type | Estimated Future SWP Exports (thousand acre-feet) | | Difference, 2009 Report vs. 2011 Report (thousand acre-feet and %) |
|---|---|---|---|
| | 2009 Report | 2011 Report | |
| Wet | 3,196 | 3,182 | -14 (- <1%) |
| Above Normal | 2,734 | 2,753 | +19 (+ <1%) |
| Below Normal | 2,557 | 2,556 | -1 (0%) |
| Dry | 2,173 | 2,120 | -53 (-2.4%) |
| Critical | 1,526 | 1,414 | -112 (7.4%) |
| *Average* | *2,550* | *2,521* | -29 (-1.1%) |

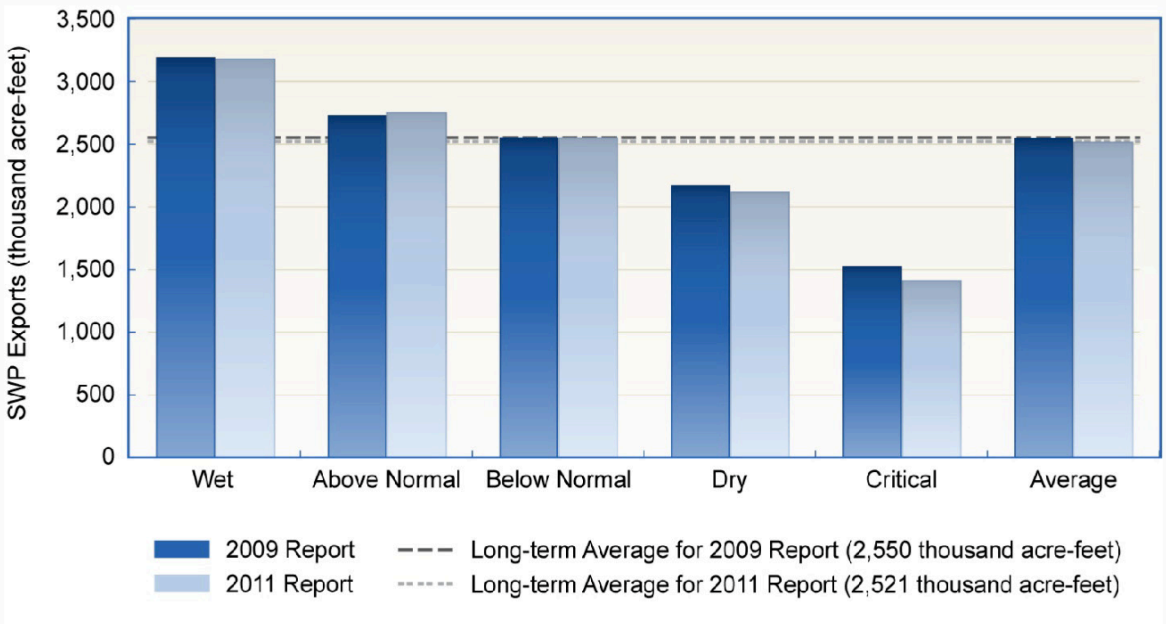



Figure 5-7. Comparison of Estimated SWP Exports by Water Year Type (Future Conditions)

## Likelihood of SWP Exports—Existing and Future Conditions

The estimated likelihood of a given level of SWP exports under existing conditions and under future conditions is presented in Figure 5-8 and Table 5-4. As shown in the figure and table, 4,106 taf is the largest export amount that was modeled for the 2011 Report.

As shown in Figure 5-8, in 79% of simulated cases for existing conditions, estimated SWP exports are between 2,000 and 3,500 taf/year. SWP exports of other amounts are less likely, with the next most likely export amount being between 1,000 and 1,500 taf/year (Table 5-4).

By comparison, in about 76% of simulated cases for future conditions, estimated SWP exports are between 2,000 and 3,500 taf/year (Figure 5-8). SWP exports of other amounts are less likely, with the next most likely export amount again being between 1,000 and 1,500 taf/year. Annual exports of 1,000–1,500 taf/year are more likely under future conditions than under existing conditions (10% versus 9%) (Table 5-4).

Table 5-4. Estimated Likelihood of SWP Annual Export Amounts—Existing and Future Conditions

| SWP Export Amount (thousand acre-feet) | Percentage Chance of Export of This Amount | |
|---|---|---|
| | Existing Conditions | Future Conditions |
| 0–500 | 0% | 0% |
| 500–1,000 | 1% | 2% |
| 1,000–1,500 | 9% | 10% |
| 1,500–2,000 | 6% | 7% |
| 2,000–2,500 | 21% | 22% |
| 2,500–3,000 | 34% | 34% |
| 3,000–3,500 | 24% | 20% |
| 3,500–4,000 | 2% | 2% |
| 4,000–4,106 | 2% | 2% |
| More than 4,106 | 0% | 0% |

As shown in Table 5-4, the likelihood of total annual SWP exports of less than 2,000 taf/year is greater under future conditions than under existing conditions (nearly 20% versus 16%), and the likelihood of exports exceeding 3,500 taf/year is nearly the same under both scenarios (nearly 5% for both existing and future conditions).

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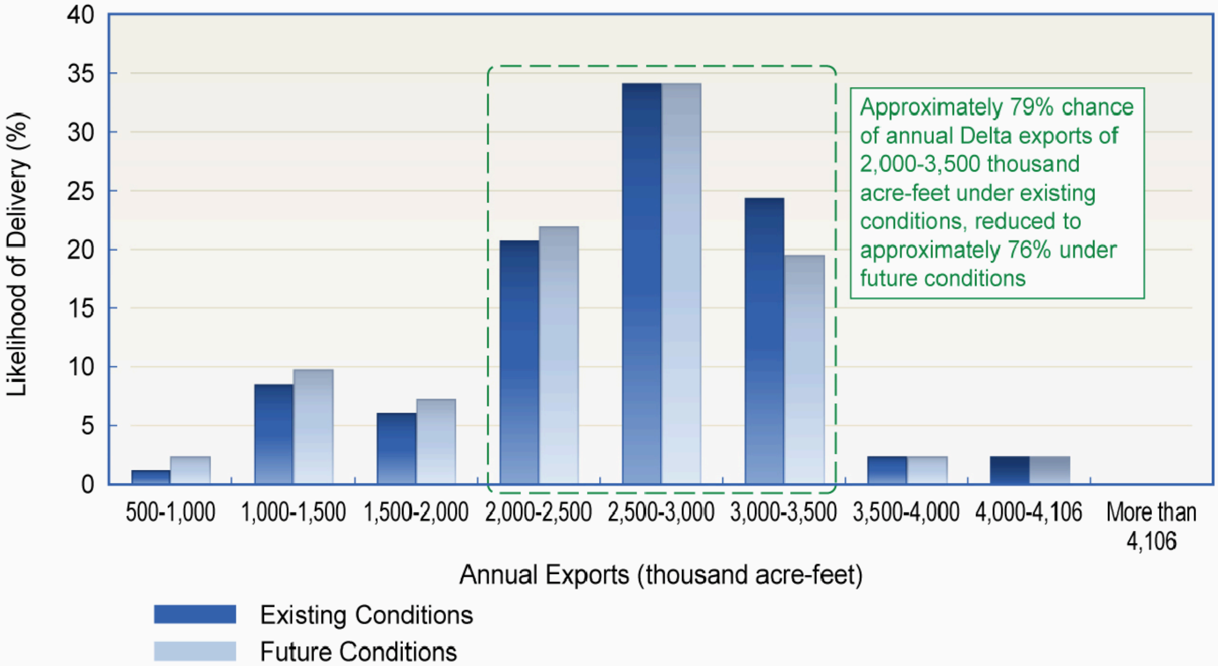
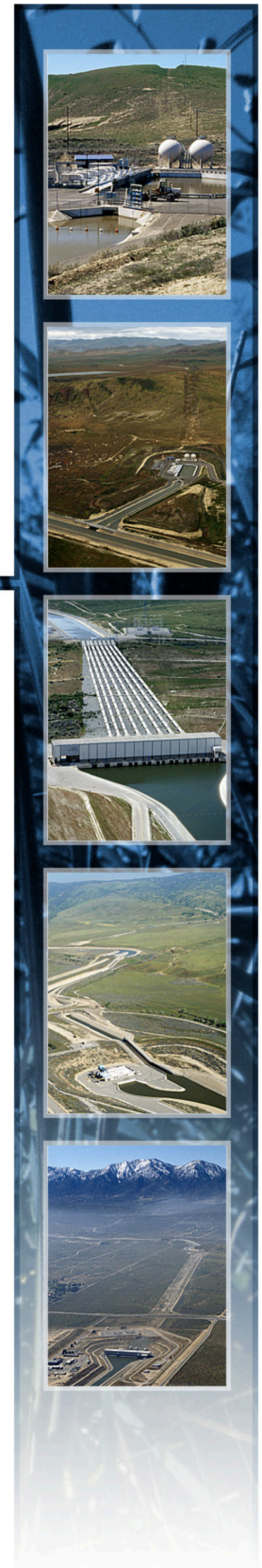



*Note: Maximum annual SWP exports from the Delta = 4,133 thousand acre-feet.*

Figure 5-8. Estimated Likelihood of SWP Exports, by Increments of 500 Acre-Feet (under Existing and Future Conditions)



# Chapter 6

## Existing SWP Water Delivery Reliability (2011)

This chapter presents estimates of the SWP's existing (2011) water delivery reliability. The estimates are presented below, alongside the reliability results obtained from the *State Water Project Delivery Reliability Report 2009* (2009 Report). Like this *State Water Project Delivery Reliability Report 2011* (2011 Report), the 2009 Report incorporated into its results the requirements of biological opinions issued by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) in December 2008 and June 2009, respectively, on the effects of coordinated operations of the SWP and Central Valley Project. These BOs are discussed in detail in Chapter 2, "A Closer Look at the State Water Project," and Chapter 4, "Factors that Affect Water Delivery Reliability."

The discussions of SWP water delivery reliability in this chapter and Chapter 7 are presented in a different format than the results presented in previous SWP delivery reliability reports, which were written for both the public and the SWP contractors. By contrast, this chapter and Chapter 7 are written primarily with the public in mind. Thus the results of DWR's updated modeling of the SWP's water delivery reliability are presented in a more graphical manner. For consistency with previous SWP delivery reliability reports, a tabular summary of the modeling results is presented in the technical addendum to this report, which is available online at http://baydeltaoffice.water.ca.gov. The technical addendum also contains distribution curves of annual delivery probability (i.e., exceedence plots) to visually show the estimated percentage of years in which a given annual delivery is equaled or exceeded.

### Hydrologic Sequence

SWP delivery amounts are estimated in this 2011 Report for existing conditions using computer modeling that incorporates the historic range of hydrologic conditions (i.e., precipitation and runoff) that occurred from water years 1922 through 2003. The historic hydrologic conditions are adjusted to account for land-use changes (i.e., the current level of development) and upstream flow regulations that characterize 2011. By using this 82-year historical flow record, the delivery estimates modeled for existing conditions reflect a reasonable range of potential hydrologic conditions from wet years to critically dry years.

## Existing Demand for Delta Water

Demand levels for the SWP water users in this report are derived from historical data and information from the SWP contractors themselves. The amount of water that SWP contractors request each year (i.e., demand) is related to:

- the magnitude and types of water demands,
- the extent of water conservation measures,
- local weather patterns, and
- water costs.

The existing level of development (i.e., the level of water use in the source areas from which the water supply originates) is based on recent land uses, and is assumed to be representative of existing conditions for the purposes of this 2011 Report.

### SWP Table A Water Demands

The current combined maximum Table A amount is 4,173 thousand acre-feet per year (taf/year). See "'Table A' Water" in Chapter 3, "SWP Contractors and Water Contracts," for a full discussion of Table A, which is a table within each water supply contract. Of the combined maximum Table A amount, 4,133 taf/year is the SWP's maximum Table A water available for delivery from the Delta. The estimated demands by SWP contractors for deliveries of Table A water from the Delta under existing conditions, as determined for the 2011 Report and previously for the 2009 Report, are shown in Figure 6-1. The estimated average demand for SWP Table A water, as well as maximum and minimum demands, is displayed because demands vary annually depending on local hydrologic patterns and other factors (e.g., water conservation efforts).

As estimated for the 2011 Report, annual demands for SWP Table A water range between 3,043 taf and 4,120 taf under existing conditions, with an average demand of 3,722 taf. There is a 95% likelihood that more than 3,200 taf/year will be requested (i.e., demanded) for delivery under existing conditions. The estimated maximum SWP Table A water demand in the 2011 Report is very near the maximum possible Table A water delivery amount of 4,133 taf/year; however, the average annual demand of 3,722 taf is approximately 400 taf less than the possible maximum annual delivery.

Figure 6-2 shows that estimated annual demands for deliveries of SWP Table A water, as calculated for the 2009 and 2011 Reports, are similar. The differences range from 5 to 36 taf (0.12% to 1.19%). Demands calculated for both reports range between 3,000 and 4,120 taf/year, regardless of whether a year is critical, wet, or anywhere in between.

### SWP Article 21 Water Demands

Under Article 21 of the SWP's long-term water supply contracts, contractors may receive additional water deliveries only under the following specific conditions:

- such deliveries do not interfere with SWP Table A allocations and SWP operations;
- excess water is available in the Delta;
- capacity is not being used for SWP purposes or scheduled SWP deliveries; and
- contractors can use the SWP Article 21 water directly or can store it in their own system (i.e., the water cannot be stored in the SWP system).

The demand for SWP Article 21 water by SWP contractors is assumed to vary depending on the month and weather conditions (i.e., amounts of precipitation and runoff). For the purposes of this discussion of SWP Article 21 water demands, a Kern wet year is defined as a year when the annual Kern River flow is projected to be greater than 1,500 taf. As shown in Figures 6-3 and 6-4, existing demands for SWP Article

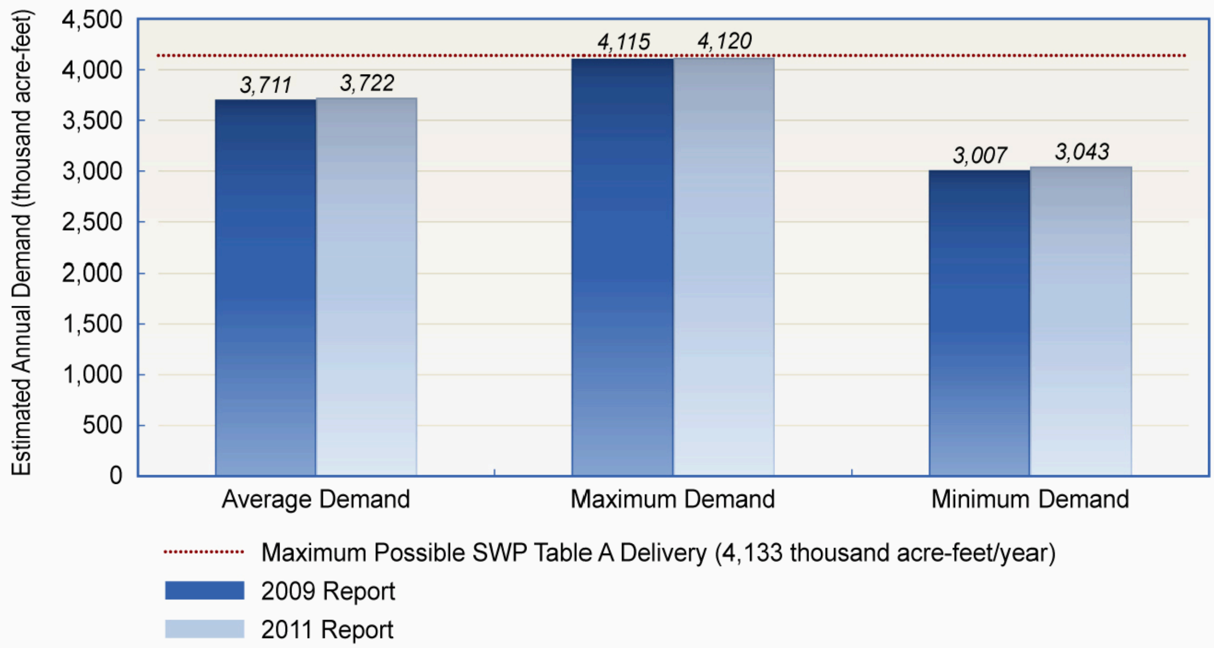



Figure 6-1. Comparison of Estimated Average, Maximum, and Minimum Demands for SWP Table A Water (Existing Conditions)

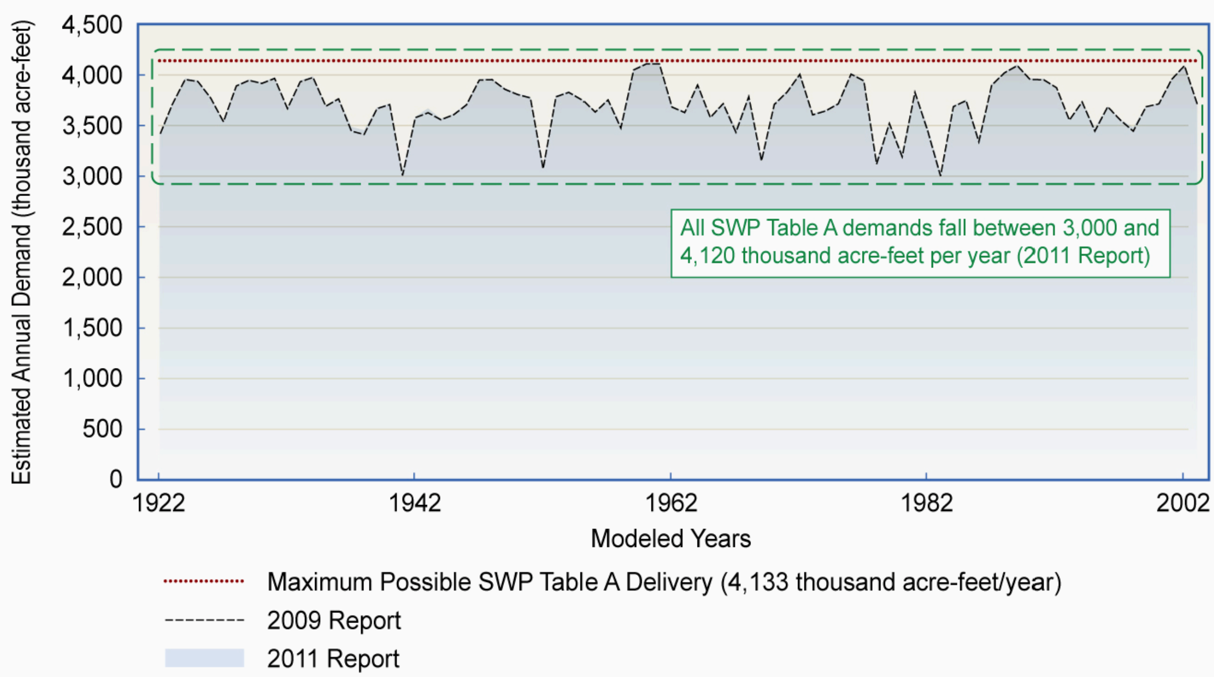



Figure 6-2. Comparison of Estimated Demands for SWP Table A Water on an Annual Basis, Using 82 Years of Hydrology (Existing Conditions)

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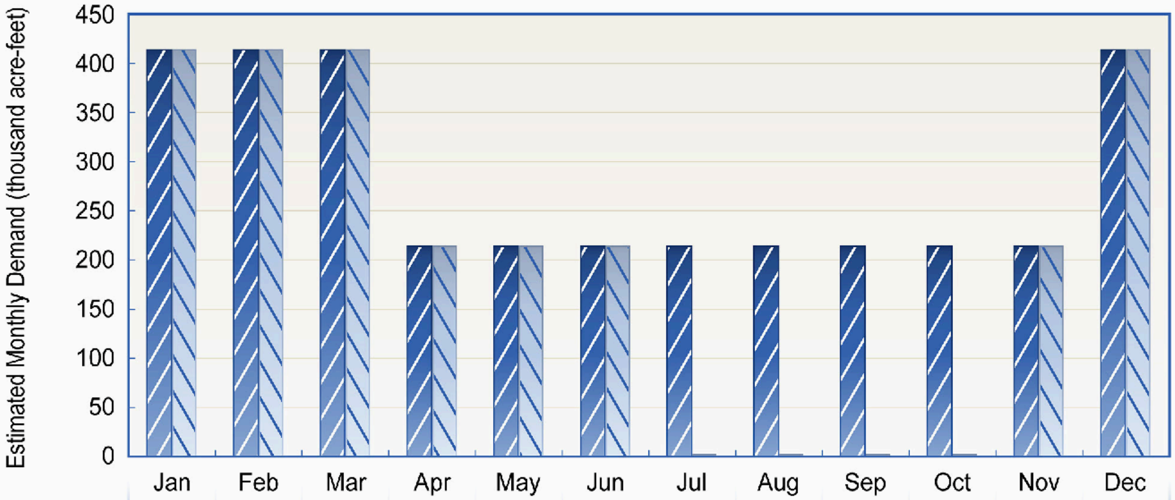
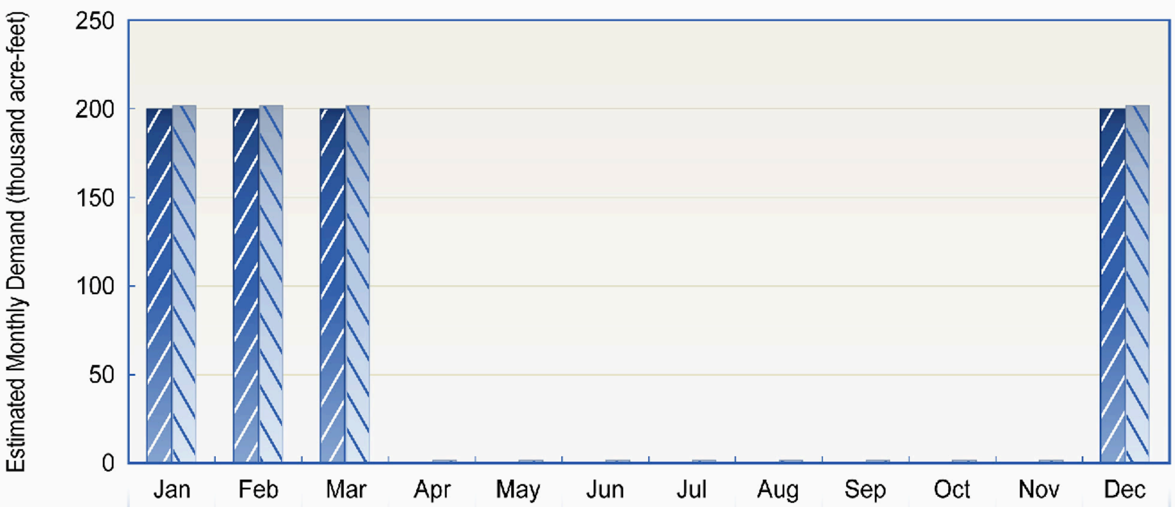



| Report: | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | 414 | 414 | 414 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 414 |
| 2011 | 414 | 414 | 414 | 214 | 214 | 214 | 2 | 2 | 2 | 2 | 214 | 414 |

Figure note: Values shown are the maximum amount that can be delivered monthly. However, the actual capability of SWP water contractors to take this amount of SWP Article 21 water is not the sum of these maximum monthly values.

Figure 6-3. Estimated Demands for SWP Article 21 Water in Years When Kern River Flow is Less than 1,500 Thousand Acre-Feet (Existing Conditions)




| Report: | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | 200 | 200 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 200 |
| 2011 | 202 | 202 | 202 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 202 |

Figure note: Values shown are the maximum amount that can be delivered monthly. However, the actual capability of SWP water contractors to take this amount of SWP Article 21 is not the sum of these maximum monthly values.

Figure 6-4. Estimated Demands for SWP Article 21 Water in Years When Kern River Flow is Greater than 1,500 Thousand Acre-Feet (Existing Conditions)

21 water estimated for this 2011 Report are assumed to be high during the spring and late fall in non–Kern wet years (214 taf/month), as well as during the winter months of December through March in all weather year types (202 taf in Kern wet years and 414 taf in other years). Demands for SWP Article 21 water are assumed to be very low (2 taf/month) from April through November of Kern wet years and from July through October of other years .

Relative to levels of demand for SWP Article 21 water presented in the 2009 Report for existing conditions, the monthly existing-conditions demands for Article 21 water are 212 taf lower from July through October in normal weather years. This reduction in demand occurs because the modeling was revised for the 2011 Report to assume that only SWP contractors receiving water from the North Bay Aqueduct will have SWP Article 21 water demands during those months. A second revision to the modeling assumptions relative to the 2009 Report resulted in the addition of a year-round demand for 2 taf/month through the North Bay Aqueduct in 2011 during wet weather years.

The estimated reduction in existing-conditions demand for SWP Article 21 water in this 2011 Report relative to the 2009 Report is the result of discussions with DWR's Operations and Maintenance staff and State Water Contractors staff, and it represents their best estimates of current practices. The SWP Article 21 water demands used in the 2009 Report, on the other hand, match the demands assumed in the studies conducted for the 2008 USFWS BO and 2009 NMFS BO, and those demands capture the upper boundary of the potential impact of SWP Article 21 exports on the Delta ecosystem. This assumption reflects a condition in which SWP contractors are able to use essentially any available SWP Article 21 water when capacity for moving that water exists in the SWP delivery system.

## Estimates of SWP Deliveries

As described previously, SWP deliveries are categorized under several different water classifications (e.g., Table A, Article 21), each available for delivery to water contractors under specific circumstances. Many contractors frequently use these additional water types to increase or reduce the amount available to them under SWP Table A.

### SWP Table A Water Deliveries

Figure 6-5 presents the annual average, maximum, and minimum estimates of SWP Table A deliveries from the Delta for existing conditions, as calculated for the 2009 and 2011 Reports. The maximum Table A deliveries are similar between the 2009 and 2011 Reports, increasing by 27 taf (1%) in 2011, and the average annual delivery of Table A water estimated for the 2011 Report is 41 taf (2%) larger than the corresponding delivery estimated for the 2009 Report. The minimum Table A delivery estimated for the 2011 Report is 79 taf/year greater than the minimum delivery estimated for the 2009 Report, which equates to a 26% increase. The increase in minimum Table A deliveries under existing conditions between the 2009 Report and the 2011 Report can be attributed primarily to changes in the modeling assumptions. Assumptions about Table A and Article 21 water demands, along with Article 56 carryover operations, have been updated in the model based on discussions with State Water Contractors staff and DWR's Operations and Control Office.

The estimated likelihood of delivery of a given amount of SWP Table A water under the existing conditions scenario, as estimated for both the 2009 and 2011 Reports, is presented in Figure 6-6. Figure 6-6 shows that the likelihood that 2,000–3,365 taf/year of Table A water will be delivered is now 82%. There is a 48% likelihood that 2,500–3,000 taf of Table A water will be delivered, a 5% likelihood of delivery of less than 1,000 taf, and 0% likelihood of delivery

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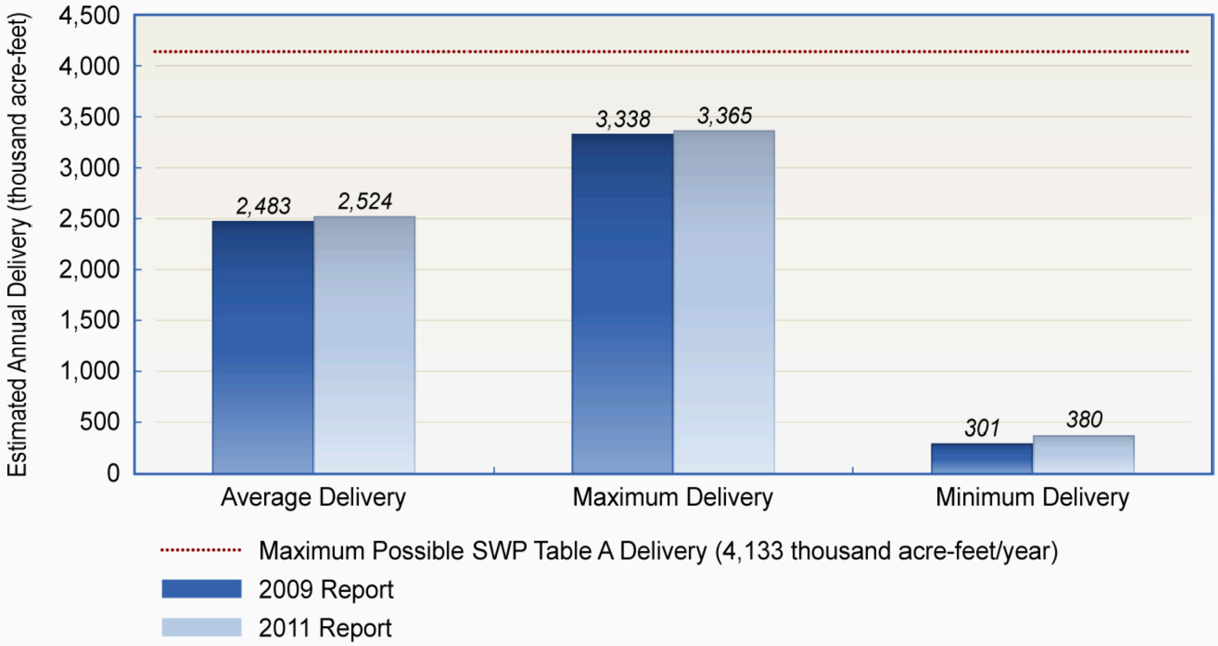


Figure 6-5. Comparison of Estimated Average, Maximum, and Minimum Deliveries of SWP Table A Water (Existing Conditions)

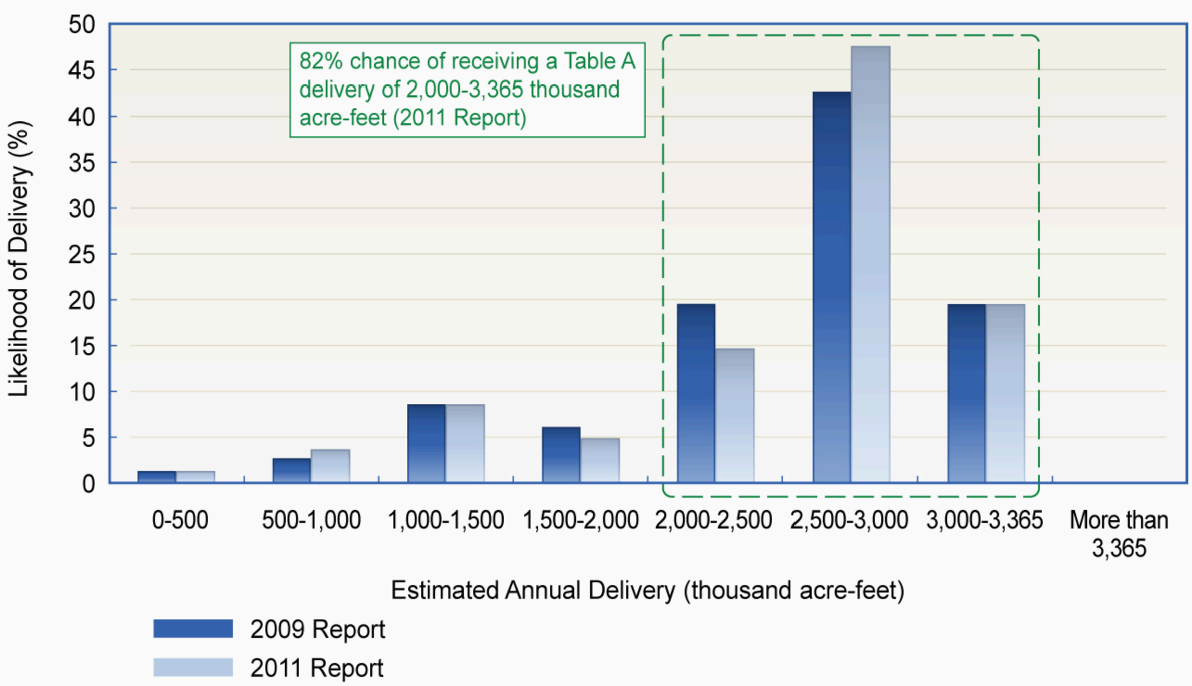


Figure 6-6. Estimated Likelihood of SWP Table A Water Deliveries (Existing Conditions)

of more than 3,365 taf in a given year. To compare the results estimated for this 2011 Report with results from the 2009 Report, an SWP contractor is just slightly more likely to receive a larger Table A water delivery under the current estimates.

Figure 6-7 illustrates that SWP contractors have a similar or greater likelihood of receiving larger Table A water deliveries under the scenario for the 2011 Report, relative to the scenario presented in the 2009 Report. For example, there is a 67% likelihood of receiving more than 2,500 taf/year of Table A water under the current scenario, while there was a 62% likelihood of receiving more than 2,500 taf/year under the scenario presented in the 2009 Report.

### Dry-Year Deliveries of SWP Table A Water

Figure 6-8 displays estimates of SWP Table A water deliveries under existing conditions during possible drought conditions and compares them with the corresponding delivery estimates calculated for the 2009 Report. Droughts are analyzed using the historical drought-period precipitation and runoff patterns from 1922 through 2003 as a reference, although existing 2011 conditions (e.g., land use, water infrastructure) are also accounted for in the modeling. For reference, the worst multiyear drought on record was the 1929–1934 drought, although the brief drought of 1976–1977 was more intensely dry.

The results of modeling existing conditions for potential drought-year scenarios indicate that SWP Table A water deliveries during dry years can be expected to range from between 380 and 1,573 taf/year. This is a 38% to 85% decrease in Table A water deliveries from the average estimated delivery calculated for this report.

Figure 6-8 shows that current estimates of SWP deliveries for existing conditions during dry periods increase relative to the corresponding deliveries estimated for the 2009 Report. For example, deliveries of 1,573 taf/year of SWP Table A water are currently estimated for the 2-year drought scenario, an increase of 77 taf/year (5%) relative to the delivery estimate calculated for the 2009 Report. The most striking change in drought-year delivery is for the single-year drought scenario, in which the estimated SWP Table A water delivery increases by 79 taf/year (26%) relative to the corresponding delivery estimated for the 2009 Report. These changes in estimated deliveries of SWP Table A water during drought years, relative to the estimates from the 2009 Report, can be attributed to recent model and assumption changes, as described previously in this chapter.

### Wet-Year Deliveries of SWP Table A Water

Figure 6-9 presents estimates of SWP Table A water deliveries in the case of a wet year and compares them with the corresponding delivery estimates calculated for the 2009 Report. Wet periods for 2011 are modeled using historical precipitation and runoff patterns from 1922–2003 as a reference, although existing 2011 conditions (e.g., land use, water infrastructure) are also accounted for in the modeling. For reference, the wettest single year on record was 1983.

The results of modeling existing conditions for potential wet periods indicate that estimated SWP Table A water deliveries during wet years can be expected to range between 2,833 and 2,958 taf/year. This is a 12% to 17% increase in Table A water deliveries from the average estimated delivery calculated for this report.

Figure 6-9 shows that current estimates of SWP deliveries for existing conditions during wet periods increase slightly (by between 1% and 3%) relative to the corresponding deliveries estimated for the 2009 Report. For example, the current results indicate delivery of an estimated 2,958 taf of SWP Table A water for the 2-year-wet-period scenario, an increase of 23 taf/year (1%) relative to the delivery estimate calculated for the 2009 Report. The current results also

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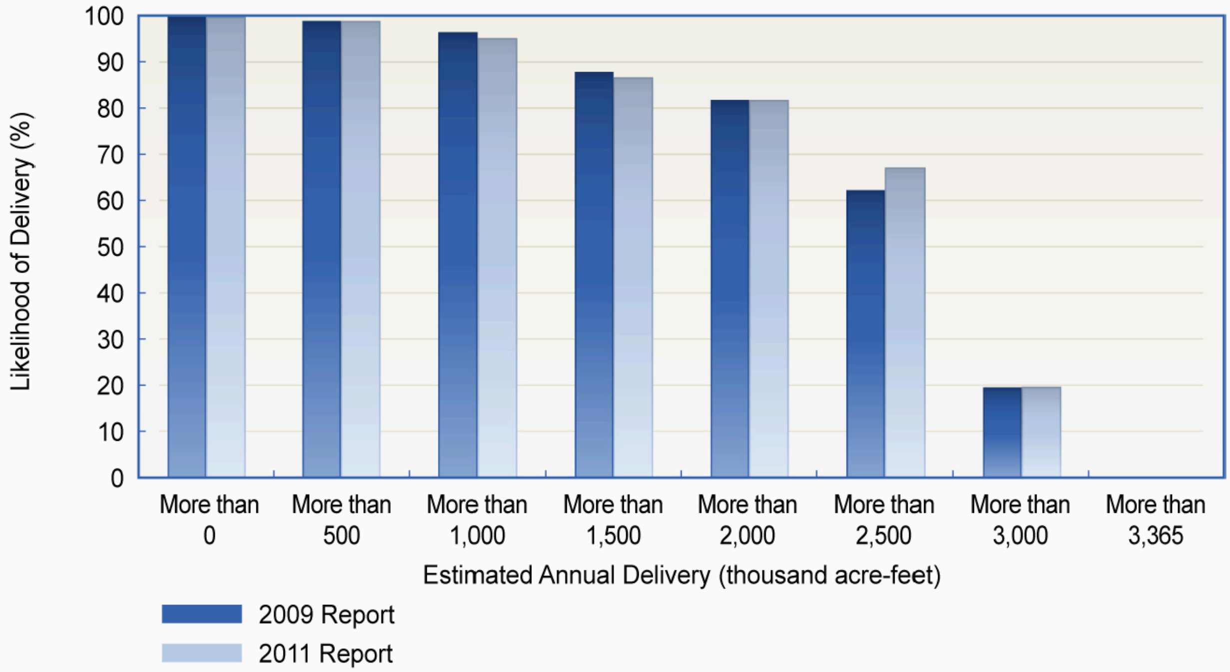


Figure 6-7. Estimated Cumulative Likelihood of SWP Table A Water Deliveries, by Increments of 500 Thousand Acre-Feet (Existing Conditions)

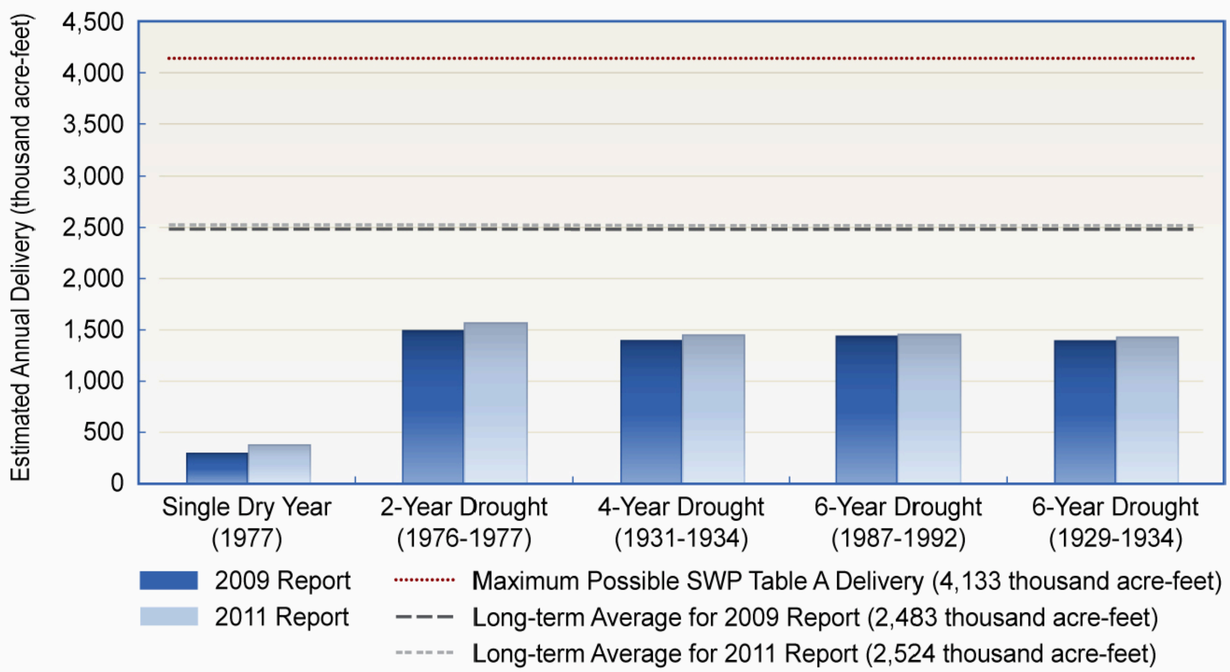


Figure 6-8. Estimated Average and Dry-Period Deliveries of SWP Table A Water (Existing Conditions)

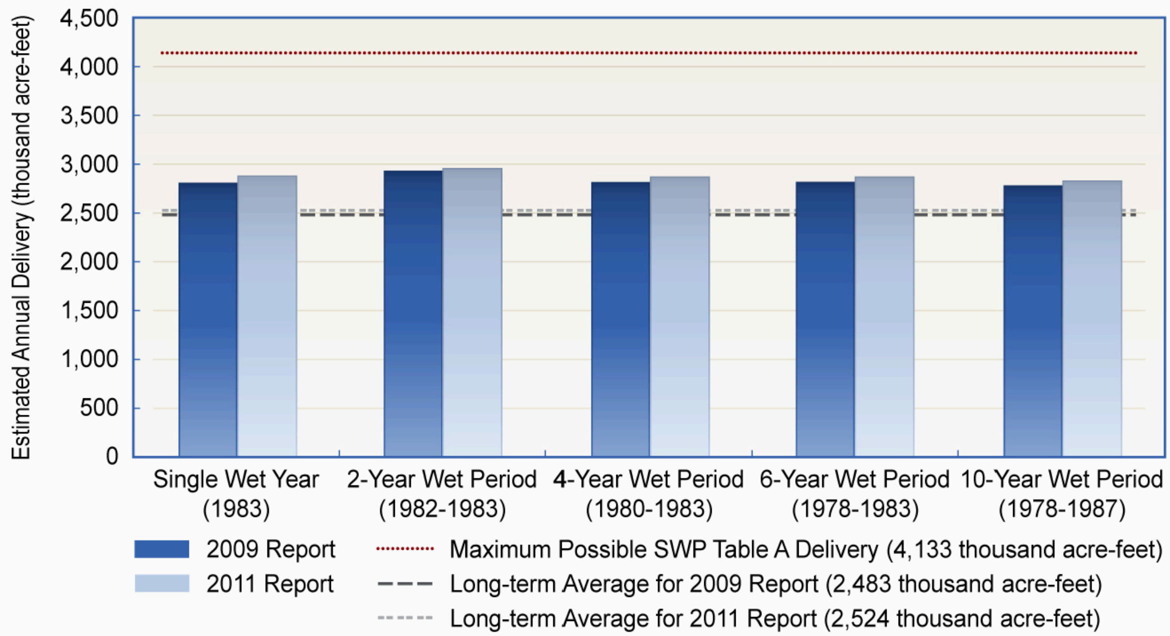


Figure 6-9. Estimated Average and Wet-Period Deliveries of SWP Table A Water (Existing Conditions)

indicate that an estimated 2,886 taf/year of SWP Table A water will be delivered during the single-year wet-period scenario, an increase of 73 taf/year (3%) relative to the corresponding delivery estimated for the 2009 Report. This small but consistent increase in SWP Table A wet-year deliveries in 2011 can be attributed to an assumed incremental increase in demand relative to the demand estimated for the 2009 Report.

## SWP Article 21 Water Deliveries

SWP water delivery is a combination of deliveries of Table A water and Article 21 water. Some SWP contractors store Article 21 water locally when extra water and capacity are available beyond that needed by normal SWP operations. Deliveries of SWP Article 21 water vary not only by year, but also by month. In the summer and early fall months (July through October), a maximum of approximately 2 taf and a minimum of 0 taf/month can be delivered. From November through June, maximum deliveries of SWP Article 21 water can be as high as 299 taf and as low as 2 taf in a given month; however, water deliveries average in the range of 0.3 to 30 taf. The estimated range of monthly deliveries of SWP Article 21 water is displayed in Figure 6-10.

The estimated likelihood that a given amount of SWP Article 21 water will be delivered is presented in Figure 6-11. Currently, there is a 26% likelihood that more than 20 taf/year of SWP Article 21 water will be delivered under existing conditions. There is a 74% likelihood that less than 20 taf/year of SWP Article 21 water will be delivered.

To compare these results to the results from the 2009 Report, the likelihood of larger deliveries of SWP Article 21 water is lower under the current scenario. In the 2009 Report, there is a 29% likelihood that more than 20 taf/year of SWP Article 21 water will be available for delivery, compared to a 26% likelihood in the results calculated for this 2011 Report. There is a 22% likelihood that more than 100 taf/year of SWP Article 21 water will be available for delivery in the 2009 Report, compared to a 20% likelihood

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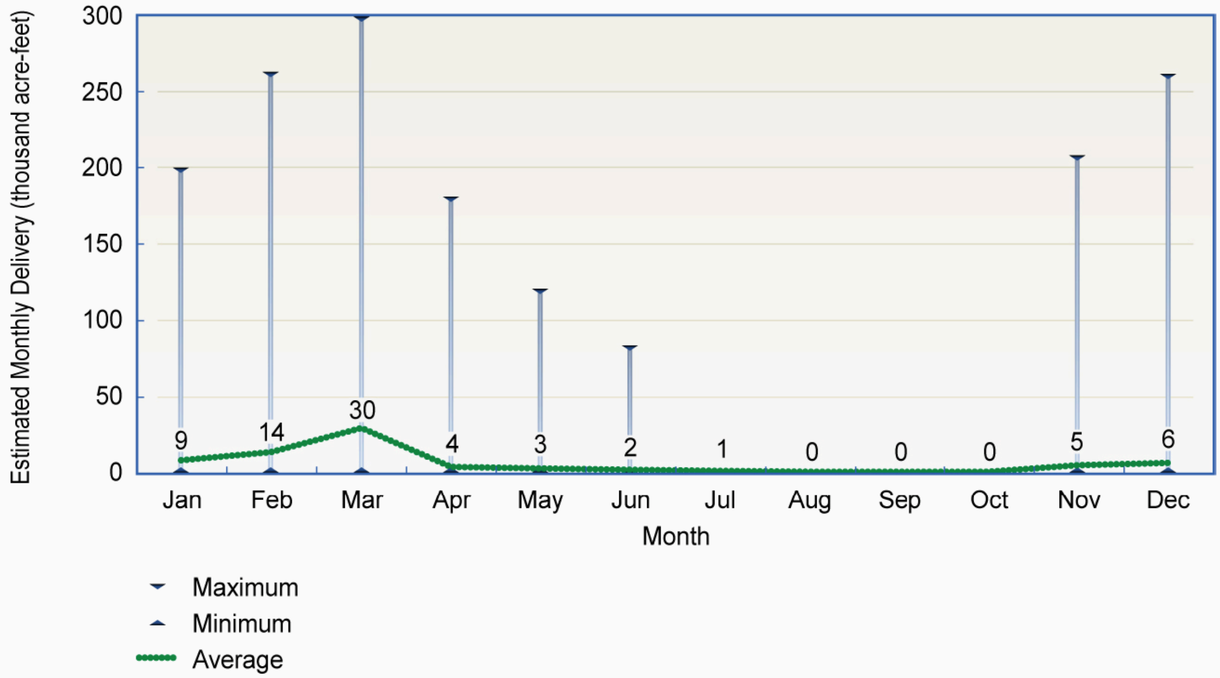


Figure 6-10. Estimated Range of Monthly Deliveries of SWP Article 21 Water (2011 Report—Existing Conditions)

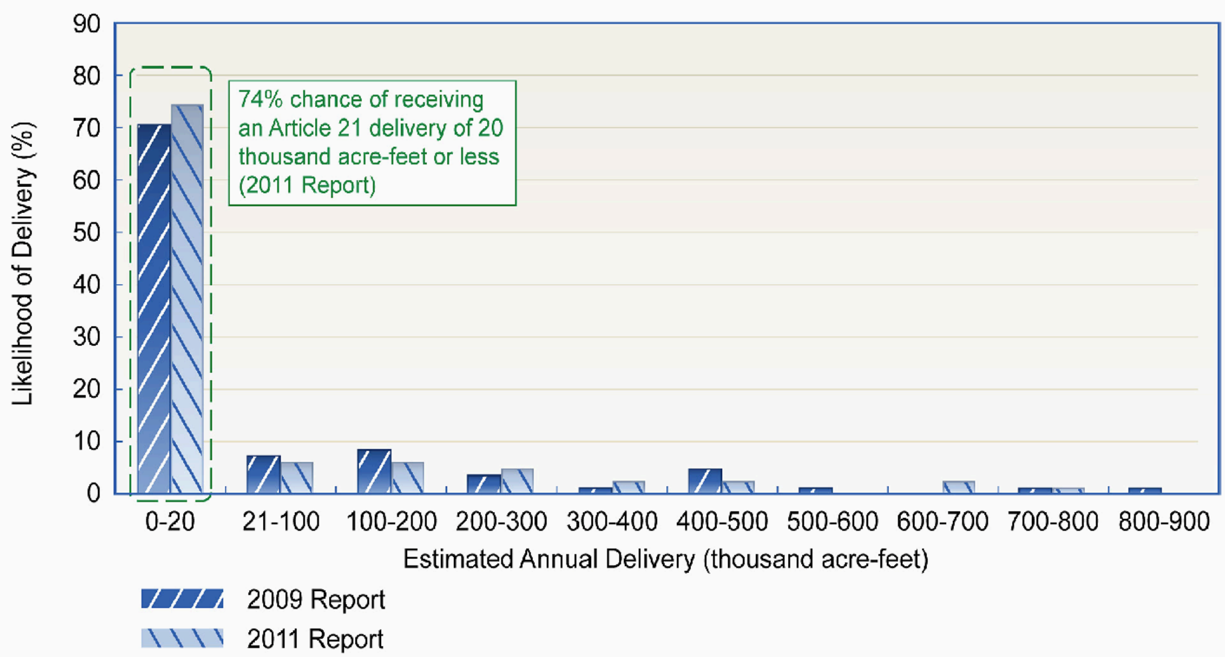


Figure 6-11. Estimated Probability of Annual Deliveries of SWP Article 21 Water (Existing Conditions)

in the current estimates. Thus, the estimated likelihood of larger Article 21 deliveries is greater in the 2009 Report than in this 2011 Report.

In both the 2009 and 2011 Reports, however, estimated deliveries of SWP Article 21 water are generally less than 20 taf/year (71% and 74% likelihood, respectively).

### Dry-Year Deliveries of SWP Article 21 Water

Although deliveries of SWP Article 21 water are smaller during dry years than during wet ones, opportunities exist to deliver SWP Article 21 water even during multiyear drought periods. For example, when looking at the periods in the modeling scenario that are known to be dry, it is apparent that SWP Article 21 water is still delivered during those times. Deliveries in dry years can often be small (less than 5 taf), ranging from 9% to 96% less than the average SWP Article 21 delivery estimated for this 2011 Report.

Figure 6-12 shows the estimates of deliveries of SWP Article 21 water during dry periods under existing conditions. To compare the results calculated for this 2011 Report to the results from the 2009 Report, deliveries during dry years in the current scenario are slightly higher (1 taf) for the single-year drought scenario, but are much lower in others (e.g., the 4-year drought scenario, for which the estimate calculated for this 2011 Report is 73 taf lower).

### Wet-Year Deliveries of SWP Article 21 Water

Figure 6-13 shows the estimates of deliveries of SWP Article 21 water during wet periods under existing conditions. Estimated deliveries in wet years are approximately 1.75 to seven times larger than the average delivery of SWP Article 21 water.

Although wet-period deliveries are estimated to be larger than those in normal and dry years, wet-year deliveries estimated for this 2011 Report are consistently smaller than the wet-period deliveries estimated for the 2009 Report. Current estimates of deliveries during wet years are up to 242 taf lower in a given year than the corresponding estimates calculated for the 2009 Report.

## Summary of Results

### SWP Table A Water Demands and Deliveries

The estimates of existing-conditions demand for deliveries of SWP Table A water as presented in the 2009 and 2011 Reports are very similar; this 2011 Report shows only a slight increase in the estimate relative to the previous report, with average demand at 3,722 taf/year, maximum demand at 4,120 taf/year, and minimum demand at 2,512 taf/year. The current estimates of existing SWP Table A water deliveries are slightly higher than the delivery estimates presented in the 2009 Report during all potential precipitation conditions (average, wet, and dry years), with average deliveries at 2,524 taf/year, maximum deliveries at 3,365 taf/year, and minimum deliveries at 380 taf/year. Not only are the estimated delivery amounts larger, but the likelihood that an SWP contractor will receive those larger Table A water deliveries is greater in the current estimate, with an 82% chance of receiving an annual Table A delivery of 2,000–3,365 taf.

### SWP Article 21 Water Demands and Deliveries

The demands for SWP Article 21 water estimated for the 2011 Report are lower than those estimated for the 2009 Report in all types of precipitation conditions except the driest years, for which the current demand estimates are slightly (2 taf/month) higher. This 2011 Report shows demands ranging from 2 to 202 taf/month in wet years and from 2 to 414 taf/month in normal years. The comparison of deliveries of SWP Article 21 water between the 2009 and 2011 Reports is nuanced, depending on precipitation. Estimates of maximum and average deliveries of SWP Article 21 water as calculated for the 2011 Report are lower than the corresponding deliveries calculated for the 2009

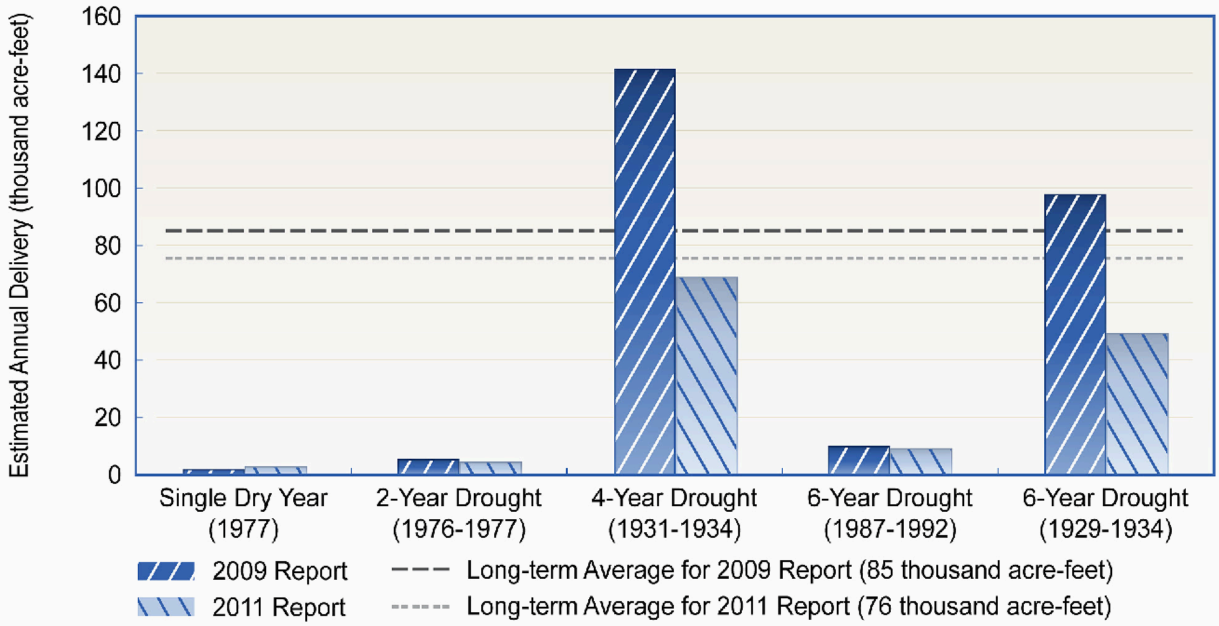


Figure 6-12. Estimated Average and Dry-Period Deliveries of SWP Article 21 Water (Existing Conditions)

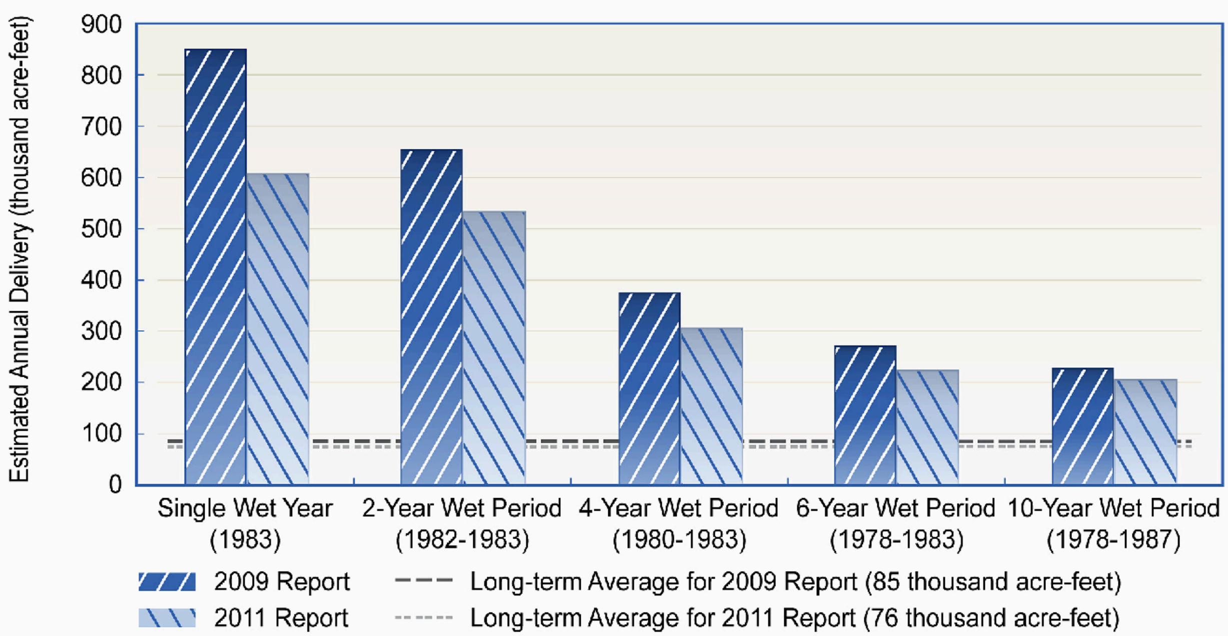


Figure 6-13. Estimated Average and Wet-Period Deliveries of SWP Article 21 Water (Existing Conditions)

Report. However, current estimates of minimum deliveries are slightly larger, leading to an overall smaller range of possible SWP Article 21 deliveries (a range of 2,708 taf/year calculated for the 2011 Report versus 2,850 taf/year for the 2009 Report).

Overall, estimated deliveries of SWP Article 21 water generally declined between the 2009 and 2011 Reports. The estimated likelihood of annual deliveries being greater than 20 taf is higher in the 2009 Report than the 2011 Report (29% versus 26%). Conversely, the likelihood annual deliveries will be 20 taf or less is 74% for the 2011 Report and 71% for the 2009 Report.

# Chapter 7

## Future SWP Water Delivery Reliability (2031)

This chapter presents estimates of the SWP's delivery reliability for conditions 20 years in the future (2031). These estimates reflect hydrologic changes that could result from climate change, but they incorporate the same requirements that are assumed under existing conditions, including the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) biological opinions (BOs).

This chapter also compares these estimates of future conditions with the future-condition results presented in the *State Water Project Delivery Reliability Report 2009* (2009 Report) for the year 2029.

As described in Chapter 6, "Existing SWP Water Delivery Reliability (2011)," the discussions of SWP water delivery reliability in this *State Water Project Delivery Reliability Report 2011* (2011 Report) are presented in a different format than the results presented in previous SWP delivery reliability reports. For consistency with previous reports, a tabular summary of the modeling results for the future conditions scenario is presented in the technical addendum to this report. The technical addendum also contains distribution curves of annual delivery probability (i.e., exceedence plots) to visually show the estimated percentage of years in which a given annual delivery is equaled or exceeded.

### Future Demand for Delta Water

Demand levels for the SWP water users in this report are derived from historical data and information from the SWP contractors themselves. The 2031 level of development (i.e., the level of water use in the source areas from which the water supply originates) is based on the projected assumptions for land use for that year, and is assumed to be representative of future conditions for the purposes of this 2011 Report.

#### SWP Table A Water Demands

Future demands for SWP Table A water, as calculated for this 2011 Report, are assumed to be the maximum possible annual amount of 4,133 thousand acre-feet (taf). There is no assumed variation in demand as a result of different annual precipitation and runoff conditions; it is assumed that by 2031, the maximum amount of SWP Table A water will be requested every year. As a reminder, 4,133 taf/year is the maximum Delta SWP Table A amount.

The SWP Table A water demands under future conditions as presented in the 2009 Report are also assumed to be the maximum amount of 4,133 taf/year.

### SWP Article 21 Water Demands

The assumed future demands for SWP Article 21 water are the same as those assumed for existing conditions (see Chapter 6, "Existing SWP Water Delivery Reliability [2011]"). Relative to the future SWP Article 21 water demands estimated for the 2009 Report, the current estimates of monthly demands for SWP Article 21 water under future conditions are 212 taf lower from July through October in normal water years.

The estimated reduction in future-conditions demand for SWP Article 21 water in this 2011 Report relative to the 2009 Report is the result of discussions with DWR's Operations and Maintenance staff and State Water Contractors staff, and it represents their best estimates of current and future practices. The SWP Article 21 water demands used in the 2009 Report, on the other hand, match the demands assumed in the studies conducted for the 2008 USFWS BO and 2009 NMFS BO, and those demands capture the upper boundary of the potential impact of SWP Article 21 exports on the Delta ecosystem. This assumption reflects a condition in which SWP contractors are able to use essentially any available SWP Article 21 water when capacity for moving that water exists in the SWP delivery system.

## Estimates of Future SWP Deliveries

When modeling water supply deliveries 20 years in the future, the unknowns are considerable and many assumptions must be made. As was assumed for existing conditions (see Chapter 6), modeling of SWP deliveries for 2031 take into account current Delta water quality regulations and the requirements of the USFWS and NMFS BOs. Climate change as well as changes to water uses in the upstream watersheds (i.e., source watersheds) are also taken into account when modeling water supply deliveries under future conditions. Additional discussion of how the modeling of SWP water delivery reliability is adjusted to account for climate change is provided in Chapter 4, "Factors that Affect Water Delivery Reliability."

One of the most important assumptions when modeling SWP water delivery under future conditions is that the rules and facilities related to Delta conveyance will remain at the status quo. That is, in the future-conditions scenario, no new facilities to convey water through or around the Delta are assumed to be in place because no new programs have been sufficiently developed that can be assumed with certainty.

### Future Deliveries of SWP Table A Water

Figure 7-1 presents the annual average, maximum, and minimum estimates of SWP Table A water deliveries from the Delta for future conditions, as calculated for the 2009 and 2011 Reports. The SWP Table A water deliveries under future conditions are similar between the 2009 and 2011 Reports, with estimated average and minimum annual deliveries decreasing by 1% and 3%, respectively. The estimated maximum future annual delivery of SWP Table A water presented in this 2011 Report is 64 taf (2%) greater than the corresponding future delivery estimated for the 2009 Report. The changes between the 2009 Report and the 2011 Report can be attributed primarily to updates in the modeling assumptions made based on discussions with State Water Contractors staff and DWR's Operations and Control Office. The maximum possible delivery of SWP Table A water, 4,133 taf/year, is not reached under future conditions.

The estimated likelihood that a given amount of SWP Table A water will be delivered under future conditions is presented in Figure 7-2. Currently, there is a 70% likelihood that 2,000–3,500 taf of SWP Table A water will be delivered under the future-conditions scenario. There is a 17% likelihood of an SWP Table A water delivery of 1,000–2,000 taf, a 7% likelihood of less than 1,000

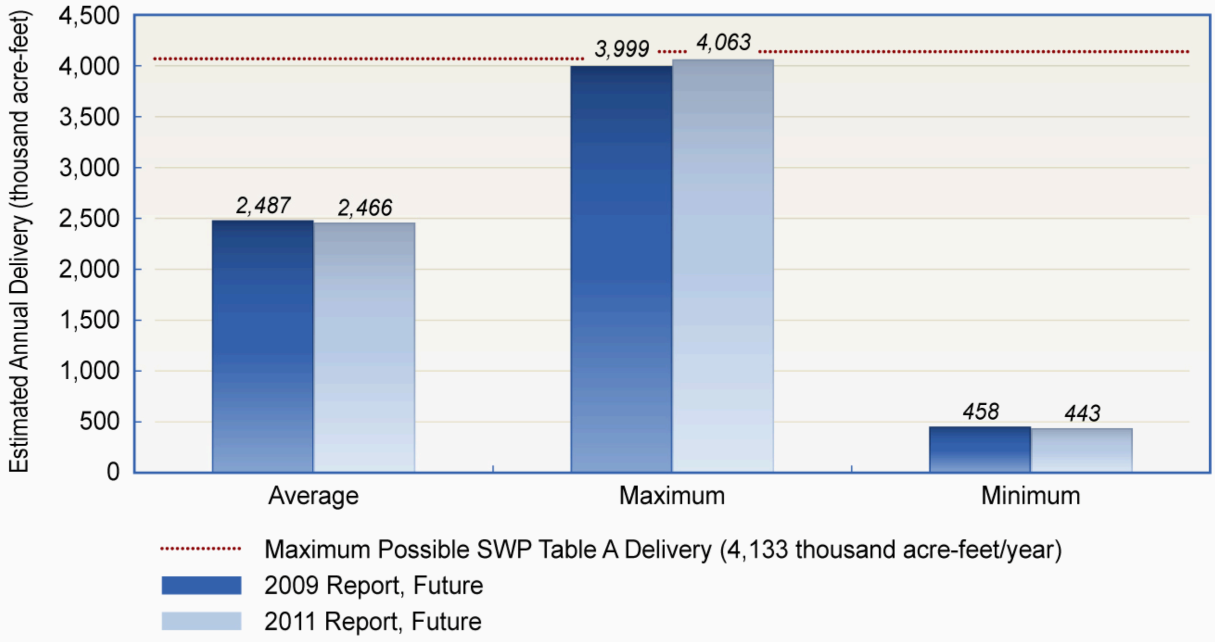


Figure 7-1. Comparison of Estimated Average, Maximum, and Minimum Deliveries of SWP Table A Water (Future Conditions)

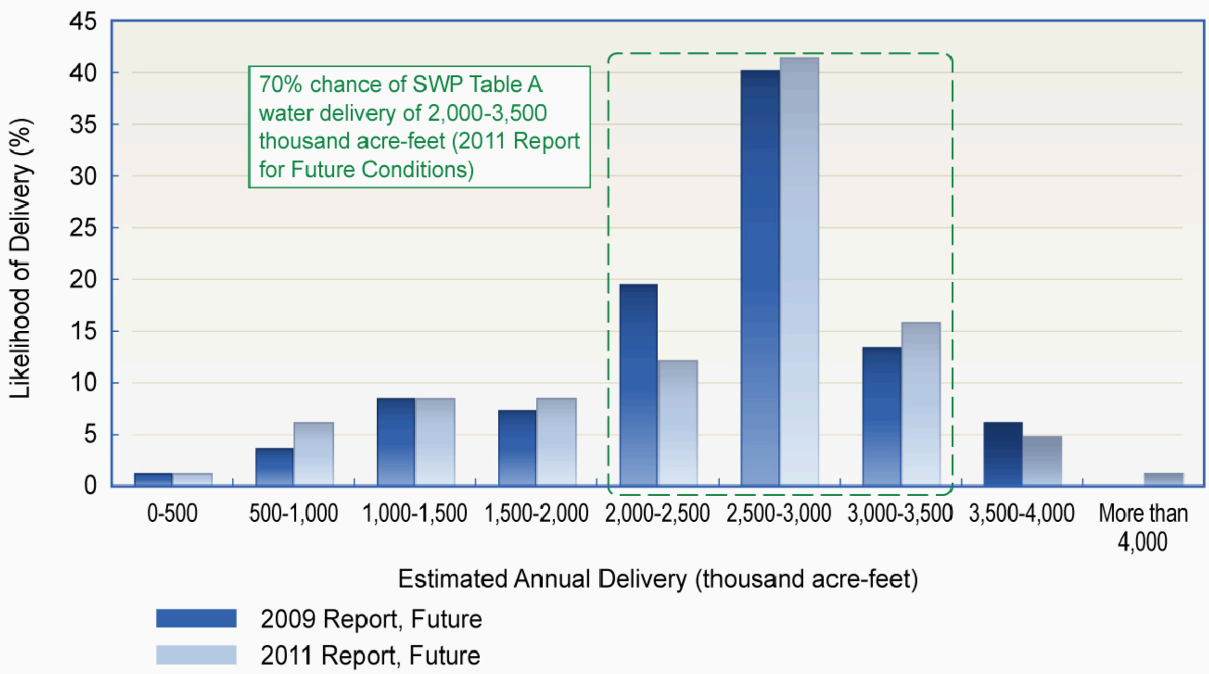


Figure 7-2. Estimated Likelihood of SWP Table A Water Deliveries, by Increments of 500 Thousand Acre-Feet (Future Conditions)

taf, and a 6% likelihood of more than 3,500 taf. The estimates of the likelihood that an SWP contractor will receive a specific amount of SWP Table A water under future conditions, as presented in the 2009 and 2011 Reports, are very similar.

As illustrated in Figure 7-3, the current likelihood that SWP contractors will receive larger deliveries of SWP Table A water under future conditions is similar to, although slightly higher than, the likelihood of larger future deliveries forecasted in the 2009 Report. For example, as estimated for this 2011 Report, there is a 22% likelihood that a contractor will receive more than 3,000 taf under future conditions, while the 2009 Report estimates a 20% likelihood that a contractor will receive more than 3,000 taf.

### Dry-Year Deliveries of SWP Table A Water under Future Conditions

Figure 7-4 presents estimates of future SWP Table A water deliveries during possible drought conditions and compares them with the corresponding delivery estimates calculated for the 2009 Report. Drought scenarios for future conditions in this 2011 Report are modeled using the historical drought-period precipitation and runoff patterns from 1922–2003 as a reference; future 2031 conditions (e.g., land use, climate change) are also accounted for in the modeling.

The results of modeling future conditions under potential drought-year scenarios indicate that estimated dry-year SWP deliveries can be expected to range between 443 and 1,457 taf/year. This is a 41% to 82% decrease in SWP Table A water deliveries from the average estimated future delivery calculated for this report.

Figure 7-4 shows that estimates of future-conditions deliveries of SWP Table A water during dry periods are consistently less than the estimates of future deliveries presented in the 2009 Report by 15–114 taf/year (2% to 8% less). For example, the current estimate of SWP Table A water that will be delivered in the 6-year drought scenario (1929–1934) is approximately 114 taf (8%) less than the corresponding delivery estimate in the 2009 Report for that future-conditions drought scenario.

### Wet-Year Deliveries of SWP Table A Water under Future Conditions

Figure 7-5 presents estimates of future SWP Table A water deliveries during a wet year and compares them with the corresponding delivery estimates calculated for the 2009 Report. Wet periods were modeled for this 2011 Report using historical precipitation and runoff patterns from 1922–2003 as a reference; 2031 future conditions were also accounted for in the modeling.

The results of modeling future conditions for potential wet periods indicate that estimated SWP Table A water deliveries during wet years can be expected to range between 2,972 and 4,063 taf/year. This is a 21% to 65% increase in SWP Table A water deliveries from the average estimated delivery under future conditions calculated for this report.

Deliveries of SWP Table A water under future conditions, as estimated for this report, are just slightly lower (by 2–5 taf) for the 4-, 6-, and 10-year wet-period scenarios than the estimates of such deliveries presented in the 2009 Report. Deliveries of SWP Table A water under future conditions are higher for the other wet-period scenarios (i.e., the single-wet-year and 2-year wet-period scenarios), with the largest increase being for the single wet year (a 2% increase relative to the corresponding delivery estimated for the 2009 Report).

### SWP Article 21 Water Deliveries under Future Conditions

Estimated deliveries of SWP Article 21 water under future conditions vary not only by year, depending on the precipitation and runoff, but also by month. In the spring, summer, and early fall months (May through October), deliveries of SWP Article 21 water under future conditions are estimated to be low, with a maximum of

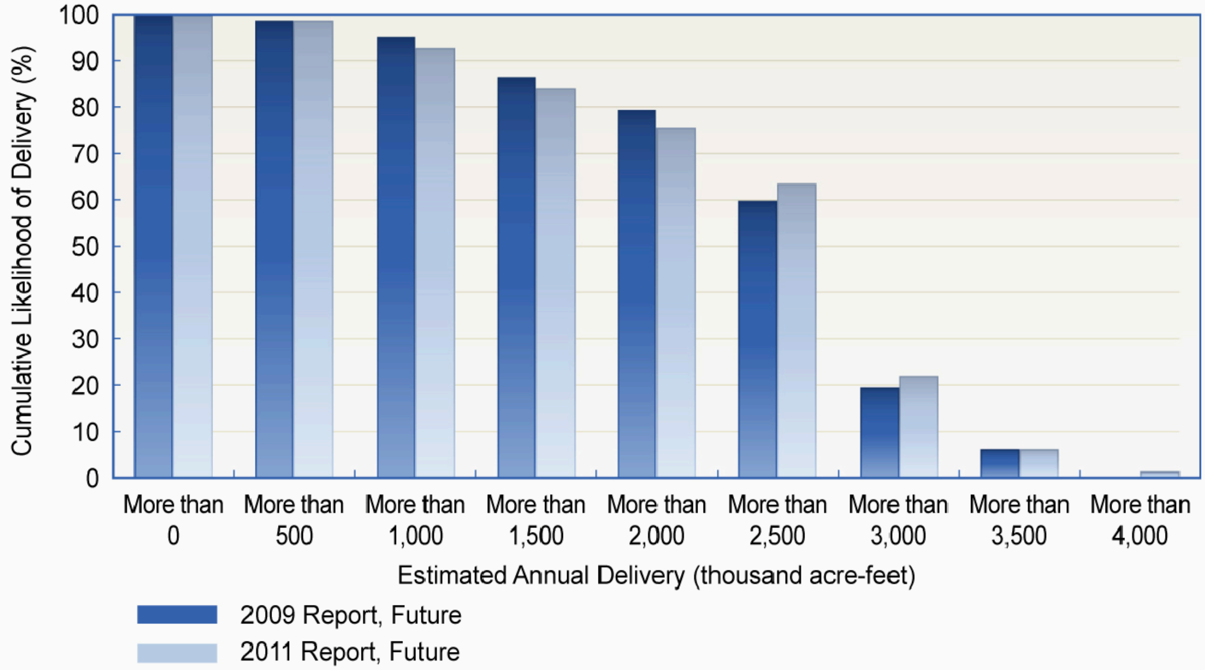


Figure 7-3. Estimated Cumulative Likelihood of SWP Table A Water Deliveries, by Increments of 500 Thousand Acre-Feet (Future Conditions)

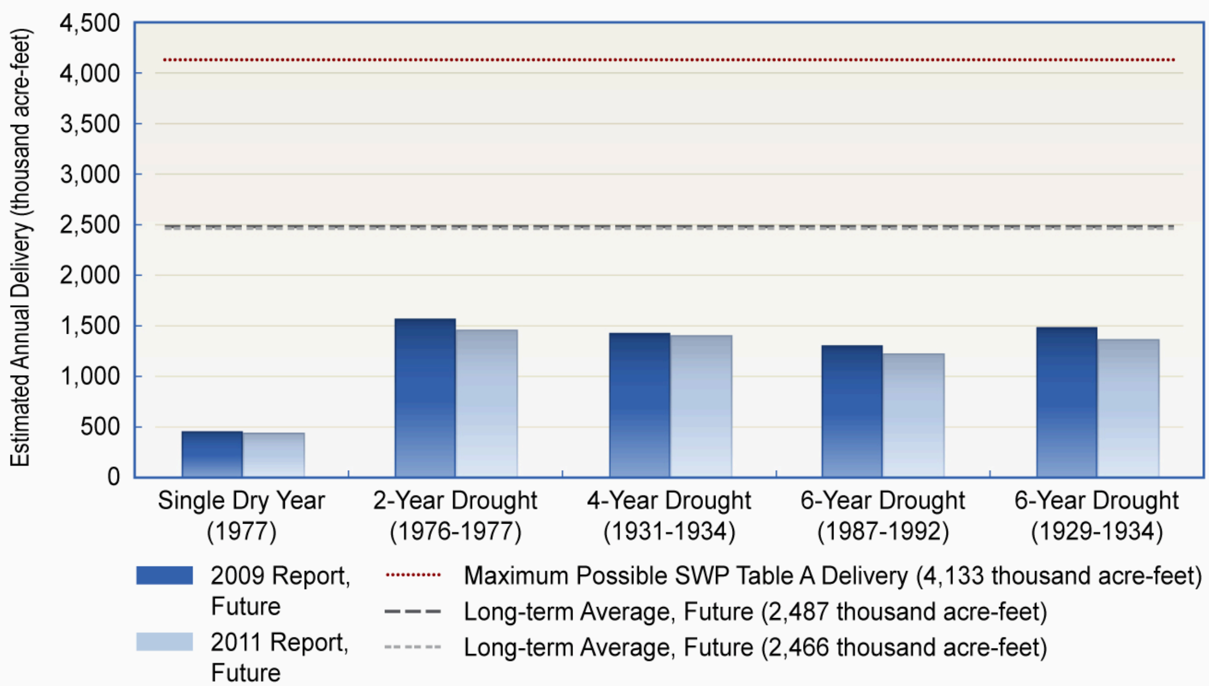


Figure 7-4. Estimated Average and Dry-Period SWP Table A Water Deliveries (Future Conditions)

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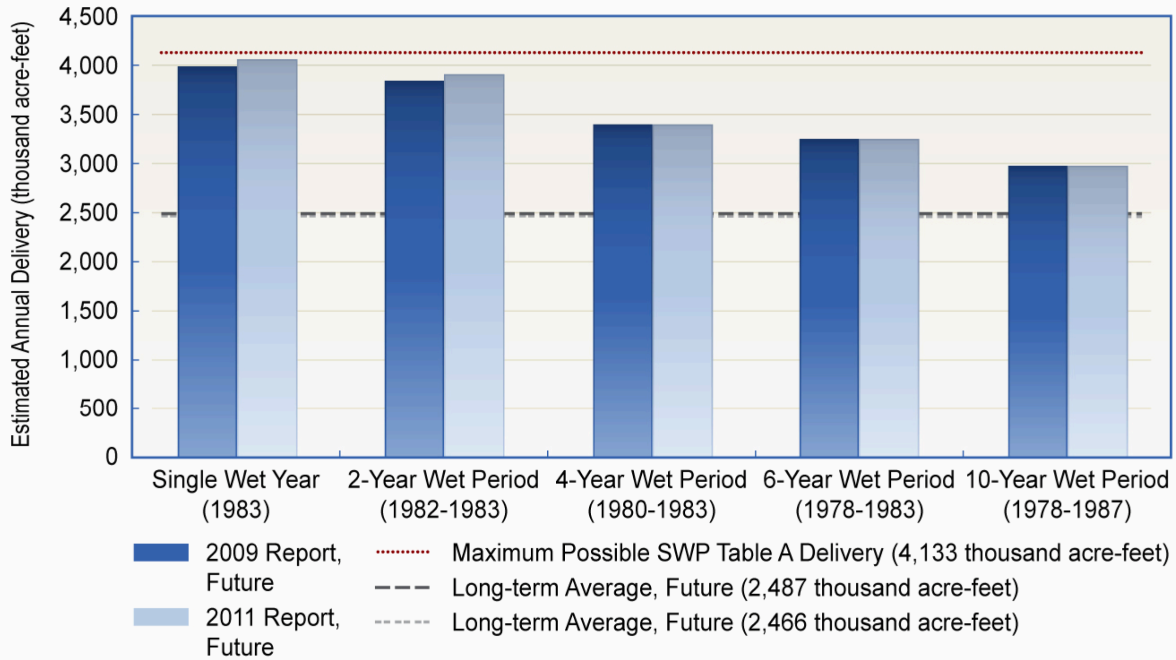



Figure 7-5. Estimated Average and Wet-Period SWP Table A Water Deliveries (Future Conditions)

approximately 10 taf/month and a minimum of 0 taf/month. From November through April, maximum estimated future deliveries of SWP Article 21 water can be as high as 251 taf and as low as 0 taf in a given month; however, water deliveries average in the range of 2–22 taf. The estimated range of monthly deliveries of SWP Article 21 water is displayed in Figure 7-6.

The estimated likelihood that a given amount of SWP Article 21 water will be delivered under future conditions is presented in Figure 7-7. Currently, there is a 22% likelihood that more than 20 taf/year of SWP Article 21 water will be delivered under future conditions, and a 78% likelihood that 20 taf/year or less will be delivered.

To compare these results to the results from the 2009 Report, the likelihood of larger deliveries of SWP Article 21 water declined in the current update. For example, the 2009 Report estimated a 28% likelihood that more than 20 taf/year of SWP Article 21 water will be delivered under future conditions, compared to a 22% likelihood estimated for this 2011 Report. Thus, larger future SWP Article 21 water deliveries were estimated to be more likely by the 2009 Report than by this 2011 Report.

In both the 2009 and 2011 Reports, however, estimated deliveries of SWP Article 21 water under future conditions are generally 20 taf/year or less (72% and 78% likelihood, respectively).

### Dry-Year Deliveries of SWP Article 21 Water under Future Conditions

Figure 7-8 shows the estimates of future deliveries of SWP Article 21 water during dry periods. The results of modeling future conditions for potential drought scenarios indicate that deliveries of SWP Article 21 water during dry years can be expected to range between 4 and 50 taf/year. This is a 0% to 92% decrease in Article 21 water deliveries from the average estimated future-conditions delivery calculated for this report. Although drought-period deliveries are typically less than deliveries in average years, Figure 7-8 shows that opportunities to deliver SWP Article 21 water exist even during multiyear drought periods.

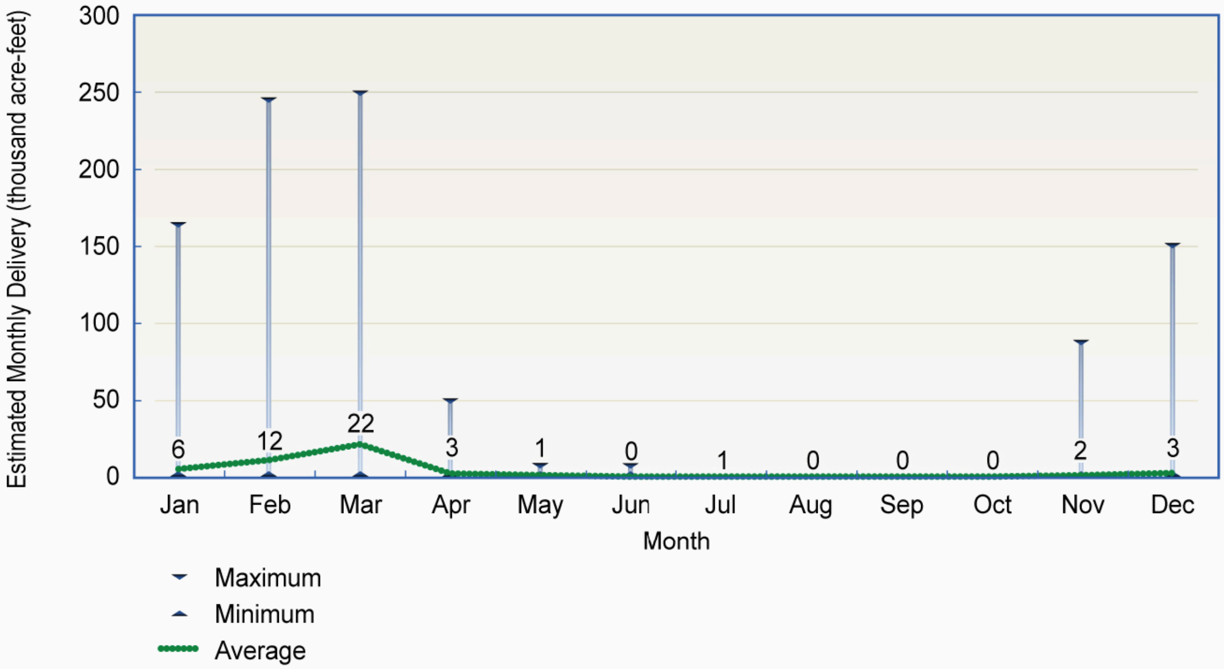



Figure 7-6. Estimated Range of Monthly Deliveries of SWP Article 21 Water (2011 Report—Future Conditions)

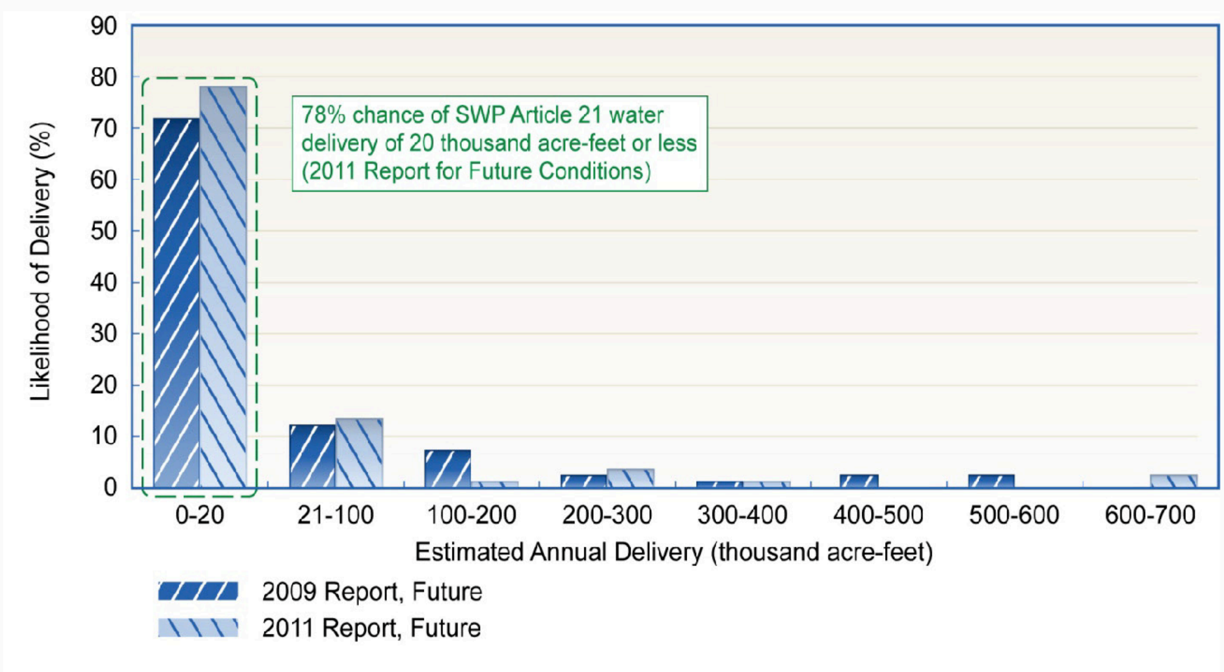



Figure 7-7. Estimated Probability of Annual Deliveries of SWP Article 21 Water (Future Conditions)

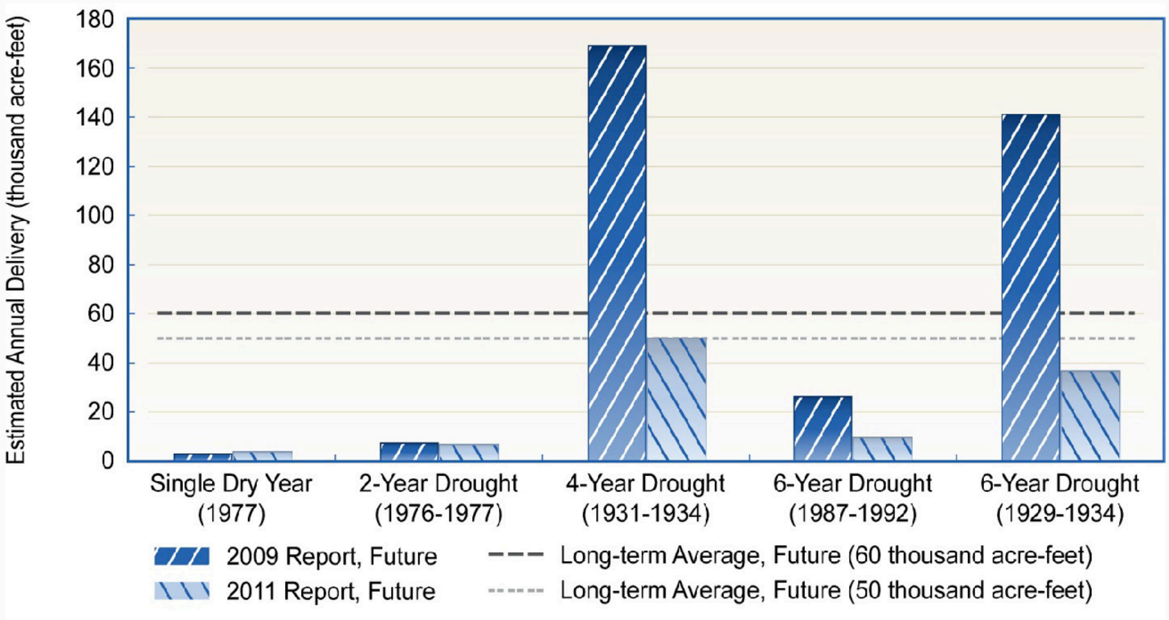



Figure 7-8. Estimated Average and Dry-Period Deliveries of SWP Article 21 Water (Future Conditions)

To compare the results for future conditions calculated for this 2011 Report to the results from the 2009 Report, deliveries during dry years in the current scenario are slightly higher in some cases, but are much lower in others (e.g., the 4-year drought scenario, for which the estimate calculated for this 2011 Report is 119 taf (70%) lower).

### Wet-Year Deliveries of SWP Article 21 Water under Future Conditions

Figure 7-9 shows the estimates of deliveries of SWP Article 21 water during wet periods under future conditions. The results of modeling future conditions for potential wet periods indicate that wet-year SWP deliveries can be expected to range between 83 and 291 taf. This is a 66% to 483% increase in deliveries of SWP Article 21 water from the average estimated future-conditions delivery calculated for this report.

Deliveries of SWP Article 21 water in wet years under future conditions, as estimated for this 2011 Report, are consistently lower in wet years than the estimates of such deliveries presented in the 2009 Report. These reductions in estimated SWP Article 21 water deliveries under future conditions range from approximately 18 to 219 taf/year, with the largest reduction being for the single-wet-year scenario (a 43% decrease in deliveries).

### Summary of Results

Assumptions about how the climate will have changed by 2031 and the assumption that no new facilities will be in place to move water through the Delta were used to estimate deliveries reflecting future conditions.

### SWP Table A Water Demands and Deliveries

The estimated demand for deliveries of SWP Table A water under future conditions is assumed to be the maximum possible annual amount of 4,133 taf/year. The same assumption was made for future conditions in the 2009 Report.

Most of the current estimates of future deliveries of SWP Table A water are slightly lower than the delivery estimates for future conditions presented in the 2009 Report, with average deliveries at 2,466 taf/year, maximum deliveries at 4,063 taf/year, and minimum deliveries at 443 taf/year. One exception is the current estimate of maximum possible delivery, which is 64 taf higher

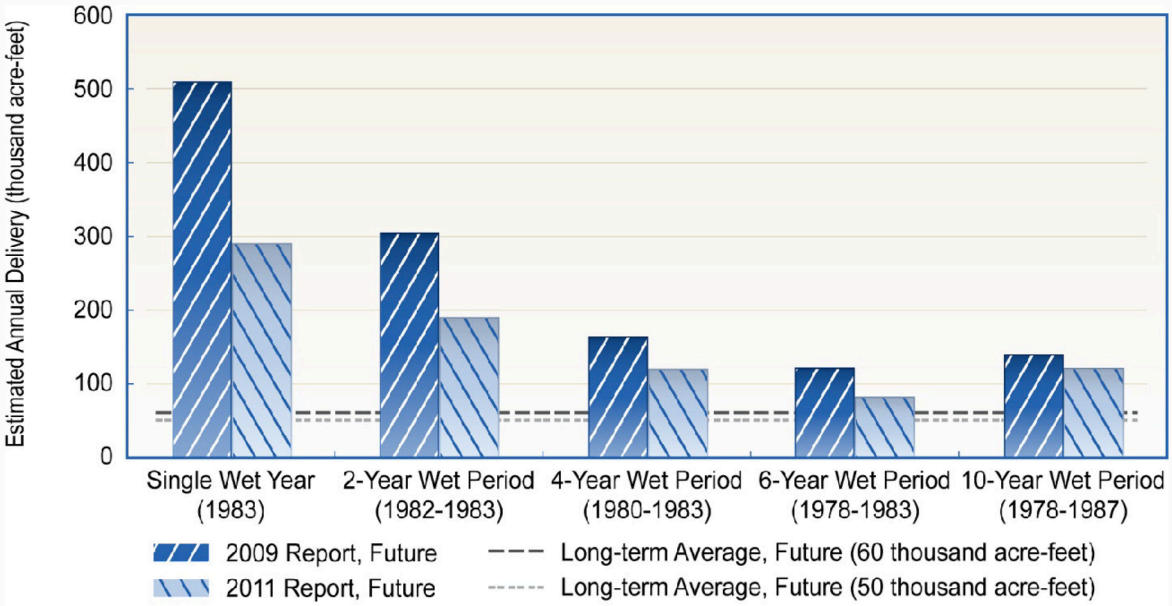



Figure 7-9. Estimated Average and Wet-Period Deliveries of SWP Article 21 Water (Future Conditions)

than the estimate from the 2009 Report. In addition, estimates of wet-year deliveries for the single-wet-year and 2-year wet-period scenarios are also higher (by 73 and 65 taf/year, respectively) than the estimates from the 2009 Report. During dry-period scenarios, this 2011 Report estimates delivery of less water (a reduction of 15–114 taf/year) under future conditions than was estimated for the 2009 Report.

The likelihood that an SWP contractor will receive larger SWP Table A water deliveries under future conditions is generally similar under both the 2009 and 2011 Report scenarios, or is only slightly higher as calculated for this 2011 Report. (For example, based on current calculations, there is a 22% likelihood of receiving a Table A water delivery of more than 3,000 taf, compared to a 20% likelihood as calculated for the 2009 Report.)

### SWP Article 21 Water Demands and Deliveries

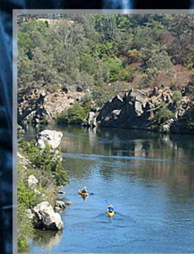
The current estimate of annual demand for SWP Article 21 water under future conditions is 200–600 taf lower than the estimate of future demand presented in the 2009 Report. Even though the future demands estimated for this 2011 Report are lower than those previously estimated, they are still very high, indicating an assumed strong desire for additional supply in the future.

Most of the current estimates of future deliveries of SWP Article 21 water are lower than the delivery estimates for future conditions presented in the 2009 Report. The nature of SWP Article 21 water deliveries is sporadic. Deliveries estimated for this 2011 Report are estimated to typically be very small, averaging 0–22 taf/month. SWP Article 21 water deliveries are very small between May and October, with maximum deliveries ranging from 1 to 10 taf/month; however, they are estimated to be larger between November and April, with a maximum monthly delivery of 251 taf.

Current estimates of wet-period deliveries of SWP Article 21 water under future conditions are lower by 18–219 taf/year than the estimates of such deliveries presented in the 2009 Report. In addition, current estimates of Article 21 water deliveries in some future drought scenarios are substantially lower (by 17–119 taf/year) than the corresponding estimates presented in the 2009 Report. However, in other future drought scenarios, the deliveries of SWP Article 21 water estimated for this 2011 Report are very similar to the corresponding estimates presented in the 2009 Report (by approximately 1 taf/year).

Overall, the estimated likelihood of larger Article 21 deliveries under future conditions is greater in the 2009 Report than in this 2011 Report, with a 28% chance of receiving an annual Article 21 delivery of more than 20 taf, compared to a 22% likelihood estimated for this 2011 Report. In both the 2009 and 2011 Reports, however, estimated deliveries of SWP Article 21 water under future conditions are generally 20 taf/year or less (72% and 78% likelihood, respectively).





# Glossary

**acre-foot** The volume of water (about 325,900 gallons) that would cover an area of 1 acre to a depth of 1 foot. This is enough water to meet the annual needs of one to two households.

**agricultural water supplier** As defined by the California Water Code, a public or private supplier that provides water to 2,000 or more irrigated acres per year for agricultural purposes or serves 2,000 or more acres of agricultural land. This can be a water district that directly supplies water to farmers or a contractor that sells water to the water district.

**annual Delta exports** The total amount of water transferred ("exported") to areas south of the Delta through the Harvey O. Banks Pumping Plant (SWP) and the C. W. "Bill" Jones Pumping Plant (CVP) in 1 year.

**appropriative water rights** Rights allowing a user to divert surface water for beneficial use. The user must first have obtained a permit from the State Water Resources Control Board, unless the appropriative water right predates 1914.

**Article 21 water** Surplus water that a contractor can receive in addition to its allocated Table A water. This water is only available if several conditions are met: (1) excess water is flowing through the Delta; (2) the contractor can use the surplus water or store it in the contractor's own system; and (3) delivering this water will not interfere with Table A allocations, other SWP deliveries, or SWP operations.

**biological opinion** A determination by the U.S. Fish and Wildlife Service or National Marine Fisheries Service on whether a proposed federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of designated "critical habitat." If jeopardy is determined, certain actions are required to be taken to protect the species of concern.

**CALSIM II** A computer model, jointly developed by DWR and the U.S. Bureau of Reclamation, that simulates existing and future operations of the SWP and CVP. The hydrology used by this model was developed by adjusting the historical flow record (1922–2003) to account for the influence of changes in land uses and regulation of upstream flows.

Among the SWP's facilities are more than 700 miles of canals that distribute water to urban and agricultural water suppliers in Northern California, the San Francisco Bay Area, the San Joaquin Valley, the Central Coast, and Southern California.

**carryover deliveries** See "carryover water."

**carryover water** A water supply "savings account" for SWP water that is allocated to an SWP contractor in a given year, but not used by the end of the year. Carryover water is stored in the SWP's share of San Luis Reservoir, when space is available, for the contractor to use in the following year.

**Central Valley Project (CVP)** Operated by the U.S. Bureau of Reclamation, the CVP is a water storage and delivery system consisting of 20 dams and reservoirs (including Shasta, Folsom, and New Melones Reservoirs), 11 power plants, and 500 miles of major canals. CVP facilities reach some 400 miles from Redding to Bakersfield and deliver about 7 million acre-feet of water for agricultural, urban, and wildlife use.

**cubic feet per second (cfs)** A measure of the rate at which a river of stream is flowing. The flow is 1 cfs if a cubic foot (about 7.48 gallons) of water passes a specific point in 1 second. A flow of 1 cubic foot per second for a day is approximately 2 acre-feet.

**Delta exports** Water transferred ("exported") to areas south of the Delta through the Harvey O. Banks Pumping Plant (SWP) and the C. W. "Bill" Jones Pumping Plant (CVP). The SWP's Delta exports are the primary component of total SWP deliveries.

**Delta inflow** The combined total of water flowing into the Delta from the Sacramento River, San Joaquin River, and other rivers and waterways.

**exceedence curve** For the SWP, a chart showing SWP delivery probability (especially for Table A water)—specifically, the likelihood that SWP contractors will receive a certain volume of water under current or future conditions.

**existing-conditions scenario** For the SWP delivery reliability reports, the results of modeling for SWP Delta exports or deliveries for the year the report was written.

**future-conditions scenario** For the SWP delivery reliability reports, the results of modeling for SWP Delta exports or SWP deliveries for 20 years into the future.

**incidental take permit** A permit issued by the U.S. Fish and Wildlife Service, under Section 10 of the federal Endangered Species Act, to private nonfederal entities undertaking otherwise lawful projects that might result in the "take" of an endangered or threatened species. In California, take may be authorized under Section 2081 of the California Fish and Game Code through issuance of either an incidental take permit or a consistency determination. The California Department of Fish and Game is authorized to accept a federal biological opinion as the take authorization for a State-listed species when a species is listed under both the federal and California Endangered Species Acts.

**riparian water rights** Water rights that apply to lands traversed by or bordering on a natural watercourse. No permit is required to use this water, which must be used on riparian (adjacent) land and cannot be stored for later use.

**State Water Project (SWP)** Operated by DWR, a water storage and delivery system of 33 storage facilities, 701 miles of open canals and pipelines, five hydroelectric power plants, and 20 pumping plants that extends for more than 600 miles in California. Its main purpose is to store and distribute water to 29 urban and agricultural water suppliers in Northern California, the San Francisco Bay Area, the San Joaquin Valley, the Central Coast, and Southern California. The SWP provides supplemental water to approximately 25 million Californians (two-thirds of California's population) and about 750,000 acres of irrigated farmland. Water deliveries have ranged from 1.4 million acre-feet in a dry year to more than 4.0 million acre-feet in a wet year.

**SWP contractors** Twenty-nine entities that receive water for agricultural or municipal and industrial uses through the SWP. Each contractor has executed a long-term water supply contract with DWR. Also sometimes referred to as "State Water Contractors."

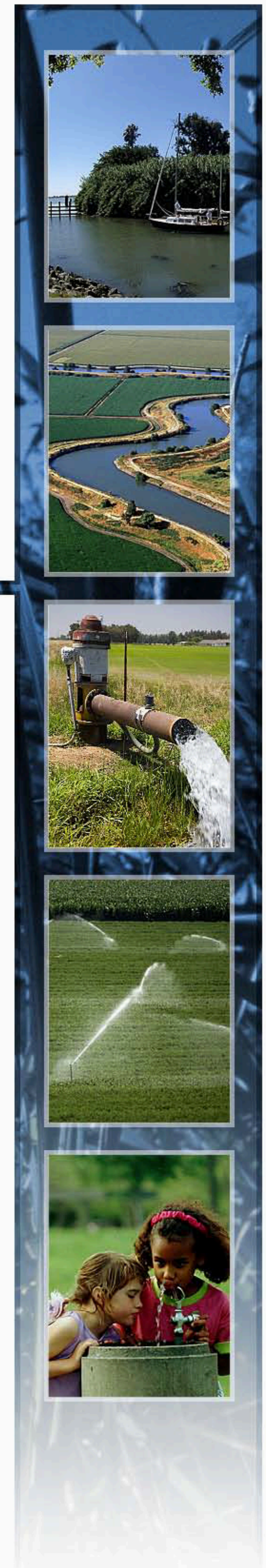
**Table A water (Table A amounts)** The maximum amount of SWP water that the State agreed to make available to an SWP contractor for delivery during the year. Table A amounts determine the maximum water a contractor may request each year from DWR. The State and SWP contractors also use Table A amounts to serve as a basis for allocation of some SWP costs among the contractors.

**turnback pool water** Allocated water that individual SWP contractors may offer early in the year for other SWP contractors to buy later at a set price.

**urban water supplier** As defined by the California Water Code, a public or private supplier that provides water for municipal use directly or indirectly to more than 3,000 customers or supplies more than 3,000 acre-feet of water in a year. This can be a water district that provides the water to local residents for use at home or work, or a contractor that distributes or sells water to that water district.

**Water Rights Decision 1641 (D-1641)** A regulatory decision issued by the State Water Resources Control Board in 1999 (updated in 2000) to implement the 1995 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta*. D-1641 assigned primary responsibility for meeting many of the Delta's water quality objectives to the SWP and CVP, thus placing certain limits on SWP and CVP operations.

**water year** In reports on surface water supply, the period extending from October 1 through September 30 of the following calendar year. The water year refers to the September year. For example, October 1, 2010, through September 30, 2011 is the 2011 water year.



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# Appendix A

## Historical SWP Delivery Tables for 2001–2010

The State Water Project (SWP) contracts define several types of SWP water available for delivery to contractors under specific circumstances: Table A water, Article 21 water, turnback pool water, and carryover water. (See the glossary for definitions of these terms; Chapter 3 describes each type of SWP water in greater detail.) Many SWP contractors frequently use Article 21, turnback pool, and carryover water to increase or decrease the amount of water available to them under SWP Table A.

The Sacramento River Index, previously referred to as the "4 River Index" or "4 Basin Index," is the sum of the unimpaired runoff of four rivers: the Sacramento River above Bend Bridge near Red Bluff, Feather River inflow to Lake Oroville Reservoir, Yuba River at Smartville, and American River inflow to Folsom Lake. The five water year types used in the Sacramento River Index are as follows:

| Sacramento River Index | Water Year Type |
|---|---|
| 1 | Wet |
| 2 | Above Normal |
| 3 | Below Normal |
| 4 | Dry |
| 5 | Critical |

Tables A-1 through A-10 list annual historical deliveries by SWP water type for each contractor for 2001 through 2010. The Sacramento River Index and water year type are presented along with the delivery results for each year. Similar delivery tables are presented for years 1999–2008 in the *State Water Project Delivery Reliability Report 2009.* SWP contractors are listed in Tables A-1 through A-10 by location, as follows:

- *Upper Feather River Area:* Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District (FCWCD)
- *North Bay Area:* Napa County FCWCD and Solano County Water Agency (WA)
- *South Bay Area:* Alameda County FCWCD, Zone 7; Alameda County Water District (WD); and Santa Clara Valley WD
- *San Joaquin Valley Area:* Dudley Ridge WD, Empire West Side Irrigation District (ID), Kern County WA, Kings County, Oak Flat WD, and Tulare Lake Basin Water Storage District (WSD)

- *Central Coastal Area:* San Luis Obispo County FCWCD and Santa Barbara County FCWCD
- *Southern California Area:* Antelope Valley–East Kern WA, Castaic Lake WA, Coachella Valley WD, Crestline–Lake Arrowhead WA, Desert Water Agency, Little Rock Creek ID, Metropolitan WD of Southern California, Mojave WA, Palmdale WD, San Bernardino County Municipal Water District (MWD), San Gabriel Valley MWD, San Gorgonio Pass WA, and Ventura County Flood Control District (FCD)

Table A-1. Historical State Water Project Deliveries, 2001
Sacramento River Index = 4, Water Year Type = Dry

| Contractor Location | SWP Contractor | SWP Water Type Delivered (acre-feet) | | | | Total SWP Deliveries (acre-feet) |
|---|---|---|---|---|---|---|
| | | Table A* | Article 21 | Carryover | Turnback | |
| Upper Feather River Area | Butte County | 513 | – | – | – | 513 |
| | Yuba City | 1,065 | – | – | – | 1,065 |
| | Plumas County FCWCD | – | – | – | – | – |
| North Bay Area | Napa County FCWCD | 4,293 | 996 | 1,723 | 82 | 7,094 |
| | Solano County WA | 17,756 | 2,304 | 1,021 | – | 21,081 |
| South Bay Area | Alameda County FCWCD, Zone 7 | 22,307 | – | 5,990 | 308 | 28,605 |
| | Alameda County WD | 13,695 | 10 | 4,192 | 107 | 18,004 |
| | Santa Clara Valley WD | 35,689 | – | 12,233 | – | 47,922 |
| San Joaquin Valley Area | Dudley Ridge WD | 18,467 | 933 | 6,815 | 347 | 26,562 |
| | Empire West Side ID | – | 253 | 1,107 | – | 1,360 |
| | Kern County WA | 363,204 | 23,233 | 92,052 | 6,502 | 484,991 |
| | Kings County | 1,560 | – | – | – | 1,560 |
| | Oak Flat WD | 2,089 | – | 101 | 22 | 2,212 |
| | Tulare Lake Basin WSD | 40,830 | 8,755 | 7,889 | 769 | 58,243 |
| Central Coastal Area | San Luis Obispo County FCWCD | 4,184 | – | – | 99 | 4,283 |
| | Santa Barbara County FCWCD | 14,285 | 396 | – | 296 | 14,977 |
| Southern California Area | Antelope Valley–East Kern WA | 45,071 | – | – | 899 | 45,970 |
| | Castaic Lake WA (+Rch 31A, 5 & 7) | 30,471 | 850 | – | 618 | 31,939 |
| | Coachella Valley WD | 9,009 | – | – | 91 | 9,100 |
| | Crestline–Lake Arrowhead WA | 1,057 | – | – | – | 1,057 |
| | Desert WA | 14,859 | – | – | 151 | 15,010 |
| | Little Rock Creek ID | – | – | – | – | – |
| | Metropolitan WD of Southern California | 686,545 | 10,415 | 200,000 | 7,949 | 904,909 |
| | Mojave WA | 4,433 | – | – | – | 4,433 |
| | Palmdale WD | 8,170 | – | 2,257 | – | 10,427 |
| | San Bernardino Valley MWD | 26,488 | – | – | – | 26,488 |
| | San Gabriel Valley MWD | 6,534 | – | – | – | 6,534 |
| | San Gorgonio Pass WA | – | – | – | – | – |
| | Ventura County FCD | 1,850 | – | – | – | 1,850 |
| | **Total SWP Deliveries** | **1,374,424** | **48,145** | **335,380** | **18,240** | **1,776,189** |
| | **Total Deliveries from the Delta**** | **1,372,846** | **48,145** | **335,380** | **18,240** | **1,774,611** |

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-2. Historical State Water Project Deliveries, 2002
Sacramento River Index = 4, Water Year Type = Dry

| Contractor Location | SWP Contractor | SWP Water Type Delivered (acre-feet) | | | | Total SWP Deliveries (acre-feet) |
|---|---|---|---|---|---|---|
| | | Table A* | Article 21 | Carryover | Turnback | |
| Upper Feather River Area | Butte County | 419 | – | – | – | 419 |
| | Yuba City | 1,181 | – | – | – | 1,181 |
| | Plumas County FCWCD | – | – | – | – | – |
| North Bay Area | Napa County FCWCD | 2,022 | 827 | 3,743 | 283 | 6,875 |
| | Solano County WA | 28,223 | 2,242 | – | – | 30,465 |
| South Bay Area | Alameda County FCWCD, Zone 7 | 40,707 | 1,484 | 8,113 | 556 | 50,860 |
| | Alameda County WD | 24,250 | 83 | 2,331 | 862 | 27,526 |
| | Santa Clara Valley WD | 55,896 | 202 | 3,311 | 2,053 | 61,462 |
| San Joaquin Valley Area | Dudley Ridge WD | 38,688 | 1,861 | 1,994 | 1,177 | 43,720 |
| | Empire West Side ID | 1,278 | 26 | 101 | – | 1,405 |
| | Kern County WA | 670,884 | 21,951 | 15,680 | 20,543 | 729,058 |
| | Kings County | 2,800 | – | – | 54 | 2,854 |
| | Oak Flat WD | 3,841 | 50 | 134 | 76 | 4,101 |
| | Tulare Lake Basin WSD | 73,785 | 3,749 | 5,385 | 2,289 | 85,208 |
| Central Coastal Area | San Luis Obispo County FCWCD | 4,355 | – | – | – | 4,355 |
| | Santa Barbara County FCWCD | 24,166 | 436 | 3,455 | 324 | 28,381 |
| Southern California Area | Antelope Valley–East Kern WA | 53,907 | – | 3,256 | 1,008 | 58,171 |
| | Castaic Lake WA (+Rch 31A, 5 & 7) | 61,880 | 280 | 6,657 | – | 68,817 |
| | Coachella Valley WD | 16,170 | 111 | – | 474 | 16,755 |
| | Crestline–Lake Arrowhead WA | 2,189 | – | – | – | 2,189 |
| | Desert WA | 26,670 | 189 | – | 781 | 27,640 |
| | Little Rock Creek ID | – | – | – | – | – |
| | Metropolitan WD of Southern California | 1,273,205 | 9,624 | 97,940 | 14,335 | 1,395,104 |
| | Mojave WA | 4,346 | – | – | – | 4,346 |
| | Palmdale WD | 8,359 | – | – | 437 | 8,796 |
| | San Bernardino Valley MWD | 68,268 | – | 3,801 | – | 72,069 |
| | San Gabriel Valley MWD | 18,353 | – | 4,698 | | 23,051 |
| | San Gorgonio Pass WA | – | – | – | – | – |
| | Ventura County FCD | 4,998 | – | – | – | 4,998 |
| | **Total SWP Deliveries** | **2,510,840** | **43,115** | **160,599** | **45,252** | **2,759,806** |
| | **Total Deliveries from the Delta**** | **2,509,240** | **43,115** | **160,599** | **45,252** | **2,758,206** |

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-3. Historical State Water Project Deliveries, 2003
Sacramento River Index = 2, Water Year Type = Above Normal

| Contractor Location | SWP Contractor | SWP Water Type Delivered (acre-feet) | | | | Total SWP Deliveries (acre-feet) |
|---|---|---|---|---|---|---|
| | | Table A* | Article 21 | Carryover | Turnback | |
| Upper Feather River Area | Butte County | 551 | – | – | – | 551 |
| | Yuba City | 1,324 | – | – | – | 1,324 |
| | Plumas County FCWCD | – | – | – | – | – |
| North Bay Area | Napa County FCWCD | 6,026 | 376 | 1,055 | 180 | 7,637 |
| | Solano County WA | 25,135 | 2,280 | 1,918 | – | 29,333 |
| South Bay Area | Alameda County FCWCD, Zone 7 | 30,695 | – | 13,099 | 656 | 44,450 |
| | Alameda County WD | 31,086 | – | 5,150 | 354 | 36,590 |
| | Santa Clara Valley WD | 90,620 | 936 | 14,104 | 841 | 106,501 |
| San Joaquin Valley Area | Dudley Ridge WD | 49,723 | 1,928 | 1,452 | 482 | 53,585 |
| | Empire West Side ID | 1,074 | 175 | 187 | – | 1,436 |
| | Kern County WA | 841,697 | 27,891 | 22,380 | 8,419 | 900,387 |
| | Kings County | 3,600 | 58 | – | 34 | 3,692 |
| | Oak Flat WD | 4,059 | 19 | 140 | 48 | 4,266 |
| | Tulare Lake Basin WSD | 94,376 | 6,243 | 4,284 | 938 | 105,841 |
| Central Coastal Area | San Luis Obispo County FCWCD | 4,417 | 36 | – | – | 4,453 |
| | Santa Barbara County FCWCD | 24,312 | 339 | 2,274 | 43 | 26,968 |
| Southern California Area | Antelope Valley–East Kern WA | 52,730 | – | 7,049 | 250 | 60,029 |
| | Castaic Lake WA (+Rch 31A, 5 & 7) | 49,895 | 991 | 4,760 | 90 | 55,736 |
| | Coachella Valley WD | 14,045 | 204 | – | 194 | 14,443 |
| | Crestline–Lake Arrowhead WA | 1,563 | – | – | – | 1,563 |
| | Desert WA | 23,168 | 330 | – | 321 | 23,819 |
| | Little Rock Creek ID | – | – | – | – | – |
| | Metropolitan WD of Southern California | 1,550,356 | 17,622 | 134,845 | 16,920 | 1,719,743 |
| | Mojave WA | 10,907 | – | 3,528 | – | 14,435 |
| | Palmdale WD | 9,701 | – | 1,846 | – | 11,547 |
| | San Bernardino Valley MWD | 25,371 | 200 | 1,844 | – | 27,415 |
| | San Gabriel Valley MWD | 13,034 | 200 | – | – | 13,234 |
| | San Gorgonio Pass WA | 116 | – | – | – | 116 |
| | Ventura County FCD | 5,000 | – | – | – | 5,000 |
| | **Total SWP Deliveries** | **2,964,581** | **59,828** | **219,915** | **29,770** | **3,274,094** |
| | **Total Deliveries from the Delta**** | **2,962,706** | **59,828** | **219,915** | **29,770** | **3,272,219** |

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-4. Historical State Water Project Deliveries, 2004
Sacramento River Index = 3, Water Year Type = Below Normal

| Contractor Location | SWP Contractor | SWP Water Type Delivered (acre-feet) | | | | Total SWP Deliveries (acre-feet) |
|---|---|---|---|---|---|---|
| | | Table A* | Article 21 | Carryover | Turnback | |
| Upper Feather River Area | Butte County | 1,440 | – | – | – | 1,440 |
| | Yuba City | 1,434 | – | – | – | 1,434 |
| | Plumas County FCWCD | – | – | – | – | – |
| North Bay Area | Napa County FCWCD | 5,030 | 1,450 | 1,602 | 52 | 8,134 |
| | Solano County WA | 17,991 | 7,787 | 47 | – | 25,825 |
| South Bay Area | Alameda County FCWCD, Zone 7 | 39,898 | – | 11,466 | – | 51,364 |
| | Alameda County WD | 20,956 | – | 6,714 | 214 | 27,884 |
| | Santa Clara Valley WD | 52,867 | 2,983 | – | 508 | 56,358 |
| San Joaquin Valley Area | Dudley Ridge WD | 36,377 | 7,393 | 2,185 | 291 | 46,246 |
| | Empire West Side ID | 1,310 | 626 | 1,626 | – | 3,562 |
| | Kern County WA | 640,190 | 86,513 | 40,120 | 5,075 | 771,898 |
| | Kings County | 5,850 | 3,157 | – | 46 | 9,053 |
| | Oak Flat WD | 4,324 | – | 276 | 29 | 4,629 |
| | Tulare Lake Basin WSD | 58,575 | 15,299 | 5,638 | 489 | 80,001 |
| Central Coastal Area | San Luis Obispo County FCWCD | 4,096 | 69 | – | – | 4,165 |
| | Santa Barbara County FCWCD | 29,566 | – | – | 122 | 29,688 |
| Southern California Area | Antelope Valley–East Kern WA | 50,532 | – | 9,199 | – | 59,731 |
| | Castaic Lake WA (+Rch 31A, 5 & 7) | 46,358 | 1,618 | 35,785 | – | 83,761 |
| | Coachella Valley WD | 8,631 | – | 6,745 | 89 | 15,465 |
| | Crestline–Lake Arrowhead WA | 2,006 | – | – | – | 2,006 |
| | Desert WA | 9,966 | – | 11,122 | 102 | 21,190 |
| | Little Rock Creek ID | – | – | – | – | – |
| | Metropolitan WD of Southern California | 1,195,807 | 91,601 | 215,000 | 10,223 | 1,512,631 |
| | Mojave WA | 11,176 | – | – | – | 11,176 |
| | Palmdale WD | 10,549 | – | 1,613 | – | 12,162 |
| | San Bernardino Valley MWD | 35,522 | – | 20,631 | – | 56,153 |
| | San Gabriel Valley MWD | 15,600 | – | – | – | 15,600 |
| | San Gorgonio Pass WA | 841 | – | – | – | 841 |
| | Ventura County FCD | 5,250 | – | – | – | 5,250 |
| | **Total SWP Deliveries** | **2,312,142** | **218,496** | **369,769** | **17,240** | **2,917,647** |
| | **Total Deliveries from the Delta**** | **2,309,268** | **218,496** | **369,769** | **17,240** | **2,914,773** |

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-5. Historical State Water Project Deliveries, 2005
Sacramento River Index = 2, Water Year Type = Above Normal

| Contractor Location | SWP Contractor | SWP Water Type Delivered (acre-feet) | | | | Total SWP Deliveries (acre-feet) |
|---|---|---|---|---|---|---|
| | | Table A* | Article 21 | Carryover | Turnback | |
| Upper Feather River Area | Butte County | 527 | – | – | – | 527 |
| | Yuba City | 1,894 | – | – | – | 1,894 |
| | Plumas County FCWCD | – | – | – | – | – |
| North Bay Area | Napa County FCWCD | 5,322 | 606 | 1,741 | – | 7,669 |
| | Solano County WA | 24,515 | 10,421 | 83 | – | 35,019 |
| South Bay Area | Alameda County FCWCD, Zone 7 | 38,388 | – | 7,849 | 275 | 46,512 |
| | Alameda County WD | 36,469 | 846 | 6,341 | 943 | 44,599 |
| | Santa Clara Valley WD | 89,476 | 6,298 | 11,899 | 342 | 108,015 |
| San Joaquin Valley Area | Dudley Ridge WD | 51,609 | 28,197 | 821 | 1,286 | 81,913 |
| | Empire West Side ID | 1,448 | 1,799 | 587 | – | 3,834 |
| | Kern County WA | 893,439 | 453,078 | 9,851 | 22,397 | 1,378,765 |
| | Kings County | 8,100 | 11,504 | – | 202 | 19,806 |
| | Oak Flat WD | 4,067 | – | – | 127 | 4,194 |
| | Tulare Lake Basin WSD | 86,604 | 47,267 | 3,973 | 2,158 | 140,002 |
| Central Coastal Area | San Luis Obispo County FCWCD | 4,006 | 245 | – | – | 4,251 |
| | Santa Barbara County FCWCD | 22,981 | – | – | 155 | 23,136 |
| Southern California Area | Antelope Valley–East Kern WA | 57,205 | – | 2,626 | – | 59,831 |
| | Castaic Lake WA (+Rch 31A, 5 & 7) | 54,303 | 2,451 | 2,702 | – | 59,456 |
| | Coachella Valley WD | 26,984 | – | 12,819 | 2,716 | 42,519 |
| | Crestline–Lake Arrowhead WA | 807 | – | – | – | 807 |
| | Desert WA | 33,168 | – | 14,799 | 1,122 | 49,089 |
| | Little Rock Creek ID | – | – | – | – | – |
| | Metropolitan WD of Southern California** | 1,269,291 | 168,300 | 106,032 | 6,530 | 1,550,153 |
| | Mojave WA | 10,360 | – | 1,201 | – | 11,561 |
| | Palmdale WD | 10,174 | – | 1,538 | – | 11,712 |
| | San Bernardino Valley MWD | 31,211 | 56 | 283 | – | 31,550 |
| | San Gabriel Valley MWD | 10,500 | – | – | – | 10,500 |
| | San Gorgonio Pass WA | 655 | 15 | – | 22 | 692 |
| | Ventura County FCD | 1,665 | – | – | – | 1,665 |
| **Total SWP Deliveries** | | **2,775,168** | **731,083** | **185,145** | **38,275** | **3,729,671** |
| **Total Deliveries from the Delta*** ** | | **2,772,747** | **731,083** | **185,145** | **38,275** | **3,727,250** |

* Table A = State Water Project Analysis Office current-year deliveries + Next year's Article 14B carryover water

** Metropolitan Water District of Southern California 2005 Table A deliveries have been updated to reflect the addition of Article 14B carryover water that was previously omitted.

*** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-6. Historical State Water Project Deliveries, 2006
Sacramento River Index = 1, Water Year Type = Wet

| Contractor Location | SWP Contractor | SWP Water Type Delivered (acre-feet) | | | | Total SWP Deliveries (acre-feet) |
|---|---|---|---|---|---|---|
| | | Table A* | Article 21 | Carryover | Turnback | |
| Upper Feather River Area | Butte County | 468 | – | – | – | 468 |
| | Yuba City | 4,148 | 1,194 | – | – | 5,342 |
| | Plumas County FCWCD | – | – | – | – | – |
| North Bay Area | Napa County FCWCD | 7,312 | 300 | 172 | – | 7,784 |
| | Solano County WA | 12,070 | 18,195 | 390 | – | 30,655 |
| South Bay Area | Alameda County FCWCD, Zone 7 | 50,785 | – | 2,252 | 491 | 53,528 |
| | Alameda County WD | – | 2,375 | 1,331 | 39,373 | 43,079 |
| | Santa Clara Valley WD | 47,344 | 26,769 | 524 | – | 74,637 |
| San Joaquin Valley Area | Dudley Ridge WD | 55,343 | 18,515 | – | 1,068 | 74,926 |
| | Empire West Side ID | 1,500 | 1,124 | 658 | – | 3,282 |
| | Kern County WA | 961,882 | 256,634 | 5,418 | 18,610 | 1,242,544 |
| | Kings County | 8,991 | 366 | – | 173 | 9,530 |
| | Oak Flat WD | 4,118 | – | 17 | 107 | 4,242 |
| | Tulare Lake Basin WSD | 48,361 | 59,424 | – | 1,787 | 109,572 |
| Central Coastal Area | San Luis Obispo County FCWCD | 3,382 | 827 | – | – | 4,209 |
| | Santa Barbara County FCWCD | 19,255 | 4,020 | – | – | 23,275 |
| Southern California Area | Antelope Valley–East Kern WA | 76,623 | – | 3,761 | – | 80,384 |
| | Castaic Lake WA (+Rch 31A, 5 & 7) | 56,758 | 2,089 | 3,905 | – | 62,752 |
| | Coachella Valley WD | 121,100 | – | – | – | 121,100 |
| | Crestline–Lake Arrowhead WA | 257 | – | – | – | 257 |
| | Desert WA | 50,000 | – | – | – | 50,000 |
| | Little Rock Creek ID | – | – | – | – | – |
| | Metropolitan WD of Southern California | 1,103,538 | 238,478 | 136,424 | 11,638 | 1,490,078 |
| | Mojave WA | 32,496 | – | 1,518 | – | 34,014 |
| | Palmdale WD | 10,374 | 1,653 | 335 | 130 | 12,492 |
| | San Bernardino Valley MWD | 31,902 | – | 3,427 | – | 35,329 |
| | San Gabriel Valley MWD | 13,524 | – | – | – | 13,524 |
| | San Gorgonio Pass WA | 4,262 | – | – | – | 4,262 |
| | Ventura County FCD | 1,850 | – | – | – | 1,850 |
| **Total SWP Deliveries** | | **2,727,643** | **631,963** | **160,132** | **73,377** | **3,593,115** |
| **Total Deliveries from the Delta**** | | **2,723,027** | **630,769** | **160,132** | **73,377** | **3,587,305** |

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

The State Water Project Draft Delivery Reliability Report 2011

Table A-7. Historical State Water Project Deliveries, 2007
Sacramento River Index = 4, Water Year Type = Dry

| Contractor Location | SWP Contractor | SWP Water Type Delivered (acre-feet) | | | | Total SWP Deliveries (acre-feet) |
|---|---|---|---|---|---|---|
| | | Table A* | Article 21 | Carryover | Turnback | |
| Upper Feather River Area | Butte County | 956 | – | – | – | 956 |
| | Yuba City | 2,327 | – | – | – | 2,327 |
| | Plumas County FCWCD | – | – | – | – | – |
| North Bay Area | Napa County FCWCD | 6,362 | 3,597 | 998 | – | 10,957 |
| | Solano County WA | 14,892 | 8,217 | 1,822 | – | 24,931 |
| South Bay Area | Alameda County FCWCD, Zone 7 | 32,972 | 912 | 2,895 | 378 | 37,157 |
| | Alameda County WD | 16,541 | 550 | 2,103 | 197 | 19,391 |
| | Santa Clara Valley WD | 38,812 | 4,840 | 8,161 | 469 | 52,282 |
| San Joaquin Valley Area | Dudley Ridge WD | 28,457 | 8,953 | 2,000 | 269 | 39,679 |
| | Empire West Side ID | 397 | 1,172 | 515 | – | 2,084 |
| | Kern County WA | 592,423 | 99,861 | 19,645 | 4,683 | 716,612 |
| | Kings County | 4,924 | 474 | – | 43 | 5,441 |
| | Oak Flat WD | 3,430 | 41 | 69 | 27 | 3,567 |
| | Tulare Lake Basin WSD | 57,272 | 12,902 | 16,459 | 450 | 87,083 |
| Central Coastal Area | San Luis Obispo County FCWCD | 3,752 | 24 | – | – | 3,776 |
| | Santa Barbara County FCWCD | 24,760 | 1,070 | 1,390 | – | 27,220 |
| Southern California Area | Antelope Valley–East Kern WA | 74,459 | – | 4,364 | – | 78,823 |
| | Castaic Lake WA (+Rch 31A, 5 & 7) | 44,974 | – | 4,216 | – | 49,190 |
| | Coachella Valley WD | 72,660 | – | – | 568 | 73,228 |
| | Crestline–Lake Arrowhead WA | 1,768 | – | – | – | 1,768 |
| | Desert WA | 30,000 | – | – | 234 | 30,234 |
| | Little Rock Creek ID | 1,380 | – | – | – | 1,380 |
| | Metropolitan WD of Southern California | 1,146,900 | 166,517 | 28,098 | 8,962 | 1,350,477 |
| | Mojave WA | 45,372 | – | 737 | – | 46,109 |
| | Palmdale WD | 12,780 | 843 | 985 | 100 | 14,708 |
| | San Bernardino Valley MWD | 57,116 | – | – | – | 57,116 |
| | San Gabriel Valley MWD | 10,000 | – | – | – | 10,000 |
| | San Gorgonio Pass WA | 4,009 | – | – | – | 4,009 |
| | Ventura County FCD | 3,000 | – | – | – | 3,000 |
| | **Total SWP Deliveries** | **2,332,695** | **309,973** | **94,457** | **16,380** | **2,753,505** |
| | **Total Deliveries from the Delta**** | **2,329,412** | **309,973** | **94,457** | **16,380** | **2,750,222** |

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-8. Historical State Water Project Deliveries, 2008
Sacramento River Index = 5, Water Year Type = Critical

| Contractor Location | SWP Contractor | SWP Water Type Delivered (acre-feet) | | | | Total SWP Deliveries (acre-feet) |
|---|---|---|---|---|---|---|
| | | Table A* | Article 21 | Carryover | Turnback | |
| Upper Feather River Area | Butte County | 9,436 | – | – | – | 9,436 |
| | Yuba City | 1,923 | – | – | – | 1,923 |
| | Plumas County FCWCD | 243 | – | – | – | 243 |
| North Bay Area | Napa County FCWCD | 3,636 | 1,219 | 7,363 | 21 | 12,239 |
| | Solano County WA | 10,436 | 1,510 | 12,389 | – | 24,335 |
| South Bay Area | Alameda County FCWCD, Zone 7 | 13,633 | – | 15,400 | – | 29,033 |
| | Alameda County WD | 4,206 | – | 8,659 | 37 | 12,902 |
| | Santa Clara Valley WD | 11,133 | – | 21,188 | 88 | 32,409 |
| San Joaquin Valley Area | Dudley Ridge WD | 12,260 | – | 5,949 | 51 | 18,260 |
| | Empire West Side ID | | – | 915 | – | 915 |
| | Kern County WA | 271,636 | – | 6,815 | 883 | 279,334 |
| | Kings County | 3,187 | – | – | 8 | 3,195 |
| | Oak Flat WD | 1,929 | – | – | 5 | 1,934 |
| | Tulare Lake Basin WSD | 32,302 | – | 281 | 85 | 32,668 |
| Central Coastal Area | San Luis Obispo County FCWCD | 8,512 | – | – | – | 8,512 |
| | Santa Barbara County FCWCD | 11,311 | – | 2,532 | 40 | 13,883 |
| Southern California Area | Antelope Valley–East Kern WA | 31,082 | – | 10,381 | 125 | 41,588 |
| | Castaic Lake WA (+Rch 31A, 5 & 7) | 18,710 | – | 12,146 | – | 30,856 |
| | Coachella Valley WD | 42,385 | – | – | 107 | 42,492 |
| | Crestline–Lake Arrowhead WA | 1,159 | – | 689 | – | 1,848 |
| | Desert WA | 17,500 | – | – | 44 | 17,544 |
| | Little Rock Creek ID | 805 | – | – | – | 805 |
| | Metropolitan WD of Southern California | 654,304 | – | – | 1,689 | 655,993 |
| | Mojave WA | 26,288 | – | 108 | – | 26,396 |
| | Palmdale WD | 4,226 | – | – | 19 | 4,245 |
| | San Bernardino Valley MWD | 30,562 | – | 4,444 | – | 35,006 |
| | San Gabriel Valley MWD | 10,080 | – | – | – | 10,080 |
| | San Gorgonio Pass WA | 5,419 | – | 300 | – | 5,719 |
| | Ventura County FCD | 3,798 | – | – | – | 3,798 |
| | **Total SWP Deliveries** | **1,242,101** | **2,729** | **109,559** | **3,202** | **1,357,591** |
| | **Total Deliveries from the Delta**** | **1,230,499** | **2,729** | **109,559** | **3,202** | **1,345,989** |

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

The State Water Project Draft Delivery Reliability Report 2011

| Table A-9. Historical State Water Project Deliveries, 2009<br>Sacramento River Index = 4, Water Year Type = Dry | | | | | | |
|---|---|---|---|---|---|---|
| Contractor Location | SWP Contractor | SWP Water Type Delivered (acre-feet) | | | | Total SWP Deliveries (acre-feet) |
| | | Table A* | Article 21 | Carryover | Turnback | |
| Upper Feather River Area | Butte County | 581 | – | – | – | 581 |
| | Yuba City | 2,114 | – | – | – | 2,114 |
| | Plumas County FCWCD | 200 | – | – | – | 200 |
| North Bay Area | Napa County FCWCD | 2,723 | 1,588 | 4,475 | 13 | 8,799 |
| | Solano County WA | 8,618 | 4,444 | 3,123 | – | 16,185 |
| South Bay Area | Alameda County FCWCD, Zone 7 | 12,093 | – | 14,584 | – | 26,677 |
| | Alameda County WD | 5,911 | – | 10,494 | 8 | 16,413 |
| | Santa Clara Valley WD | 9,188 | – | 23,867 | 54 | 33,109 |
| San Joaquin Valley Area | Dudley Ridge WD | 13,185 | – | 7,810 | 32 | 21,027 |
| | Empire West Side ID | 1,034 | – | – | – | 1,034 |
| | Kern County WA | 226,631 | – | 56,367 | 544 | 283,542 |
| | Kings County | 3,153 | – | 70 | 5 | 3,228 |
| | Oak Flat WD | 1,825 | – | 66 | 1 | 1,892 |
| | Tulare Lake Basin WSD | 35,160 | – | 1,271 | 52 | 36,483 |
| Central Coastal Area | San Luis Obispo County FCWCD | 3,799 | – | – | – | 3,799 |
| | Santa Barbara County FCWCD | 12,746 | – | 4,523 | 25 | 17,294 |
| Southern California Area | Antelope Valley–East Kern WA | 14,419 | – | 18,408 | 77 | 32,904 |
| | Castaic Lake WA (+Rch 31A, 5 & 7) | 14,858 | – | 9,529 | 52 | 24,439 |
| | Coachella Valley WD | 40,845 | – | – | 66 | 40,911 |
| | Crestline–Lake Arrowhead WA | – | – | 893 | – | 893 |
| | Desert WA | 16,865 | – | – | 27 | 16,892 |
| | Little Rock Creek ID | – | – | – | – | – |
| | Metropolitan WD of Southern California | 544,304 | – | 10,721 | 1,042 | 556,067 |
| | Mojave WA | 21,312 | – | 242 | – | 21,554 |
| | Palmdale WD | 12,095 | – | 3,229 | – | 15,324 |
| | San Bernardino Valley MWD | 26,785 | – | 9,348 | – | 36,133 |
| | San Gabriel Valley MWD | 11,516 | – | – | – | 11,516 |
| | San Gorgonio Pass WA | 5,612 | – | 480 | – | 6,092 |
| | Ventura County FCD | 3,890 | – | – | – | 3,890 |
| | **Total SWP Deliveries** | **1,051,462** | **6,032** | **179,500** | **1,998** | **1,238,992** |
| | **Total Deliveries from the Delta**** | **1,048,567** | **6,032** | **179,500** | **1,998** | **1,236,097** |

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-10. Historical State Water Project Deliveries, 2010
Sacramento River Index = 3, Water Year Type = Below Normal

| Contractor Location | SWP Contractor | SWP Water Type Delivered (acre-feet) | | | | Total SWP Deliveries (acre-feet) |
|---|---|---|---|---|---|---|
| | | Table A* | Article 21 | Carryover | Turnback | |
| Upper Feather River Area | Butte County | 807 | – | – | – | 807 |
| | Yuba City | 2,331 | – | – | – | 2,331 |
| | Plumas County FCWCD | 243 | – | – | – | 243 |
| North Bay Area | Napa County FCWCD | 7,275 | 2,207 | 2,845 | 90 | 12,417 |
| | Solano County WA | 16,793 | 5,298 | 3,661 | – | 25,752 |
| South Bay Area | Alameda County FCWCD, Zone 7 | 28,694 | – | 12,756 | 249 | 41,699 |
| | Alameda County WD | 11,668 | – | 10,889 | 14 | 22,571 |
| | Santa Clara Valley WD | 6,068 | – | 10,741 | 34 | 16,843 |
| San Joaquin Valley Area | Dudley Ridge WD | 15,833 | – | 9,752 | 156 | 25,741 |
| | Empire West Side ID | 380 | – | – | – | 380 |
| | Kern County WA | 375,426 | – | 55,419 | 3,044 | 433,889 |
| | Kings County | 4,094 | – | 522 | 29 | 4,645 |
| | Oak Flat WD | 2,412 | – | 455 | 18 | 2,885 |
| | Tulare Lake Basin WSD | 35,985 | – | 3,199 | 275 | 39,459 |
| Central Coastal Area | San Luis Obispo County FCWCD | 3,480 | – | 277 | – | 3,757 |
| | Santa Barbara County FCWCD | 8,640 | – | 7,134 | 140 | 15,914 |
| Southern California Area | Antelope Valley–East Kern WA | 36,462 | – | 20,813 | 438 | 57,713 |
| | Castaic Lake WA (+Rch 31A, 5 & 7) | 37,054 | – | 14,501 | 295 | 51,850 |
| | Coachella Valley WD | 69,175 | – | 7,595 | 429 | 77,199 |
| | Crestline–Lake Arrowhead WA | 357 | – | – | – | 357 |
| | Desert WA | 27,875 | – | 3,135 | 173 | 31,183 |
| | Little Rock Creek ID | | – | – | – | – |
| | Metropolitan WD of Southern California | 817,765 | – | 67,783 | 5,922 | 891,470 |
| | Mojave WA | 35,241 | – | 20 | – | 35,261 |
| | Palmdale WD | 5,585 | – | 5,325 | 59 | 10,969 |
| | San Bernardino Valley MWD | 37,733 | – | 11,273 | – | 49,006 |
| | San Gabriel Valley MWD | 19,180 | – | – | – | 19,180 |
| | San Gorgonio Pass WA | 6,626 | – | – | 6 | 6,632 |
| | Ventura County FCD | 4,075 | – | – | – | 4,075 |
| **Total SWP Deliveries** | | **1,617,257** | **7,505** | **248,095** | **11,371** | **1,884,228** |
| **Total Deliveries from the Delta**** | | **1,613,876** | **7,505** | **248,095** | **11,371** | **1,880,847** |

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

# OPERATIONAL UPDATES

Yucaipa Valley Water District

# Workshop Memorandum 12-035

**Date:** February 28, 2012

**Subject:** Sewer Collection System Integrity Testing

---

Smoke testing is an economical and relatively fast method for inspecting sewer mainlines to identify the location of inflow sources such as structural damage in sewer pipes or manholes and cross connections including roof vents, foundation drains, yard drains, and undocumented/illegal connections. In some cases, these defects can allow toxic fumes and wastewater to seep up into the residence itself.

In order to continue the proactive maintenance of the sewer collection system, the District staff recently tested the integrity of the sewer collection system using smoke to identify maintenance issues and improper connections.

Smoke testing was conducted as part of the evaluation in an area suspected to have inflow problems. The procedure consisted of blowing large volumes of air and smoke through the sewer mainlines. The smoke followed the path of the intruding water revealing the source of the problem within seconds.

During this workshop agenda item, the District staff will provide an overview of the smoke testing process and some of the results.

# DEVELOPMENT ISSUES

Yucaipa Valley Water District

# Workshop Memorandum 12-036

**Date:** February 28, 2012

**Subject:** Development Agreement for Tract No. 13375 Located on Oak Glen Road Approximately 1,500 Feet East of Fremont Street, Yucaipa

At the board meeting held on February 15, 2012, the District staff requested that no action be taken on the proposed development agreement for Tract No. 13375 [Director Memorandum No. 12-019]. Instead of approving a typical development agreement for this project, it seems more practical to create a specific agreement that allows for individual lot sales.

A presentation on the status of the new development agreement will be provided at the board workshop.

# CAPITAL IMPROVEMENT PROJECTS

Yucaipa Valley Water District

# Workshop Memorandum 12-037

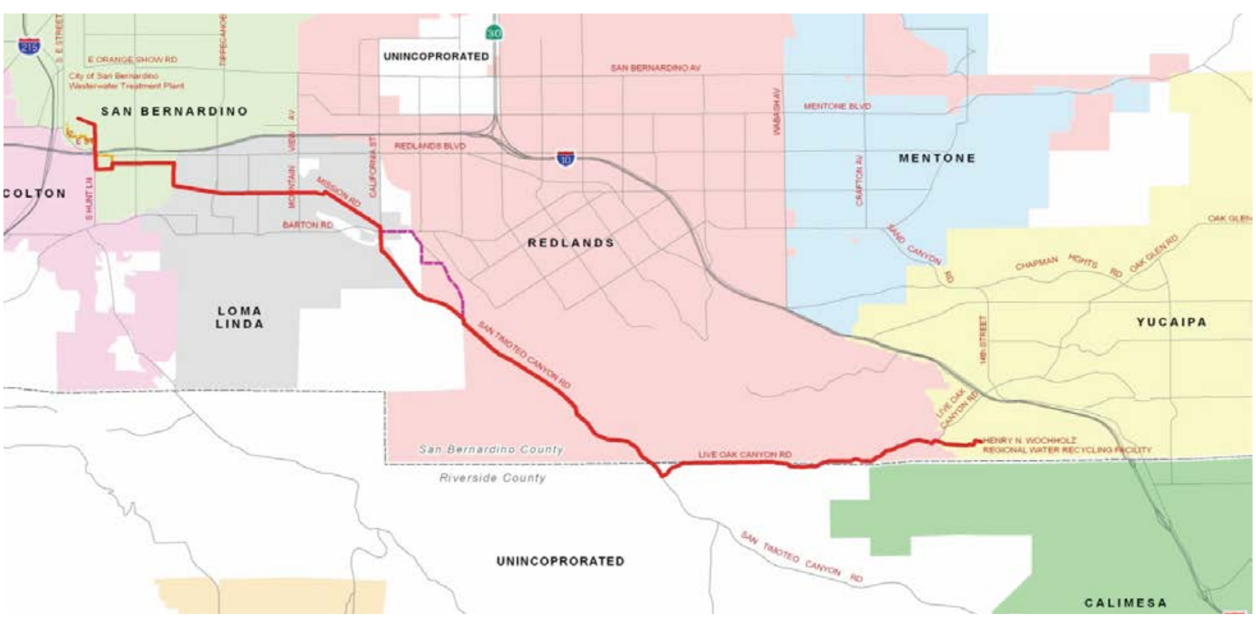
**Date:** February 28, 2012

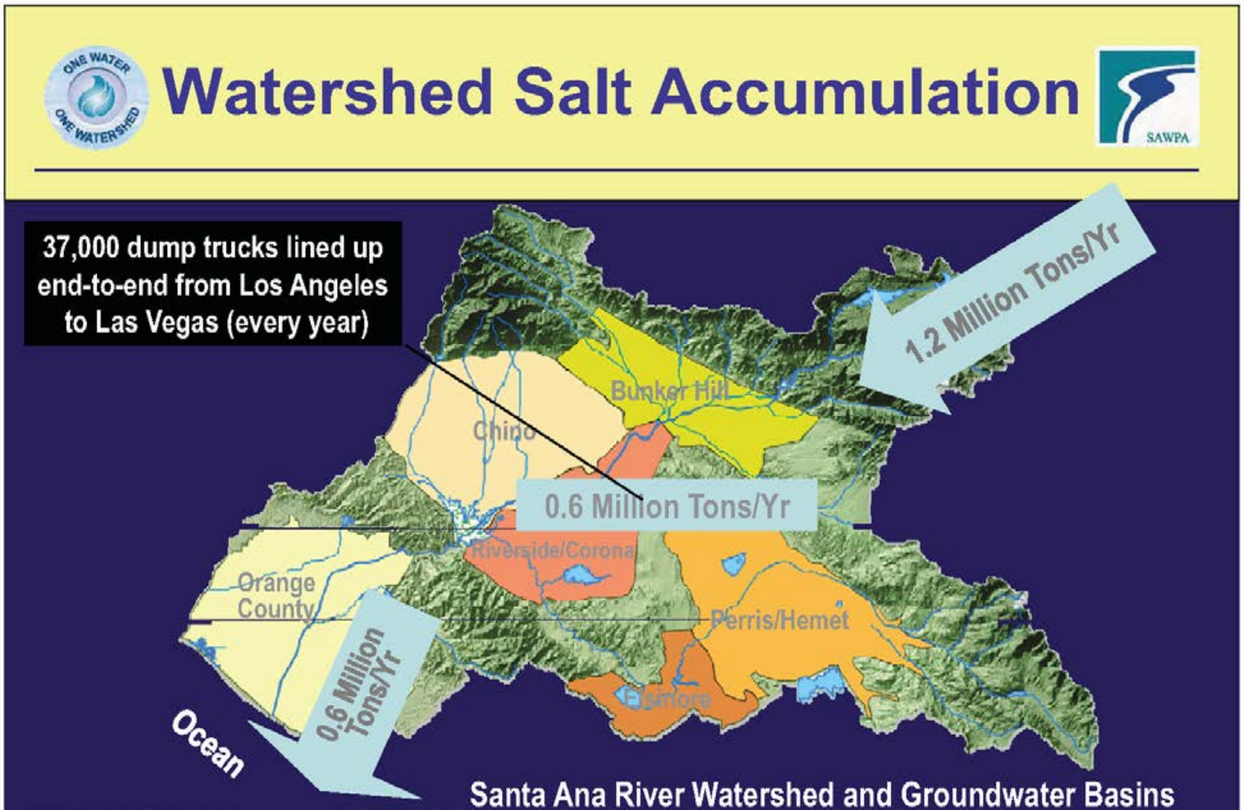
**Subject:** **Status Report on the Construction of the Yucaipa Valley Regional Brineline**

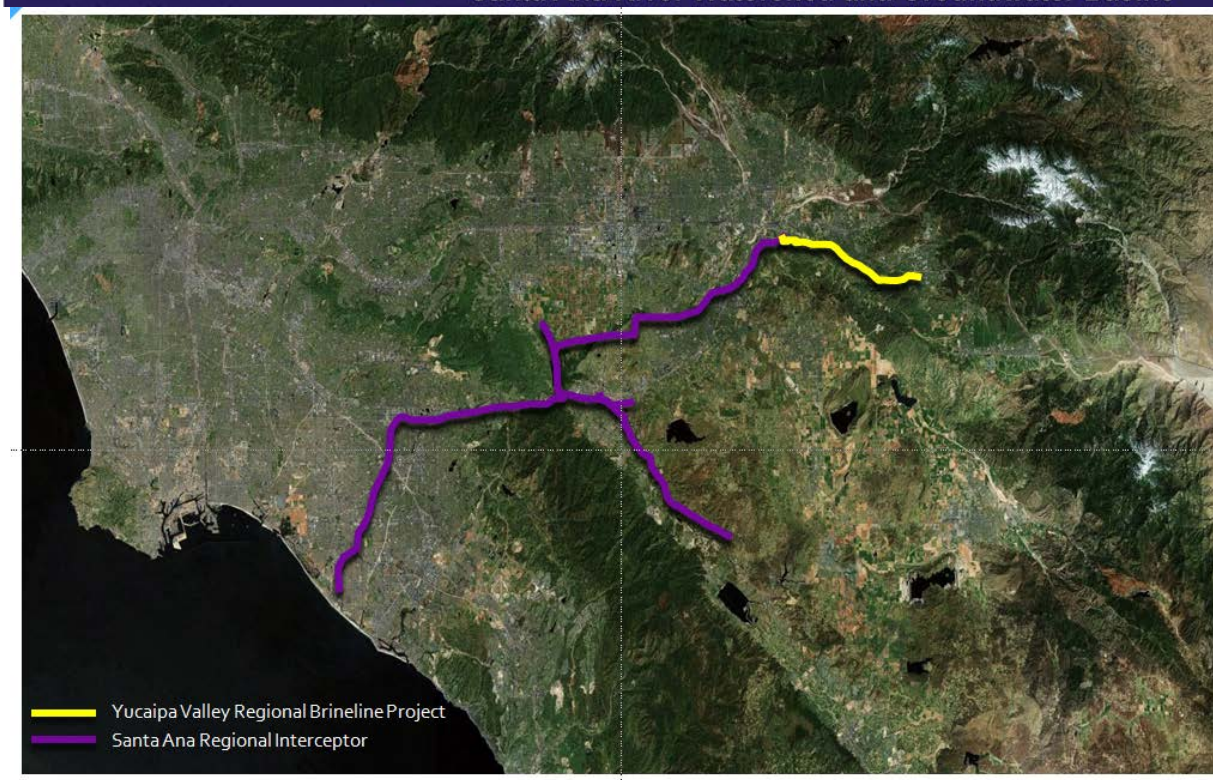
Yucaipa Valley Water District is in the process of constructing the Yucaipa Valley Regional Brineline in order to produce recycled water that complies with groundwater basin objectives as established by the Regional Water Quality Control Board. In order to comply with these limits, the District is required to add a reverse osmosis process to the wastewater treatment plant. This will enable the District to remove salts and minerals from depositing in to the groundwater basin. The proposed reverse osmosis system will produce salt water, referred to as "brine", that must be sent to the Pacific Ocean so it does not impact any fresh water supplies downstream of the Yucaipa Valley.

The Yucaipa Valley Regional Brineline Project consists of a 15-mile pipeline through which the District can safely and effectively dispose of the salt water produced. This pipeline will commence at the Wochholz Regional Water Recycling Facility and terminate at an existing brine disposal pipeline near the I-215 and I-10 Interchange. At this point the existing brineline extends another 73 miles traversing San Bernardino, Riverside and Orange counties to Orange County Sanitation District Wastewater Treatment Plant No. 2 in Huntington Beach, where the salt water is treated with domestic sewage and then sent to the ocean or reclaimed by Orange County Water District.

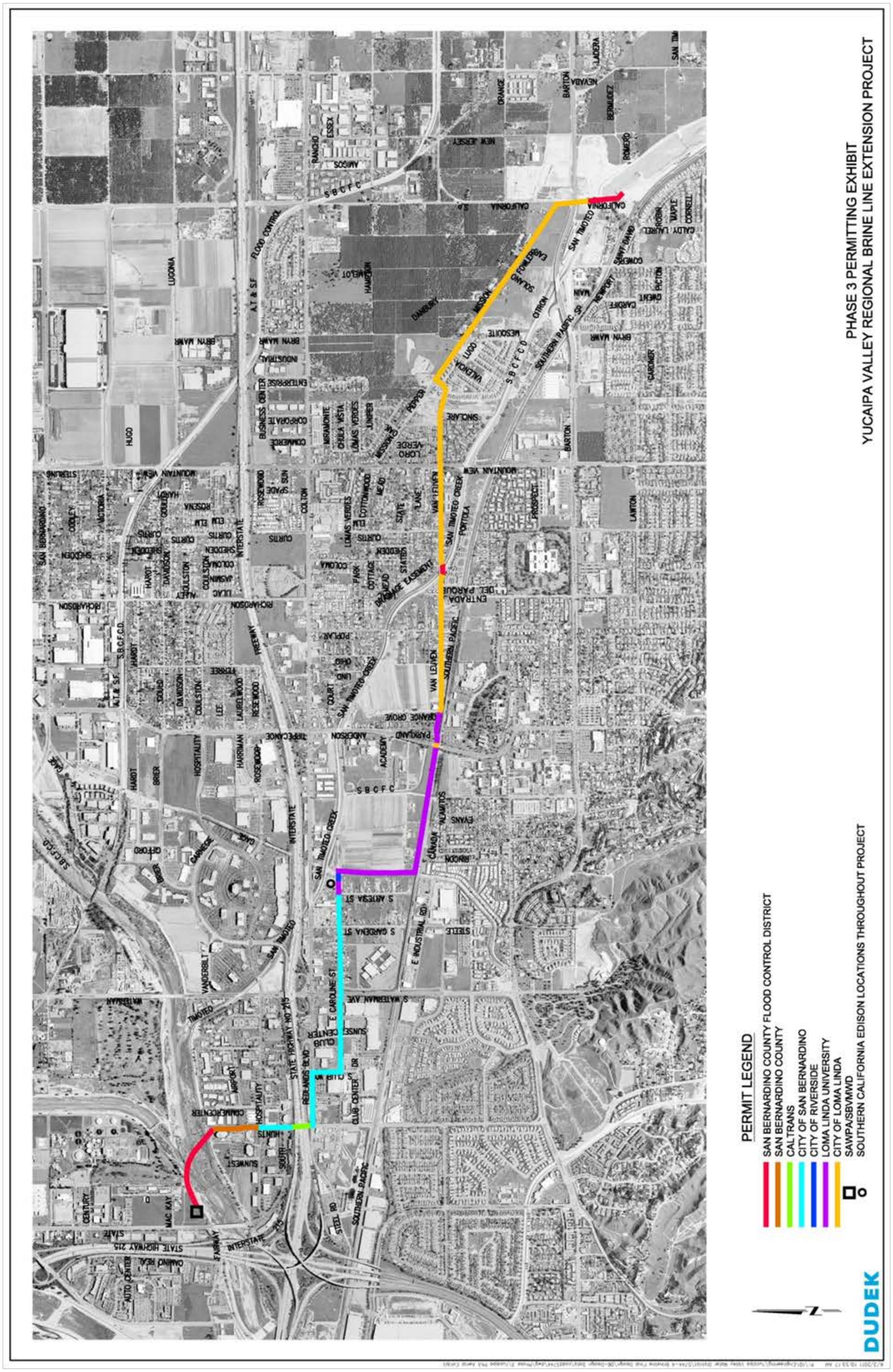
During this agenda item, the District staff will be providing an update of the construction status of the Yucaipa Valley Regional Brineline Project.





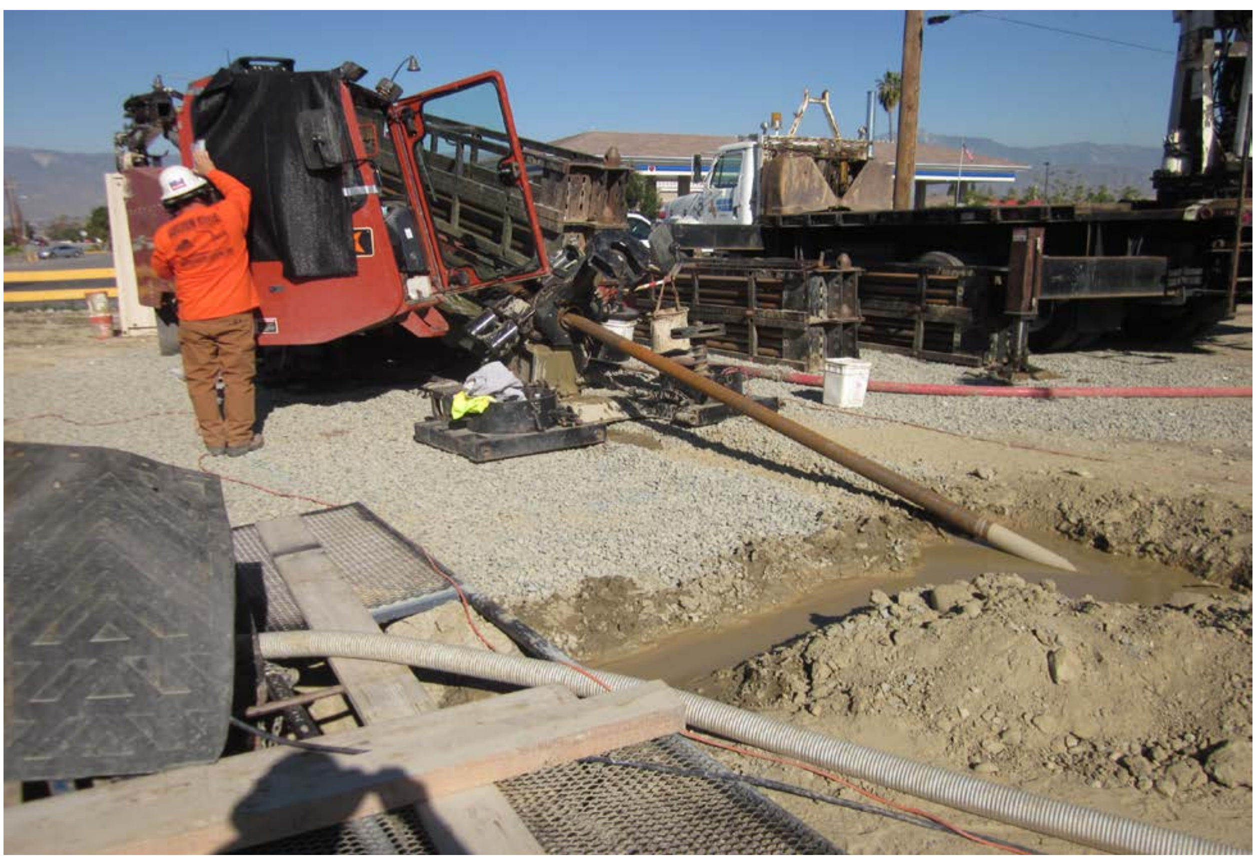




Yucaipa Valley Regional Water Supply Renewal Project


PHASE 3 PERMITTING EXHIBIT
YUCAIPA VALLEY REGIONAL BRINE LINE EXTENSION PROJECT
PERMIT LEGEND
SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT
SAN BERNARDINO COUNTY
CALTRANS
CITY OF SAN BERNARDINO
CITY OF RIVERSIDE
LOMA LINDA UNIVERSITY
CITY OF LOMA LINDA
SAWPA/SBVMWD
SOUTHERN CALIFORNIA EDISON LOCATIONS THROUGHOUT PROJECT
DUDEK


phase 3. installing the
pipe on Redlands sta.
41+81 to sta.
43+62
ROYAL
TRUCK STOP
COMPUTERS
CAT


phase 3. setting plates for
shoring of the recieving pit
on Redlands and Hunts
Hunts Ln
CAT



Yucaipa Valley Water District

# Workshop Memorandum 12-038

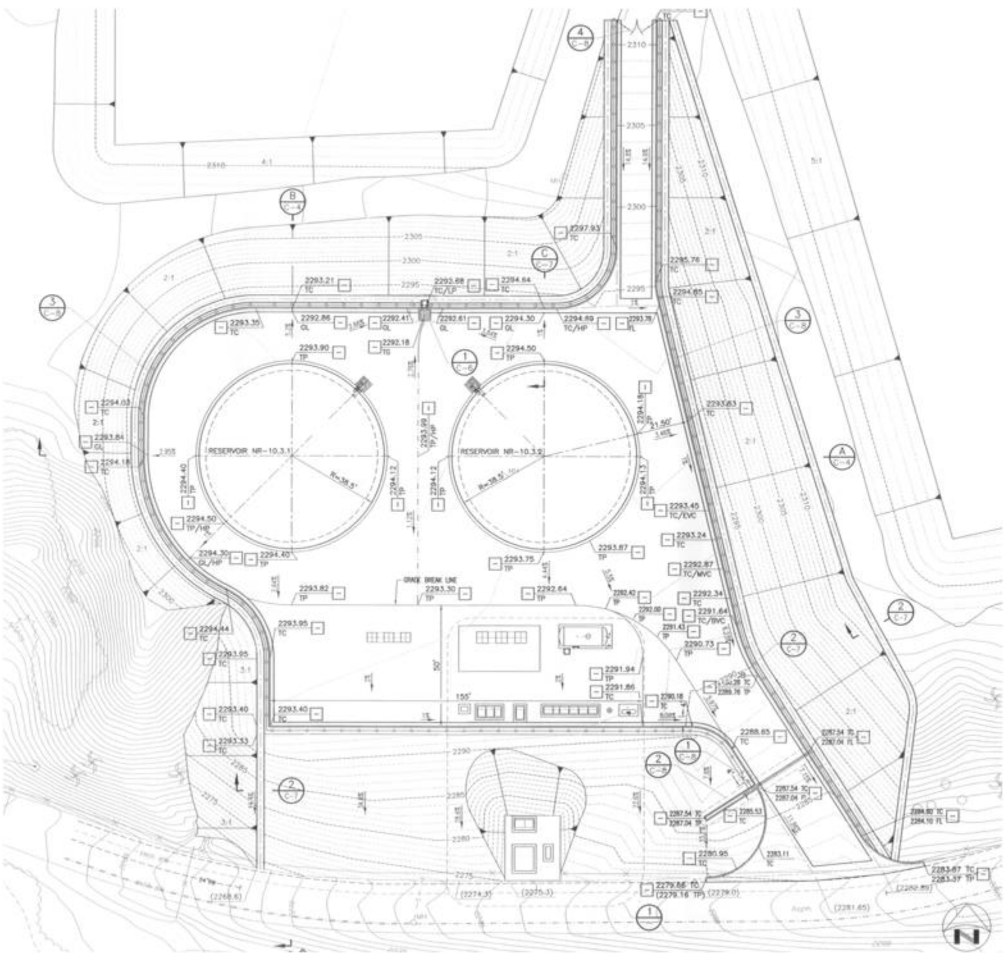
**Date:** February 28, 2012

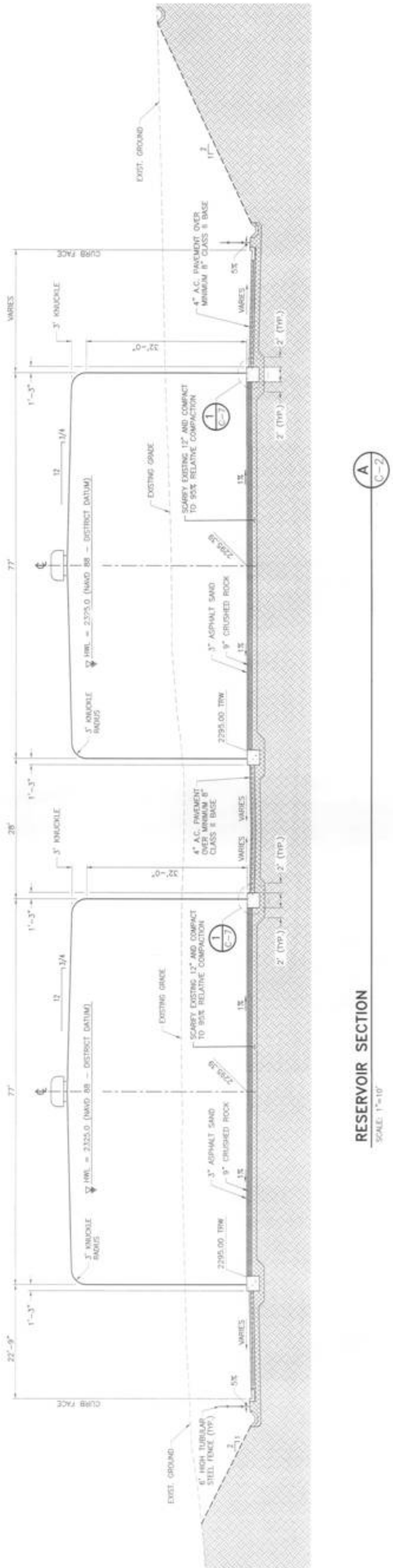
**Subject:** Status Report on the Construction of the R-10 Recycled Water Reservoir and Booster Complex

---

Yucaipa Valley Water District is in the process of constructing several recycled water facilities to prepare the community for the next drought cycle. By connecting the available recycled water supply at the Wochholz Regional Water Recycling Facility to the existing recycled water system, the District will be able to immediately reduce our dependency on imported water by more than 1,000 acre feet per year. Overall, the aggressive use of recycled water is an important element in our water resource planning.

One of the projects planned for completion over the next year is the R-10 Reservoir Complex. This facility is located at the western end of County Line Road in the City of Calimesa. During this agenda item, the District staff will be providing an update of the status of this important project.

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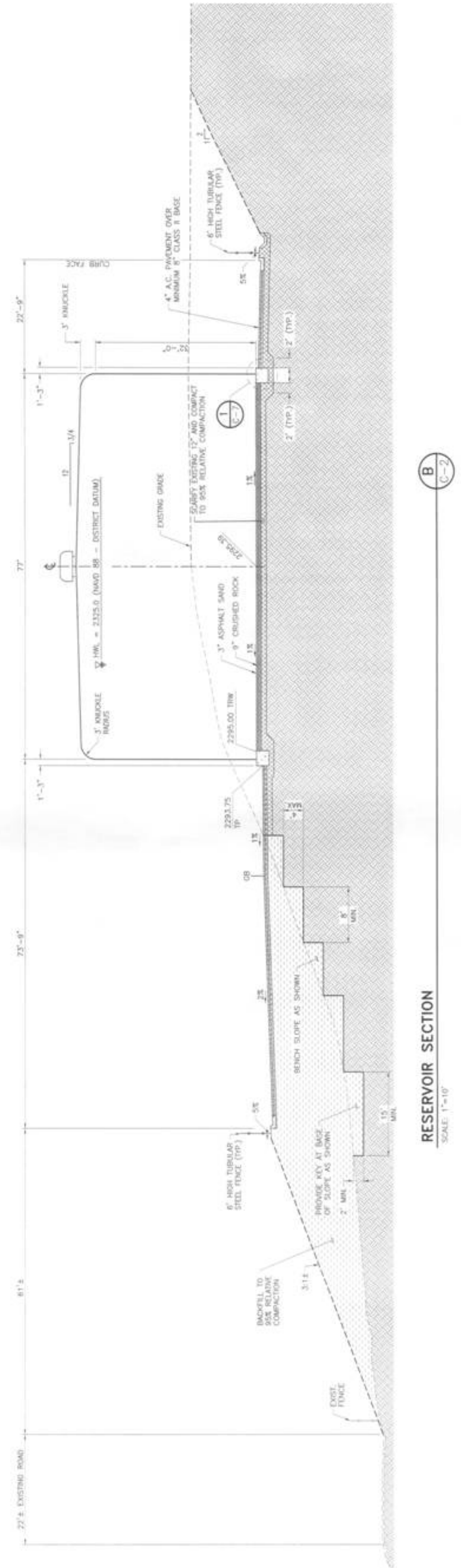
A
C-2


RESERVOIR SECTION
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C-2

Yucaipa Valley Water District

# Workshop Memorandum 12-039

**Date:** February 28, 2012

**Subject:** Status Report on the Construction of the Crow Street Pipeline

---

The Yucaipa Valley Water District is in the process of constructing several recycled water facilities to prepare the community for the next drought cycle. By connecting the available recycled water supply at the Wochholz Regional Water Recycling Facility to the existing recycled water system, the District will be able to immediately reduce our dependency on imported water by more than 1,000 acre feet per year. Overall, the aggressive use of recycled water is an important element in our water resource planning.

One of the projects planned for completion over the next year is the Crow Street Pipeline. During this agenda item, the District staff will be providing an update of the status of this important project.

Yucaipa Valley Water District

# Workshop Memorandum 12-040

**Date:** February 28, 2012

**Subject:** Status Report on the Construction of the Recycled Water Booster Facility at the Reservoir R-12.1 Complex

The Yucaipa Valley Water District is in the process of constructing several recycled water facilities to prepare the community for the next drought cycle. By connecting the available recycled water supply at the Wochholz Regional Water Recycling Facility to the existing recycled water system, the District will be able to immediately reduce our dependency on imported water by more than 1,000 acre feet per year. Overall, the aggressive use of recycled water is an important element in our water resource planning.

One of the projects planned for completion over the next year is the Recycled Water Booster Facility located at the Reservoir R-12.1 Complex. During this agenda item, the District staff will be providing an update of the status of this important project.

Yucaipa Valley Water District

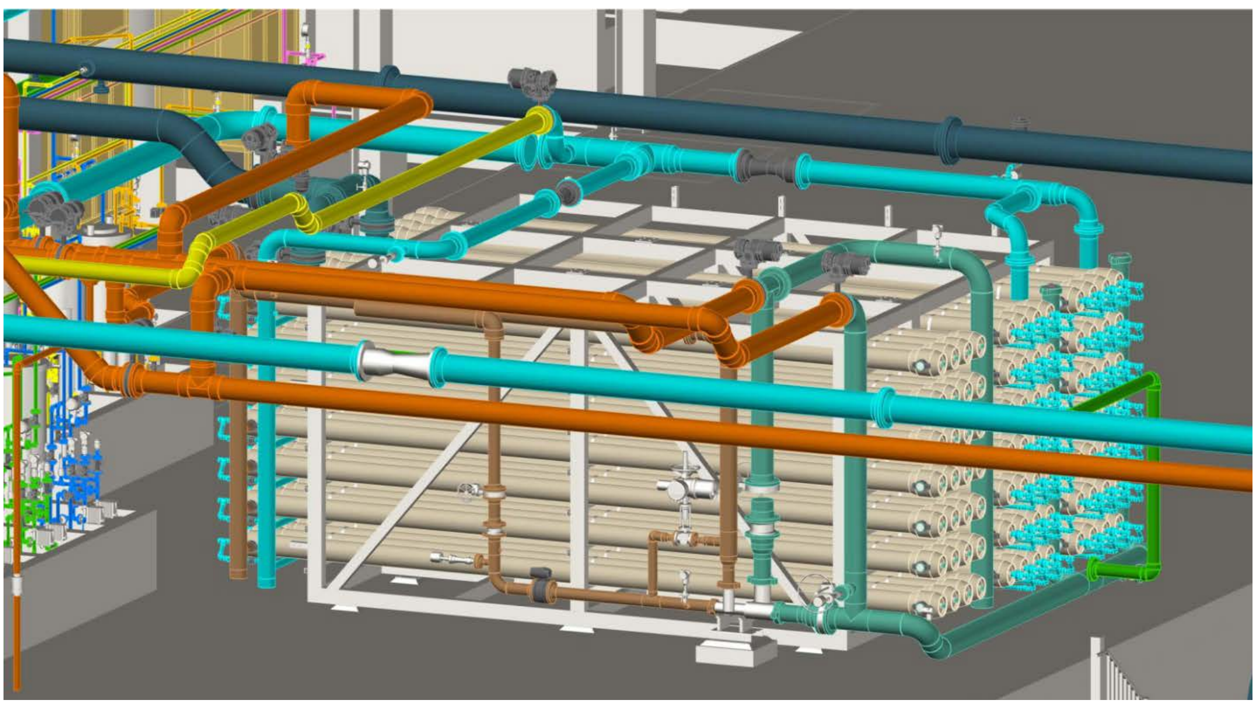
# Workshop Memorandum 12-041

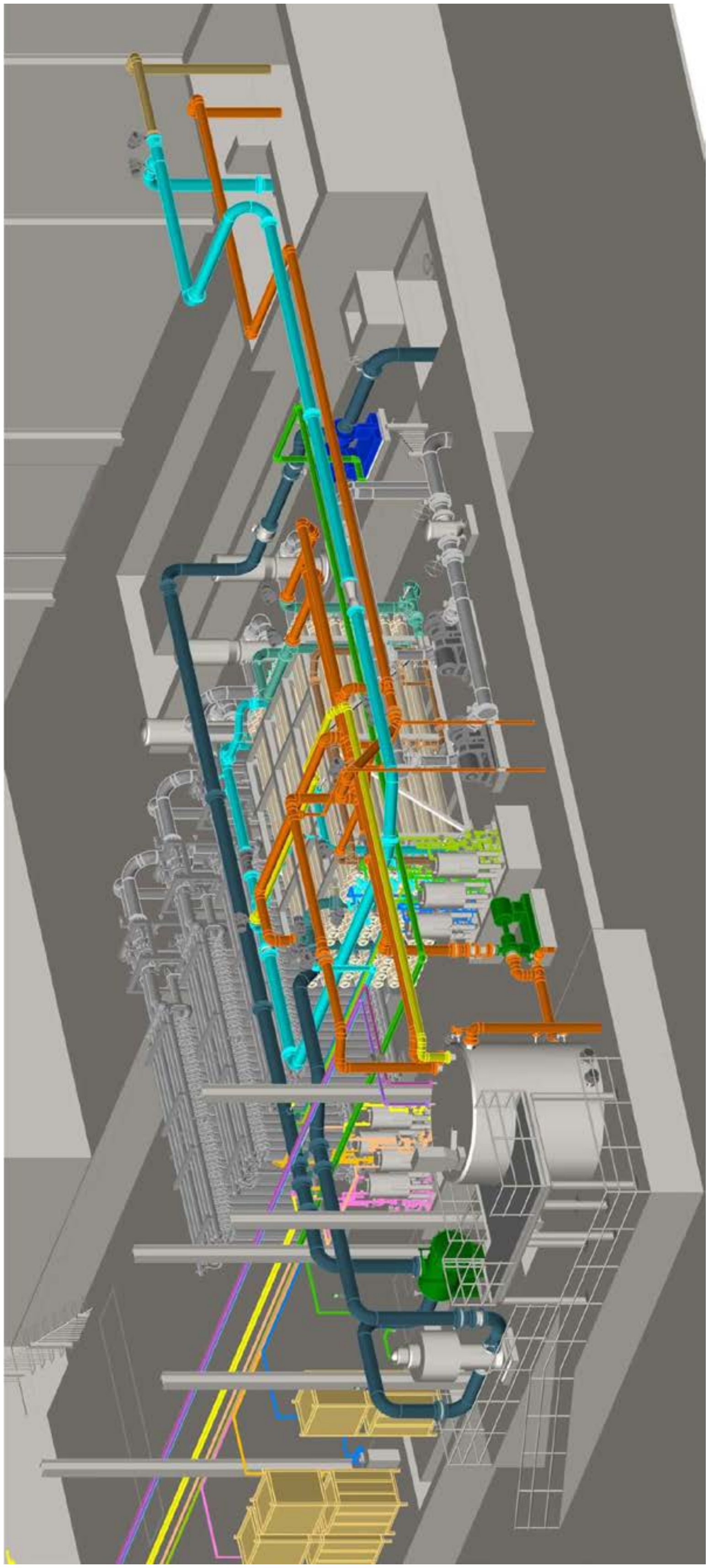
**Date:** February 28, 2012

**Subject:** Status Report on the Construction of the Wochholz Improved Salinity Effluent (WISE) Project

Yucaipa Valley Water District is in the process of constructing the Yucaipa Valley Regional Brineline in order to produce recycled water that complies with groundwater basin objectives as established by the Regional Water Quality Control Board. In order to comply with these limits, the District is required to add a reverse osmosis process to the wastewater treatment plant. This will enable the District to remove salts and minerals from depositing in to the groundwater basin. The proposed reverse osmosis system will produce salt water, referred to as "brine", that must be sent to the Pacific Ocean so it does not impact any fresh water supplies downstream of the Yucaipa Valley.

The first phase of the reverse osmosis equipment is being designed as part of the Wochholz Improved Salinity Effluent (WISE) Project. This project is currently scheduled for the completion of the construction phase by November 2012.





ADMINISTRATIVE ISSUES

# Workshop Memorandum 12-042

**Date:** February 28, 2012

**Subject:** Request for Proposals for Environmental Services Related to the Construction of Reservoirs in Pressure Zones 16 and 17

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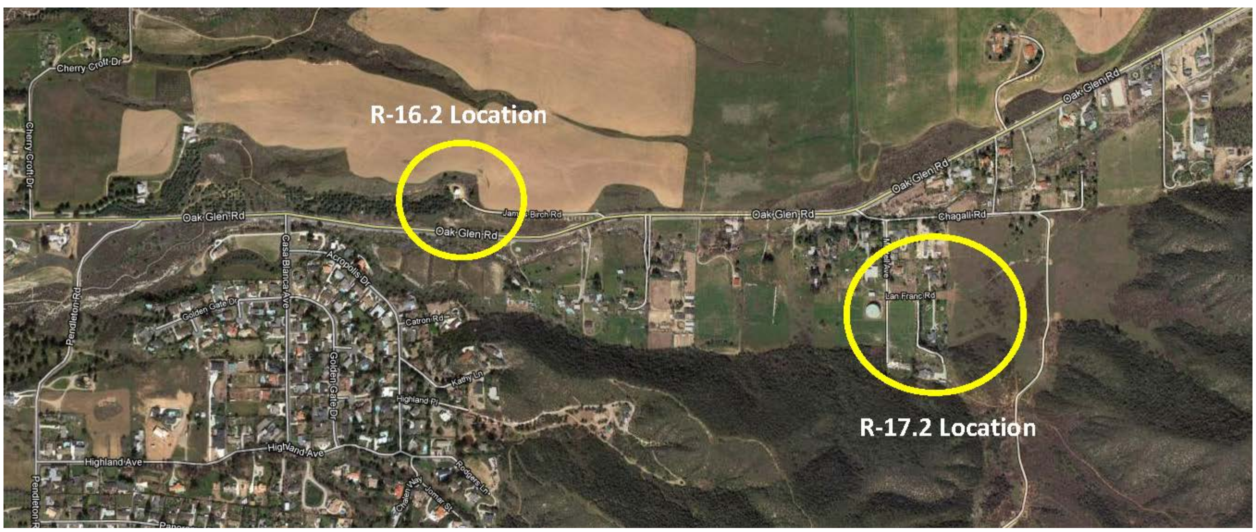
The District staff is in the process of preparing a Request for Proposals to solicit information from qualified environmental consulting firms for the preparation of environmental documents associated with the replacement of Reservoirs R-16.2 and R-17.2. Both of these reservoirs have been identified as important facilities for water service in the upper elevations of our service area.



Yucaipa Valley Water District

12770 Second Street, Yucaipa, California 92399

**Request for Proposals**
**for**
**Environmental Services**
**Related to Construction of Reservoirs 16.2 and 17.2**

**March 8, 2012**

**Proposals Due – _____________, 2012 at 2:00 p.m.**

## Contents



## Attachments:

This request for Proposals describes the basic project, the anticipated scope of services, the consultant selection process, and the minimum information that must be included in the proposal. Failure to submit information in accordance with these requirements and procedures may be cause for disqualification.

## I. BACKGROUND INFORMATION

General

Yucaipa Valley Water District is a self-governed special district responsible for water treatment, water production, water delivery, wastewater collection, wastewater treatment and recycled water delivery in the Yucaipa Valley. The service area of the District encompasses approximately 50 square miles and includes the cities of Yucaipa and Calimesa as well as unincorporated areas of San Bernardino and Riverside counties.

Water Supply System

Historically, the District has depended solely on groundwater sources and surface water from the local mountains to meet its water demand with groundwater providing approximately 92 percent of the total supplies. The District recognized that current local surface and ground waters are not sufficient to satisfy the water demands of the community resulting in the importation of State Water Project water Currently the District receives 45% of its water supply from imported water, 52% from groundwater sources and 3% from local surface water sources.

Recycled Water System

The District is operates an extensive recycled water system as a method of enhancing local water supplies. Recycled water not only provides an additional water resource, but also reduces the reliance and quantity of imported water supplies from Northern California. The ultimate recycled water system is expected to include nine reservoirs with a total capacity of seventeen million gallons, four booster stations, and approximately 50 miles of pipelines. These facilities will be used to provide recycled water to schools, parks, golf courses, and residential customers.

Sewer System

Wastewater generated within the District consists primarily of domestic flow generated from residential, commercial, institutional and light industrial sources. The District maintains a sewer collection system of approximately 170 miles of gravity lines and close to 4,000 manholes. The backbone of the District's collection system is composed of three major interceptors: Lift Station No. 1 Interceptor, Calimesa Interceptor and the 4$^{th}$ Street/Avenue E Interceptor. The District also operates five wastewater lift stations throughout the Yucaipa Valley.

The wastewater collected in the District's service area is conveyed to the Henry N. Wochholz Regional Water Recycling Facility. The wastewater treatment plant was originally constructed in 1986 and has been expanded to produce up to 8 million gallons per day of recycled water. Currently, the average wastewater flow is about 3.5 million gallons per day.

## II. PROJECT DESCRIPTION

The Yucaipa Valley Water District (the District) is requesting proposals from qualified environmental consulting firms for services associated with completion of environmental documents associated with the construction of Reservoirs R-16.2 and R-17.2.

Reservoir R-16.2

For the past four decades, the Yucaipa Valley Water District has utilized this particular site for a functional water storage reservoir that provides service to a large portion of the District's service area. The proposed project will include two water storage reservoirs: one drinking water reservoir and one recycled water reservoir. The construction project will require the removal of the existing reservoir when the drinking water reservoir is completed but prior to the construction of the recycled water reservoir.

The newly constructed reservoirs 16.2 (R-16.2) will be approximately 1.2 million gallons for the drinking water reservoir and 0.25 million gallons for the recycled water reservoir. The 1.2 MG drinking water reservoir will have a footprint of approximately 83 feet in diameter. The 0.25 recycled water reservoir will have a footprint of approximately 44 feet in diameter. The total project area of impact for the two new reservoirs and booster station is approximately two acres.

Reservoir R-17.2

Construction of Reservoir R-17.2 will also replace an existing reservoir. The newly constructed reservoirs will consist of one 1.5 million gallon drinking water reservoir and one 0.75 million gallon recycled water reservoir. The 1.5 million gallon drinking water reservoir is approximately 93 feet in diameter and the 0.75 million gallon recycled water reservoir is anticipated to be 66 feet in diameter. The total project footprint for the two tanks and booster station is approximately two to three acres. The project footprint is dependent upon the final reservoir layout alternative selected by the District.

Environmental Compliance

The selected consultant will be expected to provide the necessary justification for the proper environmental analysis.

## III. TENTATIVE SCHEDULE

The following tentative schedule has been compiled by District staff to integrate the work product from this project into other studies and reports. Therefore, any inability to meet the proposed schedule should be disclosed at the time of submitting your proposal for the project.

Request for Proposals Issued
Site Visit with Consultants
Proposals Due at District Office by 2:00 p.m.
Anticipated Meeting with Committee/Board Members
Board Approval of Consultant Agreement
Notice to Proceed with Environmental Documentation
Completion of Environmental Documentation

## IV. SCOPE OF WORK

The selected consultant shall provide a detailed written monthly progress report to the District with all invoices to receive payment. As a minimum, the Consultant's services shall include:

### 1. Preliminary Services

A. Meet with District staff to discuss the project and obtain information furnished by the District.
B. Compile and review existing documents.
C. Conduct a site tour of property, two locations to determine where reservoirs will be placed.

### 2. Environmental Documentation

Consultant shall provide the District with a project description and facilitate the completion of the necessary environmental documentation. Consultant shall analyze the project footprint and impacts to surrounding vegetation and cultural resources and other environmental factors that may be of concern to the regulatory agencies. Consultant shall perform all related environmental research necessary to complete the project.

### 3. District Meetings

The Consultant shall meet with the District staff as is necessary during execution of the project. A detailed written monthly status report is to be provided along with invoices which are due prior to the fifth of each month.

The consultant shall allow sufficient time to respond to comments and provide presentations at one board workshop, one board meeting and at the public hearing.

## V. SUBMITTAL REQUIREMENTS

The District requires that each proposal clearly address all of the requirements outlined in this Request for Proposal. The proposal shall be limited to a maximum of 10 pages including cover letter with ten hard copies and one electronic provided to the District. Resumes and company qualification brochure data may be added to the 10 page proposal, provided they are located in an appendix at the back of the proposal.

The proposal submitted may be organized as the consultant chooses. However, the proposal must be clear and concise, and contain information covering all the following topics:

- Scope of Work & Methodology

  Outline the firm's understanding of the project and summarize the basic approach to providing professional services for the project. Descriptions of specific procedures and methods to enable the District to assess the consultant's capability to conduct this project in a structured, competent and efficient fashion.

- Suggested Modifications and Enhancement of Proposal

In the event the Consultant feels that the interest of the District would better be served by inclusion, exclusion or revision of any requirement, they may include a short section describing said recommendation with estimated costs. The costs for any additional work shall be clearly identified and will be considered to be in addition to the cost included in the Estimate of Fee. In any case, all of the requirements stated in this RFP must be addressed to constitute an acceptable proposal.

- Schedule for Completion

The tentative schedule shown in Section III of this RFP has been compiled by District staff to comply with the funding requirements for this project. Therefore, any inability to meet the proposed schedule should be disclosed at the time of submitting your proposal for the project. The Consultant shall therefore address any scheduling issues associated with the project with a brief description of how any suggested modifications or enhancements will affect the proposed schedule.

The consultant shall provide the District with a proposed schedule for the completion of the environmental documentation based on the proposed environmental documentation required.

- Personnel

Provide the resumes of individuals that will be assigned to the project and other staff personnel available to support the project.

The contract will provide that any substitution of these key personnel is subject to the written approval of the District; and if not approved, the contract may be terminated.

The consultant shall designate a Contact Person who shall be one of the key personnel. Said Contact Person shall respond to inquiries and otherwise provide information requested by the District. In addition, the Contact Person shall keep the District up to date in regard to all progress on the services provided and otherwise provide information regarding the status of the project.

- Qualifications

Submit descriptions of similar projects that have been performed by the firm within the last five years. Include with the description the client name, address, phone number and a contact person familiar with the work performed by the consultant.

- Proposed Fee for Services – To Be Included With Proposal

The District anticipates on proceeding with this project by issuing one task order to the selected consultant. The task order will be for the completion of environmental documentation for the proposed project.

On a table marked “Environmental Documentation Costs” provide details on the proposed fee for services and include the following:

1. Hours of work allocated for completion of the Environmental Documentation. This should include a breakdown of the hours required to complete the project per person with the individual's title and hourly rate identified. Please be advised that the District's Board of Directors intend on issuing Task Order No. 1 as a **sum not-to-exceed** for the negotiated contract amount.
2. A summary of all anticipated additional expense items should be included for completion of the Project. The District will not allow a percentage mark-up of any outside expenses related to this project.
3. An hourly rate schedule for all personnel indicated in the proposal including any a separate rate schedule for any sub consultants used. The District will not allow a labor rate change for employees and sub-consultants of the selected Consultant during the term of this contract.

Selection of the consultant, if one is selected, will be based on demonstrated competence and qualifications to render the services at a fair price.

## VI. SELECTION PROCESS

Selection Criteria

Major selection criteria used to evaluate the technical proposals received include, but are not limited to the following:

- Past performance and qualifications of the proposed key project team members on similar projects.
- Reasonable cost estimates for the proposed work.
- Familiarity with and capability to handle all aspects of the work.
- Ability to commence work immediately and complete the project within the proposed time frame.
- The proposed project approach, scope, manner and thoroughness in which it is presented in the proposal.
- The firm's experience, the designated project manager's experience, staff availability, stability, financial responsibility and past performance on similar projects.
- Lack of personnel and/or organizational conflicts of interest.
- List any subcontract employees or firms and their specific responsibility for completing a portion of the project.
- Ability to schedule and complete the project in a timely manner.

Selection Process

The proposals will be evaluated and ranked by a committee of selected District staff and may include board members. The top firm will meet with the members of a committee of the Board and/or workshop of the board to discuss the contract prior to presentation to the Board of Directors for approval. If agreement cannot be reached with the top ranked firm, the negotiations will be terminated and the firm so informed in writing. The second ranked firm will then be invited to enter into the negotiation process and so on, until an agreement is reached. With the ability to select more than one consultant for the proposed project, there may be negotiations conducted with more than one consultant.

Contract Award and Agreement

The contract, if awarded, will include the scope of work and a not to exceed contract price with the selected consultant for each phase of the project.

A sample contract agreement is included in Attachment D within this RFP for the consultant's review. Consultant's having any concerns or objections to the terms and requirements of the proposed Agreement shall clearly identify the terms of concern, the nature and reasons for their concern and recommend specific alternative language. Any proposed changes to the agreement (and supporting information) should be included with the Consultants submittal for the project. The District's legal counsel has reviewed this agreement and has determined that it is appropriate for the term "Contractor" to be used for this agreement. The District is not inclined to change the reference of "Contractor" to "Consultant" for this agreement.

Any revisions or changes to the Agreement submitted by the selected Consultant shall not be made a part of this Agreement unless or until approved by the District in its sole discretion. The Consultant thereby agrees to be bound to the form of the Agreement attached hereto subject only to changes and amendments agreed to by the District.

Contract Amount

The Board of Directors will be awarding the proposed work for a sum not to exceed with the understanding that additional work by the Consultant over and beyond the original contract amount may not be approved.

## VII. PROJECT REQUIREMENTS AND CONDITIONS

Clarification

If additional information is needed to interpret this RFP, written questions shall be submitted to Jennifer Ares, Resource Sustainability Manager who will be the Contract Administrator for this project.

Responsiveness

The detailed requirements set forth in Section V are mandatory for providing a proposal for this project. Failure by a proposer to respond to a specific requirement may result in disqualification.

Right to Reject Proposals

The District reserves the right to reject any or all proposals.

Labor Laws

The successful proposer and the proposer's agents, employees and subcontractors shall comply with all applicable provisions of the Labor Code and all federal, state and local laws and regulations which affect the hours of work, wages and other compensation of employees, nondiscrimination and other conduct of the work.

Incurring Costs

The District is not liable for any costs incurred by proposer in responding to this RFP.

Ownership of Data

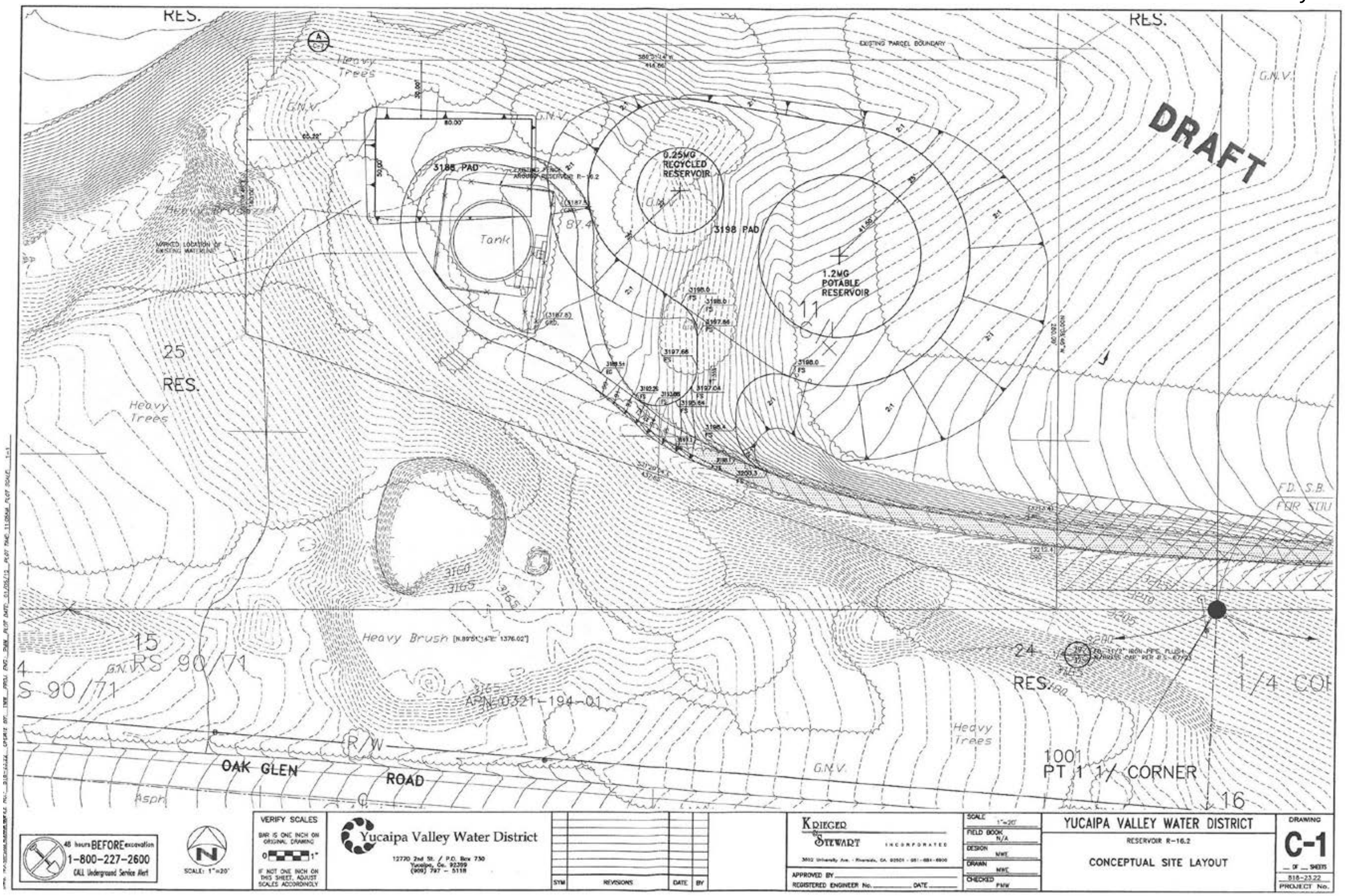
Upon completion of all work under this contract, ownership entitled to all reports, documents, plans, specifications and estimates produced as part of this contract will automatically be vested in the District and no further agreement will be necessary to transfer ownership to the District. Copies made for the Consultant's records shall not be furnished to others without prior written authorization from the District.

Inclusion in Contract with Consultant

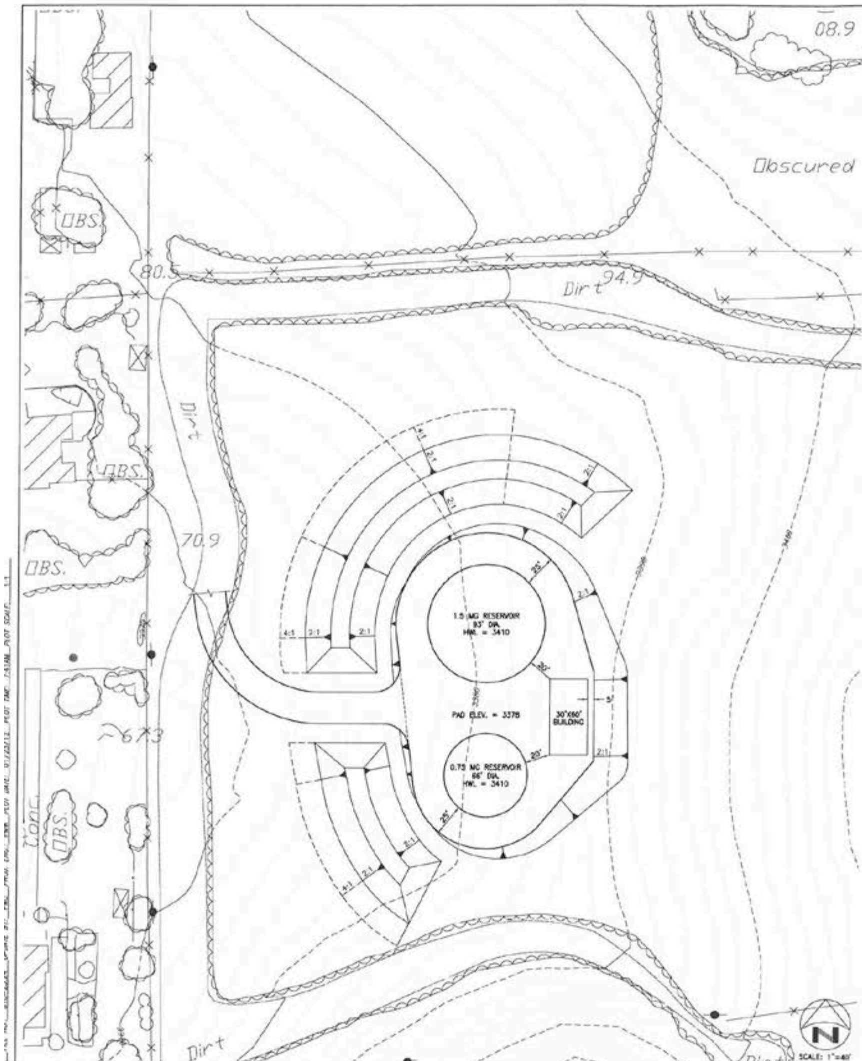
It is understood that this Request for Proposals shall be included as a part of the contract with the consultant.

Attachment A – Reservoir R-16.2 Site Layout
Attachment B – Reservoir R-17.2 Site Layout – Alternative 1
Attachment C - Reservoir R-17.2 Site Layout – Alternative 2
Attachment D – Agreement for Services by a Consultant as an Independent Contractor for the Yucaipa Valley Water District

Attachment A – Reservoir R-16.2 Site Layout



Attachment B – Reservoir R-17.2 Site Layout – Alternative 1





VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

Krieger & Stewart Incorporated

YUCAIPA VALLEY WATER DISTRICT
RESERVOIR R-17.2 SITE LAYOUT
SITE LAYOUT
ALTERNATIVE I

SCALE: AS SHOWN DATE: 1/23/12 DRAWN BY: PMD CHECKED BY: PKW W.O. 816-23.24

FIGURE 1 OF 2

Attachment C - Reservoir R-17.2 Site Layout – Alternative 2

Attachment D – Agreement for Services by a Consultant as an Independent Contractor for the Yucaipa Valley Water District

**AGREEMENT FOR SERVICES BY A CONSULTANT**
**AS AN INDEPENDENT CONTRACTOR**
**FOR THE YUCAIPA VALLEY WATER DISTRICT**

THIS AGREEMENT is made and effective as of the 5th day of April 2012, by and between the YUCAIPA VALLEY WATER DISTRICT ("OWNER") whose address is Post Office Box 730, Yucaipa, California 92399 and ________________, ("CONTRACTOR") whose contact information is:

| | |
|---|---|
| Attention: | ________________ |
| Company: | ________________ |
| Address: | ________________ |
| | ________________ |
| Telephone: | ________________ |
| Facsimile: | ________________ |
| E-mail: | ________________ |
| Federal I.D. No. | ________________ |

**RECITALS**

This Agreement is entered into on the basis of the following facts, understandings and intentions of the parties to this Agreement:

A. OWNER desires to engage the services of CONTRACTOR to perform such services as may be assigned, from time to time, by OWNER in writing for the purpose of providing professional engineering services for the Yucaipa Valley Water District.

B. The services to be performed by CONTRACTOR shall be specifically described in one or more written Task Orders issued by OWNER to CONTRACTOR pursuant to this Agreement.

C. CONTRACTOR agrees to provide such services pursuant to, and in accordance with, the terms and conditions of this Agreement, and has represented to OWNER that CONTRACTOR possesses the necessary skills, qualifications, and personnel to provide such services.

## AGREEMENT

NOW, THEREFORE, in consideration of the foregoing Recitals and mutual covenants contained herein, OWNER and CONTRACTOR agree as follows:

1. Term of Agreement. This Agreement is effective as of the date first above written and shall continue for ______(__) months, unless extended or sooner terminated as provided for herein.

2. Services to be Performed by CONTRACTOR. CONTRACTOR agrees to provide such services as may be assigned and accepted by CONTRACTOR, from time to time, in writing by the Board of Directors and/or the General Manager of OWNER. Each such assignment shall be made in the form of a written Task Order. Each such Task Order shall include, but shall not be limited to, a description of the nature and scope of the services to be performed by CONTRACTOR, the amount of compensation to be paid, and the expected time of completion.

3. Associates and Subcontractors. CONTRACTOR may, at CONTRACTOR's sole cost and expense, employ such competent and qualified independent associates, subcontractors and consultants as CONTRACTOR deems necessary to perform each such assignment; provided, however, that CONTRACTOR shall not subcontract any of the work to be performed without the prior written consent of OWNER.

4. Compensation.

4.01 In consideration for the services to be performed by CONTRACTOR, OWNER agrees to pay CONTRACTOR as provided for in each Task Order.

4.02 Each Task Order shall specify a total not-to-exceed sum of money and shall be based upon CONTRACTOR's schedule of regular hourly rates customarily charged by CONTRACTOR to its clients.

4.03 OWNER shall reimburse CONTRACTOR for reasonable and necessary expenses incurred by CONTRACTOR in the performance of services for OWNER. Reimbursement shall be according to a schedule of reimbursable expenses included in each Task Order.

4.04 CONTRACTOR shall not be compensated for any services rendered nor reimbursed for any expenses incurred in excess of those authorized in any Task Order unless approved in advance by the General Manager or Board of Directors of OWNER, in writing.

4.05 Unless otherwise provided for in any Task Order issued pursuant to this Agreement, CONTRACTOR agrees that payment of compensation earned shall be made in monthly installments within 30 business days after receipt of a detailed, corrected, written invoice describing in reasonable detail, to the extent applicable, the services performed, the time spent performing such services, the hourly rate charged therefore, the identity of individuals performing such services for the benefit of OWNER, and materials consumed or used. Such invoice shall also include a detailed itemization of authorized expenses incurred. Invoices and supporting documentation shall be received by the 5th of each month in order for the CONTRACTOR to have payments approved by the Board at the second monthly board meeting. The CONTRACTOR also will be required to submit a written progress report with each monthly invoice discussing the status of the project.

5. Obligations of Contractor.

5.01 CONTRACTOR agrees to perform all assigned services in accordance with the terms and conditions of this Agreement and those specified in each Task Order.

5.02 Except as otherwise provided for in each Task Order, CONTRACTOR will supply all personnel, materials and equipment required to perform the assigned services.

5.03 CONTRACTOR shall keep OWNER informed as to the progress of the work assigned hereunder, by means of regular and frequent consultations. From time-to-time, when requested by the OWNER, CONTRACTOR shall prepare written status reports.

5.04 CONTRACTOR hereby agrees to be solely responsible for the health and safety of its employees and agents in performing the services assigned by OWNER. Therefore, CONTRACTOR hereby covenants and agrees to:

a. Obtain a comprehensive general liability insurance policy on ISO-CGL Form No. GL 20 10 03 97 in an amount of not less than one million dollars ($1,000,000) per occurrence for all coverage naming OWNER as an additional insured using ISO additional assured endorsement form CG 20 10 11 97;

b. (Check one:) YES _X_ NO __ Obtain a policy of errors and omissions insurance in a minimum amount of $1,000,000 per claim to cover any negligent acts or omissions committed by CONTRACTOR, its employees and/or agents in the performance of any services for OWNER;

c. Comply with all applicable local, state and federal laws, rules and regulations regarding, by way of example and not by limitation, nondiscrimination and payment of wages;

d. Provide worker's compensation insurance for CONTRACTOR's employees and agents with limits as prescribed by law and custom.

CONTRACTOR waives all rights of subrogation against OWNER. Evidence of all insurance coverage shall be provided to OWNER prior to issuance of the first Task Order. Such policies shall be issued by a highly rated insurer (minimum Best's Ins. Guide rating of "A:VII") licensed to do business in California, and shall provide that they shall not be cancelled without 30 days' prior written notice to OWNER. CONTRACTOR acknowledges and agrees that all such insurance is in addition to CONTRACTOR's obligation to fully indemnify and hold OWNER completely free and harmless from and against any and all claims arising out of any, loss, injury or damage to property or persons caused by the negligent acts or omissions of CONTRACTOR in performing services assigned by OWNER.

5.05 CONTRACTOR hereby agrees to indemnify the OWNER (its employees, agents and officials), to the extent permitted by law, be fully protected from any loss, injury, damage, claim, lawsuit, cost, expense, attorneys' fees, litigation costs, defense costs, court costs or any other costs arising out of or in any way related to the performance of professional services under this Agreement.

6. Obligations of Owner.

6.01 OWNER shall do the following in a manner so as not to unreasonably hinder the performance of services by CONTRACTOR:

a. Provide information, requirements and criteria regarding OWNER's project;

b. Furnish all existing studies, reports and other available data and items pertinent to each Task Order that are in OWNER's possession;

c. Designate a person to act as a liaison between CONTRACTOR and the General Manager and Board of Directors of OWNER.

7. Additional Services, Changes and Deletions.

7.01 During the term of this Agreement, the Board of Directors or General Manager of OWNER may, from time to time, and without affecting the validity of this Agreement or any Task Order issued thereunder, order changes, deletions and additional services by the issuance of written change orders authorized and approved by the Board of Directors or General Manager of OWNER along with an equitable adjustment in compensation.

7.02 In the event CONTRACTOR performs additional or different services than those described in any Task Order or authorized change order without the prior written approval of the Board of Directors or General Manager of OWNER, CONTRACTOR shall not be compensated for such services.

7.03 CONTRACTOR shall promptly advise OWNER as soon as reasonably practicable upon gaining knowledge of a condition, event or accumulation of events which may affect the scope and/or cost of services to be provided pursuant to this Agreement. All proposed changes, modifications, deletions and/or requests for additional services shall be reduced to writing for review and approval by the Board of Directors or General Manager of OWNER.

7.04 In the event that OWNER orders services deleted or reduced, compensation shall likewise be deleted or reduced by a fair and reasonable amount and CONTRACTOR shall only be compensated for services actually performed. In the event additional services are properly authorized, payment for the same shall be made as provided in Section 4 above.

8. Termination of Agreement.

8.01 In the event the time specified for completion of an assigned task in a Task Order exceeds the term of this Agreement, the term of this Agreement shall be automatically extended for such additional time as is necessary to complete such Task Order, and thereupon this Agreement shall automatically terminate without further notice.

8.02 Notwithstanding any other provision of this Agreement, OWNER, at its sole option, may terminate this Agreement at any time by giving 10 days' written notice to CONTRACTOR, whether or not a Task Order has been issued to CONTRACTOR.

8.03 In the event of termination, the payment of monies due CONTRACTOR for work performed prior to the effective date of such termination shall be paid within 45 business days after receipt of an invoice as provided in this Agreement. Upon payment for such services, CONTRACTOR agrees to promptly provide and deliver to OWNER all original documents, reports, studies, plans, specifications and the like which are in the possession or control of CONTRACTOR and pertain to OWNER.

9. Status of Contractor.

9.01 CONTRACTOR shall perform the services assigned by OWNER in CONTRACTOR's own way as an independent contractor, and in pursuit of CONTRACTOR's independent calling, and not as an employee of OWNER. CONTRACTOR shall be under the control of OWNER only as to the result to be accomplished and the personnel assigned to perform services. However, CONTRACTOR shall regularly confer with OWNER's General Manager and Board of Directors as provided for in this Agreement.

9.02 CONTRACTOR hereby specifically represents and warrants to OWNER that the services to be rendered pursuant to this Agreement shall be performed in accordance with the standards customarily applicable to an experienced and competent professional rendering the same or similar services. Further, CONTRACTOR represents and warrants that the individual signing this Agreement on behalf of CONTRACTOR has the full authority to bind CONTRACTOR to this Agreement.

10. Audit; Ownership of Documents.

10.01 All draft and final reports, plans, drawings, studies, maps, photographs, specifications, data, notes, manuals, warranties and all other documents of any kind or nature prepared, developed or obtained by CONTRACTOR in connection with the performance of services assigned to it by OWNER shall become the sole property of OWNER, and CONTRACTOR shall promptly deliver copies of all such materials to OWNER in electronic format and hard copies per the OWNER’s request. If OWNER uses such documents for any purpose other than for which they were prepared without CONTRACTOR's prior written approval, OWNER hereby waives any claims against CONTRACTOR and will hold CONTRACTOR harmless from any claim or liability for injury or loss arising from OWNER's unauthorized use.

10.02 CONTRACTOR shall retain and maintain, for a period not less than four years following termination of this Agreement, all time records, accounting records and vouchers and all other records with respect to all matters concerning services performed, compensation paid and expenses reimbursed. At any time during normal business hours and as often as OWNER may deem necessary, CONTRACTOR shall make available to OWNER's agents for examination all of such records and shall permit OWNER's agents to audit, examine and reproduce such records.

11. Miscellaneous Provisions.

11.01 This Agreement supersedes any and all previous agreements, either oral or written, between the parties hereto with respect to the rendering of services by CONTRACTOR for OWNER and contains all of the covenants and agreements between the parties with respect to the rendering of such services in any manner whatsoever. Any modification of this Agreement will be effective only if it is in writing signed by both parties.

11.02 CONTRACTOR shall not assign or otherwise transfer any rights or interest in this Agreement without the prior written consent of OWNER. Unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under this Agreement.

11.03 CONTRACTOR shall comply with all applicable local, state and federal laws, rules, regulations, entitlements and/or permits applicable to, or governing the services authorized hereunder.

11.04 If required by law, CONTRACTOR shall file Conflict of Interest Statements with OWNER.

11.05 Any dispute which may arise by and between the OWNER and the CONTRACTOR, including the CONTRACTOR's subcontractors, laborers, and suppliers, shall be submitted to binding arbitration. Arbitration shall be conducted by the Judicial Arbitration and Mediation Services, Inc./Endispute, in accordance with its construction industry rules in effect at the time of the commencement of the arbitration proceeding, and as set forth in this Paragraph. Arbitration shall be conducted before a panel of three arbitrators, unless the PARTIES agree in writing to submit the matter before a single arbitrator. The arbitrators must decide each and every dispute in accordance with the laws of the State of California, and all other applicable laws. The arbitrators' decision and award are subject to judicial review for errors of fact or law in accordance with Section 1296 of the Code of Civil Procedure, by a Superior Court of competent venue and jurisdiction. Discovery may be conducted in the arbitration proceeding pursuant to Section 1283.05 of the Code of Civil Procedure. Unless the PARTIES stipulate to the contrary, prior to the appointment of the arbitrators, all disputes shall first be submitted to non-binding mediation, conducted by either the American Arbitration Association or Judicial Arbitration and Mediation Services, Inc./Endispute, in accordance with their respective rules and procedures for such mediation. In any arbitration or litigation arising out of this Agreement, or the performance of any obligation under this Agreement, the arbitrators or the court in such arbitration or litigation shall award costs and expenses of arbitration or litigation, including mediation and arbitration fees and expenses, expert witness fees and attorneys' fees, to the prevailing PARTY.

IN WITNESS WHEREOF, the parties hereby have made and executed this Agreement as of the day and year first above-written.

YUCAIPA VALLEY WATER DISTRICT

Dated: ______________________ By: ________________________________

________________________________
Print Name

________________________________
Print Title

CONTRACTOR:

________________________________

Dated: ______________________ By: ________________________________

________________________________
Print Name

________________________________
Print Title

**YUCAIPA VALLEY WATER DISTRICT**

**INDEPENDENT CONTRACTOR'S TASK ORDER NO. 1**

Task Order No.: 1

Project Name: Environmental Documentation for the Yucaipa Valley Regional Water Supply Renewal Project

Contractor Name: ______________________________

Contractor Address: ______________________________

Contractor Telephone: ______________________________

Contractor Fax: ______________________________

Contractor E-mail: ______________________________

Federal Tax ID: ______________________________

THIS TASK ORDER is issued pursuant to that certain Agreement for Services by Independent Contractor between the YUCAIPA VALLEY WATER DISTRICT ("OWNER") and ______________ ("CONTRACTOR") dated May 7, 2003 (the "AGREEMENT").

1. Task to be Performed. CONTRACTOR shall provide all labor, materials and equipment to perform the following task (check one):

X See Exhibit "A", attached hereto
Description of Task:

2. Time of Performance. CONTRACTOR shall begin work within 5 calendar days of the date this Task Order is signed by the OWNER and shall complete performance of such services by or before ___________.

3. Liaison of OWNER. (Check one:) The _X_ General Manager ___ District Engineer ___ District representative (______________________) shall serve as liaison between OWNER and CONTRACTOR.

4. Staff Assignments. CONTRACTOR will assign the following staff personnel to perform the services required by this Task Order: (__ Not Applicable)

| | |
|---|---|
| ______________________ | ______________________ |
| ______________________ | ______________________ |
| ______________________ | ______________________ |
| ______________________ | ______________________ |
| ______________________ | ______________________ |

5. Deliverables. CONTRACTOR shall deliver to OWNER not later than the date or dates indicated, the following: (Check if Not Applicable: _ )

See Exhibit "A"

6. Compensation. For all services rendered by CONTRACTOR pursuant to this Task Order, CONTRACTOR shall receive a total not-to exceed lump sum of ____________________ (______________) payable as contained within Section 4 of the Agreement.

7. Reimbursable Expenses. Included in the amount of compensation provided for in Paragraph 6 above, CONTRACTOR (check one:) ___ shall/ X  shall not be entitled to reimbursement for expenses. If authorized by this Task Order, reimbursable expenses shall be limited to: ______________________________

8. Miscellaneous Matters. The following additional matters are made a part of this Task Order (check one):

Not applicable

X See Exhibit "A" attached hereto

Description:

IN WITNESS WHEREOF, the parties have executed this Task Order on the date indicated below.

| Yucaipa Valley Water District | ______________________<br>Name of Consultant |
|---|---|
| By: ______________________ | By: ______________________ |
| Dated: ______________________ | Dated: ______________________ |
| Name: ______________________ | Name: ______________________ |
| Title: ______________________ | Title: ______________________ |

Yucaipa Valley Water District

# Workshop Memorandum 12-043

**Date:** **February 28, 2012**

**Subject:** **Ratification of State Water Resources Grant Agreement No. 11-162-550 for the Construction of Recycled Water Facilities**

On February 23, 2012, the District received a State Water Resources Control Board Grant Agreement No. 11-162-550 for the construction of recycled water facilities. The $3,197,000 grant will be applied to recycled water infrastructure scheduled for completion within the next twelve months.

CALIFORNIA Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

**State Water Resources Control Board**

**DO NOT MODIFY ENCLOSED GRANT AMENDMENT SETS**

Mr. Joseph Zoba
P.O. Box 730
Yucaipa, CA 92399-0730

February 23, 2012

Dear Mr. Zoba:

Enclosed are four (4) original sets of your Grant Agreement Amendment (Agreement No. 11-162-550. Page two of each Grant Agreement set must be signed and dated in **BLUE INK** by you, as the General Manager, who is authorized to sign on behalf of your agency as designated in your authorizing resolution.

It is imperative that all four (4) sets, bearing an original signature on each, be returned within ten (10) working days from the date of this letter.

**PLEASE NOTE: VERY IMPORTANT TO SUCCESSFUL GRANT COMPLETION**

***Timely return of the signed four (4) Grant Agreement sets is essential. Project funding may be jeopardized by not responding to this letter in a timely manner.***
*If you cannot comply with the ten (10) day turnaround, you must notify us by e-mail immediately with the reason for the delay and an approximate date when you will be able to comply.*
*Your immediate attention and compliance with the request(s) in this letter is greatly appreciated.*

| Grant documents may be sent by Overnight or Certified mail to: | *OR* | by U. S. Postal Service to: |
|---|---|---|
| Susan Mitchell<br>Division of Financial Assistance<br>State Water Resources Control Board<br>1001 I Street, 17th Floor<br>Sacramento, CA 95814 | | Susan Mitchell<br>Division of Financial Assistance<br>State Water Resources Control Board<br>P. O. Box 944212<br>Sacramento, California 94244-2120 |

Upon execution, we will provide you an original signed copy of the Amended Grant Agreement. If you have any questions, please contact Susan Mitchell at (916) 322-3603 or at smitchell@waterboards.ca.gov.

Sincerely,

Susan Mitchell

Enclosures

| FOR STATE USE ONLY |
|---|
| DGS REGISTRATION NO. |

PROPOSITION 50 – WATER RECYCLING GRANT PROGRAM
GRANT AGREEMENT
BETWEEN THE
STATE WATER RESOURCES CONTROL BOARD, hereinafter called "State" or "State Water Board"
AND

Yucaipa Valley Water District, hereinafter called "Grantee"

Non-Potable Water Infrastructure Project Phase II Expansion, hereinafter called "Project"

AGREEMENT NO.11-162-550

State and Grantee hereby agree as follows:

PROVISION(S). The following provision(s) authorize the State Water Board to enter into this type of Grant Agreement:

Water Code § 79550(g) (Proposition 50 Water Recycling)

The State Water Board, pursuant to the Preliminary Funding Commitment, Division of Financial Assistance (Division) Determination No. 2011-023 approved on December 19, 2011 and State Water Board Delegation Resolution No. 2007-0004 has authorized Water Recycling Grant Program funds for the Project.

PURPOSE. State shall provide a grant to and for the benefit of Grantee for the purpose of installing Reverse Osmosis facilities for the Wocholz Improvement Salinity Effluent project at the Wocholz Regional Water Recycling Facility and construct the infrastructure required to deliver recycled water to existing and future users connected to the non-potable system

GRANT AMOUNT. The maximum amount payable under this Agreement shall not exceed $3,197,000. Global Positioning System (GPS) locations for any monitoring must be identified for this Project prior to any disbursements.

TERM OF AGREEMENT. The term of the Agreement shall begin on December 19, 2011 and continue through final payment plus thirty-five (35) years unless otherwise terminated or amended as provided in the Agreement. HOWEVER, ALL WORK SHALL BE COMPLETED BY MARCH 31, 2015. ABSOLUTELY NO FUNDS MAY BE REQUESTED AFTER MAY 1, 2015.

Project Representatives. The Project Representatives during the term of this Agreement will be:

| State Water Resources Control Board | Grantee: Yucaipa Valley Water District |
|---|---|
| Name: Mr. Daniel Newton, Grant Manager | Name: Mr. Joseph Zoba, Project Director |
| Address: 1001 I Street, 16th Floor<br>Sacramento, CA 95814 | Address: P.O. Box 730<br>Yucaipa, CA 92399-0730 |
| Phone: (916) 324-8404 | Phone: (909) 797-5119 |
| Fax: (916) 341-5707 | Fax: (909) 797-6381 |
| e-mail: dnewton@waterboards.ca.gov | e-mail: jzoba@yvwd.dst.ca.us |

Direct all inquiries to:

| State Water Resources Control Board | Grantee: Yucaipa Valley Water District |
|---|---|
| Section/Unit: Division of Financial Assistance | Section/Unit: |
| Attention: James Garcia, Project Manager | Attention: Mr. Scott Goldman, Grant Contact |
| Address: 1001 I Street, 16th Floor<br>Sacramento, CA 95814 | Address: P.O. Box 730<br>Yucaipa, CA 92399-0730 |
| Phone: (916) 341-5647 | Phone: (949) 587-1700 |
| Fax: (916) 341-5707 | Fax: (949) 587-1300 |
| e-mail: jgarcia@waterboards.ca.gov | e-mail: sgoldman@rmcwater.com |

Either party may change its Project Representative upon written notice to the other party.

STANDARD PROVISIONS. The following exhibits are attached and made a part of this Agreement by this reference:

| | |
|---|---|
| Exhibit A | SCOPE OF WORK |
| Exhibit B | INVOICING, BUDGET DETAIL, AND REPORTING PROVISIONS |
| Exhibit C | STATE WATER BOARD - GENERAL CONDITIONS |
| Exhibit D | WATER RECYCLING GRANT PROGRAM – SPECIAL CONDITIONS |

GRANTEE REPRESENTATIONS. The Grantee accepts and agrees to comply with all terms, provisions, conditions, and commitments of this Agreement, including all incorporated documents, and to fulfill all assurances, declarations, representations, and commitments made by the Grantee in its application, accompanying documents, and communications filed in support of its request for grant funding. Grantee shall comply with and require its contractors and subcontractors to comply with all applicable laws, policies and regulations.

IN WITNESS THEREOF, the parties have executed this Agreement on the dates set forth below.

By: ______________________________
Grantee Signature

______________________________
Grantee Typed/Printed Name

______________________________
Title and Date

By: ______________________________
Elizabeth L. Haven, Deputy Director
Division of Financial Assistance,
State Water Resources Control Board

______________________________
Date

Reviewed by:
Office of Chief Counsel
Date:

EXHIBIT A – SCOPE OF WORK

1. Work To Be Performed by Grantee:

All work under this Grant Agreement shall be performed in accordance with the "Facilities Plan Approval" Letter dated August 23, 2011 and any amendments thereto, State Water Board "Preliminary Funding Commitment", Division Determination No. 2011-023 dated December 19, 2011, and Project construction plans and specifications approved by the State Water Board.

If the Water Recycling Funding Program financing agreement is not signed by February 28, 2012 this Grant Agreement shall immediately and automatically terminate, unless a time extension of up to one hundred twenty (120) days is approved.

State Disclosure Requirements – Include the following disclosure statement in any document, written report, or brochure prepared in whole or in part pursuant to this Agreement:

"Funding for this project has been provided in full or in part through an agreement with the State Water Resources Control Board. The contents of this document do not necessarily reflect the views and policies of the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use."

Signage shall be posted in a prominent location at Project site (if applicable) and shall include the State Water Board logo (available from the Program Analyst) and the following disclosure statement:

Water Boards

"Funding for this project has been provided in full or in part through an agreement with the State Water Resources Control Board."

The Grantee shall also include in each of its contracts for work under this Agreement a provision that incorporates the requirements stated within this work item. (Gov. Code, § 7550)

Documents referenced above are hereby incorporated into this Grant Agreement in their entirety.

EXHIBIT B – DISBURSEMENT, BUDGET DETAIL AND REPORTING PROVISIONS

1. Request for Disbursement

1.1 An original Disbursement Request (Form 260) along with an original Grantee invoice shall be submitted to the State Water Board's Disbursement Coordinator. The Grantee may submit disbursement requests initially after this Agreement has been executed and subsequently not more frequently than every thirty (30) calendar days. Also required for disbursement of funds for Construction projects is a Construction Spreadsheet (Form 259). All disbursement forms and supporting documentation must be completed in accordance with the supplied instructions. All documents must have original signatures and dates (in ink) by Grantee's Authorized Representative, designee, or Project Director. Final disbursement requests shall be clearly marked 'FINAL" and submitted NO LATER THAN MAY 1, 2015.

The address for submittal is:

State Water Resources Control Board,
Division of Financial Assistance
Attention: Disbursement Coordinator
17th Floor, Administration Unit
P. O. Box 944212
Sacramento, CA 94244-2120

Street Address: 1001 I Street, 17th Floor
Sacramento, CA 95814

1.2 Payment will be made only after receipt of a complete, adequately supported, properly documented and accurately addressed Form 260. Forms received by the State Water Board that are not consistent with the approved format will cause delay in disbursement. In the event of a delayed disbursement, the State Water Board's Disbursement Coordinator will notify the Grantee. Full payment will not be made until the issue(s) for the delay are resolved. Failure to use the address exactly as provided above may result in return of the invoice or payment request to the Grantee. Payment shall be deemed complete upon deposit of the payment, properly addressed, postage prepaid, in the United States mail. The State Water Board's Grant Manager must approve all payments.

1.3 Notwithstanding any other provision of this Agreement, no disbursement shall be required at any time or in any manner which is in violation of or in conflict with Federal or State laws, rules, or regulations, or which may require any rebates to the Federal Government, or any loss of tax-free status on State bonds, pursuant to any Federal statute or regulation.

1.4 Grantee shall use disbursement amounts to pay outstanding costs incurred immediately, if Grantee has not already paid such costs.

2. Budget Contingency Clause

The maximum amount to be encumbered under this Agreement for the 2010-11 fiscal year ending June 30, 2011 shall not exceed three million one hundred ninety-seven thousand dollars ($3,197,000).

The Grantee agrees to pay any and all costs associated with the completion of the Project, including without limitation, any and all Project costs exceeding the State Water Board approved grant amount.

If federal or other state funding assistance for Project costs is made available, the Grantee may retain all federal or other state funds received up to an amount that equals the Grantee's local share of Project costs. Any excess funds received, up to the total amount of the State Water Board grant funds received, shall be remitted to the State Water Board to the extent not prohibited by the requirements of the other funding sources. Any residue shall be the property of the Grantee.

Upon execution and delivery of this Agreement, and award of a construction subcontract or commencement of construction by a force account, the Grantee may request disbursement of funds based on eligible construction costs incurred. Grant Project Funds will be disbursed to the Grantee upon receipt of Disbursement Request (Form 260) duly completed and executed by the Grantee for incurred costs consistent with the Final Plans and Specifications Approval Letter. Only costs incurred in accordance with Water Recycling Funding Program (WRFP) Guidelines are eligible for reimbursement under this Agreement. Disbursement requests shall not be submitted more frequently than every thirty (30) days.

The Grantee may request a grant allowance for engineering, legal, and construction management costs for the purposes of design and construction of the Project. Legal costs incurred for Project-related litigation are not reimbursable. The eligible allowance shall be at most fifteen percent (15%) of the eligible construction costs, provided the allowance does not exceed the actual costs incurred for the purposes of the allowance or of other purposes associated with the design or construction of the Project. For purposes of this provision, "construction cost" means the cost of erecting, installing, placing, altering, remodeling, improving, or extending facilities, whether accomplished by subcontract or force account. The allowance provided for herein shall be the total amount allowed under this Agreement for engineering, legal, and construction management of the Project, regardless of the actual costs thereof. The allowance shall be disbursed as part of each disbursement request and shall not exceed fifteen percent (15%) of the eligible construction costs for that disbursement request.

If the State Budget Act of the current year and/or any subsequent years covered under this Agreement does not appropriate sufficient funds for the program, this Agreement shall be of no force and effect. This provision shall be construed as a condition precedent to the obligation of the State Water Board to make any payments under this Agreement. In this event, the State shall have no liability to pay any funds whatsoever to Grantee or to furnish any other considerations under this Agreement and Grantee shall not be obligated to perform any provisions of this Agreement. Nothing in this Agreement shall be construed to provide the Grantee with a right of priority for payment over any other Grantee.

If this Agreement's funding for any fiscal year is reduced or deleted by the Budget Act, by Executive Order, or by order of the Department of Finance, the State shall have the option to either cancel this Agreement with no liability occurring to the State, or offer an Agreement amendment to the Grantee to reflect the reduced amount.

3. Line Item Budget

| Description | Grant Amount |
|---|---|
| Construction | $3,197,000 |
| | |
| | |
| Total | $3,197,000 |

4. Reports.

4.1 Grantee shall submit quarterly progress reports/construction status reports to the State Water Board's Grant Manager by the end of the calendar quarter (March, June, September, and December). The Grantee agrees to expeditiously provide, status reports on the Project no less frequently than quarterly, starting with the execution of this Agreement. At a minimum the reports will contain the following information: a summary of progress to date including a description of progress since the last report, milestones achieved, and any problems encountered in the performance of the work under this Agreement. Items to include during construction include: percent construction complete, percent contractor invoiced, and percent schedule elapsed; a listing of change orders including amount, description of work, and change in contract amount and schedule; and any problems encountered, proposed resolution, schedule for resolution, and status of previous problem resolutions.

4.2 Every three (3) months (quarterly) during the work performed under Exhibit A section of this Agreement, the Grantee shall develop and submit to the Grant Manager expenditure/invoice projections for future quarters to enable funding to be available for payment of invoices.

4.3 The Grantee shall submit annual reports to the State Water Board for a period commencing with completion of construction, as determined by the State Water Board, through one (1) full year after all proposed recycled water users included in the Project are connected for service (minimum five [5] years).

The first annual report is due on February 28th following the first complete calendar year of operation and shall cover the period from the completion of construction through the end of the first full calendar year thereafter. Subsequent annual reports are due by February 28th following the year covered. The annual reports shall be prepared in accordance with the "Water Reclamation Loan Program Guidelines for Annual Progress Reports," dated July 2008, or any successor guidelines.

The reports shall be submitted in hard copy and electronically to the Grant Manager and shall include the following:

4.3.1 Data on monthly recycled water deliveries to each user identified in the Facilities Plan Approval and any new users;

4.3.2 Data on total amount of recycled water delivered by the Grantee by the following use types: agricultural irrigation, landscape irrigation, industrial reuse, energy production, groundwater recharge, seawater barrier, recreational impoundment, wildlife habitat, or other;

4.3.3 An updated schedule for any existing/future user added to the Project since the original Project user list was approved;

4.3.4 Any current plans for use of any Project capacity not under contract for use;

4.3.5 A description of compliance with any special conditions of this Agreement;

4.3.6 A list of the power and maintenance costs associated with the Project for the period; and,

4.3.7 Any other information as may be reasonably required to evaluate the Project's benefits and use of Project facilities.

4.4 Within one hundred twenty (120) days after Completion of Construction, the Grantee agrees to provide to the Grant Manager a final cost summary report on the Project. The summary shall include at a minimum, a statement of:

4.4.1 Total Eligible Project Costs and total Project costs including change orders;

4.4.2 The amount of any unexpended Grant Project Funds;

4.4.3 The total amount of assistance funds received from all sources and the allocation of those funds to the Project's costs;

4.4.4 The amount of interest earned, if any, on Grant Project Funds before expenditure on incurred Project costs. If no interest has been earned, this fact shall be expressly stated;

4.4.5 The report shall be accompanied by such other financial information as may be reasonably required by the State Water Board to verify Grantee entitlement to assistance, to assure program integrity of the WRFP. The Authorized Representative shall certify the report as correct, that costs attributed to the Project have been incurred in the amounts and for the purposes represented, and that the work or material for which payment has been requested is satisfactory. Any change in the information supplied shall be promptly reported to the State Water Board.

4.5 The Grantee agrees to expeditiously provide, during work on the Project and throughout the term of this Agreement, such reports, data, information, and certifications as may be reasonably required by the State Water Board.

5. Payment of Project Costs. The Grantee agrees that it will provide for payment of its full share of Project costs, and that all costs connected with the Project will be paid by the Grantee on a timely basis.

6. Final Disbursement. Notwithstanding any other provision of this Agreement, the Grantee agrees that the State Water Board may retain an amount equal to ten percent (10%) of the grant amount specified in this Agreement until completion of the Project to the reasonable satisfaction of the State Water Board. Any retained amounts due to the Grantee will be promptly disbursed to the Grantee, without interest, upon completion of the Project.

7. Audit Disallowances. The Grantee agrees it shall return any audit disallowances to the State Water Board.

8. Project Certification. One (1) year after initiation of operations, the Grantee shall certify to the State Water Board whether or not the Project, as of that date, meets the Project performance standards agreed upon as part of final plans and specifications approval, including the quality of recycled water and the expected deliveries of recycled water during the first year of Project operation. If the Grantee cannot certify that the Project meets such performance standards at that time, the Grantee will, at its own expense and in a timely manner, expeditiously make all needed corrections and perform all additional work necessary to allow affirmative certification for the Project.

9. Project Access. The Grantee agrees to ensure that the State Water Board, or any authorized representative thereof, will have suitable access to the Project site at all reasonable times during Project construction and thereafter for the useful life of the Project.

10. Project Deliveries. The Grantee agrees to obtain sufficient recycled water users connected to Project facilities to make deliveries of recycled water in accordance with the schedule specified in Exhibit A.

11. Failure To Submit Report. Failure to submit any reports pursuant to this Exhibit required by the State Water Board shall constitute a breach of a material provision of this Agreement. The Grantee understands and acknowledges that upon failure to provide any such report pursuant to this Exhibit, the Division of Financial Assistance (Division) will stop processing any pending and future applications for new loans or grants and withhold payments on any existing loans and grants that the Grantee may have with the State Water Board until the report has been submitted to the Grant Manager's reasonable satisfaction. Further, upon failure to submit a report pursuant to this Exhibit, the Division shall issue a notification and request for the report and initiate administrative proceedings pursuant to Water Code sections 13267 and 13268 or use any other legal means to obtain the report. The Grantee further acknowledges that failure to submit required reports may result in termination of this Agreement and immediate repayment of all grant funds disbursed hereunder.

12. Fraud and Misuse of Public Funds. All invoices submitted shall be accurate and signed under penalty of perjury. Any and all costs submitted pursuant to this Agreement shall only be for the tasks set forth herein or incorporated by reference. The Grantee shall not submit any invoice containing costs that are ineligible or have been reimbursed from other funding sources unless required and specifically noted as such (i.e., match costs). Any eligible costs for which the Grantee is seeking reimbursement shall not be reimbursed from any other source. Double or multiple billing for time, services, or any other eligible cost is illegal and constitutes fraud. Any suspected occurrences of fraud, forgery, embezzlement, theft, or any other misuse of public funds may result in suspension of disbursements of grant funds and/or termination of this Agreement requiring the repayment of all funds disbursed hereunder. Additionally, the Deputy Director of the Division of Financial Assistance may request an audit pursuant to Exhibit C, paragraph 4 and refer the matter to the Attorney General's Office or the appropriate district attorney's office for criminal prosecution or the imposition of civil liability. (Civ. Code, §§ 1572-1573; Pen. Code, §§ 470, 489-490.)

EXHIBIT C — STATE WATER BOARD GENERAL CONDITIONS

1. AMENDMENT: No amendment or variation of the terms of this Agreement shall be valid unless made in writing, signed by the parties and approved as required. No oral understanding or Agreement not incorporated in the Agreement is binding on any of the parties.

2. APPROVAL: The Grantee will not proceed with any work on the Project until authorized in writing by the State Water Board.

3. ASSIGNMENT: This Grant is not assignable by the Grantee, either in whole or in part, without the written consent of the State Water Board.

4. AUDIT: The Grantee agrees that the State Water Board, the Bureau of State Audits, the Governor of the State, of the Internal Revenue Service, or any authorized representative of the foregoing shall have the right to review and to copy any records and supporting documentation pertaining to the performance of this Agreement. The Division of Financial Assistance (Division), at its option, may call for an audit of financial information relative to the Project, where the Division determines that an audit is desirable to assure program integrity or where such an audit becomes necessary because of federal requirements. Where such an audit is called for, the audit shall be performed by a certified public accountant independent of the Grantee and at the cost of the Grantee. The audit shall be in the form required by the Division. The Grantee agrees to maintain such records for a possible audit for a minimum of thirty-five (35) years after final payment, unless a longer period of records retention is stipulated. The Grantee agrees to allow the auditor(s) access to such records during normal business hours and to allow interviews of any employees who might reasonably have information related to such records. Further, the Grantee agrees to include a similar right of the State to audit records and interview staff in any contract related to performance of this Agreement. The Grantee agrees it shall return any audit disallowances to the State Water Board.
(Gov. Code, § 8546.7; Pub. Contract Code, § 10115 et seq.)

5. BONDING: Where contractors are used, the Grantee shall not authorize construction to begin until each such contractor has furnished a performance bond in favor of the Grantee in the following amounts: faithful performance (100%) of contract value; labor and materials (100%) of contract value. This requirement shall not apply to any contract for less than $20,000.00. Copies of performance bonds must be submitted to the Grant Manager prior to the authorization of construction activities.

6. CEQA/NEPA: No work that is subject to the California Environmental Quality Act (CEQA) or National Environmental Policy Act (NEPA) may proceed under this Agreement until documents that satisfy the CEQA/NEPA process are received by the Grant Manager and the State Water Board has given environmental clearance. No work that is subject to an Environmental Impact Report or a Mitigated Negative Declaration may proceed until and unless approved by the Deputy Director of the Division. Such approval is fully discretionary and shall constitute a condition precedent to any work for which it is required. Proceeding with work subject to CEQA and/or NEPA without environmental clearance by the State Water Board shall constitute a breach of a material provision of this Agreement.

7. COMPLIANCE WITH LAW, REGULATIONS, ETC.: The Grantee agrees that it will, at all times, comply with and require its contractors and subcontractors to comply with all applicable federal and state laws, rules, guidelines, regulations, and requirements. Without limitation of the foregoing, the Grantee agrees that, to the extent applicable, the Grantee will comply with the provisions of the adopted environmental mitigation plan for the term of this Agreement, or the useful life of the Project, whichever is longer.

8. COMPUTER SOFTWARE: The Grantee certifies that it has appropriate systems and controls in place to ensure that state funds will not be used in the performance of this Agreement for the acquisition, operation or maintenance of computer software in violation of copyright laws.

9. CONFLICT OF INTEREST: The Grantee certifies that it is in compliance with applicable state and/or federal conflict of interest laws.

10. CONTINUOUS USE OF PROJECT; LEASE OR DISPOSAL OF PROJECT: The Grantee agrees that, except as provided in the Agreement, it will not abandon, substantially discontinue use of, lease, or dispose of the Project or any significant part or portion thereof during the useful life of the Project without prior written approval of the State Water Board. Such approval may be conditioned as determined to be appropriate by the State Water Board, including conditions requiring repayment of all grant funds or any portion of disbursed grant funds covered by this Agreement together with accrued interest and any penalty assessments that may be due. The Grantee shall not take any action, including but not limited to actions relating to user fees, charges, and assessments that could adversely affect the ability of the Grantee to meet its obligations under this Agreement, without prior written permission of the State Water Board.

11. DAMAGES FOR BREACH AFFECTING TAX EXEMPT STATUS: In the event that any breach of any of the provisions of this Agreement by the Grantee shall result in the loss of tax exempt status for any state bonds, or if such breach shall result in an obligation on the part of the State to reimburse the federal government by reason of any arbitrage profits, the Grantee shall immediately reimburse the State in an amount equal to any damages paid by or loss incurred by the State due to such breach.

12. DATA MANAGEMENT: This Project includes appropriate data management activities so that Project data can be incorporated into appropriate statewide data systems.

13. DISPUTES: The Grantee shall continue with its responsibilities under this Agreement during any dispute. Any dispute arising under this Agreement which is not otherwise disposed of by agreement shall be decided by the Deputy Director of the Division, or his or her authorized representative. The decision shall be reduced to writing and a copy thereof furnished to the Grantee and to the State Water Board's Executive Director. The decision of the Division shall be final and conclusive unless, within thirty (30) calendar days after mailing of the Division decision to the Grantee, the Grantee mails or otherwise furnishes a written appeal of the decision to the State Water Board's Executive Director. The decision of the State Water Board's Executive Director shall be final and conclusive unless determined by a court of competent jurisdiction to have been fraudulent, or capricious, or arbitrary, or so grossly erroneous as necessarily to imply bad faith, or not supported by substantial evidence. In connection with any appeal under this clause, the Grantee shall be afforded an opportunity to be heard and to offer evidence in support of its appeal. Pending final decision of a dispute hereunder, the Grantee shall continue to fulfill and comply with all the terms, provisions, commitments, and requirements of this Agreement. This clause does not preclude consideration of legal questions, provided that nothing herein shall be construed to make final the decision of the State Water Board, or any official or representative thereof, on any question of law.

14. FISCAL MANAGEMENT SYSTEMS AND ACCOUNTING STANDARDS: The Grantee agrees that, at a minimum, its fiscal control and accounting procedures will be sufficient to permit tracing of grant funds to a level of expenditure adequate to establish that such funds have not been used in violation of state law or this Agreement. The Grantee further agrees that it will maintain separate Project accounts in accordance with generally accepted accounting principles.

15. GOVERNING LAW: This Grant is governed by and shall be interpreted in accordance with the laws of the State of California.

16. GRANTEE'S RESPONSIBILITY FOR WORK: The Grantee shall be responsible for work and for persons or entities engaged in work, including, but not limited to, subcontractors, suppliers, and providers of services. The Grantee shall be responsible for any and all disputes arising out of its contracts for work on the Project, including but not limited to payment disputes with contractors, subcontractors. The State will not mediate disputes between the Grantee and any other entity concerning responsibility for performance of work.

17. INCOME RESTRICTIONS: The Grantee agrees that any refunds, rebates, credits, or other amounts (including any interest thereon) accruing to or received by the Grantee under this Agreement shall be paid by the Grantee to the State, to the extent that they are properly allocable to costs for which the Grantee has been reimbursed by the State under this Agreement.

18. INDEPENDENT ACTOR: The Grantee, and its agents and employees, if any, in the performance of this Agreement, shall act in an independent capacity and not as officers, employees or agents of the State Water Board.

19. INSPECTION: The State Water Board, the Bureau of State Audits, or any authorized representative of the foregoing, shall have suitable access to the Project site at all reasonable times during Project implementation and thereafter for the life of the Project to ascertain compliance with this Agreement and its goals. The Grantee acknowledges that the Project records and location are public records.

20. INSURANCE: Throughout the life of the Project, the Grantee shall provide and maintain insurance against fire, vandalism and other loss, damage, or destruction of the facilities or structures constructed pursuant to this Agreement, if any. This insurance shall be issued by a company or companies admitted to transact business in the State of California. The insurance policy shall contain an endorsement specifying that the policy will not be cancelled or reduced in coverage without thirty (30) days prior written notice to the State Water Board. In the event of any damage to or destruction of the Project or any larger system of which it is a part, the net proceeds of insurance shall be applied to the reconstruction, repair or replacement of the damaged or destroyed parts of the Project or its larger system. The Grantee shall begin such reconstruction, repair, or replacement as expeditiously as possible and shall pay out of such net proceeds all costs and expenses in connection with such reconstruction, repair or replacement so that the same shall be completed and the larger system shall be free of all claims and liens.

21. NONDISCRIMINATION:

    a. During the performance of this Agreement, the Grantee and its consultants and contractors shall not unlawfully discriminate, harass, or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, sexual orientation, physical disability (including HIV and AIDS), mental disability, medical condition (cancer), age (over 40), marital status, and denial of family care leave.

    b. The Grantee, its consultants, and contractors shall insure that the evaluation and treatment of their employees and applicants for employment are free from such discrimination and harassment.

    c. The Grantee, its consultants, and contractors shall comply with the provisions of the Fair Employment and Housing Act (Gov. Code, § 12990 (a-f) et seq.) and the applicable regulations promulgated thereunder (Cal. Code Regs., tit. 2, § 7285 et seq.). The applicable regulations of the Fair Employment and Housing Commission implementing Government Code section 12990 (a-f), set forth in Chapter 5 of Division 4 of Title 2 of the California Code of Regulations, are incorporated into this Agreement by reference and made a part hereof as if set forth in full.

    d. The Grantee, its consultants, and contractors shall give written notice of their obligations under this clause to labor organizations with which they have a collective bargaining or other Agreement, if any.

    e. The Grantee shall include the nondiscrimination and compliance provisions of this clause in all subcontracts to perform work under the Agreement. Failure by the Grantee to carry out these requirements and applicable requirements of 40 C.F.R. part 33 is a breach of a material provision of this Agreement which may result in its termination

22. NO THIRD PARTY RIGHTS: The parties to this Grant Agreement do not create rights in, or grant remedies to, any third party as a beneficiary of this Grant Agreement, or of any duty, covenant, obligation or undertaking established herein.

23. NOTICE:

    a. The Grantee shall notify the State Water Board prior to conducting construction, monitoring, demonstration, or other implementation activities such that State Water Board and/or Regional Water Quality Control Board (Regional Water Board) staff may observe and document such activities.

b. The Grantee shall promptly notify the State Water Board of events or proposed changes that could affect the scope, budget, or work performed under this Agreement. The Grantee agrees that no substantial change in the scope of the Project will be undertaken until written notice of the proposed change has been provided to the State Water Board, and the State Water Board has given written approval for such change.

c. The Grantee shall promptly notify the State Water Board of the discovery of any potential archeological or historical resources. Should a potential archeological or historical resource be discovered during construction of the Project, the Grantee agrees that all work in the area of the find will cease until a qualified archeologist has evaluated the situation and made recommendations regarding preservation of the resources, and the Division has determined what actions should be taken to protect and reserve the resources. The Grantee agrees to implement appropriate actions as directed by the Division.

d. The Grantee shall promptly notify the State Water Board of the discovery of any unexpected endangered or threatened species, as defined in the federal Endangered Species Act. Should a federally protected species be unexpectedly encountered during construction of the Project, the Grantee agrees to cease all work in the area until a qualified biologist has evaluated the situation and made recommendations regarding the avoidance or minimization of impact on the species and/or habitat. The Grantee agrees to implement appropriate actions as directed by the Division.

e. The Grantee shall notify the State Water Board at least ten (10) working days prior to any public or media event publicizing the accomplishments and/or results of this Agreement and provide the opportunity for attendance and participation by State Water Board representatives.

f. The Grantee shall promptly notify the State Water Board in writing of completion of work on the Project.

g. The Grantee shall promptly notify the State Water Board in writing of any cessation of all major construction work on the Project where such cessation of work is expected to or does extend for a period of thirty (30) days or more and of any circumstance, combination of circumstances, or condition, which is expected to or does delay completion of construction for a period of ninety (90) days or more beyond the estimated date of completion of construction previously provided.

24. OPERATIONS & MAINTENANCE: The Grantee shall maintain and operate the facility and structures constructed or improved as part of the Project throughout the life of the Project, consistent with the purposes for which this Grant was made. The Grantee assumes all operations and maintenance costs of the facilities and structures; the State Water Board shall not be liable for any cost of such maintenance, management or operation. The Grantee may be excused from operations and maintenance only upon the written approval of the Grant Manager. For purposes of this Agreement, "operation costs" include direct costs incurred for material and labor needed for operations, utilities, insurance, and similar expenses. "Maintenance costs" include ordinary repairs and replacements of a recurring nature necessary to prolong the life of capital assets and basic structures, and the expenditure of funds necessary to replace or reconstruct capital assets or basic structures.

25. PERMITS, CONTRACTING, AND DEBARMENT: The Grantee shall procure all permits and licenses necessary to accomplish the work contemplated in this Agreement, pay all charges and fees, and give all notices necessary and incidental to the due and lawful prosecution of the work. Any contractors, outside associates, or consultants required by the Grantee in connection with the services covered by this Agreement shall be limited to such individuals or firms as were specifically identified and agreed to during negotiations for this Agreement, if any, or as are specifically authorized by the State Water Board's Grant Manager during the performance of this Agreement. Any substitutions in, or additions to, such contractors, associates, or consultants, shall be subject to the prior written approval of the State Water Board's Grant Manager. The Grantee shall not contract with any party who is debarred or suspended or otherwise excluded from or ineligible for participation in federal assistance programs under Executive Order 12549, "Debarment and Suspension." The Grantee shall not contract with any individual or organization on USEPA's List of Violating Facilities. (40 C.F.R. Part 31.35; Gov. Code, § 4477) www.epls.gov. The Grantee certifies to the best of its knowledge and belief, that it and its principals:

a. Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded by any federal department or Grantee;

b. Have not within a three-year period preceding this Agreement been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (federal, state or local) transaction or contract under a public transaction; violation of federal or state antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

c. Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (federal, state or local) with commission of any of the offenses enumerated in paragraph (b) of this certification; and

d. Have not within a three-year period preceding this application/proposal had one or more public transactions (federal, state or local) terminated for cause or default.

26. PREVAILING WAGES AND LABOR COMPLIANCE: If applicable, the Grantee agrees to be bound by all the provisions of the Labor Code regarding prevailing wages and shall monitor all contracts subject to reimbursement from this Agreement to assure that the prevailing wage provisions of the Labor Code are being met. The Grantee certifies that it has a Labor Compliance Program (LCP) in place or has contracted with a third party that has been approved by the Director of the Department of Industrial Relations (DIR) to operate an LCP pursuant to Labor Code, § 1771.5 and section 16423 of title 8 of the California Code of Regulations. Current DIR requirements may be found at http://www.dir.ca.gov/lcp.asp.

27. PROFESSIONALS: The Grantee agrees that only licensed professionals will be used to perform services under this Agreement where such services are called for.

28. RECORDS: Without limitation of the requirement to maintain Project accounts in accordance with generally accepted accounting principles, the Grantee agrees to:

a. Establish an official file for the Project which shall adequately document all significant actions relative to the Project;

b. Establish separate accounts which will adequately and accurately depict all amounts received and expended on this Project, including all grant funds received under this Agreement;

c. Establish separate accounts which will adequately depict all income received which is attributable to the Project, especially including any income attributable to grant funds disbursed under this Agreement;

d. Establish an accounting system which will adequately depict final total costs of the Project, including both direct and indirect costs;

e. Establish such accounts and maintain such records as may be necessary for the state to fulfill federal reporting requirements, including any and all reporting requirements under federal tax statutes or regulations; and

f. If a Force Account is used by the Grantee for any phase of the Project, establish an account that documents all employee hours, and associated tasks charged to the Project per employee.

29. RELATED LITIGATION: Under no circumstances may a Grantee use funds from any disbursement under this Grant Agreement to pay costs associated with any litigation the Grantee pursues against the State Water Board or any Regional Water Board. Regardless of the outcome of any such litigation, and notwithstanding any conflicting language in this Agreement, the Grantee agrees to complete the Project funded by this Agreement or to repay all of the grant funds plus interest.

30. RIGHTS IN DATA: The Grantee agrees that all data, plans, drawings, specifications, reports, computer programs, operating manuals, audio and video recordings, notes, and other written or graphic work produced in the performance of this Agreement shall be in the public domain. The Grantee may disclose, disseminate and use in whole or in part, any final form data and information received, collected, and developed under this Agreement, subject to appropriate acknowledgement of credit to the State Water Board for financial support. The Grantee shall not utilize the materials for any profit-making venture or sell or grant rights to a third party who intends to do so.

31. STATE REVIEWS AND INDEMNIFICATION: The parties agree that review or approval of Project applications, documents, permits, plans and specifications or other Project information by the State Water Board is for administrative purposes only and does not relieve the Grantee of its responsibility to properly plan, design, construct, operate, maintain, implement, or otherwise carry out the Project. To the extent permitted by law, the Grantee agrees to indemnify, defend and hold harmless the State Water Board and the State against any loss or liability arising out of any claim or action brought against the State Water Board and/or the State from and against any and all losses, claims, damages, liabilities or expenses, of every conceivable kind, character and nature whatsoever arising out of, resulting from, or in any way connected with (1) the Project or the conditions, occupancy, use, possession, conduct or management of, work done in or about, or the planning, design, acquisition, installation or construction, of the Project or any part thereof; (2) the carrying out of any of the transactions contemplated by this Agreement or any related document; (3) any violation of any applicable law, rule or regulation, any environmental law (including, without limitation, the Federal Comprehensive Environmental Response, Compensation and Liability Act, the Resource Conservation and Recovery Act, the California Hazardous Substance Account Act, the Federal Water Pollution Control Act, the Clean Air Act, the California Hazardous Waste Control Law and California Water Code § 13304, and any successors to said laws), rule or regulation or the release of any toxic substance on or near the System; or (4) any untrue statement or alleged untrue statement of any material fact or omission or alleged omission to state a material fact necessary to make the statements required to be stated therein, in light of the circumstances under which they were made, not misleading with respect to any information provided by the Grantee for use in any disclosure document utilized in connection with any of the transactions contemplated by this Agreement. To the fullest extent permitted by law, the Grantee agrees to pay and discharge any judgment or award entered or made against the State Water Board and/or the State with respect to any such claim or action, and any settlement, compromise or other voluntary resolution. The provisions of this section shall survive the term of this Agreement.

32. SUPPLEMENTAL ENVIRONMENTAL PROJECTS: Grant Funds shall not be used for supplemental environmental projects required by Regional Water Boards.

33. STATE WATER BOARD ACTION, COSTS, AND ATTORNEY FEES: The Grantee agrees that any remedy provided in this Agreement is in addition to and not in derogation of any other legal or equitable remedy available to the State Water Board as a result of breach of this Agreement by the Grantee, whether such breach occurs before or after completion of the Project, and exercise of any remedy provided by this Agreement by the State Water Board shall not preclude the State Water Board from pursuing any legal remedy or right which would otherwise be available. In the event of litigation between the parties hereto arising from this Agreement, it is agreed that each party shall bear its own filing costs and attorney fees.

34. TERMINATION, IMMEDIATE REPAYMENT, INTEREST: This Grant Agreement may be terminated by written notice at any time prior to completion of the Project, at the option of the State Water Board, upon violation by the Grantee of any material provision after such violation has been called to the attention of the Grantee and after failure of the Grantee to bring itself into compliance with the provisions of this Agreement within a reasonable time as established by the State Water Board. In the event of such termination, the Grantee agrees, upon demand, to immediately repay to the State Water Board an amount equal to the amount of grant funds disbursed to the Grantee prior to such termination. In the event of termination, interest shall accrue on all amounts due at the highest legal rate of interest from the date that notice of termination is mailed to the Grantee to the date of full repayment by the Grantee.

35. TIMELINESS: Time is of the essence in this Agreement. The Grantee shall proceed with and complete the Project in an expeditious manner.

36. TRAVEL AND PER DIEM: Any reimbursement for necessary travel shall be at rates not to exceed those set by the Department of Personnel Administration. These rates may be found at http://www.dpa.ca.gov/personnel-policies/travel/hr-staff.htm. Reimbursement will be at the State travel and per diem amounts that are current as of the date costs are incurred by the Grantee. No travel outside the State of California shall be reimbursed unless prior written authorization is obtained from the Grant Manager.

37. UNENFORCEABLE PROVISION: In the event that any provision of this Agreement is unenforceable or held to be unenforceable, then the parties agree that all other provisions of this Agreement shall continue to have full force and effect and shall not be affected thereby.

38. USEFUL LIFE OF PROJECT: For the purpose of this Agreement, the useful life of any constructed portions of this Project begins upon completion of construction and continues until fifty (50) years thereafter for pipelines and structures and twenty (20) years for all else.

39. VENUE: The State Water Board and the Grantee hereby agree that any action arising out of this Agreement shall be filed and maintained in the Superior Court in and for the County of Sacramento, California, or in the United States District Court in and for the Eastern District of California. The Grantee hereby waives any existing sovereign immunity for the purposes of this Agreement.

40. WAIVER AND RIGHTS OF THE STATE WATER BOARD: Any waiver of rights with respect to a default or other matter arising under the Agreement at any time by either party shall not be considered a waiver of rights with respect to any other default or matter. Any rights and remedies of the State provided for in this Agreement are in addition to any other rights and remedies provided by law.

41. WATERSHED MANAGEMENT PLAN CONSISTENCY: Grantee certifies that any watershed protection activity undertaken as part of this Project will be consistent with the applicable, adopted, local watershed management plans and the applicable Water Quality Control Plan (Basin Plan) adopted by a Regional Water Board, where such plans exist.

42. WITHHOLDING OF GRANT DISBURSEMENTS: The State Water Board may withhold all or any portion of the grant funds provided for by this Agreement in the event that the Grantee has materially violated, or threatens to materially violate, any term, provision, condition, or commitment of this Agreement; or the Grantee fails to maintain reasonable progress toward completion of the Project.

EXHIBIT D – WATER RECYCLING GRANT PROGRAM TERMS AND CONDITIONS

1. If this Project affects water quality, the Grantee certifies that it shall include a monitoring component that allows the integration of data into statewide monitoring efforts, including but not limited to, the State Water Board's surface water ambient monitoring program (SWAMP).

2. The Grantee certifies that this Project shall be consistent with the CALFED Programmatic Record of Decision.

3. If this Project affects groundwater, the Grantee certifies that it shall include a monitoring component consistent with the Groundwater Quality Monitoring Act of 2001 (Wat. Code, § 10780 et seq.).

4. The Grantee certifies that activities carried out under this Agreement comply with the requirements of the California Environmental Quality Act.

5. The Grantee certifies that it is an Urban Water Supplier and the Department of Water Resources has determined that the Grantee is eligible to receive this grant.

6. The Grantee acknowledges that its eligibility for project financing is conditioned on its compliance with Water Code section 5103(e)(1), if applicable. The Grantee further certifies that it has filed, and will continue to file, its required Statements of Diversion with the State Water Board in accordance with Water Code sections 5101 and 5103.

Yucaipa Valley Water District

# Workshop Memorandum 12-044

**Date:** February 28, 2012

**Subject:** Change Order No. 3 to the Contract with Sukut Construction for the Yucaipa Regional Brineline Extension and Non-Potable Water / Outfall Pipeline Project (Phase 1 & 2)

At the regular meeting on April 7, 2010, the Board awarded a contract to Sukut Construction, Inc. for the construction of Phase 1 and 2 of the Yucaipa Valley Regional Brineline Extension and Non-Potable Water/Outfall Pipeline for a sum not to exceed $6,956,567 [DM 10-020].

Change Order No. 1 pertained to the concrete interference at the Beaumont Avenue bridge undercrossing from Station 48+00 to Station 54+00 [DM 10-089].

Change Order No. 2 was for additions and deletions of various items of work necessary to complete the project [DM 11-085].

Change Order No. 3 is a necessary requirement of the funding agencies that the most current Davis Bacon Requirements and Wage Determination at time of bid be included directly in the Contract for this project. This change order is administrative and will not result in additional project costs.

| | Contract Changes | Contract Amount | Percentage Change from Original Bid Amount | Reference |
|---|---|---|---|---|
| Original Bid Amount | | $6,956,567.00 | - - | DM 10-020 |
| Change Order No. 1 | $40,300.42 | $6,996,867.42 | 0.6% increase | DM 10-089 |
| Change Order No. 2 | $188,937.00 | $7,185,804.42 | 3.3% increase | DM 11-085 |
| Change Order No. 3 | -0- | $7,185,804.42 | 3.3% increase | DM 12-0xx |

Financial Considerations:

The costs associated with this project will be funded by US Environmental Protection Agency grant, a Proposition 50 grant, an American Recovery and Reinvestment Act grant and a State Revolving Fund loan.

C.O. NO. 3
PAGE 1 OF 2

# CONTRACT CHANGE ORDER NO. 3

CONTRACT Yucaipa Valley Regional Brineline Extension (Phases 1 & 2) and Non-Potable Water/Outfall Pipeline (Project No. P-65-106) DATED April 7, 2010
BY AND BETWEEN Yucaipa Valley Water District (OWNER),
AND Sukut Construction, Inc. (CONTRACTOR),
is hereby directed to make the following change(s) in Contract Work:

| ITEM NO. | DESCRIPTION OF CHANGE | DECREASE $ | INCREASE $ |
|---|---|---|---|
| 1 | Add Exhibit G - Davis Bacon Requirements to Contract (Copy Attached) | $0.00 | $0.00 |
| 2 | Add Davis Bacon Wage Determination CA080037 MOD 37 to Contract (Copy Attached) | $0.00 | $0.00 |

| | |
|---|---|
| Total DECREASE in Contract Amount | ($0.00) |
| Total INCREASE in Contract Amount | $0.00 |
| Net change in Contract Amount | $0.00 |
| Contract Amount Prior to Change | $7,185,804.42 |
| Contract Amount Adjusted for Change | $7,185,804.42 |

CONTRACT CHANGE ORDER NO. 3 PAGE 2 OF 2

By reason of Change Order No. 3, time of completion shall be adjusted as follows: 0 Days.

All provisions of the Contract shall apply hereto, and shall become effective when fully executed (signed and dated) by both parties.

Recommended by (Engineer) Patrick M. Watson Date: 2-10-12

Accepted by (Contractor) [signature] Date: 2/17/12

Approved by (Owner) ______________________ Date: ____________

Remarks ______________________

Yucaipa Valley Water District

# Workshop Memorandum 12-045

**Date:** **February 28, 2012**

**Subject:** **Change Order No. 1 to the Contract with W.A. Rasic Construction for the Yucaipa Regional Brineline Extension Pipeline Project (Phase 3)**

At the regular meeting on August 17, 2011, the Board awarded a contract to W.A. Rasic Construction Company for the construction of Phase 3 of the Yucaipa Valley Regional Brineline Extension for a sum not to exceed $9,350,000 [DM 11-080].

Change Order No. 1 is a necessary requirement of the funding agencies that the most current Davis Bacon Requirements and Wage Determination at time of bid be included directly in the Contract for this project. This change order is administrative and will not result in additional project costs.

| | Contract Changes | Contract Amount | Percentage Change from Original Bid Amount | Reference |
|---|---|---|---|---|
| Original Bid Amount | | $9,350,000.00 | - - | DM 11-080 |
| Change Order No. 1 | -0- | $9,350,000.00 | 0.0% Change | DM 12-0xx |

Financial Considerations:

The costs associated with this project will be funded by a Proposition 50 Integrated Resource Grant, an American Recovery and Reinvestment Act grant and a State Revolving Fund loan.

C.O. NO. 1
PAGE 1 OF 2

# CONTRACT CHANGE ORDER NO. 1

CONTRACT Yucaipa Valley Regional Brineline Extension (Phase 3) DATED August 17, 2011
BY AND BETWEEN Yucaipa Valley Water District (OWNER),
AND W.A. Rasic Construction Co., Inc. (CONTRACTOR),
is hereby directed to make the following change(s) in Contract Work:

| ITEM NO. | DESCRIPTION OF CHANGE | DECREASE $ | INCREASE $ |
|---|---|---|---|
| 1 | Add Exhibit G - Davis Bacon Requirements to Contract (Copy Attached) | $0.00 | $0.00 |
| 2 | Add Davis Bacon Wage Determination CA100037 MOD 26 to Contract (Copy Attached) | $0.00 | $0.00 |

| | |
|---|---|
| Total DECREASE in Contract Amount | ($0.00) |
| Total INCREASE in Contract Amount | ($0.00) |
| Net change in Contract Amount | ($0.00) |
| Contract Amount Prior to Change | $9,350,000.00 |
| Contract Amount Adjusted for Change | $9,350,000.00 |

CONTRACT CHANGE ORDER NO. 1 PAGE 2 OF 2

By reason of Change Order No. 1, time of completion shall be adjusted as follows: 0 Working Days.

Adjusted Contract Completion Date shall be: August 31, 2012.

All provisions of the Contract shall apply hereto, and shall become effective when fully executed (signed and dated) by both parties.

Recommended by (Engineer) Patrick M. Watson Date: 2-14-12.

Accepted by (Contractor) ______________________ Date: ____________

Approved by (Owner) ______________________ Date: ____________

Remarks ______________________

Yucaipa Valley Water District

# Workshop Memorandum 12-046

**Date:** February 28, 2012

**Subject:** Change Order No. 1 to the Contract with Canyon Springs Enterprises dba RSH for the R-10.3 Recycled Water Storage and Booster Complex

At the regular meeting on January 4, 2012, the Board awarded a contract to Canyon Springs Enterprises dba RSH for the construction of the R-10.3 Recycled Water Storage and Booster Complex located at the entrance to Crow Canyon for a sum not to exceed $4,177,087 [DM 12-002].

Change Order No. 1 is a necessary requirement of the funding agencies that the most current Davis Bacon Requirements and Wage Determination at time of bid be included directly in the Contract for this project.

| | Contract Changes | Contract Amount | Percentage Change from Original Bid Amount | Reference |
|---|---|---|---|---|
| Original Bid Amount | | $4,177,087.00 | - - | DM 12-002 |
| Change Order No. 1 | -0- | $4,177,087.00 | 0.0% Change | DM 12-0xx |

<u>Financial Considerations:</u>

The costs associated with this project will be funded by the US EPA, Bureau of Reclamation and an SRF loan.

C.O. NO. 1

PAGE 1 OF 2

CONTRACT CHANGE ORDER NO. 1

CONTRACT Non-Potable Reservoirs NR-10.3.1 and NR-10.3.2 and Booster Station NR-10.3 DATED January 4, 2012
BY AND BETWEEN Yucaipa Valley Water District (OWNER),
AND Canyon Springs Enterprises dba RSH Construction (CONTRACTOR),
is hereby directed to make the following change(s) in Contract Work:

| ITEM NO. | DESCRIPTION OF CHANGE | DECREASE $ | INCREASE $ |
|---|---|---|---|
| 1 | Add Exhibit G, Davis Bacon Requirements to Contract (copy attached). | 0.00 | 0.00 |
| 1 | Add Davis Bacon Wage Determination CA100036 MOD 35 to Contract (copy attached) | 0.00 | 0.00 |

| | |
|---|---|
| Total DECREASE in Contract Amount | $0.00 |
| Total INCREASE in Contract Amount | $0.00 |
| Net change in Contract Amount | $0.00 |
| Contract Amount Prior to Change | $4,177,087.00 |
| Contract Amount Adjusted for Change | $4,177,087.00 |

Non-Potable Reservoirs NR-10.3.1 and NR-10.3.2
and Booster Station NR-10.3
11/11/2011

Change Order Form L-1

CONTRACT CHANGE ORDER NO. 1 PAGE 2 OF 2

By reason of Change Order No. 1, time of completion shall be adjusted as follows:

0 Working Days. Adjusted Contract Completion Date shall be November 10, 2012.

All provisions of the Contract shall apply hereto, and shall become effective when fully executed (signed and dated) by both parties.

Recommended by (Engineer) [signature] Date: 2-21-12

Accepted by (Contractor) ______________________ Date: __________

Approved by (Owner) ______________________ Date: __________

Remarks ______________________

Non-Potable Reservoirs NR-10.3.1 and NR-10.3.2
and Booster Station NR-10.3
11/11/2011

Change Order Form L-2

Yucaipa Valley Water District

# Workshop Memorandum 12-047

**Date:** **February 28, 2012**

**Subject:** **Notice of Completion for the Contract with Sukut Construction for the Yucaipa Regional Brineline Extension and Non-Potable Water / Outfall Pipeline Project (Phase 1 & 2)**

At the regular meeting on April 7, 2010, the Board awarded a contract to Sukut Construction, Inc. for the construction of Phase 1 and 2 of the Yucaipa Valley Regional Brineline Extension and Non-Potable Water/Outfall Pipeline for a sum not to exceed $6,956,567 [DM 10-020].

Change Order No. 1 pertained to the concrete interference at the Beaumont Avenue bridge undercrossing from Station 48+00 to Station 54+00 [DM 10-089].

Change Order No. 2 was for additions and deletions of various items of work necessary to complete the project [DM 11-085].

Change Order No. 3 was administrative and reaffirmed the most current Davis Bacon Requirements and Wage Determination at time of bid be included directly in the Contract for this project. This change order is administrative and will not result in additional project costs.

| | Contract Changes | Contract Amount | Percentage Change from Original Bid Amount | Reference |
|---|---|---|---|---|
| Original Bid Amount | | $6,956,567.00 | - - | DM 10-020 |
| Change Order No. 1 | $40,300.42 | $6,996,867.42 | 0.6% increase | DM 10-089 |
| Change Order No. 2 | $188,937.00 | $7,185,804.42 | 3.3% increase | DM 11-085 |
| Change Order No. 3 | -0- | $7,185,804.42 | 3.3% increase | DM 12-0xx |

The project is now complete and District staff recommends that the Board authorizes the filing of the Notice of Completion and release of the retention amount of $718,580.40 thirty-five days after the recorded date.

Financial Considerations:

The costs associated with this project will be funded by US Environmental Protection Agency grant, a Proposition 50 grant, an American Recovery and Reinvestment Act grant and a State Revolving Fund loan.

KRIEGER & STEWART
INCORPORATED • ENGINEERING CONSULTANTS
3602 University Ave • Riverside, CA 92501 • Tel 951-684-6900 • Fax 951-684-6986

February 1, 2012 818-63.6.1 F/C

Brent Anton
Yucaipa Valley Water District
P.O. Box 730
Yucaipa, CA 92399

Subject: Yucaipa Valley Regional Brineline Extension (Phases 1 & 2) and Non-Potable Water / Outfall Pipeline Recommendation of Acceptance of Contract Work

Dear Mr. Anton:

All work required to be performed by Sukut Construction, Inc. for the Yucaipa Valley Regional Brineline Extension (Phases 1 & 2) and Non-Potable Water/Outfall Pipeline Project is essentially complete and the final Contract Amount for same is set forth as follows:

| | |
|---|---|
| Original Contract Amount: | $6,956,567.00 |
| Contract Change Order No. 1 | $40,300.42 |
| Contract Change Order No. 2 | $188,937.00 |
| Final Contract Amount: | $7,185,804.42 |

Since the Contract Work has been essentially completed in accordance with the Contract Documents, we recommend the District accept said Work. Subsequent to Board acceptance, a Notice of Completion should be filed and thereafter, following the lien period, the District should make final payment (i.e. release retained amount; attached is Sukut's request for retention payment), provided no Stop Notices have been filed and four minor punchlist items are completed (obtain final property releases, file SWPPP Notice of Termination, install manhole cover, and resolve P&F wage claim). If these punchlist items are not completed by the end of the retention period, the District should withhold approximately $10,000 from the retained amount for completion of these items and release the balance ($708,580.40).

If you have any questions, please call.

Sincerely,

KRIEGER & STEWART

Patrick M. Watson

PMW/blt
818-63-RECACCEPT

Attachment: Retention Payment Request

Record Without Fee
Per Govt. Code 6103

Recording Requested By:
Yucaipa Valley Water District

And When Recorded Mail To:
Yucaipa Valley Water District
P.O. Box 730
Yucaipa, CA 92399

SPACE ABOVE THIS LINE FOR RECORDERS USE

# NOTICE OF COMPLETION

Project Number: N/A CMMS Number: P-03-213
Director Memorandum Number for Authorization: DM 10-020
Director Memorandum Number for Notice of Completion: DM 12-0xx

Notice pursuant to Civil Code Section 3093, must be filed within 10 days after completion.
Notice is hereby given that:

1. The undersigned is owner or corporate officer of the owner of the interest in the property hereinafter described:
2. The full name of the owner is Yucaipa Valley Water District
3. The full address of the owner is 12770 Second Street, Yucaipa, CA 92399
4. All work performed hereinafter described was completed on February 1, 2012. The work done was: Construction of the Yucaipa Regional Brineline Extension (Phase 1 & 2) & Non-Potable Water/Outfall Pipeline
5. The name of the contractor for such work was: Sukut Construction, Inc.
   April 7, 2010
   (Date of Contract)
6. The property on which said work was complete in the Cities of Yucaipa and Redlands County of San Bernardino, State of CA, and is described as APN: N/A
7. The street address of said property is None
   (if no street address has been assigned, insert "none")

Dated February 23, 2012

Brent Anton, Engineering Manager

## Verification

I, the undersigned, say: I am the General Manager of the Declarant of the foregoing Notice of Completion; I have read said Notice of Completion and know the comments thereof; the same is true to my knowledge. I declare under penalty of perjury that the foregoing is true and correct.

Executed on March 7, 2012 at Yucaipa, CA.

Joseph B. Zoba, General Manager

Record Without Fee
Per Govt. Code 6103

Recording Requested By:
Yucaipa Valley Water District

And When Recorded Mail To:
Yucaipa Valley Water District
P.O. Box 730
Yucaipa, CA 92399

SPACE ABOVE THIS LINE FOR RECORDERS USE

# NOTICE OF COMPLETION

Project Number: N/A CMMS Number: P-03-213
Director Memorandum Number for Authorization: DM 10-020
Director Memorandum Number for Notice of Completion: DM 12-0xx

Notice pursuant to Civil Code Section 3093, must be filed within 10 days after completion.
Notice is hereby given that:

1. The undersigned is owner or corporate officer of the owner of the interest in the property hereinafter described:
2. The full name of the owner is Yucaipa Valley Water District
3. The full address of the owner is 12770 Second Street, Yucaipa, CA 92399
4. All work performed hereinafter described was completed on February 1, 2012. The work done was: Construction of the Yucaipa Regional Brineline Extension (Phase 1 & 2) & Non-Potable Water/Outfall Pipeline
5. The name of the contractor for such work was: Sukut Construction, Inc.
   April 7, 2010
   (Date of Contract)
6. The property on which said work was complete in the Cities of N/A
   County of Riverside, State of CA, and is described as APN: N/A
7. The street address of said property is None
   (if no street address has been assigned, insert "none")

Dated February 23, 2012

Brent Anton, Engineering Manager

## Verification

I, the undersigned, say: I am the General Manager of the Declarant of the foregoing Notice of Completion; I have read said Notice of Completion and know the comments thereof; the same is true to my knowledge. I declare under penalty of perjury that the foregoing is true and correct.

Executed on March 7, 2012 at Yucaipa, CA.

Joseph B. Zoba, General Manager

Yucaipa Valley Water District
P.O. Box 730
Yucaipa, CA 92399
(909) 797-5118

PARTIAL PAYMENT ESTIMATE # 17 A/B - Brineline

Name of Contractor:

Sukut Construction, Inc.

Name of Owner:

Yucaipa Valley Water District

| Date of Completion: | | Amount of Contract: | | Dates of Estimate: | |
|---|---|---|---|---|---|
| Original: | 04/18/11 | Original: | $ 6,956,567.00 | From: | 08/25/11 |
| Revised: | | Revised: | $ ~~7,623,867.84~~ $ 7,185,304.42 | To: | 12/25/11 |

Description of Job:

**Yucaipa Valley Regional Brineline Extension (Phases 1 & 2)**

| | Contract Items | | | | This Period | | Total to Date | |
|---|---|---|---|---|---|---|---|---|
| Item # | Description | Quantity | Unit Price | Total | Quantity | Amount | Quantity | Amount |
| 1.A.1 | General Requirements | 1 | $ 46,000.00 | $ 46,000.00 | 0.00 | $ - | 1.00 | $ 46,000.00 |
| 1.A.2 | Mobilization / Demobilization | 1 | $ 70,000.00 | $ 70,000.00 | 0.00 | $ - | 1.00 | $ 70,000.00 |
| 1.A.3 | Excavation Safety Measures | 1 | $ 79,000.00 | $ 79,000.00 | 0.00 | $ - | 1.00 | $ 79,000.00 |
| 1.A.4 | 12" HDPE | 21000 | $ 40.80 | $ 856,800.00 | 0.00 | $ - | 21000.00 | $ 856,800.00 |
| 1.A.5 | 16" HDPE | 1850 | $ 49.00 | $ 90,650.00 | 0.00 | $ - | 1850.00 | $ 90,650.00 |
| 1.A.6 | 16" DIP at Live Oak Creek Bridge | 1 | $ 96,000.00 | $ 96,000.00 | 0.00 | $ - | 1.00 | $ 96,000.00 |
| 1.A.7 | 16" DIP at San Timoteo Creek Bridge | 1 | $ 70,000.00 | $ 70,000.00 | 0.00 | $ - | 1.00 | $ 70,000.00 |
| 1.A.8 | Jack & Bore 30" Casing with 16" HDPE | 1 | $ 146,000.00 | $ 146,000.00 | 0.00 | $ - | 1.00 | $ 146,000.00 |
| 1.A.9 | Brineline Maintenance Hole | 15 | $ 14,000.00 | $ 210,000.00 | 0.00 | $ - | 14.37 | $ 201,150.00 |
| 1.A.10 | Brineline Air Ventilation Valves | 15 | $ 10,000.00 | $ 150,000.00 | 0.00 | $ - | 13.65 | $ 136,508.75 |
| 1.A.11 | Brineline Drains | 12 | $ 8,500.00 | $ 102,000.00 | 0.00 | $ - | 10.07 | $ 85,575.00 |
| 1.A.12 | Brineline Transition Manholes | 1 | $ 44,000.00 | $ 44,000.00 | 0.00 | $ - | 1.00 | $ 44,000.00 |
| 1.A.13 | Remove Existing AC Paving & Base | 19500 | $ 1.50 | $ 29,250.00 | 0.00 | $ - | 19500.00 | $ 29,250.00 |
| 1.A.14 | T-Trench AC & CAB over Mainline and | 6000 | $ 18.00 | $ 108,000.00 | 0.00 | $ - | 6000.00 | $ 108,000.00 |
| 1.A.15 | 0.25' of AC & CAB over Mainline and Br | 13500 | $ 14.00 | $ 189,000.00 | 0.00 | $ - | 13500.00 | $ 189,000.00 |
| 1.A.16 | Owner Directed: Geotextile Fabric | 1000 | $ 12.30 | $ 12,300.00 | 0.00 | $ - | 0.00 | $ - |
| 1.A.17 | Owner Directed: Mobilization / Demobili: | 3 | $ 5,425.00 | $ 16,275.00 | 0.00 | $ - | 0.00 | $ - |
| 1.A.18 | Owner Directed: Pipeline Depth at 1.1' to | 2000 | $ 2.50 | $ 5,000.00 | 0.00 | $ - | 0.00 | $ - |
| 1.A.19 | Owner Directed: Pipeline Depth at 2.1' to | 500 | $ 4.00 | $ 2,000.00 | 0.00 | $ - | 0.00 | $ - |
| 1.A.20 | 0.10' AC Grind & Overlay | 220000 | $ 0.80 | $ 176,000.00 | 0.00 | $ - | 205000.00 | $ 164,000.00 |
| 1.A.21 | Traffic Control | 1 | $ 65,000.00 | $ 65,000.00 | 0.00 | $ - | 1.00 | $ 65,000.00 |
| 1.A.22 | Cutoff Walls | 11 | $ 1,090.00 | $ 11,990.00 | 0.00 | $ - | 10.00 | $ 10,900.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1.A.23 | Owner Directed: Over-Excavation | 1000 | $ 10.50 | $ 10,500.00 | 0.00 | $ - | 80.00 | $ 840.00 |
| 1.B.1 | General Requirements | 1 | $ 50,000.00 | $ 50,000.00 | 0.00 | $ - | 1.00 | $ 50,000.00 |
| 1.B.2 | Mobilization / Demobilization | 1 | $ 75,000.00 | $ 75,000.00 | 0.00 | $ - | 1.00 | $ 75,000.00 |
| 1.B.3 | Excavation Safety Measures | 1 | $ 39,000.00 | $ 39,000.00 | 0.00 | $ - | 1.00 | $ 39,000.00 |
| 1.B.4 | 16" HDPE | 23800 | $ 55.30 | $ 1,316,140.00 | 0.00 | $ - | 23800.00 | $ 1,316,140.00 |
| 1.B.5 | Jack & Bore 30" Casing with 20" HDPE ( | 1 | $ 172,000.00 | $ 172,000.00 | 0.00 | $ - | 1.00 | $ 172,000.00 |
| 1.B.6 | Brineline Maintenance Hole | 14 | $ 14,500.00 | $ 203,000.00 | 0.00 | $ - | 14.00 | $ 203,000.00 |
| 1.B.7 | Brineline Air Ventilation Valves | 8 | $ 10,500.00 | $ 84,000.00 | 0.00 | $ - | 8.00 | $ 84,000.00 |
| 1.B.8 | Brineline Drains | 3 | $ 8,800.00 | $ 26,400.00 | 0.00 | $ - | 2.38 | $ 20,925.00 |
| 1.B.9 | Remove Existing AC Paving & Base | 14500 | $ 1.35 | $ 19,575.00 | 0.00 | $ - | 14500.00 | $ 19,575.00 |
| 1.B.10 | 0.25' of AC & CAB over Mainline and Br | 14500 | $ 17.25 | $ 250,125.00 | 0.00 | $ - | 14500.00 | $ 250,125.00 |
| 1.B.11 | Owner Directed: Geotextile Fabric | 1000 | $ 13.00 | $ 13,000.00 | 0.00 | $ - | 0.00 | $ - |
| 1.B.12 | Brineline Transition Manholes | 1 | $ 159,000.00 | $ 159,000.00 | 0.00 | $ - | 1.00 | $ 159,000.00 |
| 1.B.13 | Owner Directed: Mobilization / Demobiliz | 3 | $ 5,500.00 | $ 16,500.00 | 0.00 | $ - | 0.00 | $ - |
| 1.B.14 | Owner Directed: Pipeline Depth at 1.1' to | 2000 | $ 2.50 | $ 5,000.00 | 0.00 | $ - | 0.00 | $ - |
| 1.B.15 | Owner Directed: Pipeline Depth at 2.1' to | 500 | $ 4.00 | $ 2,000.00 | 0.00 | $ - | 0.00 | $ - |
| 1.B.16 | 0.10' AC Grind & Overlay | 280000 | $ 0.80 | $ 224,000.00 | 0.00 | $ - | 210000.00 | $ 168,000.00 |
| 1.B.17 | Cutoff Walls | 13 | $ 1,130.00 | $ 14,690.00 | 0.00 | $ - | 11.00 | $ 12,430.00 |
| 1.B.18 | Concrete Encasement | 600 | $ 96.00 | $ 57,600.00 | 0.00 | $ - | 600.00 | $ 57,600.00 |
| 1.B.19 | Traffic Control | 1 | $ 5,000.00 | $ 5,000.00 | 0.00 | $ - | 1.00 | $ 5,000.00 |
| 1.B.20 | Owner Directed: Over-Excavation | 1000 | $ 4.50 | $ 4,500.00 | 0.00 | $ - | 0.00 | $ - |
| 1.P.1 | Permits - Brineline | 1 | $ 400,000.00 | $ 400,000.00 | 0.00 | $ - | 0.64 | $ 256,350.20 |
| CO1 | Beaumont Bridge & SBCFCD Area | 1 | $ 40,300.42 | $ 40,300.42 | 0.00 | $ - | 1.00 | $ 40,300.42 |
| CO2 | Closing Change Order - Brineline | 1 | $ 476,350.25 | $ 476,350.25 | 0.00 | $ - | 1.00 | $ 476,350.25 |
| | | | | | | | | |
| | | | | | | | | |

| Amount | This Period | Total To Date |
|---|---|---|
| Amount Earned | $ - | $ 5,893,469.62 |
| Amount Retained | $ 589,346.96 | $ 589,346.96 |
| Previous Payments | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | |
| Amount Due | $ 589,346.96 | |

Estimated Percentage of Job Completed ~~94.25%~~ 100 %

Is Contractor's Construction Progress on Schedule? ____________ [ ] Yes [ ] No

I hereby certify that I have carefully inspected the work and as a result of my inspection and to the best of my knowledge and belief, the quantities shown in this estimate are correct and have not been shown in previous estimates and the work has been perfomed in accordance with the contract documents.

Yucaipa Valley Regional Brineline Extention (Phases 1 2)
and Non-Potable Water / Outfall Pipeline
Project No. P-65-106

Partial Payment Form
5744-4
K-2

Date: 12-25-11

Sukut Construction, Inc.
Name of Contractor

By: [signature]

HR Manager
Title

YUCAIPA VALLEY WATER DISTRICT

By: [signature]
Engineer

By: [signature]
Inspector
YVWD

Yucaipa Valley Regional Brineline Extention (Phases 1 2)
and Non-Potable Water / Outfall Pipeline
Project No. P-65-106

Partial Payment Form
5744-4
K-2

Yucaipa Valley Water District
P.O. Box 730
Yucaipa, CA 92399
(909) 797-5118

PARTIAL PAYMENT ESTIMATE # 17 C - Outfall

Name of Contractor:

Sukut Construction, Inc.

Name of Owner:

Yucaipa Valley Water District

| Date of Completion: | | Amount of Contract: | | | Dates of Estimate: | |
|---|---|---|---|---|---|---|
| Original: | 04/18/11 | Original: | $ | 6,956,567.00 | From: | 08/25/11 |
| Revised: | | Revised: | $ | 7,623,867.84 | To: | 12/25/11 |

Description of Job:

**Non-Potable Water / Outfall Pipeline**

| | Contract Items | | | | This Period | | Total to Date | |
|---|---|---|---|---|---|---|---|---|
| Item # | Description | Quantity | Unit Price | Total | Quantity | Amount | Quantity | Amount |
| 1.C.1 | General Requirements | 1 | $ 15,000.00 | $ 15,000.00 | 0.00 | $ - | 1.00 | $ 15,000.00 |
| 1.C.2 | Mobilization / Demobilization | 1 | $ 15,000.00 | $ 15,000.00 | 0.00 | $ - | 1.00 | $ 15,000.00 |
| 1.C.3 | Excavation Safety Measures | 1 | $ 14,500.00 | $ 14,500.00 | 0.00 | $ - | 1.00 | $ 14,500.00 |
| 1.C.4 | 12" HDPE | 12700 | $ 42.50 | $ 539,750.00 | 0.00 | $ - | 12700.00 | $ 539,750.00 |
| 1.C.5 | 12" DIP at Live Oak Creek Bridge | 1 | $ 57,000.00 | $ 57,000.00 | 0.00 | $ - | 1.00 | $ 57,000.00 |
| 1.C.6 | 4" NPW Blow-Off | 6 | $ 4,500.00 | $ 27,000.00 | 0.00 | $ - | 5.22 | $ 23,500.00 |
| 1.C.7 | 2" Combination Air & Vacuum Valve | 7 | $ 3,700.00 | $ 25,900.00 | 0.00 | $ - | 6.50 | $ 24,040.00 |
| 1.C.8 | 12" Valve & Flow Meter Vaults | 1 | $ 133,000.00 | $ 133,000.00 | 0.00 | $ - | 1.00 | $ 133,000.00 |
| 1.C.9 | Outfall Facility | 1 | $ 25,000.00 | $ 25,000.00 | 0.00 | $ - | 1.00 | $ 25,000.00 |
| 1.C.10 | Remove Existing AC Paving & Base (1.A | 12700 | $ 0.36 | $ 4,572.00 | 0.00 | $ - | 12700.00 | $ 4,572.00 |
| 1.C.11 | T-Trench AC & CAB over Mainline and | 4400 | $ 20.00 | $ 88,000.00 | 0.00 | $ - | 4400.00 | $ 88,000.00 |
| 1.C.12 | 0.25' of AC & CAB over Mainline and Br | 8300 | $ 16.00 | $ 132,800.00 | 0.00 | $ - | 8300.00 | $ 132,800.00 |
| 1.C.13 | Owner Directed: Geotextile Fabric | 1000 | $ 12.30 | $ 12,300.00 | 0.00 | $ - | 0.00 | $ - |
| 1.C.14 | Disinfect NPW Pipeline | 1 | $ 7,000.00 | $ 7,000.00 | 0.00 | $ - | 0.00 | $ - |
| 1.C.15 | Owner Directed: Mobilization / Demobili: | 3 | $ 5,000.00 | $ 15,000.00 | 0.00 | $ - | 0.00 | $ - |
| 1.C.16 | Owner Directed: Pipeline Depth at 1.1' to | 1500 | $ 2.50 | $ 3,750.00 | 0.00 | $ - | 0.00 | $ - |
| 1.C.17 | Owner Directed: Pipeline Depth at 2.1' to | 500 | $ 4.00 | $ 2,000.00 | 0.00 | $ - | 0.00 | $ - |
| 1.C.18 | Cutoff Walls (1.A.22) | 6 | $ 1,200.00 | $ 7,200.00 | 0.00 | $ - | 5.00 | $ 6,000.00 |
| 1.C.19 | Owner Directed: Over-Excavation (1.A.2 | 1000 | $ 4.50 | $ 4,500.00 | 0.00 | $ - | 0.00 | $ - |
| 1.C.20 | Traffic Control (1.A.21) | 1 | $ 5,000.00 | $ 5,000.00 | 0.00 | $ - | 1.00 | $ 5,000.00 |
| 1.P.1 | Permits - Outfall | 1 | $ 100,000.00 | $ 100,000.00 | 0.00 | $ - | 0.59 | $ 58,522.63 |
| CO2 | Closing Change Order - Outfall | 1 | $ 150,650.17 | $ 150,650.17 | 0.00 | $ - | 1.00 | $ 150,650.17 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

| Amount | This Period | Total To Date |
|---|---|---|
| Amount Earned | $ - | $ 1,292,334.80 |
| Amount Retained | $ 129,233.48 | $ 129,233.48 |
| Previous Payments | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx | |
| Amount Due | $ 129,233.48 | |

Estimated Percentage of Job Completed ~~94.25%~~ 100 %

Is Contractor's Construction Progress on Schedule? ____________ [ ] Yes [ ] No

I hereby certify that I have carefully inspected the work and as a result of my inspection and to the best of my knowledge and belief, the quantities shown in this estimate are correct and have not been shown in previous estimates and the work has been perfomed in accordance with the contract documents.

Date: 12-25-11

Sukut Construction Inc.
Name of Contractor

By: [signature]

AR Manager
Title

YUCAIPA VALLEY WATER DISTRICT

By: [signature]
Engineer

By: [signature]
~~Inspector~~ YVWD

Yucaipa Valley Regional Brineline Extention (Phases 1 2)
and Non-Potable Water / Outfall Pipeline
Project No. P-65-106

Partial Payment Form
5744-4
K-2

# Workshop Memorandum 12-048

**Date:** **February 28, 2012**

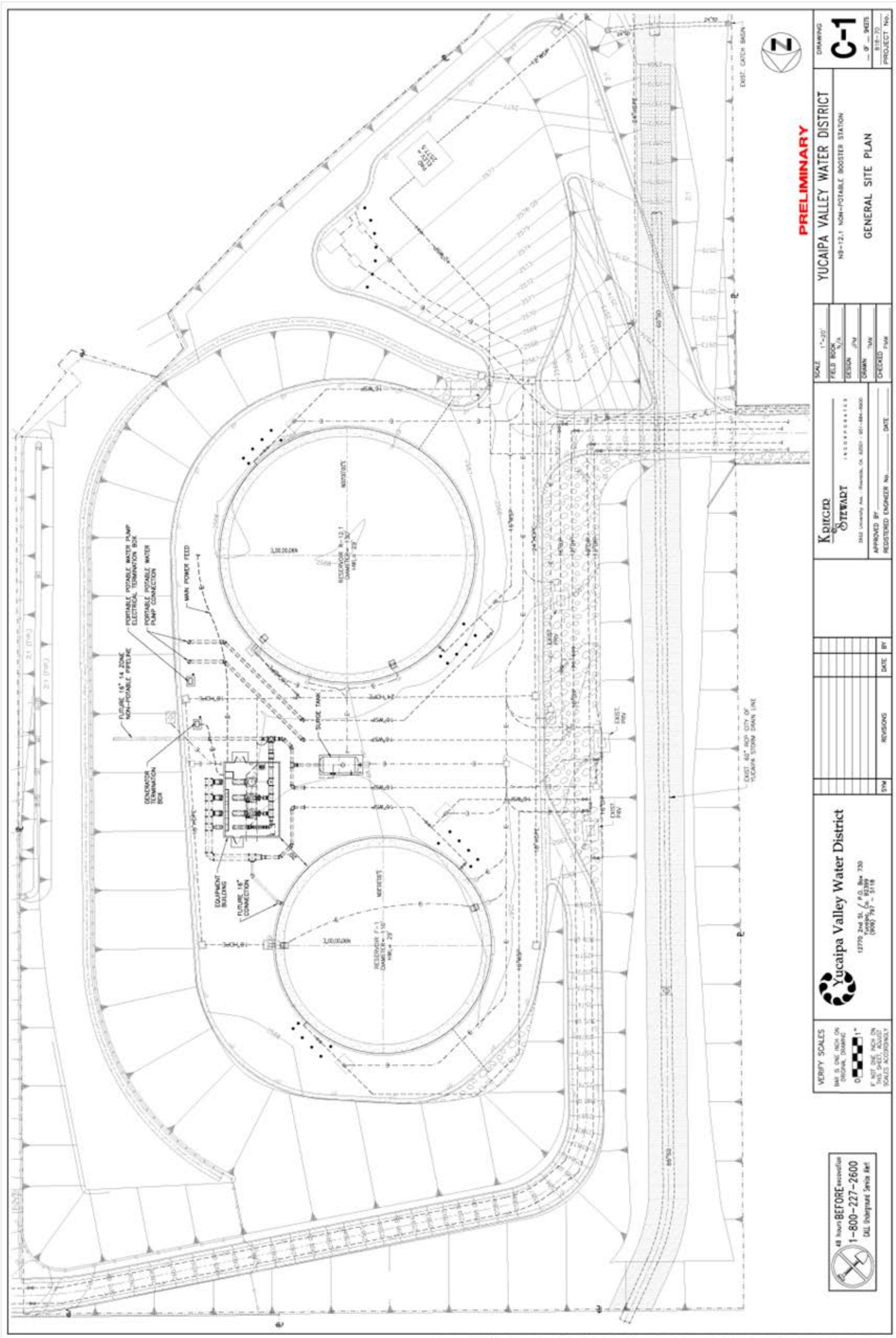
**Subject:** **Authorization to Solicit Bids for the Construction of the 12.1 Recycled Water Booster Station**

The Yucaipa Valley Water District has essentially completed the design and bid package for the recycled water booster facility to be located at the R-12.1 Reservoir complex.

The District staff and our consultant have completed final design drawings and bid specifications. Upon receiving authorization to solicit bids, the District staff will finalize the bid documents, solicit bids and provide the bid results back to the Board for consideration at a future board meeting.

Financial Considerations:

The costs associated with this project will be funded by a combination of State Revolving Funds, Proposition 50 Integrated Regional Water Management Implementation Grant and EPA Water Infrastructure Grant.


PRELIMINARY
YUCAIPA VALLEY WATER DISTRICT
NB-12.1 NON-POTABLE BOOSTER STATION
GENERAL SITE PLAN
C-1
Yucaipa Valley Water District
1-800-227-2600

Yucaipa Valley Water District

# Workshop Memorandum 12-049

**Date:** February 28, 2012

**Subject:** Authorization to Petition for the Vacation of Crow Street, Calimesa

The Yucaipa Valley Water District is in the process of constructing the R-10.3 Recycled Water Reservoir and Booster complex. The project is located in an undeveloped tract that needs to be adjusted to reflect all of the parcels owned by the District.

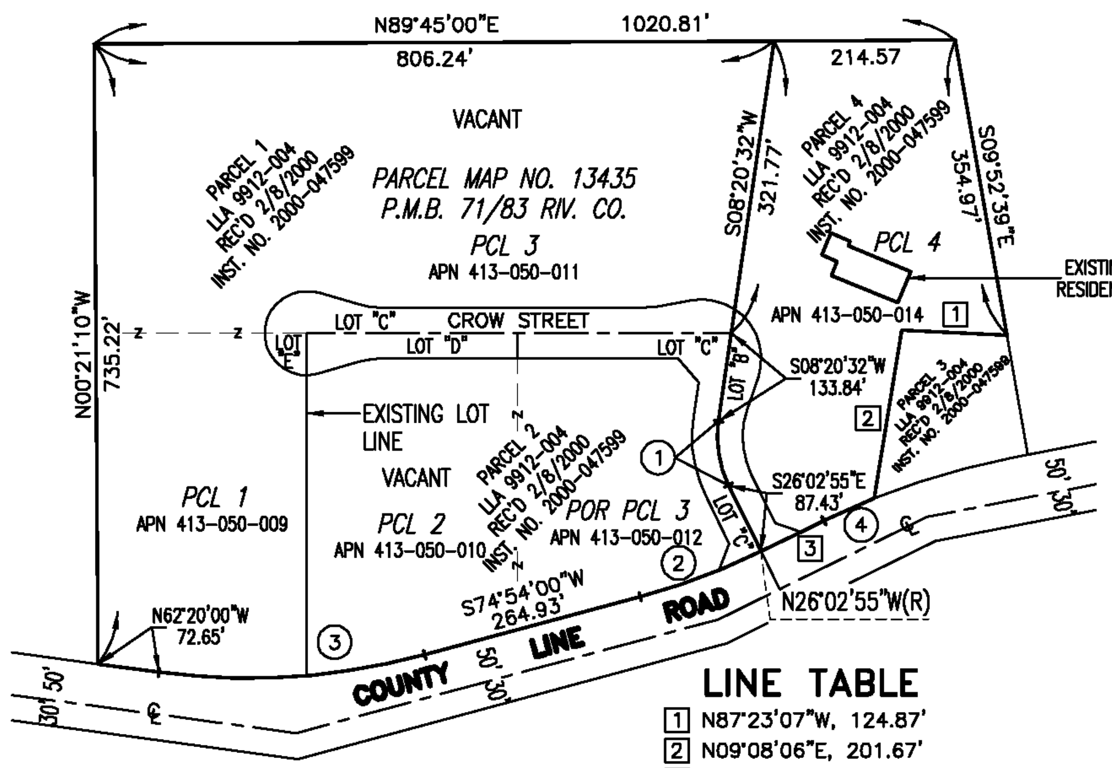
The District staff requests authorization to work with the City of Calimesa staff to vacate Crow Street in this undeveloped property.

# EXHIBIT "B"

## CURVE DATA

| | R | Δ | L | T |
|---|---|---|---|---|
| 1 | R=130.00' | Δ=34°23'27" | L=78.03' | T=40.23' |
| 2 | R=800.00' | Δ=10°56'55" | L=152.87' | T=76.67' |
| 3 | R=800.00' | Δ=22°46'00" | L=317.88' | T=161.07' |
| 4 | R=900.00' | Δ=04°11'38" | L=65.88' | T=32.95' |

SCALE: 1"=200'




## LINE TABLE

| | |
|---|---|
| 1 | N87°23'07"W, 124.87' |
| 2 | N09°08'06"E, 201.67' |
| 3 | N63°57'05"E, 82.80' |

PROFESSIONAL LAND SURVEYOR
FREDERICK A. ELLIOTT
Exp. 9-30-13
4741
STATE OF CALIFORNIA

**This Plat is Solely an Aid in Locating the Parcel(s) Described in the Attached Document.**

PREPARED BY:
KRIEGER & STEWART INCORPORATED
3602 University Ave. • Riverside, CA. 92501 • 951-684-6900

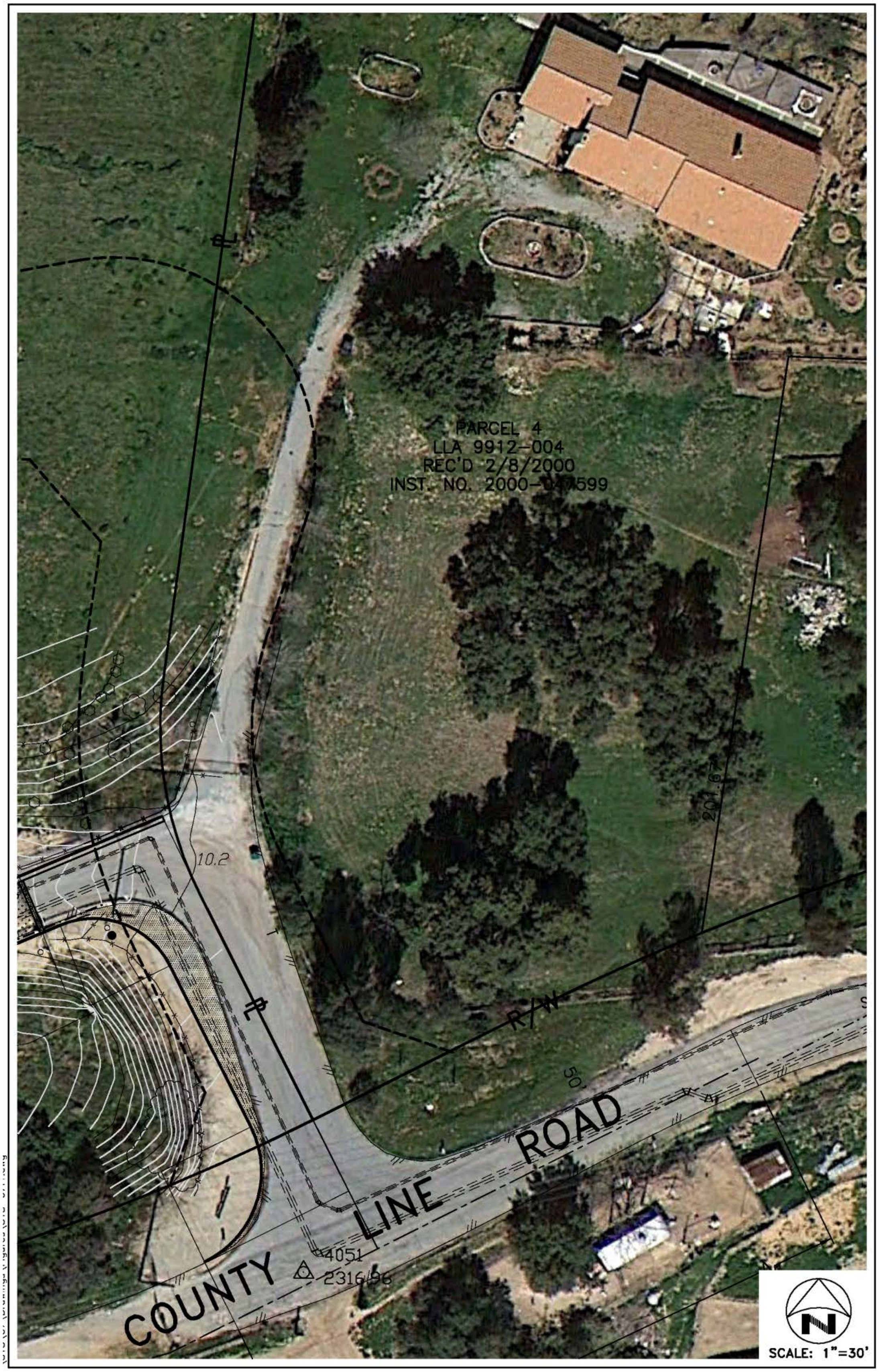
CITY OF CALIMESA

CROW STREET VACATION PLAT
APN'S 413-050-009, 010, 011, 012 & 014
PORTION OF PARCEL MAP NO. 13435

EXHIBIT B

SHEET 1 OF 1

SCALE: 1"=200' DATE: 2/23/12 DRAWN BY: MWE CHECKED BY: FAE W.O.: 818-67


PARCEL 4
LLA 9912-004
REC'D 2/8/2000
INST. NO. 2000-047599
10.2
R/W
50
COUNTY LINE ROAD
4051
2316.96
SCALE: 1"=30'