SANTA ANA RIVER WATERMASTER

FOR

ORANGE COUNTY WATER DISTRICT

VS. CITY OF CHINO, et al.

CASE NO. 117628 - COUNTY OF ORANGE

TWENTY-SECOND ANNUAL REPORT OF THE SANTA ANA RIVER WATERMASTER

1991-92

APRIL 30, 1993

SANTA ANA RIVER WATERMASTER

ORANGE COUNTY WATER DISTRICT VS. CITY OF CHINO ET AL
CASE NO. 117628--COUNTY OF ORANGE

WATERMASTER
Harvey O. Banks
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April 30, 1993

To: Clerk of Superior Court of Orange County and all Parties

Re: Watermaster Report for 1991-92

Gentlemen:

We have the honor of submitting herewith the Twenty-second Annual Report of the Santa Ana River Watermaster.

The principal findings of the Watermaster for the water year 1991-92 are as follows:

<u>At Prado</u>

1.	Base Flow at Prado	106,948 acre-feet
2.	Annual Weighted TDS of Base and Storm Flows	499 mg/L
3.	Annual Adjusted Base Flow	124,869 acre-feet
4.	Cumulative Adjusted Base Flow	2,070,909 acre-feet
5.	Cumulative Entitlement of OCWD	924,000 acre-feet
6.	Cumulative Credit	1,146,909 acre-feet
7.	One-third of Cumulative Debit	0 acre-feet
8.	Minimum Required Base Flow in 1992-93	34,000 acre-feet

<u>At Riverside Narrows</u>

1.	Base Flow at Riverside Narrows	40,306 acre-feet
2.	Annual Weighted TDS of Base Flow	620 mg/L

3.	Annual Adjusted Base Flow	40,306 acre-feet
4.	Cumulative Adjusted Base Flow	801,363 acre-feet
5.	Cumulative Entitlement of CBMWD and WMWD	335,500 acre-feet
6.	Cumulative Credit	465,863 acre-feet
7.	One-third of Cumulative Debit	0 acre-feet
8.	Minimum Required Base Flow in 1992-93	12,420 acre-feet

The above findings show that at the end of the 1991-92 water year, Chino Basin Municipal Water District and Western Municipal Water District have a cumulative credit of 1,146,909 acre-feet to their Base Flow obligation at Prado Dam. San Bernardino Valley Municipal Water District has a cumulative credit of 465,863 acre-feet to its Base Flow obligation at Riverside Narrows.

The Watermaster continued to exercise surveillance over the many active and proposed projects within the watershed for their potential effect on Base Flow.

Sincerely yours,

Santa Ana River Watermaster

By: Harvey O. Banks
Harvey O. Banks

Donald L. Harriger

William J. Carroll

William R. Mills, Jr.

Robert L. Reiter

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CHAPTER I

WATERMASTER ACTIVITIES

This is the Twenty-second Annual Report of the Santa Ana River Watermaster required by the Stipulated Judgment for water year 1991-92 in the case of Orange County Water District vs. City of Chino, et al., entered by the court on April 17, 1969. This Stipulated Judgment became effective on October 1, 1970, and contains a declaration of rights of the entities in the Lower Area of the Santa Ana River Basin downstream of Prado Dam as against those in the Upper Area, and provides a physical solution to implement the provisions of the Judgment. The physical solution accomplishes, in general, a regional intrabasin allocation of the surface flow of the Santa Ana River System. All defendants and cross-defendants were dismissed except the four major public water districts within the Santa Ana River Basin, namely, the San Bernardino Valley Municipal Water District (SBVMWD), Western Municipal Water District (WMWD), Chino Basin Municipal Water District (CBMWD), and Orange County Water District (OCWD). The boundaries of these districts are shown on Plate 1. This arrangement leaves to each of the major hydrologic units in the watershed the determination and regulation of individual rights therein and the development and implementation of its own basin management plan. The History of Litigation and the Summary of Judgment are included as Appendices G and H of the Twentieth Report.

In order to administer the provisions of the Judgment, the court appointed a Watermaster composed of five persons. Since August 15, 1985, the Santa Ana Watermaster Committee has consisted of Harvey O. Banks, William J. Carroll, William R. Mills, Jr., Donald L. Harriger, and Robert L. Reiter. In 1991-92 Mr. Banks continued to serve as chairman, and Mr. Reiter continued to serve as secretary/treasurer.

The time for submission of the annual report is seven months after the end of the water year. The items to be reported upon are listed in the letter of transmittal of this report.

Stream Flow and Water Quality Measurements

Stream flow measurements and water quality data required by the Watermaster are, for the most part, furnished by the U.S. Geological Survey (USGS). The financing of the cooperative monitoring program with the USGS is shared by the parties to the Judgment. These costs are set forth in Table 1.

The USGS measured and computed the mean daily discharges of the Santa Ana River at Metropolitan Water District of Southern California (MWDSC) Upper Feeder Crossing and below Prado Dam. Runoff data have also been provided for the Santa Ana River at E Street in San Bernardino and for several smaller streams tributary to Prado

TABLE 1

COST TO THE PARTIES AND USGS FOR MEASUREMENTS
WHICH PROVIDE DATA USED BY THE
SANTA ANA RIVER WATERMASTER

October 1, 1991 to September 30, 1992

	Agency Cost	USGS Cost
SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT		
At Riverside Narrows (MWD Crossing)		
Water Quality Monitoring/TDS Samples	$870	$2,610
Surface Water Gage	2,220	6,660
WESTERN MUNICIPAL WATER DISTRICT		
Same as SBVMWD	3,090	
Cucamonga Creek Discharge	2,375	4,750
Chino Creek Discharge	1,583	4,750
CHINO BASIN MUNICIPAL WATER DISTRICT		
Same as WMWD	7,048	
ORANGE COUNTY WATER DISTRICT		
At Prado Dam		
Water Quality Monitoring/TDS Samples		
Water Quality Sampling & Conductivity Programs	6,855	5,775
Chino Creek		
Surface Water Gage	1,584	
TOTAL FOR PARTIES	$25,625	
UNITED STATES GEOLOGICAL SURVEY		$24,545
GRAND TOTAL		$50,170

Reservoir; namely, Chino Creek at Schaefer Avenue, Cucamonga Creek near Mira Loma and Temescal Wash at Corona.

Precipitation during 1991-92 was below normal and totaled 16.54 inches at San Bernardino County Hospital, 92% of the 26-year base period (1934-35 through 1959-60) average of 17.98 inches. In October and November 1991, precipitation totalled 0.79 inches. In December, 1.84 inches of rain were measured. In January 1992, 1.86 inches were recorded. In February, 5.51 inches, and in March, 6.07 inches were measured. In April, 0.19 inches were recorded. Only 0.05 inches were measured in May and none in June. There was 0.23 inches of precipitation in July and none in August and September 1992.

Base flow amounted to 5,972 acre-feet, and 611 acre-feet of storm flow were recorded at Prado during October. Storm flow amounted to 234 acre-feet and base flow to 2,741 acre-feet in October at Riverside Narrows. An increase in base flow and little storm flow occurred in November, and a further small increase in base flow and minor amounts of storm flow occurred from December 28 through January 11 at both Prado and Riverside Narrows and from February 6 through April 11 at both Prado and Riverside Narrows. Small amounts of intermittent storm runoff occurred after April 12 at Prado and April 9 at Riverside Narrows. Base flow at Prado peaked at about 184 cfs in February and decreased to 134 cfs at the end of September 1992. Similarly, maximum base flow at Riverside Narrows was approximately 62 cfs late in December and decreased to a minimum of 32 cfs in September.

The 1991-92 discharge record for the USGS gaging station, "Santa Ana below Prado," is considered by the USGS to be a "good" record. Eleven (11) direct discharge measurements, which ranged from about 126 to 2,570 cfs, were made during the year. For the period December 28, 1991, through January 19, 1992, minor amounts of water were stored in and released from Prado Reservoir; the maximum amount in storage during this period was 6,308 acre-feet on January 6. From February 7, 1992, through May 5, 1992, the discharge was continuously regulated by Prado Reservoir with a maximum of 18,144 acre-feet in storage on March 24 and 27, 1992. The maximum average daily discharge after regulation by Prado Reservoir occurred on February 14, 1992, and amounted to 4,010 cfs. The mean annual discharge was approximately 274 cfs, including Arlington Desalter releases and Upper Basin pumped groundwater released for OCWD.

No State Water Project water was released by MWDSC from turnout OC-59 into San Antonio Creek.

The Arlington Desalter operated intermittently during the water year as shown on Plate 2 (see Appendix E for details). It discharged a total of 3,548 acre-feet of product water to the drainage tributary to the Santa Ana River below Riverside Narrows.

The overall 1991-92 discharge recorded for the USGS gaging station, "Santa Ana River at MWD Crossing", is considered by the USGS to be a "poor" record at both low and high stages because of the shifting channel and vegetative growth. The station was located at the MWDSC Upper Feeder Crossing for the entire year. Eighteen (18) direct discharge measurements, which range from about 34 to 2,040 cfs, were made during the year. The mean annual discharge was approximately 99 cfs. Total measured flow for 1991-92 was 71,768 acre-feet.

Compilation and Analysis of Basic Data

The Watermaster has established procedures for compiling and analyzing the basic data necessary to carry out the provisions of the Stipulated Judgment. Determinations were made of the Base Flow, Storm Flow, Nontributary Flow, and relationships between electric conductivity (EC) and total dissolved solids (TDS). These determinations are explained in detail in Chapters III and IV.

Administration Costs

In accordance with Paragraph 7(d) of the Stipulated Judgment, the fees and expenses of each of the members of the Watermaster are borne by the district which nominated such member. All other Watermaster administrative costs and expenses are borne by the parties, with OCWD paying 40% of the cost and WMWD, SBVMWD, and CBMWD each paying 20% of the cost. The Stipulated Judgment further provides that the Watermaster may from time to time, at its discretion, require advances of operating capital from the parties.

At its meeting on January 31, 1992, the Watermaster adopted a budget for the fiscal year 1991-92 in the amount of $16,000. Table 2 shows the items and amount included in said budget. The expenses for the fiscal year 1991-92 are also shown. The budget for fiscal year 1992-93 was adopted on April 9, 1992.

An audit prepared by Diehl, Evans and Company showing the details of income and expenses of the Santa Ana River Watermaster for the fiscal year 1991-92 is included herein as Appendix F.

TABLE 2

SANTA ANA RIVER WATERMASTER BUDGET AND EXPENSES

Budget Item	July 1, 1991 to June 30, 1992 Budget	July 1, 1991 to June 30, 1992 Expenses	July 1, 1992 to June 30, 1993 Budget
Administration	$1,200.00	$1,148.25	$1,200.00
Support Engineering Services	9,000.00	8,756.56	9,000.00
Reproduction of Annual Report	5,800.00	2,987.10	5,800.00
TOTAL	$16,000.00	$12,891.91	$16,000.00

Summary Of Findings

A summary of findings by the Watermaster for the period 1970-71 through 1991-92 is presented in Table 3. The Base Flow obligations at both Riverside Narrows and Prado Dam provided for in the Stipulated Judgment have been met and cumulative credits have been established.

TABLE 3

SUMMARY OF FINDINGS

AT PRADO

Water Year	Rainfall (in)[1]	Total Flow (ac-ft)[2]	Base Flow (ac-ft)	Weighted TDS (mg/L)[3]	Adjusted Base Flow (ac-ft)	Cumulative Credit (ac-ft)
1970-71	11.97	51,864	38,402	727	38,402	-3,598
1971-72	9.62	51,743	40,146	707	40,416	-5,182
1972-73	18.46	77,484	48,999	638	51,531	4,349
1973-74	12.72	63,620	43,106	633	45,513	7,862
1974-75	13.49	61,855	50,176	694	51,263	17,125
1975-76	15.86	59,209	45,627	635	48,098	23,223
1976-77	11.95	62,953	48,387	660	50,000	31,223
1977-78	30.47	252,837	58,501	383	73,955	63,178
1978-79	17.51	134,486	71,863	580	79,049	100,227
1979-80	30.93	527,760	82,509	351	106,505	164,732
1980-81	10.45	117,888 [4]	74,875 [5]	728	74,875 [5]	205,652 [6]
1981-82	18.34	143,702	81,548	584	89,431	253,083
1982-83	32.36	426,273 [4]	111,692 [5]	411	138,591 [5]	353,036 [6]
1983-84	10.81	178,395 [4]	109,231 [5]	627	115,876 [5]	431,514 [6]
1984-85	12.86	162,912	125,023	617	133,670	523,184
1985-86	17.86	196,565	127,215 [8]	567	141,315	622,499
1986-87	8.08	140,538	119,848	622	127,638	708,137
1987-88	13.78	170,279 [9]	124,104 [9]	582	136,308	802,445
1988-89	12.64	152,743 [9]	119,572 [9]	583	131,230	891,675
1989-90	8.53	144,817	119,149 [10]	611	127,986	977,611
1990-91	15.48	195,186	111,151 [11]	514	128,379	1,064,040
1991-92	16.54	198,280	106,948 [11]	499	124,869	1,146,909

TABLE 3 (CONTINUED)

SUMMARY OF FINDINGS

AT RIVERSIDE NARROWS

Water Year	Rainfall (in)[1]	Total Flow (ac–ft)[2]	Base Flow (ac–ft)	Weighted TDS (mg/L)[3]	Adjusted Base Flow (ac–ft)	Cumulative Credit (ac–ft)
1970–71	11.97	24,112	17,061	704	17,021	1,762
1971–72	9.62	22,253	16,157	712	16,017	2,529
1972–73	18.46	32,571	17,105	700	17,105	4,384
1973–74	12.72	24,494	16,203	700	16,203	5,337
1974–75	13.49	19,644	15,445	731	15,100	5,187
1975–76	15.86	26,540	17,263	723	16,977	6,914
1976–77	11.95	23,978	18,581	722	18,286	9,950
1977–78	30.47	181,760	22,360	726	21,941	16,641
1978–79	17.51	47,298	26,590	707	26,456	27,847
1979–80	30.93	254,077	25,549 [7]	676	25,549	38,146
1980–81	10.45	34,278	19,764	715	19,550	42,446
1981–82	18.34	83,050	32,778	678	32,778	59,974
1982–83	32.36	279,987	57,128	610	57,128	101,852
1983–84	10.81	82,745	56,948	647	56,948	143,550
1984–85	12.86	79,771	69,772 [8]	633	69,772	198,072
1985–86	17.86	99,258	68,220 [8]	624	68,220	251,042
1986–87	8.08	77,752	59,808	649	59,808	295,600
1987–88	13.78	79,706	55,324	620	55,324	335,674
1988–89	12.64	62,376	52,259	607	52,259	372,683
1989–90	8.53	58,500	53,199	590	53,583	411,016
1990–91	15.48	74,525	45,041	616	45,041	440,807
1991–92	16.54	71,768	40,306	620	40,306	465,863

(1) Measured at San Bernardino County Hospital.
(2) Excludes Nontributarv Flow.
(3) For Base and Storm Flow at Prado and Base Flow only at Riverside Narrows.
(4) Includes 16,090 acre-feet of water pumped from Lake Elsinore which passed Prado Dam in 1980-81; 7,720 acre-feet in 1982-83; and 12,550 acre-feet in 1983-84.
(5) Excludes water pumped from Lake Elsinore.
(6) Includes 8,045 acre-feet in 1979-80; 3,362 acre-feet in 1982-83; and 4,602 acre-feet in 1983-84 of Lake Elsinore discharge.
(7) Includes Rubidoux Wastewater in 1979-80 and subsequent years.
(8) Includes groundwater pumped from San Bernardino Basin and released to the river in accordance with Court Orders approving agreement and allowing temporary additional extractions of water from the San Bernardino Basin Area.
(9) Excludes Nontributary Flow released to San Antonio Creek by MWDSC under the Ontario/MWDSC Exchange Program
(10) Excludes water discharged to Santa Ana River from Arlington Desalter in 1989-90 and subsequent years in accordance with an agreement between OCWD, WMWD, and Santa Ana Watershed Project Authority.
(11) Excludes groundwater pumped from San Bernardino, Colton, and Riverside Basins and discharged to Santa Ana River to flow to OCWD under the Drought Emergency Exchange agreement discussed in subsequent chapters.

Note: For the years 1973-74 through 1979-80, a correction has been made for different losses of State Water than assumed in reports published for these years. The values changed are Base Flow, weighted TDS, and adjusted Base Flow. These changes, in turn, have changed the cumulative credit for these years. See Appendix C in the Twelfth Annual Report 1981-82.

CHAPTER II

WATER SUPPLY CONDITIONS

The precipitation in the Santa Ana River Watershed during 1991-92, as measured at San Bernardino County Hospital, was about 92% of normal in terms of the Base Period average. The Total Flow of the Santa Ana River below Prado Dam during the 1991-92 water year was about 198,280 acre-feet as compared to a total flow of 195,186 acre-feet which occurred in the previous year. The unadjusted Base Flow amounts at Riverside Narrows and Prado, were 40,306 acre-feet and 106,948 acre-feet, respectively in 1991-92, which are 4,735 acre-feet and 4,203 less than the corresponding values for 1990-91.

Chino Basin Groundwater Storage Program

The Sixteenth Annual Report described a program proposed by MWDSC to store State Water Project water in the Chino Basin for its future use. The project was never implemented. In the 1991-92 water year, a small, modified project, now called the "Mini Conjunctive Use Project" was implemented. Through the Mini Conjunctive Use Project, MWDSC delivered 4,806 acre-feet of surface water to purveyors who normally pump groundwater in exchange for and in-lieu of their pumping the groundwater. MWDSC may at some future date remove this water from the basin. Storage of this quantity of water should have no impact on the rising groundwater and, therefore, has no impact on the base flow in the Santa Ana River. Should a larger scale project of this nature be implemented, the Watermaster will evaluate the need to modify the scalped base flow each year for the estimated effects of the program to determine the amount of base flow within the meaning and intent of the judgment.

Discharge of Groundwater from San Bernardino Basin Area to Santa Ana River

This program also was described in the Sixteenth Annual Report. No groundwater was pumped from San Bernardino Basin and discharged to the Santa Ana River in 1991-92 under this program.

Discharge of State Water Project Water Above Prado Ontario/MWDSC Exchange Program

The Sixteenth Annual Report presents a description of this program and its implications with respect to the responsibilities and activities of the Watermaster. During 1991-92 MWDSC did not deliver any Colorado River exchange water to the City of Ontario. No State Water Project water was released to San Antonio Creek in 1991-92.

Discharge of Drought Emergency Exchange Water to Santa Ana River

The Twenty-first Annual Report presents a description of this program and its implications with respect to the responsibilities and activities of the Watermaster. During 1991-92, a total of 4,721 acre-feet of drought emergency exchange water was pumped from the San Bernardino, Colton, and Riverside groundwater basins and discharged into the Santa Ana River. This discharge was not considered as augmentation of the base flow of the Santa Ana River. Details of these discharges are presented on Plate 2 and in Appendix G.

Arlington Desalter

The Twentieth Annual Report presents a detailed description of the Arlington Desalter project and its implications with respect to the responsibilities and activities of the Watermaster. In 1991-92 the Desalter delivered 3,548 acre-feet of water to the Santa Ana River. This augmentation of the flow passing Prado is not considered as Base Flow under the provisions of the Joint Participation Agreement which was ratified by all four Parties to the Judgment.

Santa Ana Watershed Project Authority Projects Affecting Base Flow in the Santa Ana River

The activities of the Santa Ana Watershed Project Authority of interest to the Watermaster in carrying out its responsibilities were discussed in the Seventeenth Annual Report. A number of potential water projects are under active consideration, which if implemented, would impact the hydrology of the Santa Ana River and, therefore, could influence the determinations of the Watermaster. No decisions have been made on the potential projects. At least one possible project being discussed would involve exportation of reclaimed water from the Santa Ana River Basin for irrigation and groundwater recharge. The Watermaster will monitor all such projects as they are developed.

Lake Elsinore Project

Work on modifications to Lake Elsinore itself have been largely completed, but construction of the outlet channel which would discharge to the headwaters of Temescal Creek has not been started. It is understood that the U.S. Army Corps of Engineers will start work on the channel soon. The discharge of lake overflows to the Santa Ana River basin must be considered by the Watermaster in water accounting as it has in the past.

Prado Wetlands Study

During the water year 1991-92, the OCWD investigated the removal of nitrogen and total organic carbon in the Santa Ana River water as a portion of it flows through approximately 600 acres of constructed wetlands located in the Prado Basin. Recommendations and preliminary design for wetlands modifications to enhance the natural water quality improvement processes have been made. Modifications to the constructed wetlands are expected to take place in 1993.

Santa Ana River Flood Control District

The project has been authorized and work has started on certain upstream features including Seven Oaks Dam.

Provision for Additional Conservation at Prado and Seven Oaks Dam

The U.S. Army Corps of Engineers has recently released a Final Reconnaissance Report entitled "Seven Oaks and Prado Dams Water Conservation Study." The study was authorized in HR 101-96, June 20, 1989, and was requested by OCWD and SBVMWD. It was undertaken to determine the potential feasibility of operating Prado and Seven Oaks Dams to provide seasonal water conservation storage in addition to that already authorized under the Santa Ana River Mainstem Project. Any additional storage to be provided could require authorization by the Congress.

A number of alternatives were studied at a reconnaissance level including a seasonal water conservation pool up to elevation 512 at Prado Dam and a pool up to elevation 2,418 at Seven Oaks Dam. The study showed that substantial additional water conservation could be achieved. Further study was recommended to refine alternatives and optimize benefits.

For Seven Oaks Dam and Reservoir, a feasibility study is recommended to complete the plan formulation and evaluation process. The locally preferred plan for Seven Oaks would involve a seasonal water conservation pool at elevation 2,418 which would provide 50,000 acre-feet of additional storage under present conditions and increase the yield an estimated 8,000 acre-feet under future conditions.

Precipitation During 1991-92

During the 1991-92 water year, the precipitation at the San Bernardino County Hospital amounted to 16.54 inches, which is 92% of the Base Period average. Most of the precipitation, 15.28 inches, 92%, occurred during the months of December through March. In October and November precipitation totaled 0.79 inches. The maximum monthly precipitation of 6.07 inches occurred during March. In April, 0.24

inches were measured and 0.05 inches in May. There was no precipitation in June, August, or September.

Figure 1 shows the seasonal precipitation from 1931-32 through 1991-92 and the accumulated departure from the 1934-35 through 1959-60 Base Period average.

Runoff During 1991-92

At Prado

The calculated total seasonal inflow to Prado Reservoir in 1991-92 was 198,280 acre-feet including Arlington Desalter discharge, 3,548 acre-feet, and Upper Basin groundwater pumped for OCWD, 4,721 acre-feet, well above the Base Period (1934-35 through 1959-60) average of 78,780 acre-feet per year. During the month of February 1992, inflow amounted to 48,384, or 24% of the seasonal total. The recorded maximum storage in Prado Reservoir occurred on March 24 and 27, 1992, when 18,144 acre-feet (about 12% of the reservoir capacity at spillway level) was in storage. The maximum release of 4,010 cfs from Prado Reservoir occurred February 14, 1992.

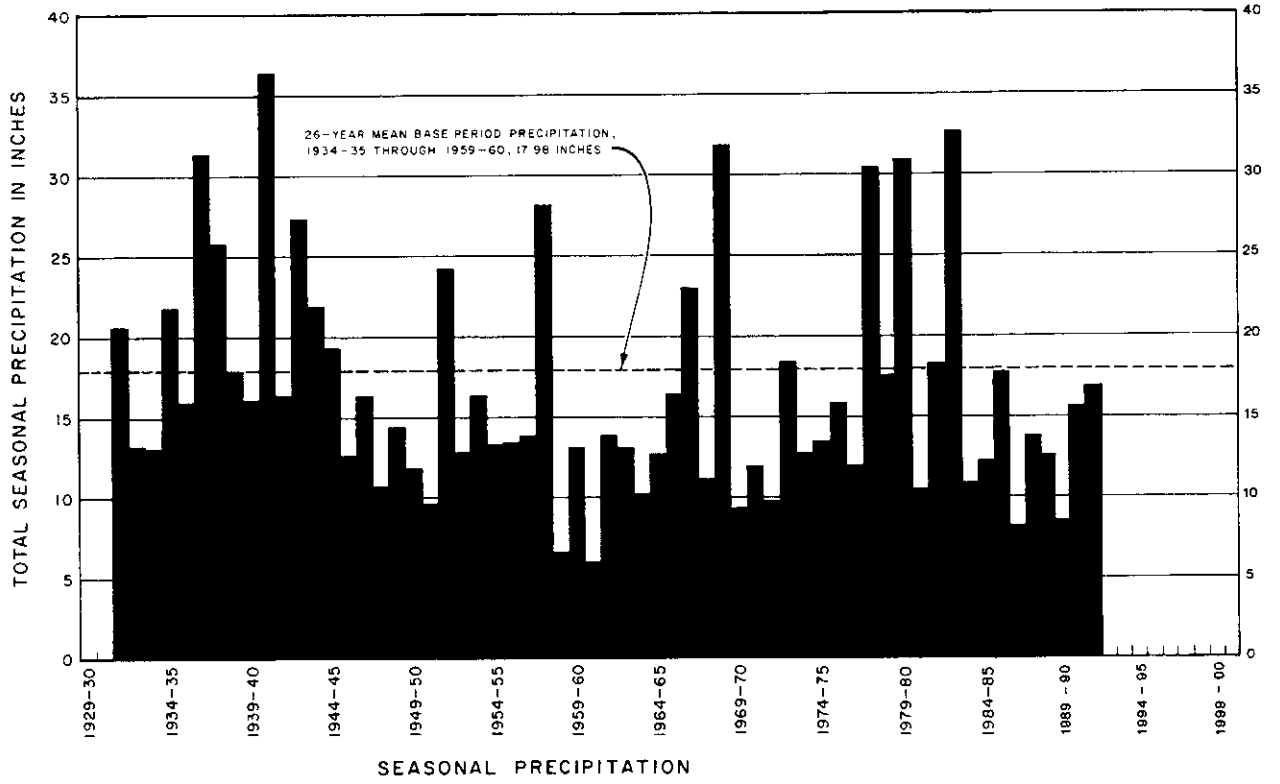
After 1943-44 the Base Flow at Prado Dam progressively decreased and reached a low in 1960-61 of 26,160 acre-feet. Since that year, the Base Flow has substantially increased. During the 22-year period (1970-71 through 1991-92) since the Stipulated Judgment went into effect, the Base Flow, unadjusted for quality, has averaged 84,458 acre-feet per year. This compares to the 26-year Base Period average of 47,470 acre-feet and the Base Flow requirements under the Stipulated Judgment of 42,000 acre-feet. The 1991-92 unadjusted Base Flow amounted to 106,948 acre-feet, an increase of 22,490 acre-feet over the 22-year average.

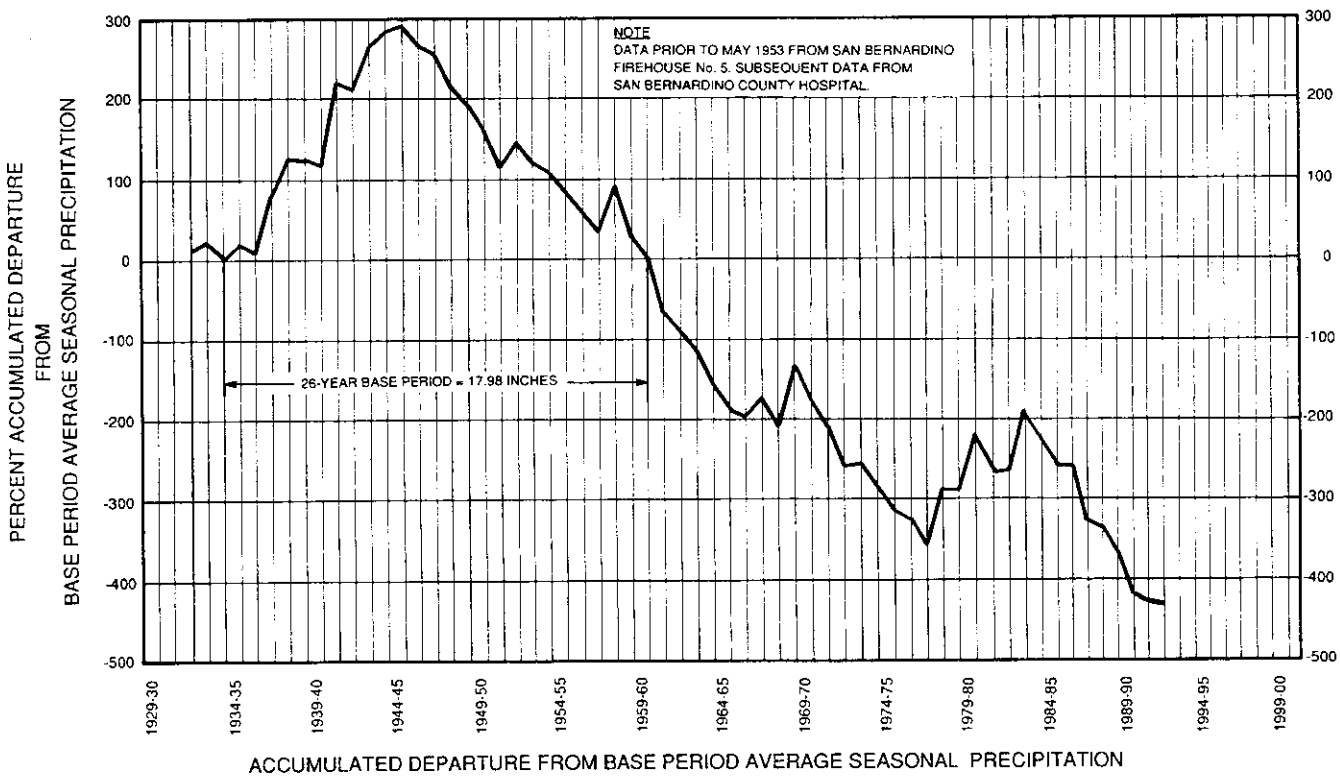
Figure 2 shows the Storm and Base Flow components of the Total Flow in the Santa Ana River below Prado Dam during the period 1934-35 through 1991-92.

At Riverside Narrows

The Total Flow of the Santa Ana River at Riverside Narrows for the 1991-92 water year was 71,768 acre-feet.

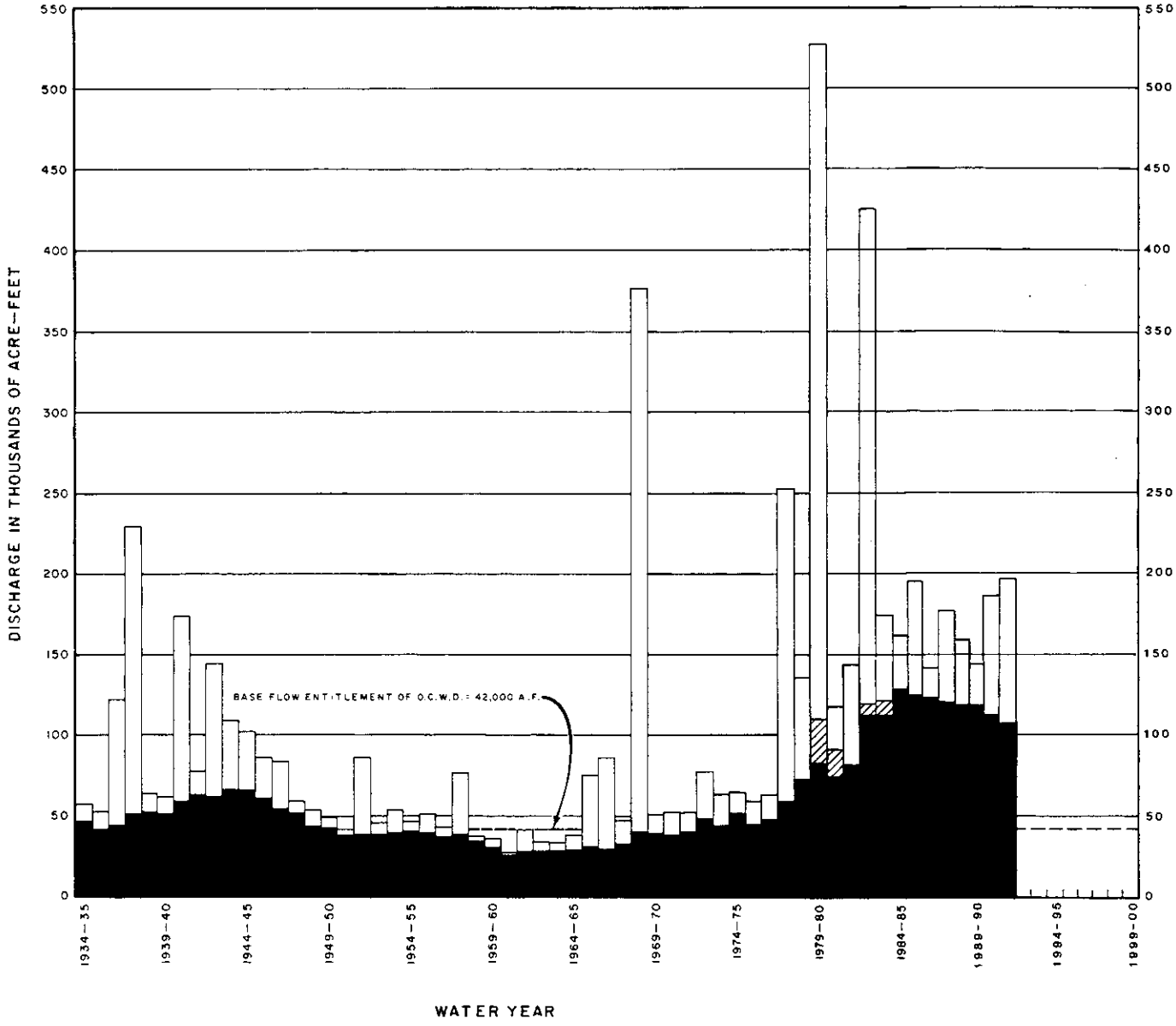
The unadjusted Base Flow at Riverside Narrows decreased from 27,120 acre-feet in 1943-44 to an all-time low of 13,450 acre-feet in 1965-66. Since that time, the Base Flow at Riverside Narrows has substantially increased. During the 22-year period 1970-71 through 1991-92, the Base Flow has averaged 36,494 acre-feet per year. The 1991-92 unadjusted Base Flow amounted to 40,306 acre-feet, an increase of 3,812 acre-feet over the 22-year average.





VARIATION IN PRECIPITATION AT SAN BERNARDINO

FIGURE 1



Notes

1. DISCHARGE EXCLUDES NONTIBUTARY WATER, ARLINGTON DESALTER WATER, AND DROUGHT EMERGENCY EXCHANGE WATER.
2. DISCHARGE INCLUDES EMERGENCY LAKE ELSINORE WATER IN 1979-80, 1980-81, 1982-83 AND 1983-84

LEGEND

- STORM FLOW
- LAKE ELSINORE FLOW
- BASE FLOW

DISCHARGE OF SANTA ANA RIVER AT PRADO DAM

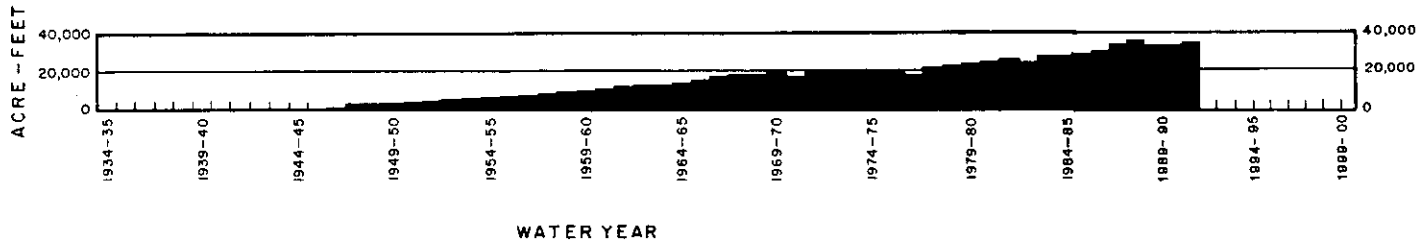
FIGURE 2

Figure 3 shows the components of Total Flow in the Santa Ana River at Riverside Narrows for the period from 1934-35 through 1991-92.

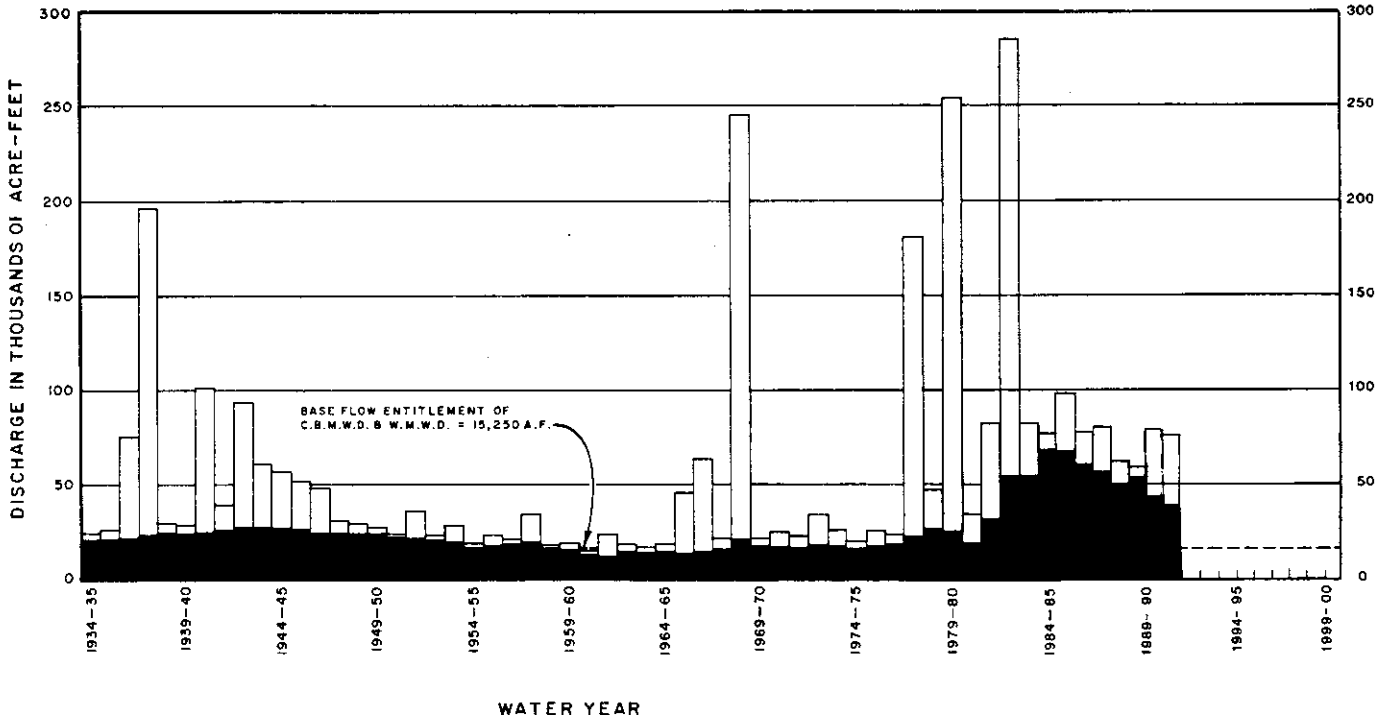
Wastewater Effluent Discharge

A portion of the Base Flow at Prado is made up of treated wastewater effluent discharged from a number of wastewater treatment plants located above Prado Dam.

The quantities discharged by the major agencies are shown on Table 4. For the year 1991-92, about 132,670 acre-feet were discharged above Prado Dam.



SEWAGE EFFLUENT FROM RIVERSIDE WATER QUALITY CONTROL PLANTS



NOTES

1. DISCHARGE EXCLUDES SEWAGE EFFLUENT FROM THE RIVERSIDE WATER QUALITY CONTROL PLANTS AND IMPORTED M.W.D. COLORADO RIVER OR STATE WATER PROJECT WATER BEING TRANSPORTED IN THE SANTA ANA RIVER.
2. DISCHARGE OF RUBIDOUX WASTEWATER PLANT INCLUDED IN BASE FLOW COMMENCING IN 1979-80.

LEGEND

STORM FLOW

BASE FLOW

DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS

FIGURE 3

TABLE 4

WASTEWATER EFFLUENT DISCHARGED
ABOVE PRADO BY MAJOR AGENCIES
(acre-feet)

Year	Redlands	San Bernardino	Colton	Rialto	Riverside	Corona	CBMWD #1	CBMWD #2	CBMWD CCWRF*	Total
1970-71	2,650	17,860	2,520	2,270	18,620	3,190	--	--	--	47,110
1971-72	2,830	16,020	2,230	2,400	19,010	3,230	6,740	--	--	52,460
1972-73	2,810	18,670	2,530	2,260	19,060	3,340	10,380	--	--	59,050
1973-74	2,770	17,680	2,530	2,320	19,560	3,510	11,440	2,320	--	61,950
1974-75	2,540	16,750	1,980	2,320	19,340	4,020	14,960	2,280	--	64,190
1975-76	2,450	17,250	2,540	2,240	19,580	4,700	15,450	2,950	--	67,160
1976-77	3,170	17,650	3,260	2,330	18,770	5,010	14,640	3,380	--	68,210
1977-78	3,280	18,590	3,810	2,380	20,310	5,200	14,650	4,060	--	72,280
1978-79	3,740	19,040	3,850	3,050	21,070	5,390	15,040	5,070	--	76,250
1979-80	4,190	20,360	4,190	2,990	22,910	5,360	14,410	5,520	--	79,930
1980-81	4,410	20,550	3,930	3,370	24,180	5,590	17,270	5,260	--	84,560
1981-82	4,420	23,340	3,780	3,470	25,640	5,410	19,580	5,360	--	91,000
1982-83	4,530	24,160	3,600	3,620	25,020	5,860	20,790	4,290	--	91,870
1983-84	5,150	22,080	3,700	3,830	26,090	6,200	20,950	3,950	--	91,950
1984-85	4,990	23,270	3,830	4,070	27,750	6,250	25,160	4,280	--	99,600
1985-86	5,200	24,720	4,010	4,720	28,820	5,900	28,240	2,660	--	104,270
1986-87	5,780	26,810	4,170	5,350	30,340	6,170	27,160	5,000	--	110,780
1987-88	6,060	27,880	5,240	6,040	34,660	6,050	31,290	5,500	--	122,720
1988-89	5,250	27,640	5,550	6,280	35,490	8,080	35,510	6,180	--	129,980
1989-90	6,360	28,350	5,810	6,260	33,210	9,140	34,760	5,730	--	129,620
1990-91	6,690	27,570	5,670	6,290	32,180	9,110	36,840	6,100	--	130,450
1991-92	6,230	25,060	5,660	6,360	32,660	9,010	40,360	5,780	1,550	132,670

* CCWRF = Carbon Canyon Water Reclamation Facility

The amounts shown in Table 4 were determined from data provided by the agencies.

CHAPTER III

BASE FLOW AT PRADO

This chapter deals with determinations of 1) the components of flow at Prado, which include Nontributary Flow, Arlington Desalter Flow, Drought Emergency Exchange Water, Storm Flow and Base Flow; and 2) the Adjusted Base Flow at Prado credited to CBMWD and WMWD.

Total Flow at Prado

The Total Flow of the Santa Ana River amounted to 198,280 acre-feet, measured at the USGS gaging station below Prado. There was no storage behind Prado Dam at the beginning of the year. No water was in storage at the end of the water year. The inflow into the reservoir comprised 106,948 acre-feet of Base Flow and 82,729 acre-feet of Storm Flow. Nontributary Flow during 1991-92 due to the release of State Water Project water above Riverside Narrows during 1972-73 was 334 acre-feet. Other flows due to Arlington Desalter Project water releases to Temescal Creek and Drought Emergency Exchange Water during 1991-92 were 3,548 acre-feet and 4,721 acre-feet, respectively. The components of flow of the Santa Ana River at Prado for each month in the 1991-92 water year are listed in Table 5, and are shown graphically on Plate 2.

Nontributary Flow

Since May 1973, OCWD has from time to time purchased State Water Project water for the replenishment of the groundwater basin in Orange County. The water has been released at two locations: Santa Ana River above Riverside Narrows (1972-73 only) and San Antonio Creek near Upland.

Releases Above Riverside Narrows

As fully discussed in Appendix F of the Fifth Annual Report, the Watermaster Committee determined a schedule of credits to OCWD for State Water Project water which was released above Riverside Narrows during 1972-73. A portion of this water, because it percolated in the basin above the Narrows, did not reach the Narrows in 1972-73. The schedule as developed in the Fifth Annual Report, is the best estimate of the amount that reaches Riverside Narrows each year. In 1991-92 the credit is 334 acre-feet, assumed to be distributed uniformly throughout the year, as shown in Table 5.

TABLE 5

COMPONENTS OF FLOW AT PRADO DAM

FOR WATER YEAR 1991–92
(acre-feet)

		USGS Measured Outflow	Storage Change[1]	Computed Inflow	Storm Flow	Nontributary Water Riverside Narrows [2]	Exchange Water [3]	Arlington Desalter	Base Flow
1991	October	7,924	0	7,924	611	28	896	417	5,972
	November	10,114	1	10,115	0	28	1,441	165	8,481
	December	14,162	1,133	15,295	2,806	28	1,958	580	9,923
1992	January	20,592	–1,134	19,458	8,485	28	0	224	10,721
	February	45,963	2,421	48,384	37,864	28	220	176	10,096
	March	27,959	14,563	42,522	31,091	28	155	199	11,049
	April	25,559	–14,177	11,382	1,418	28	0	0	9,936
	May	13,248	–2,808	10,440	286	28	0	0	10,126
	June	8,291	10	8,301	0	28	0	172	8,101
	July	8,501	–3	8,498	169	28	0	487	7,814
	August	7,964	–5	7,959	0	27	0	584	7,348
	September	8,003	–2	8,001	0	27	51	544	7,379
Total		198,280	0	198,280	82,729	334	4,721	3,548	106,948

(1) The monthly change in storage is included in the monthly components of flow.

(2) That portion of State Water Project water released during 1972–73 upstream of Riverside Narrows, determined to have reached Prado in 1991–92.

(3) Drought Emergency Exchange Water pumped from the San Bernardino, Colton and Riverside groundwater Basins and discharged into the Santa Ana River.

Releases to San Antonio Creek

There were no releases from OC-59 into San Antonio Creek during the water year 1991-92.

Arlington Desalter

The underflow from the Arlington groundwater sub-basin has historically been a component of the Santa Ana River flow. These groundwaters have increasingly been degraded through agricultural and other uses. Two participants to the Stipulated Judgment, WMWD and OCWD, as members of the Santa Ana Watershed Project Authority, constructed a groundwater cleanup project which is designed to eliminate the poor quality underflow from the sub-basin. This project is known as the Arlington Desalter and consists of five extraction wells and a treatment facility which reduces concentrations of salinity, nitrates and an agricultural chemical (DBCP). The capacity of the facility is approximately 6 mgd. The facility began operations in July 1990, with OCWD buying the product water delivered through the Santa Ana River. During the 1991-92 water year, 3,548 acre-feet of water discharged from the Arlington Desalter was determined to have reached Prado Dam.

All parties to the Stipulated Judgment agreed that the product water from this facility would not be considered as Santa Ana River Base Flow.

Releases of Exchange Water

During water year 1991-92, Drought Emergency Exchange water was delivered to the Santa Ana River upstream of Prado Dam. The exchange plan is more fully described in Chapter II of the Twenty-first Annual Report. The combined amount of groundwater delivered by WMWD above Riverside Narrows and below Van Buren Boulevard during 1991-92 was 4,721 acre-feet. The agreed upon loss of 5 percent of the release was not considered this year, but will be accounted for next year.

Since the exchange water is effectively nontributary water delivered upstream of Prado Dam for the benefit of OCWD, the amount of pumped exchange groundwater reaching Prado Dam is excluded from the computation of Base Flow and Base Flow quality.

Storm Flow

Portions of storm flows are retained behind Prado Dam for regulation of downstream flows and for water conservation purposes. The U.S. Army Corps of Engineers (Corps) owns and operates Prado Dam and operates according to a release schedule utilizing a debris pool elevation of 494 feet until March 15 of each year. After March 15, the debris pool is lowered, for environmental purposes, to an elevation of 490

feet. Storm flows captured within the reservoir are released following the storm to downstream groundwater recharge facilities. Monthly and annual quantities of storm flow are shown in Table 5.

By the end of the water year, the Corps was nearing completion of a federally funded Environmental Impact Study and Statement on seasonal water conservation at Prado. The study evaluates the impacts of a seasonal water conservation program, beginning in March of each year on all existing uses within Prado Reservoir at various elevations up to a maximum of 505 feet. The preliminary draft concludes that a seasonal water conservation operating plan at Prado Dam would be consistent with sound flood control practices, is viable, and has a positive benefit-to-cost ratio at all elevations up to 505 feet. However, OCWD must secure all necessary agreements and would be responsible for all implementation and operational costs. The primary factor which must be resolved is related to the least Bell's vireo, an endangered species.

As a result of heavy rainfall and runoff in late February and early March, an emergency water conservation agreement was negotiated between the Corps, U.S. Fish and Wildlife Service and OCWD. The temporary agreement provided a minimum of $100,000 for least Bell's vireo monitoring and habitat management. Additionally, OCWD agreed to provide additional funds for these purposes if the amount of water conserved because of the emergency water conservation agreement exceeded 20,000 acre-feet. The additional funds would accrue at a rate of $5 per acre-foot for water conserved beyond the 20,000 acre-feet amount. The agreement allowed OCWD to store flood waters to elevation 500 feet, which increased the water conservation pool by about 14,000 acre-feet and resulted in the capture of several thousand acre-feet of water that would have been discharged to the ocean.

During the spring of 1992, the cowbird trapping program in Prado Basin was continued by the Nature Conservancy. The cowbird trapping program is intended to enhance the environment for the least Bell's vireo. The cowbird is a marauder of the vireo. During the four-year program, the number of least Bell's vireos dramatically increased and it is believed that the cowbird trapping program was primarily responsible.

During the year, construction continued on elements of the Santa Ana River Mainstem project, including the Seven Oaks Dam, located on the Santa Ana River above Mentone.

During the 1991-92 water year, more than 100 acre-feet of water were stored behind Prado during the periods December 29 - January 19, February 7 - March 17, and March 20 - May 5. During those periods, the water stored in Prado Reservoir varied up to a maximum of 18,144 acre-feet and the maximum daily flow released to the Santa Ana River was 4,010 cfs.

Base Flow

The Base Flow is affected by Nontributary Flow which had been released previously above Riverside Narrows. The general procedure used by the Watermaster to separate the 1991-92 flow components was the same as used for previous years and is fully described in the Fifth Annual Report and the Twelfth Annual Report. The monthly and annual amounts are shown in Table 5.

Water Quality

The weighted average total dissolved solids (TDS) for the total flow passing Prado Dam, including Nontributary Flow released above Riverside Narrows, Drought Emergency Exchange Water and Arlington Desalter output was found to be 496 mg/L. This determination was based on records from a continuous monitoring device, operated by the USGS for electrical conductivity (EC) of the Santa Ana River flow below Prado, supplemented by grab samples for EC and TDS determination, and a statistical correlation of EC and TDS.

The EC of the outflow at Prado was recorded hourly on a punched tape by the USGS. The USGS collected a total of 19 grab samples and performed laboratory analyses for TDS. Daily flow-weighted EC values were calculated from the hourly EC data. A correlation between TDS and EC was developed using the TDS data from the grab samples and the field EC recorded by the technician at the times when the samples were collected. Data used for the statistical analysis are listed in Table B-1, Appendix B. The statistical analysis yields the best fit equation shown as follows:

$$TDS = EC \times 0.615286$$

where: TDS = mg/L
EC = microsiemens/cm

Using the daily EC data, flow-weighted average daily values for TDS were estimated using the above equation and are listed in Table B-2, Appendix B. The plot of estimated TDS on Plate 3 shows the daily average TDS concentration of the Santa Ana River flow passing Prado Dam.

Water Quality Adjustment for Nontributary Flow

The weighted average annual TDS value of 496 mg/L, shown in Table B-3, Appendix B, represents the quality of Total Flow which includes Nontributary Flow from release of State Water Project water to Santa Ana River above Riverside Narrows. The Stipulated Judgment requires that Base Flow shall be subject to adjustment based on the TDS of Base Flow and Storm Flow only. Hence a determination of the TDS of Base Flow plus Storm Flow TDS only, is detailed in the following paragraphs.

The flow-weighted average TDS of State Water Project water released above Riverside Narrows during 1972-73 was 235 mg/L and was adjusted to 242 mg/L to reflect a 3% evapotranspiration loss of the water released.

Water Quality Adjustment for Arlington Desalter

During July of the 1989-90 water year, Arlington Desalter went into operation and began to discharge product water into a storm channel tributary to the Santa Ana River. The amount of product water discharged to the Santa Ana River during the 1991-92 water year totaled 3,548 acre-feet at an average TDS of 443 mg/L (Appendix E). This flow-weighted average TDS of 443 mg/L was estimated from daily EC readings measured from the discharge into the channel.

Water Quality Adjustment for Exchange Water

The City of Riverside continued to pump groundwater which was discharged into the Riverside Canal for delivery to OCWD. The amount of water discharged to the Santa Ana River during the 1991-92 water year totaled 4,721 acre-feet at an average TDS of 420 mg/L (Appendix G). This flow-weighted average TDS of 420 mg/L was estimated from periodic grab samples taken at the Riverside Canal gaging station near Jefferson Street.

Type of Flow	Annual Flow (acre-feet)	Average TDS (mg/L)	Annual Flow x Average TDS (acre-feet x mg/L)
1. Total Flow	198,280	496	98,346,880
2. Nontributary Flow Riverside Narrows	334	242	80,828
3. Arlington Desalter	3,548	443	1,571,764
4. Exchange Water	4,721	420	1,982,820
5. Total Flow Less Nontributary Flow, Arlington Desalter Flow and Exchange Water	189,677		94,711,468
Average TDS of total Base and Storm Flows	94,711,468 ÷ 189,677 = 499 mg/L		

After adjusting for Nontributary Flow of State Water Project water from above Riverside Narrows, Drought Emergency Exchange Water and the Arlington Desalter flows, the weighted average annual TDS of Storm Flow and Base Flow for 1991-92 was 499 mg/L, as shown above.

Adjusted Base Flow at Prado

The Stipulated Judgment provides that the amount of Base Flow at Prado received during any year shall be subjected to adjustment based on weighted average annual TDS of the Base Flow and Storm Flow at Prado as follows:

If the Weighted Average TDS in Base Flow and Storm Flow at Prado is:	Then The Adjusted Base Flow shall be determined by the formula:
Greater than 800 mg/L	$Q - \frac{35}{42,000} Q(TDS-800)$
700 mg/L to 800 mg/L	Q
Less than 700 mg/L	$Q + \frac{35}{42,000} Q(700-TDS)$

Where: Q = Base Flow actually received.

The weighted average annual TDS of 499 mg/L is less than 700 mg/L. Therefore, the Base Flow must be adjusted by the above equation for TDS less than 700 mg/L. Thus the Adjusted Base Flow is as follows:

$$(106,948 \text{ ac-ft}) + \frac{35}{42,000} (106,948 \text{ ac-ft}) (700 - 499) = 124,869 \text{ ac-ft}$$

Entitlement and Credit or Debit

From pages 12 and 13 of the Stipulated Judgment, the following obligation of the CBMWD and WMWD is given: "CBMWD and WMWD shall be responsible for an average annual Adjusted Base Flow of 42,000 acre-feet at Prado. CBMWD and WMWD each year shall be responsible for not less than 37,000 acre-feet of Base Flow at Prado, plus one-third of any cumulative debit; provided, however, that for any year commencing on or after October 1, 1986, when there is not cumulative debit, or for any year prior to 1986 whenever the cumulative credit exceeds 30,000 acre-feet, said minimum shall be 34,000 acre-feet."

The Watermaster's findings concerning flow at Prado for 1991-92 required under the Stipulated Judgment are as follows:

1.	Total Flow at Prado	198,280 acre-feet
2.	Base Flow at Prado	106,948 acre-feet
3.	Annual Weighted TDS of Base and Storm Flow	499 mg/L
4.	Annual Adjusted Base Flow	124,869 acre-feet
5.	Cumulative Adjusted Base Flow	2,070,909 acre-feet
6.	Cumulative Entitlement of OCWD	924,000 acre-feet
7.	Cumulative Credit	1,146,909 acre-feet
8.	One-Third of Cumulative Debit	0 acre-feet
9.	Minimum Required Base Flow in 1992-93	34,000 acre-feet

CHAPTER IV

BASE FLOW AT RIVERSIDE NARROWS

This chapter deals with determinations of 1) the components of flow at Riverside Narrows, which include Nontributary Flow, Storm Flow and Base Flow; and 2) the Adjusted Base Flow at Riverside Narrows credited to SBVMWD.

Total Flow at Riverside Narrows

The total flow of the Santa Ana River at Riverside Narrows amounted to 71,768 acre-feet, measured at the USGS gaging station near the MWDSC Upper Feeder Crossing. Separated into its components, Base Flow was 40,306 acre-feet, Storm Flow was 33,158 acre-feet, Nontributary Flow due to a prior release of State Water Project water above Riverside Narrows was 341 acre-feet. Included in Base Flow are 2,037 acre-feet of wastewater from Rubidoux Community Services District which now bypasses the USGS gaging station. The components of flow of the Santa Ana River at Riverside Narrows for each month in the 1991-92 water year are listed in Table 6 and graphically shown on Plate 4.

Nontributary Flow

During the period May through September 1973, 11,617 acre-feet of State Water Project water from the East Branch of the California Aqueduct were purchased by the Orange County Water District and released into the Santa Ana River in the vicinity of Colton.

The Watermaster's determination of the effect of these releases has been discussed in the Fifth Annual Report of the Watermaster. For the water year 1991-92 the amount of State Water Project water reaching Riverside Narrows has been agreed upon as 341 acre-feet.

Release of Exchange Water

During water year 1991-92, no Drought Emergency Exchange water was delivered to the Santa Ana River upstream of the Riverside Narrows.

TABLE 6

COMPONENTS OF FLOW AT RIVERSIDE NARROWS

FOR WATER YEAR 1991-92
(acre-feet)

		Total Flow USGS Measurement	Storm Flow	Non-tributary Flow	Exchange Water (1)	Rubidoux Waste-water	Base Flow (2)
1991	October	2,834	239	29	0	170	2,736
	November	3,158	23	29	0	167	3,273
	December	4,742	1,043	29	0	167	3,837
1992	January	6,294	2,719	29	0	169	3,715
	February	21,076	17,712	29	0	161	3,496
	March	14,543	10,754	28	0	175	3,936
	April	4,213	514	28	0	168	3,839
	May	3,681	79	28	0	173	3,747
	June	2,999	0	28	0	168	3,139
	July	3,279	73	28	0	172	3,350
	August	2,537	0	28	0	174	2,683
	September	2,412	0	28	0	173	2,557
Total		71,768	33,158	341	0	2,037	40,306

(1) Drought Emergency Exchange Water pumped from the San Bernardino, Colton and Riverside Groundwater Basins and discharged into the Santa Ana River above Riverside Narrows.

(2) Base Flow includes Rubidoux wastewater discharged below Riverside Narrows.

Base Flow

Based on the hydrograph shown on Plate 4 and utilizing in general the procedures reflected in the Work Papers of the engineers (as referenced in Paragraph 2 of the Engineering Appendix of the Stipulated Judgment), a separation was made between Storm Flow and the sum of Base Flow and Nontributary Flow.

Nontributary Flow was assumed to be equally distributed throughout the year (341 acre-feet divided by 12 months) and subtracted from the sum of the Base Flow and Nontributary Flow as shown on Table 6.

In April 1980, Rubidoux Community Services District made the first delivery of wastewater to the regional treatment plant at Riverside. Prior to that time, Rubidoux had discharged to the river upstream of the Riverside Narrows Gaging Station. Wastewater from Rubidoux during water year 1991-92, in the amount of 2,037 acre-feet as shown in Appendix D, has been added to the streamflow as measured at the gaging station.

Water Quality

The determination of water quality at the Riverside Narrows Gaging Station was made using periodic grab samples taken and analyzed for TDS by the USGS, DWR and the City of Riverside. The results are summarized in Appendix C, Table C-1. Table C-2 shows the flow-weighted quality of streamflow passing the gaging station which includes the Nontributary Flow.

The flow-weighted quality of wastewater from Rubidoux is shown in Appendix D, Table D-1 as 717 mg/L. The Base Flow quality resulting from exclusion of the Nontributary Flow and inclusion of the Rubidoux wastewater is shown in the following table as 620 mg/L.

	Type of Flow	Annual Flow (acre-feet)	Average TDS (mg/L)	Annual Flow x Average TDS (ac-ft x mg/L)
1.	Base Flow including Nontributary Flow	38,610	612	23,629,320
2.	Less Nontributary Flow	341	237	80,817
3.	Plus Rubidoux Wastewater	2,037	717	1,460,529
4.	Average TDS of Base Flow	25,009,032 ÷ 40,306 = 620 mg/L		

Adjusted Base Flow at Riverside Narrows

The Stipulated Judgment provides that the amount of Base Flow at Riverside Narrows received during any year shall be subject to adjustment based on the weighted average annual TDS of the Base Flow as follows:

If the Weighted Average TDS in Base Flow at Riverside Narrows is:	Than the Adjusted Base shall be determined by the formula:
Greater than 700 mg/L	$Q - \frac{11}{15,250} Q(TDS-700)$
600 mg/L to 700 mg/L	Q
Less than 600 mg/L	$Q + \frac{11}{15,250} Q(600-TDS)$

Where: Q = Base Flow actually received.

From the previous subsection, the weighted average annual TDS in the Base Flow at Riverside Narrows for the water year 1991-92 was 620 mg/L. Therefore, no adjustment is necessary, and the Adjusted Base Flow for 1991-92 is 40,306 acre-feet.

Entitlement and Credit or Debit

Paragraph 5(b) of the Stipulated Judgment states that "SBVMWD shall be responsible for an average annual Adjusted Base Flow of 15,250 acre-feet at Riverside Narrows... SBVMWD each year shall be responsible at Riverside Narrows for not less than 13,420 acre-feet of Base Flow plus one-third of any cumulative debit, provided, however, that for any year commencing on or after October 1, 1986, when there is no cumulative debit, or for any year prior to 1986 whenever the cumulative credit exceeds 10,000 acre-feet, said minimum shall be 12,420 acre-feet."

The Watermaster's findings at Riverside Narrows for 1991-92 required under the Stipulated Judgment are as follows:

1.	Base Flow at Riverside Narrows	40,306 acre-feet
2.	Annual Weighted TDS of Base Flow	620 acre-feet
3.	Annual Adjusted Base Flow	40,306 acre-feet
4.	Cumulative Adjusted Base Flow	801,363 acre-feet
5.	Cumulative Entitlement of CBMWD and WMWD	335,500 acre-feet
6.	Cumulative Credit	465,863 acre-feet
7.	One-Third of Cumulative Debit	0 acre-feet
8.	Minimum Required Base Flow in 1992-93	12,420 acre-feet

APPENDIX A

NONTRIBUTARY WATER RELEASED BY MWDSC TO SAN ANTONIO CREEK NEAR UPLAND

CONNECTION OC-59

1991-92

PREPARED BY

DONALD L. HARRIGER

TABLE A-1

NONTRIBUTARY WATER FROM OC-59
MONTHLY TOTALS
(Acre-Feet)

WATER YEAR 1991-92

No water was released during Water Year 1991-92
for the Orange County Water District.

APPENDIX B

WATER QUALITY
SANTA ANA RIVER BELOW PRADO DAM

1991-92

PREPARED BY

WILLIAM R. MILLS,JR.

TABLE B–1

USGS WATER QUALITY SAMPLES BELOW PRADO DAM
WATER YEAR 1991–92

DATE	EC (microsiemens/cm)	TDS (mg/L)	SOURCE
10/01	1,000	626	USGS
10/16	1,020	656	USGS
11/04	1,050	648	USGS
11/19	1,040	635	USGS
01/10	590	377	USGS
01/30	1,070	652	USGS
02/04	1,050	652	USGS
02/25	780	468	USGS
03/17	1,140	701	USGS
04/01	552	343	USGS
05/13	1,070	648	USGS
05/21	1,080	684	USGS
06/23	1,050	634	USGS
07/08	1,040	604	USGS
07/16	1,040	628	USGS
08/10	990	602	USGS
08/25	1,030	615	USGS
09/01	1,040	684	USGS
09/15	1,030	630	USGS

TABLE B–2

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991–92

OCTOBER 1991

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC (microsiemens/cm)	COMPUTED TDS[1] (mg/L)	OUTFLOW x TDS
1	103	987	607	62,549
2	100	1,000	615	61,527
3	98	1,050	646	63,311
4	103	1,060	652	67,175
5	101	1,020	628	63,385
6	107	1,010	621	66,492
7	110	995	612	67,341
8	111	995	612	67,953
9	109	1,000	615	67,064
10	110	998	614	67,544
11	106	1,010	621	65,871
12	108	1,010	621	67,113
13	112	999	615	68,841
14	114	992	610	69,579
15	112	1,000	615	68,910
16	112	1,010	621	69,599
17	113	1,020	628	70,916
18	114	1,020	628	71,543
19	115	1,020	628	72,171
20	126	1,020	628	79,074
21	132	1,020	628	82,840
22	138	1,020	628	86,605
23	139	1,020	628	87,233
24	136	1,040	640	87,024
25	142	1,070	658	93,484
26	157	1,090	671	105,291
27	308	929	572	176,048
28	219	1,040	640	140,133
29	144	1,060	652	93,915
30	144	1,050	646	93,029
31	154	1,070	658	101,384
TOTAL	3,997			2,504,943
MONTHLY FLOW WEIGHTED TDS			627	

1. TDS = EC x 0.615268

TABLE B–2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991–92

NOVEMBER 1991

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC (microsiemens/cm)	COMPUTED TDS [1] (mg/L)	OUTFLOW x TDS
1	146	1,080	664	97,015
2	163	1,080	664	108,312
3	190	1,030	634	120,408
4	190	1,040	640	121,577
5	191	1,050	646	123,392
6	173	1,060	652	112,828
7	162	1,060	652	105,654
8	156	1,060	652	101,741
9	152	1,060	652	99,132
10	155	1,060	652	101,089
11	153	1,050	646	98,843
12	134	1,050	646	86,568
13	134	1,050	646	86,568
14	134	1,040	640	85,744
15	136	1,040	640	87,024
16	134	1,050	646	86,568
17	147	1,030	634	93,158
18	158	1,020	628	99,157
19	165	1,020	628	103,550
20	178	1,010	621	110,613
21	180	1,020	628	112,963
22	183	1,020	628	114,846
23	185	1,010	621	114,963
24	183	1,010	621	113,720
25	196	994	612	119,869
26	198	994	612	121,092
27	214	994	612	130,877
28	201	1,010	621	124,906
29	205	999	615	126,004
30	203	996	613	124,400
TOTAL	5,099			3,232,578
MONTHLY FLOW WEIGHTED TDS			634	

1. TDS = EC x 0.615268

TABLE B–2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991–92

DECEMBER 1991

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC [2] (microsiemens/cm)	COMPUTED TDS [1] (mg/L)	OUTFLOW x TDS
1	200	997	613	122,684
2	183	1,010	621	113,720
3	179	1,020	628	112,336
4	186	1,010	621	115,584
5	197	1,010	621	122,420
6	200	1,000	615	123,054
7	213	985	606	129,086
8	216	982	604	130,506
9	215	986	607	130,431
10	209	983	605	126,405
11	214	982	604	129,297
12	206	985	606	124,844
13	205	985	606	124,238
14	210	984	605	127,078
15	210	982	604	126,887
16	211	981	603	127,300
17	218	979	602	131,325
18	225	978	602	135,338
19	239	976	601	143,542
20	216	975	600	129,532
21	205	973	599	122,750
22	203	972	598	121,368
23	206	970	597	122,975
24	208	969	596	123,980
25	222	967	595	132,123
26	213	966	594	126,573
27	212	964	593	125,787
28	349	963	592	206,757
29	314	961	592	185,737
30	400	960	591	236,244
31	456	958	590	268,905
TOTAL	7,140			4,298,804
MONTHLY FLOW WEIGHTED TDS			602	

1. TDS = EC x 0.615268
2. Dec. 14 – Dec. 31 EC values are estimated.

TABLE B–2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991–92

JANUARY 1992

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC [2] (microsiemens/cm)	COMPUTED TDS [1] (mg/L)	OUTFLOW x TDS
1	419	957	589	246,706
2	334	955	588	196,355
3	300	955	587	176,182
4	304	867	533	162,165
5	304	784	482	146,641
6	245	735	452	110,794
7	334	636	391	130,698
8	442	600	369	163,169
9	489	592	364	178,113
10	486	583	359	174,329
11	484	606	373	180,461
12	479	631	388	185,964
13	474	655	403	191,022
14	467	679	418	195,097
15	468	721	444	207,609
16	479	788	485	232,234
17	477	823	506	241,536
18	461	865	532	245,347
19	433	902	555	240,303
20	356	951	585	208,303
21	205	965	594	121,715
22	200	963	593	118,501
23	192	982	604	116,005
24	192	992	610	117,186
25	187	1,010	621	116,206
26	187	1,020	628	117,356
27	187	1,040	640	119,657
28	206	1,040	640	131,815
29	205	1,060	652	133,698
30	198	1,060	652	129,132
31	188	1,060	652	122,611
TOTAL	10,382			5,156,909
MONTHLY FLOW WEIGHTED TDS			497	

1. TDS = EC x 0.615268
2. Jan. 1 – Jan. 3 EC values are estimated.

TABLE B–2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991–92

FEBRUARY 1992

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC (microsiemens/cm)	COMPUTED TDS [1] (mg/L)	OUTFLOW x TDS
1	183	1,060	652	119,350
2	189	1,050	646	122,100
3	188	1,050	646	121,454
4	191	1,050	646	123,392
5	195	1,060	652	127,176
6	181	1,020	628	113,591
7	249	759	467	116,280
8	312	674	415	129,383
9	308	761	468	144,211
10	315	863	531	167,258
11	301	672	413	124,451
12	1,690	456	281	474,150
13	3,260	363	223	728,096
14	4,010	340	209	838,856
15	1,790	375	231	412,999
16	2,690	457	281	756,367
17	1,210	470	289	349,903
18	474	523	322	152,526
19	503	562	346	173,928
20	500	600	369	184,580
21	498	637	392	195,179
22	493	684	421	207,476
23	482	830	511	246,144
24	474	824	507	240,309
25	474	810	498	236,226
26	505	858	528	266,589
27	480	879	541	259,594
28	521	918	565	294,269
29	507	965	594	301,023
TOTAL	23,173			7,726,861
MONTHLY FLOW WEIGHTED TDS			333	

1. TDS = EC x 0.615268

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991-92

MARCH 1992

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (microsiemens/cm)	COMPUTED TDS [1] (mg/L)	OUTFLOW x TDS
1	473	996	613	289,858
2	140	1,070	658	92,167
3	381	1,020	628	239,105
4	481	945	581	279,667
5	333	877	540	179,683
6	212	815	501	106,306
7	226	801	493	111,380
8	229	837	515	117,930
9	397	756	465	184,662
10	470	787	484	227,581
11	491	814	501	245,907
12	499	851	524	261,273
13	486	910	560	272,108
14	469	978	602	282,212
15	443	1,020	628	278,015
16	317	1,080	664	210,643
17	255	1,120	689	175,721
18	247	1,120	689	170,208
19	218	1,120	689	150,224
20	221	1,070	658	145,492
21	248	329	202	50,201
22	330	361	222	73,297
23	479	396	244	116,706
24	668	456	281	187,416
25	673	420	258	173,912
26	558	412	253	141,448
27	1,760	423	260	458,055
28	836	451	277	231,978
29	520	493	303	157,730
30	519	509	313	162,536
31	517	524	322	166,681
TOTAL	14,096			5,940,102
MONTHLY FLOW WEIGHTED TDS			421	

1. TDS = EC x 0.615268

TABLE B–2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991–92

APRIL 1992

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC (microsiemens/cm)	COMPUTED TDS [1] (mg/L)	OUTFLOW x TDS
1	514	551	339	174,253
2	514	611	376	193,227
3	515	654	402	207,228
4	513	685	421	216,208
5	509	687	423	215,149
6	505	677	417	210,351
7	500	686	422	211,037
8	498	708	436	216,934
9	494	720	443	218,839
10	506	729	449	226,956
11	511	727	447	228,570
12	506	729	449	226,956
13	497	741	456	226,589
14	491	749	461	226,270
15	506	761	468	236,919
16	511	762	469	239,574
17	502	784	482	242,150
18	495	790	486	240,601
19	486	798	491	238,618
20	505	800	492	248,568
21	515	835	514	264,581
22	504	868	534	269,163
23	492	891	548	269,716
24	291	929	572	166,331
25	129	963	593	76,433
26	127	961	591	75,092
27	127	971	597	75,873
28	126	982	604	76,128
29	124	996	613	75,988
30	373	979	602	224,676
TOTAL	12,886			6,018,977
MONTHLY FLOW WEIGHTED TDS			467	

1. TDS = EC x 0.615268

TABLE B–2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991–92

MAY 1992

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC (microsiemens/cm)	COMPUTED TDS [1] (mg/L)	OUTFLOW x TDS
1	517	979	602	311,414
2	503	976	601	302,052
3	482	972	598	288,256
4	458	980	603	276,157
5	401	1,030	634	254,124
6	199	1,050	646	128,560
7	200	1,070	658	131,667
8	205	1,090	671	137,482
9	195	1,090	671	130,775
10	195	1,090	671	130,775
11	179	1,090	671	120,045
12	167	1,090	671	111,997
13	180	1,070	658	118,501
14	173	1,070	658	113,892
15	175	1,070	658	115,209
16	166	1,060	652	108,263
17	156	1,070	658	102,701
18	173	1,060	652	112,828
19	175	1,050	646	113,055
20	165	1,060	652	107,610
21	142	1,050	646	91,736
22	147	1,030	634	93,158
23	152	1,010	621	94,456
24	151	1,010	621	93,835
25	145	1,010	621	90,106
26	154	999	615	94,657
27	152	1,010	621	94,456
28	148	1,010	621	91,970
29	136	1,030	634	86,187
30	144	1,020	628	90,371
31	144	1,030	634	91,257
TOTAL	6,679			4,227,550
MONTHLY FLOW WEIGHTED TDS			633	

1. TDS = EC x 0.615268

TABLE B–2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991–92,

JUNE 1992

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC (microsiemens/cm)	COMPUTED TDS [1] (mg/L)	OUTFLOW x TDS
1	142	1,040	640	90,863
2	137	1,040	640	87,663
3	134	1,030	634	84,919
4	136	1,020	628	85,350
5	128	1,010	621	79,542
6	136	995	612	83,258
7	139	996	613	85,180
8	140	1,000	615	86,138
9	139	1,000	615	85,522
10	136	1,020	628	85,350
11	136	1,030	634	86,187
12	142	1,010	621	88,242
13	140	1,000	615	86,138
14	140	1,010	621	86,999
15	141	1,020	628	88,488
16	142	1,030	634	89,989
17	141	1,040	640	90,223
18	139	1,040	640	88,943
19	135	1,040	640	86,384
20	138	1,030	634	87,454
21	139	1,040	640	88,943
22	147	1,040	640	94,062
23	151	1,040	640	96,622
24	147	1,040	640	94,062
25	139	1,030	634	88,088
26	139	1,020	628	87,233
27	139	1,020	628	87,233
28	140	1,020	628	87,860
29	139	1,020	628	87,233
30	139	1,030	634	88,088
TOTAL	4,180			2,632,254
MONTHLY FLOW WEIGHTED TDS			630	

1. TDS = EC x 0.615268

TABLE B–2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991–92

JULY 1992

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC (microsiemens/cm)	COMPUTED TDS [1] (mg/L)	OUTFLOW x TDS
1	139	1,030	634	88,088
2	140	1,040	640	89,583
3	138	1,040	640	88,303
4	139	1,040	640	88,943
5	135	1,050	646	87,214
6	127	1,050	646	82,046
7	112	1,070	658	73,734
8	141	1,040	640	90,223
9	152	1,030	634	96,326
10	152	1,030	634	96,326
11	136	1,030	634	86,187
12	134	1,070	658	88,217
13	141	986	607	85,538
14	141	1,000	615	86,753
15	144	1,000	615	88,599
16	143	1,010	621	88,863
17	141	1,020	628	88,488
18	139	1,030	634	88,088
19	140	1,020	628	87,860
20	139	1,030	634	88,088
21	136	1,020	628	85,350
22	136	1,030	634	86,187
23	137	1,030	634	86,820
24	139	1,030	634	88,088
25	139	1,030	634	88,088
26	140	1,030	634	88,722
27	139	1,030	634	88,088
28	140	1,030	634	88,722
29	135	1,040	640	86,384
30	136	1,030	634	86,187
31	138	1,030	634	87,454
TOTAL	4,288			2,717,556
MONTHLY FLOW WEIGHTED TDS			634	

1. TDS = EC x 0.615268

TABLE B–2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991–92

AUGUST 1992

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC (microsiemens/cm)	COMPUTED TDS [1] (mg/L)	OUTFLOW x TDS
1	136	1,030	634	86,187
2	134	1,040	640	85,744
3	132	1,030	634	83,652
4	134	1,030	634	84,919
5	133	1,030	634	84,286
6	128	1,030	634	81,117
7	152	1,000	615	93,521
8	164	983	605	99,189
9	170	985	606	103,027
10	155	1,000	615	95,367
11	118	1,050	646	76,232
12	112	1,070	658	73,734
13	115	1,060	652	75,001
14	128	951	585	74,895
15	123	1,020	628	77,192
16	125	1,030	634	79,216
17	133	1,030	634	84,286
18	134	1,020	628	84,095
19	137	1,020	628	85,978
20	129	1,020	628	80,957
21	118	1,020	628	74,054
22	118	1,020	628	74,054
23	122	1,010	621	75,813
24	118	1,020	628	74,054
25	116	1,020	628	72,799
26	120	1,020	628	75,309
27	119	1,020	628	74,681
28	120	1,020	628	75,309
29	122	1,020	628	76,564
30	124	1,020	628	77,819
31	126	1,020	628	79,074
TOTAL	4,015			2,518,120
MONTHLY FLOW WEIGHTED TDS			627	

1. TDS = EC x 0.615268

TABLE B–2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

FOR WATER YEAR 1991–92

SEPTEMBER 1992

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC (microsiemens/cm)	COMPUTED TDS [1] (mg/L)	OUTFLOW x TDS
1	128	1,030	634	81,117
2	132	1,030	634	83,652
3	132	1,030	634	83,652
4	129	1,030	634	81,751
5	128	1,020	628	80,329
6	132	1,010	621	82,028
7	142	1,010	621	88,242
8	150	1,000	615	92,290
9	142	1,010	621	88,242
10	138	1,010	621	85,756
11	139	1,010	621	86,377
12	136	1,010	621	84,513
13	140	1,010	621	86,999
14	144	1,010	621	89,485
15	145	1,020	628	90,998
16	140	1,030	634	88,722
17	139	1,030	634	88,088
18	143	1,040	640	91,503
19	139	1,040	640	88,943
20	137	1,040	640	87,663
21	139	1,040	640	88,943
22	135	1,050	646	87,214
23	134	1,050	646	86,568
24	133	1,060	652	86,740
25	137	1,070	658	90,192
26	130	1,070	658	85,584
27	116	1,080	664	77,081
28	115	1,080	664	76,416
29	116	1,090	671	77,794
30	125	1,100	677	84,599
TOTAL	4,035			2,571,482
MONTHLY FLOW WEIGHTED TDS			637	

1. TDS = EC x 0.615268

TABLE B–3

ANNUAL SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1991–92

MONTH	MONTHLY FLOW (cfs–days)	MONTHLY WEIGHTED TDS [1] (mg/L)	MONTHLY FLOW x TDS
OCTOBER	3,997	627	2,504,943
NOVEMBER	5,099	634	3,232,578
DECEMBER	7,140	602	4,298,804
JANUARY	10,382	497	5,156,909
FEBRUARY	23,173	333	7,726,861
MARCH	14,096	421	5,940,102
ARPIL	12,886	467	6,018,977
MAY	6,679	633	4,227,550
JUNE	4,180	630	2,632,254
JULY	4,288	634	2,717,556
AUGUST	4,015	627	2,518,120
SEPTEMBER	4,035	637	2,571,482
TOTAL	99,970		49,546,137
WATER YEAR WEIGHTED TDS		496	

1. Values for December and January include estimated data from Dec. 14 – Jan. 3.

APPENDIX C

WATER QUALITY
SANTA ANA RIVER AT RIVERSIDE NARROWS

1991-92

PREPARED BY

DONALD L. HARRIGER

TABLE C-1

WATER QUALITY ANALYSES
SANTA ANA RIVER AT RIVERSIDE NARROWS

WATER YEAR 1991-92

Date Sampled	EC microsiemens/cm	TDS mg/L	Source
1991			
10-01	950	603	USGS
10-03	870	610	C of R
10-08	890	621	C of R
10-13	989	621	DWR
10-16	940	613	USGS
10-17	900	597	C of R
10-21	938	598	C of R
10-31	944	636	C of R
11-01	950	589	USGS
11-05	800	578	C of R
11-14	920	578	C of R
11-19	940	607	C of R
11-21	935	589	USGS
11-28	930	594	C of R
12-03	901	585	C of R
12-04	965	593	DWR
12-12	905	586	C of R
12-17	900	584	C of R
12-26	920	588	C of R
1992			
01-09*	790	513	C of R
01-10	940	583	USGS
01-14	948	666	C of R
01-23	924	593	C of R

* Data not used in determining monthly averages, storm flow.

C of R City of Riverside
USGS United States Geological Survey
DWR Department of Water Resources

TABLE C-1 (continued)

WATER QUALITY ANALYSES
SANTA ANA RIVER AT RIVERSIDE NARROWS

WATER YEAR 1991-92

Date Sampled	EC microsiemens/cm	TDS mg/L	Source
1992			
01-23	924	593	C of R
01-27	970	602	USGS
01-28	1000	612	C of R
02-04	970	612	USGS
02-06	1000	658	C of R
02-11*	-	458	C of R
02-21*	854	514	USGS
02-25	1020	639	C of R
03-03*	555	358	C of R
03-04	1020	654	DWR
03-06*	590	610	C of R
03-09*	891	526	USGS
03-19	1110	630	C of R
04-02*	940	551	C of R
04-06*	905	661	USGS
04-07*	1100	650	C of R
04-16	1080	660	C of R
04-21	980	609	C of R
04-28	965	623	C of R
05-05	1075	660	C of R
05-12	933	-	DWR
05-14	1000	651	C of R
05-19	1060	603	C of R

* Data not used in determining monthly averages, storm flow.

C of R City of Riverside
USGS United States Geological Survey
DWR Department of Water Resources

TABLE C-1 (continued)

WATER QUALITY ANALYSES
SANTA ANA RIVER AT RIVERSIDE NARROWS

WATER YEAR 1991-92

Date Sampled	EC microsiemens/cm	TDS mg/L	Source
1992			
05-21	927	546	USGS
05-28	1020	634	C of R
06-02	1085	590	C of R
06-11	710	562	C of R
06-24	908	570	USGS
06-25	1000	629	C of R
06-30	980	611	C of R
07-08*	895	548	USGS
07-09*	1160	624	C of R
07-14	860	589	C of R
07-22	940	572	USGS
07-23	960	637	C of R
07-28	945	607	C of R
08-10	970	582	USGS
08-11	1275	619	C of R
08-20	1010	598	C of R
08-25	978	635	C of R
08-26	886	538	USGS
09-01	945	594	USGS
09-03	1000	632	C of R
09-08	945	619	C of R
09-16	950	584	USGS
09-17	950	620	C of R
09-22	980	617	C of R

* Data not used in determining monthly averages, storm flow.

C of R City of Riverside
USGS United States Geological Survey
DWR Department of Water Resources

TABLE C - 2

FLOW-WEIGHTED TDS OF BASE FLOW AT RIVERSIDE NARROWS
(Including Nontributary Flow
Discharged Above the Narrows)

WATER YEAR 1991-92

Month	Acre-feet [1]	TDS [2] mg/L	Acre-feet x TDS
October	2,595	612	1,588,140
November	3,135	589	1,846,515
December	3,697	587	2,170,139
January	3,575	608	2,173,600
February	3,364	636	2,139,504
March	3,789	642	2,432,538
April	3,699	631	2,334,069
May	3,602	619	2,229,638
June	2,999	592	1,775,408
July	3,206	605	1,939,630
August	2,537	594	1,506,978
September	2,412	611	1,473,732
	38,610		23,609,891

$$\text{Flow-weighted TDS} = \frac{23,609,891}{38,610} = 612 \text{ mg/L}$$

(1) Total Flow minus Storm Flow from Table 6
(2) Estimated average TDS based on water quality data from Table C - 1

APPENDIX D

QUANTITY AND QUALITY OF WASTEWATER FROM RUBIDOUX COMMUNITY SERVICES DISTRICT DISCHARGED BELOW THE RIVERSIDE NARROWS GAGING STATION

1991-92

PREPARED BY

DONALD L. HARRIGER

TABLE D-1

QUANTITY AND QUALITY OF WASTEWATER FROM RUBIDOUX
DISCHARGE BELOW THE
RIVERSIDE NARROWS GAGING STATION

WATER YEAR 1991-92

Month	Acre-feet	TDS mg/L	Acre-feet x TDS
1991			
October	170	725	123,556
November	167	725	121,240
December	167	725	120,771
1992			
January	169	706	119,512
February	161	579	92,967
March	175	697	121,967
April	168	770	129,188
May	173	766	132,631
June	168	728	122,142
July	172	730	125,502
August	174	694	120,825
September	173	754	130,762
	2,037		1,461,063

$$\text{Flow-weighted TDS} = \frac{1{,}461{,}063}{2{,}037} = 717 \text{ mg/L}$$

APPENDIX E

WATER RELEASED FROM THE ARLINGTON DESALTER TO THE SANTA ANA RIVER BELOW THE RIVERSIDE NARROWS VIA THE ARLINGTON VALLEY DRAIN

1991-92

PREPARED BY

DONALD L. HARRIGER

TABLE E-1

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

MONTHLY TOTALS
(Acre-Feet)

WATER YEAR 1991-92

	Acre-feet Discharged
1991	
October	417
November	165
December	580
1992	
January	224
February	176
March	199
April	0
May	0
June	172
July	487
August	584
September	544
Total	3,548

TABLE E-2

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

OCTOBER 1991
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	9
2	6
3	3
4	3
5	6
6	9
7	9
8	8
9	9
10	9
11	9
12	9
13	9
14	9
15	8
16	8
17	8
18	8
19	8
20	8
21	8
22	8
23	8
24	8
25	8
26	4
27	0
28	0
29	0
30	3
31	8
Total in CFS-DAYS	210
Total AF	417

TABLE E-2 (continued)

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

NOVEMBER 1991
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	7
2	7
3	5
4	8
5	9
6	9
7	3
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	1
27	4
28	10
29	10
30	10
Total in CFS-DAYS	83
Total AF	165

TABLE E-2 (continued)

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

DECEMBER 1991
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	10
2	9
3	10
4	10
5	10
6	10
7	10
8	10
9	10
10	10
11	10
12	10
13	10
14	10
15	10
16	10
17	10
18	10
19	10
20	10
21	10
22	10
23	10
24	10
25	10
26	9
27	10
28	10
29	4
30	0
31	
Total in CFS-DAYS	292
Total AF	580

TABLE E-2 (continued)

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

JANUARY 1992
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	4
21	10
22	8
23	10
24	10
25	10
26	10
27	10
28	10
29	10
30	10
31	10
Total in CFS-DAYS	113
Total AF	224

TABLE E-2 (continued)

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

FEBRUARY 1992
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	10
2	10
3	10
4	10
5	10
6	10
7	10
8	10
9	9
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
Total in CFS-DAYS	89
Total AF	176

TABLE E-2 (continued)

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

MARCH 1992
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	5
14	10
15	10
16	10
17	10
18	10
19	10
20	10
21	10
22	10
23	4
24	0
25	0
26	0
27	0
28	0
29	0
30	0
31	0
Total in CFS-DAYS	100
Total AF	199

TABLE E-2 (continued)

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

APRIL 1992
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
30	0
Total in CFS-DAYS	0
Total AF	0

TABLE E-2 (continued)

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

MAY 1992
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
30	0
31	0
Total in CFS-DAYS	0
Total AF	0

TABLE E-2 (continued)

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

JUNE 1992
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	6
23	10
24	10
25	9
26	10
27	10
28	10
29	10
30	10
Total in CFS-DAYS	87
Total AF	172

TABLE E-2 (continued)

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

JULY 1992
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	10
2	6
3	0
4	0
5	0
6	0
7	0
8	0
9	5
10	10
11	10
12	10
13	10
14	10
15	10
16	10
17	10
18	10
19	10
20	10
21	10
22	10
23	10
24	10
25	10
26	10
27	10
28	10
29	10
30	10
31	10
Total in CFS-DAYS	245
Total AF	487

TABLE E-2 (continued)

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

AUGUST 1992
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	8
2	9
3	7
4	7
5	7
6	8
7	10
8	10
9	10
10	10
11	10
12	10
13	10
14	10
15	10
16	10
17	10
18	10
19	10
20	10
21	10
22	10
23	10
24	10
25	10
26	10
27	10
28	10
29	10
30	10
31	10
Total in CFS-DAYS	295
Total AF	584

TABLE E-2 (continued)

WATER DISCHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

SEPTEMBER 1992
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	10
2	10
3	10
4	10
5	10
6	10
7	10
8	10
9	9
10	10
11	10
12	10
13	10
14	10
15	10
16	10
17	10
18	10
19	10
20	10
21	10
22	10
23	10
24	10
25	7
26	6
27	0
28	5
29	10
30	10
Total in CFS-DAYS	274
Total AF	544

TABLE E-3

QUALITY OF WATER DISCHARGED FROM THE
ARLINGTON DESALTER
VIA THE ARLINGTON DRAIN

WATER YEAR 1991-92

Month	Acre-feet	TDS mg/L	Acre-feet x TDS
1991			
October	416.91	286	119,236
November	164.57	358	58,916
December	579.71	473	274,203
1992			
January	224.29	409	91,735
February	175.89	422	74,226
March	199.00	442	87,958
April	0.00	-	-
May	0.00	-	-
June	172.10	441	75,896
July	486.93	440	214,249
August	584.39	474	277,001
September	543.85	550	299,118
Total	3,547.64		1,572,537

$$\frac{1,572,537}{3,548} = 443$$

Flow-weighted average TDS for 1991-92 is 443 mg/L

APPENDIX F

SANTA ANA RIVER WATERMASTER
FINANCIAL STATEMENTS WITH REPORT
ON EXAMINATION BY
CERTIFIED PUBLIC ACCOUNTANTS

SANTA ANA RIVER WATERMASTER

FINANCIAL STATEMENTS

WITH REPORT ON AUDIT
BY INDEPENDENT
CERTIFIED PUBLIC ACCOUNTANTS

JUNE 30, 1992

DIEHL, EVANS
& COMPANY
CERTIFIED PUBLIC ACCOUNTANTS

A PARTNERSHIP INCLUDING ACCOUNTANCY CORPORATIONS

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HARVEY J. SCHROEDER, CPA

February 25, 1993

INDEPENDENT AUDITORS' REPORT

Santa Ana River Watermaster
San Bernardino, California

We have audited the accompanying statement of assets and liabilities arising from cash transactions of Santa Ana River Watermaster as of June 30, 1992, and the related statement of revenue collected, expenses paid and changes in fund balance for the year then ended. These financial statements are the responsibility of the Watermaster's management. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with generally accepted auditing standards. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

As described in Note 1, these financial statements were prepared on the basis of cash receipts and disbursements, which is a comprehensive basis of accounting other than generally accepted accounting principles.

In our opinion, the financial statements referred to above present fairly, in all material respects, the assets and liabilities arising from cash transactions of Santa Ana River Watermaster as of June 30, 1992, and its revenue collected, expenses paid, and changes in fund balance during the year then ended, on the basis of accounting described in Note 1.

Diehl, Evans and Company

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SANTA ANA RIVER WATERMASTER

STATEMENT OF ASSETS AND LIABILITIES
ARISING FROM CASH TRANSACTIONS

June 30, 1992

ASSETS

Cash in checking account (Note 3)	$ 3,321
Cash in savings account (Note 3)	2,071
TOTAL ASSETS	$ 5,392

FUND BALANCE

Fund balance	$ 5,392

See independent auditors' report and notes to financial statements.

SANTA ANA RIVER WATERMASTER

STATEMENT OF REVENUE COLLECTED, EXPENSES PAID AND CHANGES IN FUND BALANCE

For the year ended June 30, 1992

		Actual	Budget	Over (Under) Budget
REVENUE COLLECTED:				
Water district contributions (Note 2):				
Orange County Water District		$ 12,800	$ 6,400	$ 6,400
Chino Basin Municipal Water District		3,200	3,200	-
San Bernardino Valley Municipal Water District		3,200	3,200	-
Western Municipal Water District		3,200	3,200	-
Interest from savings account		148	-	148
TOTAL REVENUE COLLECTED		22,548	16,000	6,548
EXPENSES PAID:				
Professional engineering services		26,385	9,000	17,385
Administrative expenses:				
Office and bank service charges	$ 12			
Auditing services	1,136	1,148	1,200	(52)
Annual reports		2,987	5,800	(2,813)
TOTAL EXPENSES PAID		30,520	16,000	14,520
EXCESS OF EXPENSES PAID OVER REVENUE COLLECTED		(7,972)	$ -	$ (7,972)
FUND BALANCE AT JULY 1, 1991		13,364		
FUND BALANCE AT JUNE 30, 1992		$ 5,392		

See independent auditors' report and notes to financial statements.

SANTA ANA RIVER WATERMASTER

NOTES TO FINANCIAL STATEMENTS

June 30, 1992

1. SIGNIFICANT ACCOUNTING POLICIES:

Basis of Accounting:

The Santa Ana River Watermaster's ("Watermaster") policy is to prepare its financial statements on the cash basis of accounting; consequently, certain revenues are recognized when received rather than when earned, and certain expenses are recognized when cash is disbursed rather than when the obligation is incurred.

2. ORGANIZATION AND HISTORY:

The Santa Ana River Watermaster is composed of a committee of five representatives from four water districts. Two representatives serve from Orange County Water District and one representative each serves from Chino Basin Municipal Water District, Western Municipal Water District and San Bernardino Valley Municipal Water District. The committee was established on April 23, 1969 by order of the Superior Court of California in Orange County as part of a judgment resulting from a lawsuit by the Orange County Water District as plaintiff vs. City of Chino, et al, as defendants.

Costs and expenses incurred by the individual representatives are reimbursed directly from the water districts. Collective Watermaster costs and expenses are budgeted and paid for by the Watermaster after receiving contributions from the water districts. Water district contributions are made in the following ratios:

Orange County Water District	40%
Chino Basin Municipal Water District	20%
Western Municipal Water District	20%
San Bernardino Valley Municipal Water District	20%
Total	100%

The Watermaster issues a report each year to satisfy its obligation to monitor and test water flows from the Upper Area to the Lower Area of the Santa Ana River.

See independent auditors' report.

3. CASH IN BANK:

The following disclosures are made in accordance with Statement No. 3 of the Governmental Accounting Standards Board (GASB 3):

Cash at June 30, 1992 consisted of the following:

Bank of America:	
Checking account	$ 3,321
Savings account	2,071
	$ 5,392

All cash is fully insured by the FDIC.

See independent auditors' report.

APPENDIX G

DROUGHT EMERGENCY EXCHANGE GROUNDWATER DISCHARGED TO THE SANTA ANA RIVER ABOVE PRADO

1991-92

PREPARED BY

DONALD L. HARRIGER

TABLE G-1

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO

MONTHLY TOTALS
(Acre-Feet)

WATER YEAR 1991-92

	Discharged Above the Narrows	Discharged Below the Narrows	Total
1991			
October	--	896	896
November	--	1,441	1,441
December	--	1,958	1,958
1992			
January	--	0	0
February	--	220	220
March	--	155	155
April	--	0	0
May	--	0	0
June	--	0	0
July	--	0	0
August	--	0	0
September	--	51	51
Total	0	4,721	4,721

TABLE G-2

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

OCTOBER 1991
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	7
2	8
3	8
4	7
5	7
6	7
7	8
8	8
9	8
10	8
11	10
12	9
13	9
14	10
15	10
16	10
17	12
18	21
19	28
20	26
21	27
22	13
23	13
24	32
25	21
26	2
27	3
28	13
29	35
30	38
31	37
Total in CFS-DAYS	452
Total AF	896

TABLE G-2 (continued)

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

NOVEMBER 1991
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	37
2	37
3	37
4	32
5	2
6	1
7	1
8	2
9	2
10	2
11	2
12	2
13	2
14	2
15	10
16	34
17	38
18	39
19	42
20	41
21	39
22	28
23	29
24	39
25	33
26	34
27	39
28	42
29	39
30	42
Total in CFS-DAYS	727
Total AF	1,441

TABLE G-2 (continued)

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

DECEMBER 1991
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	16
2	14
3	14
4	13
5	27
6	43
7	42
8	42
9	41
10	38
11	38
12	43
13	50
14	49
15	47
16	44
17	43
18	45
19	39
20	30
21	29
22	30
23	40
24	48
25	45
26	46
27	31
28	0
29	0
30	0
31	0
Total in CFS-DAYS	987
Total AF	1,958

TABLE G-2 (continued)

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

JANUARY 1992
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
30	0
31	0
Total in CFS-DAYS	0
Total AF	0

TABLE G-2 (continued)

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

FEBRUARY 1992
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	0
2	4
3	11
4	14
5	14
6	15
7	15
8	13
9	13
10	11
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
Total in CFS-DAYS	111
Total AF	220

TABLE G-2 (continued)

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

MARCH 1992
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	3
17	12
18	14
19	11
20	5
21	14
22	14
23	6
24	0
25	0
26	0
27	0
28	0
29	0
30	0
31	0
Total in CFS-DAYS	78
Total AF	155

TABLE G-2 (continued)

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

APRIL 1992
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
30	0
Total in CFS-DAYS	0
Total AF	0

TABLE G-2 (continued)

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

MAY 1992
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
30	0
31	0
Total in CFS-DAYS	0
Total AF	0

TABLE G-2 (continued)

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

JUNE 1992
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
30	0
Total in CFS-DAYS	0
Total AF	0

TABLE G-2 (continued)

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

JULY 1992
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
30	0
31	0
Total in CFS-DAYS	0
Total AF	0

TABLE G-2 (continued)

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

AUGUST 1992
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
30	0
31	0
Total in CFS-DAYS	0
Total AF	0

TABLE G-2 (continued)

DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

SEPTEMBER 1992
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
0	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	4
29	11
30	11
Total in CFS-DAYS	26
Total AF	51

TABLE G-3

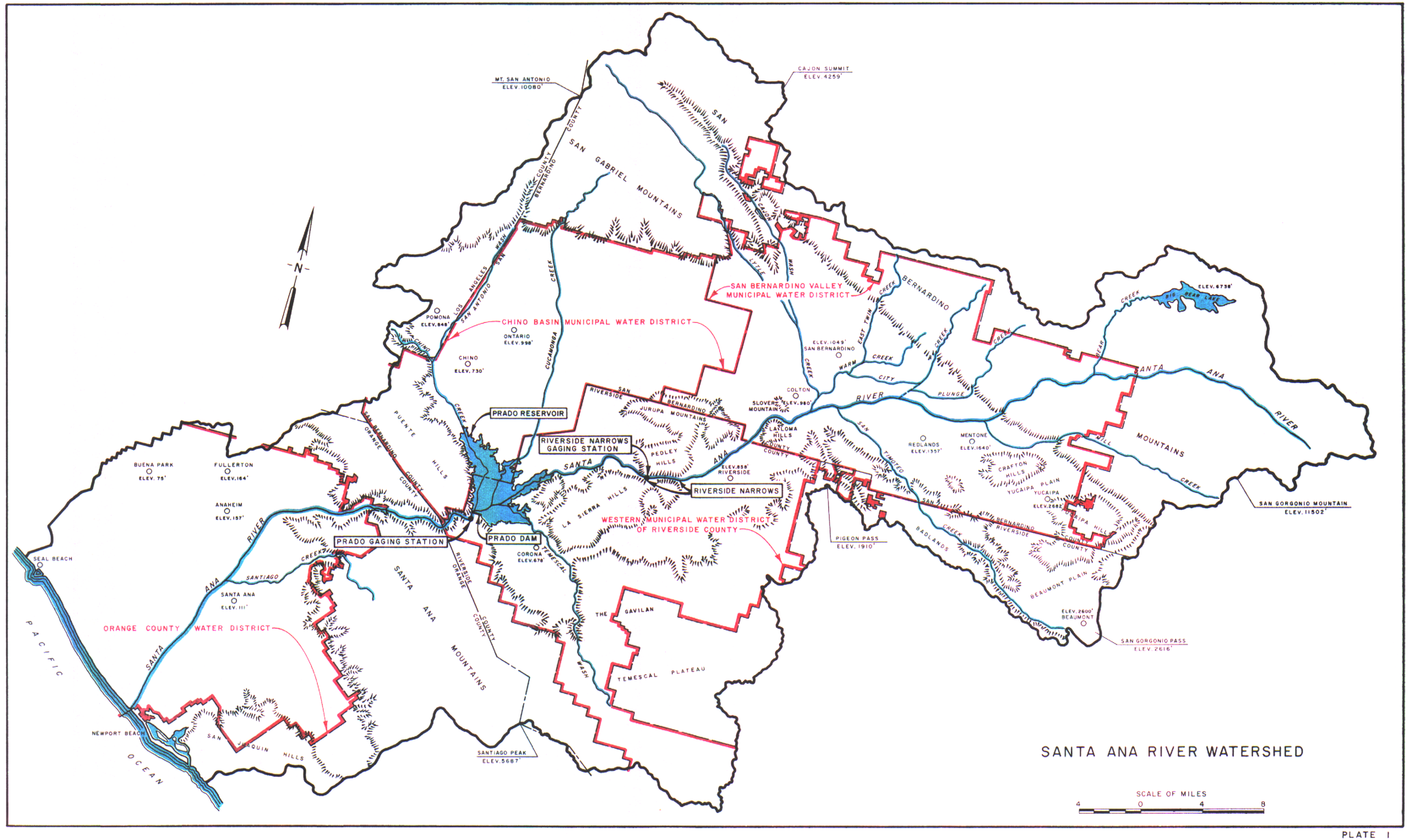
QUALITY OF DROUGHT EMERGENCY
EXCHANGE GROUNDWATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

WATER YEAR 1991-92

Month	Acre-feet	TDS mg/L	Acre-feet x TDS
1991			
October	896	450	403,169
November	1,441	408	587,924
December	1,958	388	759,580
1992			
January	0	-	0
February	220	580	127,467
March	155	470	72,902
April	0	-	0
May	0	-	0
June	0	-	0
July	0	-	0
August	0	-	0
September	51	580	29,795
Total	4,721		1,980,835

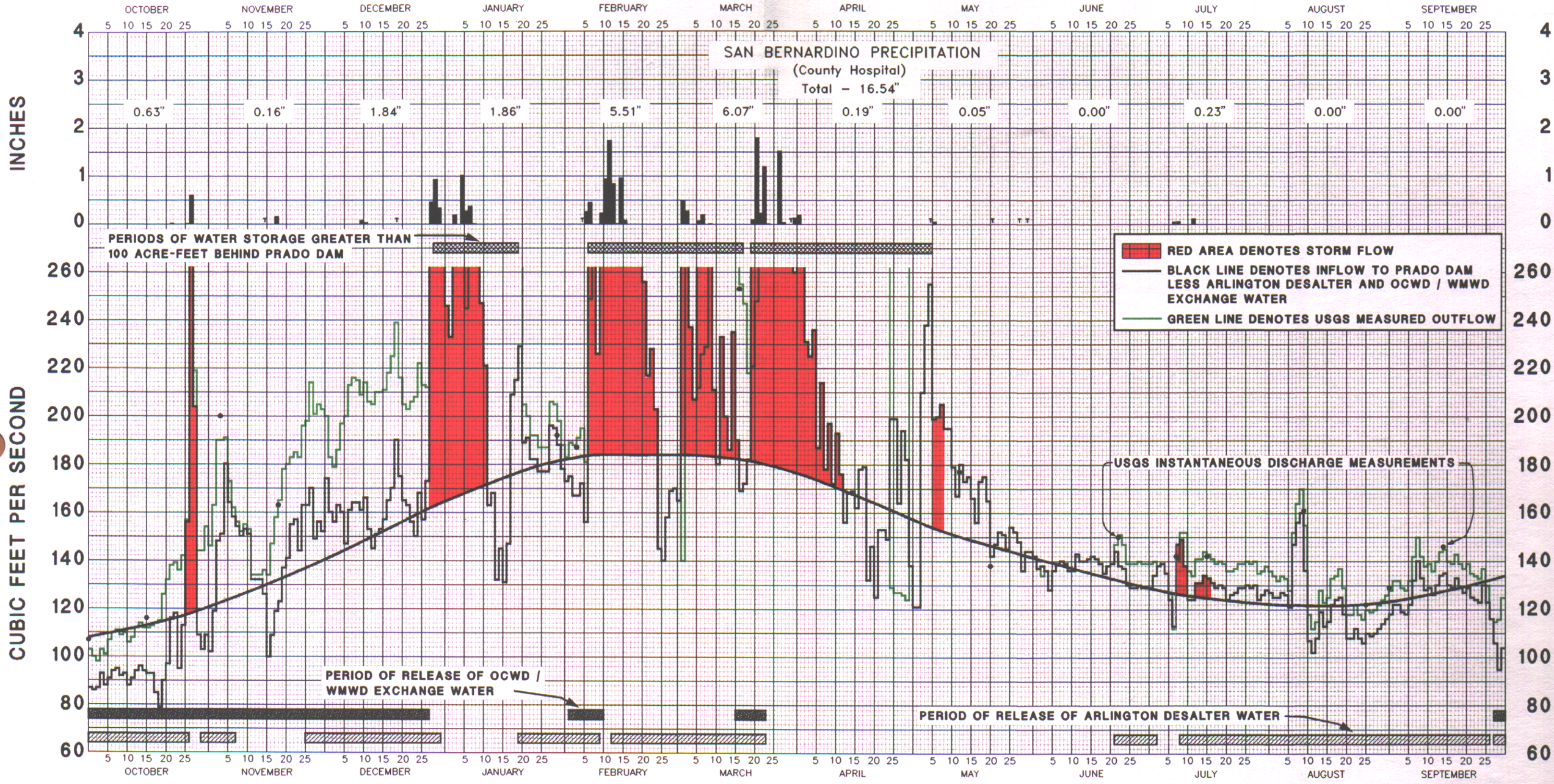
$$\frac{1,980,835}{4,721} = 420$$

Flow-weighted average TDS for 1991-92 is 420 mg/L



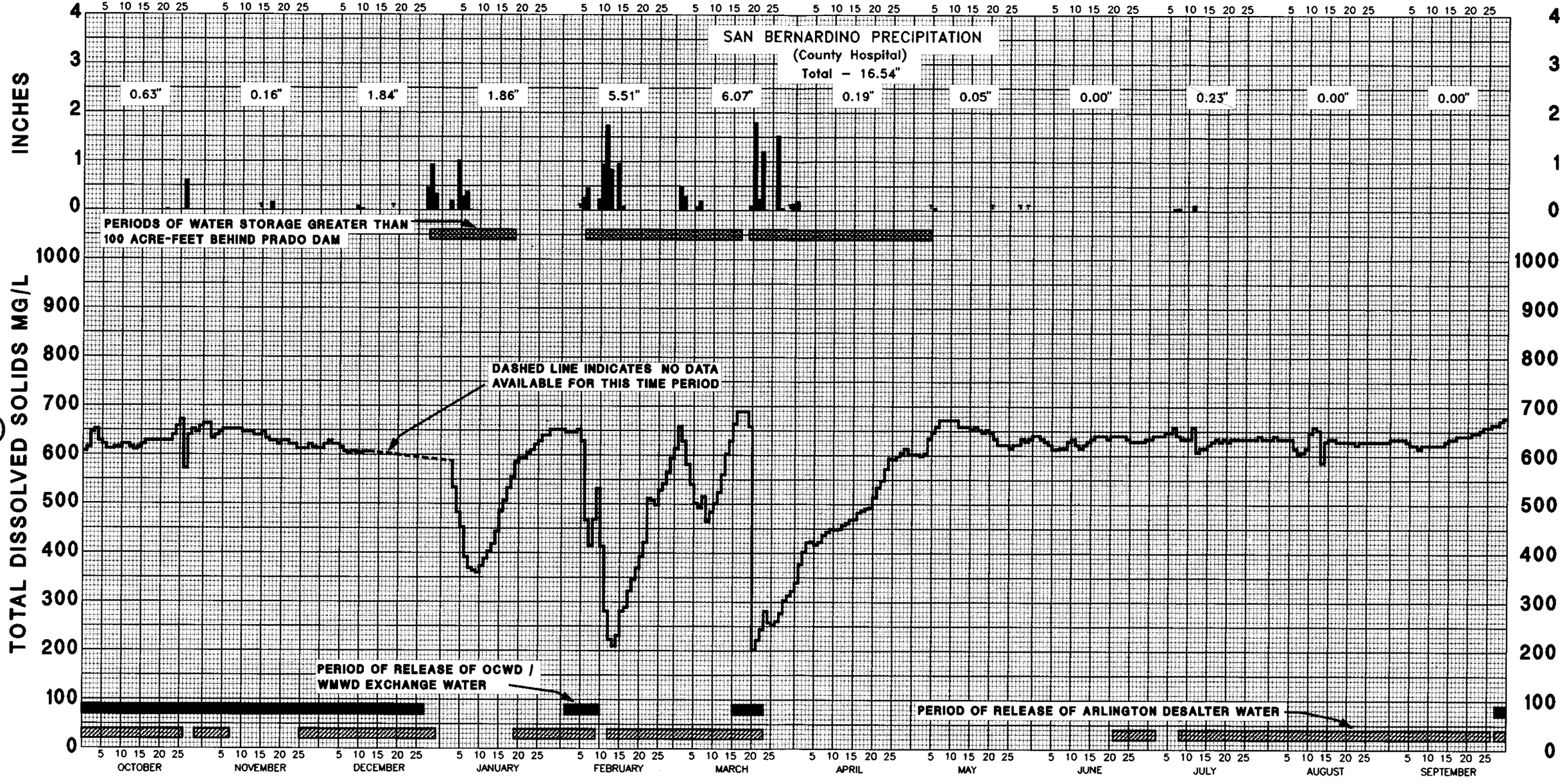
SANTA ANA RIVER WATERSHED

PLATE I



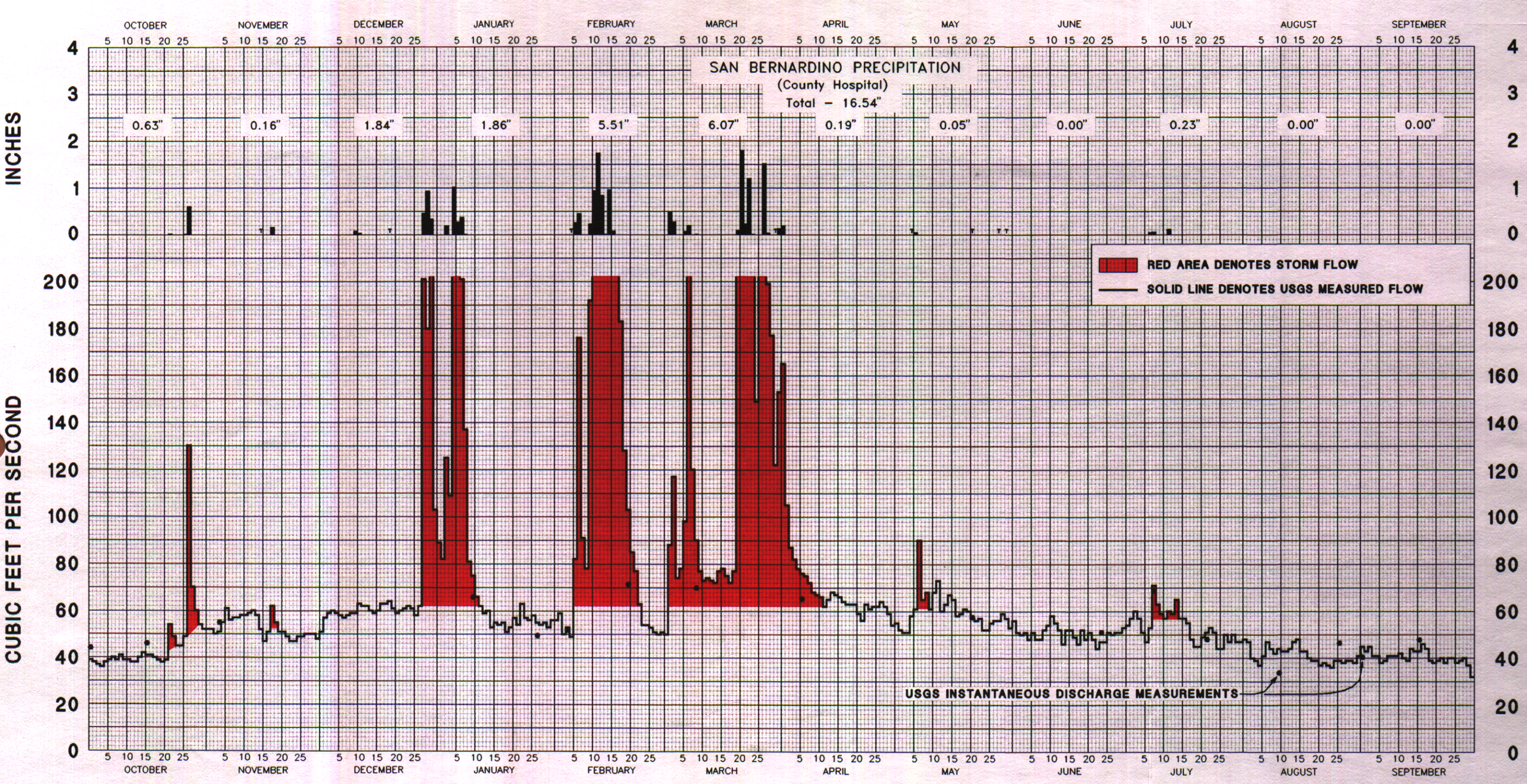
DISCHARGE OF SANTA ANA RIVER AT PRADO DAM & SAN BERNARDINO PRECIPITATION
WATER YEAR 1991-92

Plate 2



DISSOLVED SOLIDS IN SANTA ANA RIVER BELOW PRADO DAM
WATER YEAR 1991-92

Plate 3



DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS & SAN BERNARDINO PRECIPITATION
WATER YEAR 1991-92

Plate 4