SANTA ANA RIVER WATERMASTER

FOR

ORANGE COUNTY WATER DISTRICT

VS. CITY OF CHINO, et al

CASE NO. 117628 - COUNTY OF ORANGE

TWENTY-FIRST
ANNUAL REPORT
OF THE
SANTA ANA RIVER WATERMASTER

1990-91

APRIL 30, 1992

SANTA ANA RIVER WATERMASTER

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

WATERMASTER
Harvey O. Banks
William J. Carroll
Donald L. Harriger
William R. Mills, Jr.
Robert L. Reiter

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April 30, 1992

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-first 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	111,151 acre-feet
2.	Annual Weighted TDS of Base and Storm Flows	514 mg/L
3.	Annual Adjusted Base Flow	128,379 acre-feet
4.	Cumulative Adjusted Base Flow	1,946,040 acre-feet
5.	Cumulative Entitlement of OCWD	882,000 acre-feet
6.	Cumulative Credit	1,064,040 acre-feet
7.	One-third of Cumulative Debit	0 acre-feet
8.	Minimum Required Base Flow in 1991-92	34,000 acre-feet

<u>At Riverside Narrows</u>

1.	Base Flow at Riverside Narrows	45,041 acre-feet
2.	Annual Weighted TDS of Base Flow	616 mg/L

5.	Cumulative Entitlement of CBMWD and WMWD	320,250 acre-feet
6.	Cumulative Credit	440,807 acre-feet
7.	One-third of Cumulative Debit	0 acre-feet
8.	Minimum Required Base Flow in 1991-92	12,420 acre-feet

The above findings show that at the end of the ~~1991-92~~ 1990-91 water year, Chino Basin Municipal Water District and Western Municipal Water District have a cumulative credit of 1,064,040 acre-feet to their Base Flow obligation at Prado Dam. San Bernardino Valley Municipal Water District has a cumulative credit of 440,807 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
Donald L. Harriger

William J. Carroll
William J. Carroll

William R. Mills, Jr.
William R. Mills, Jr.

Robert L. Reiter
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CHAPTER I

WATERMASTER ACTIVITIES

This is the Twenty-first Annual Report of the Santa Ana River Watermaster required by the Stipulated Judgment 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 1990-91 Mr. Banks continued to serve as chairman, and Mr. Reiter served 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 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 Reservoir; namely, Chino Creek at Schaefer Avenue, Cucamonga Creek near Mira Loma and Temescal Wash at Corona.

Precipitation during 1990-91 was below normal and totaled 15.48 inches at San Bernardino County Hospital, 86% of the 26-year base period average of 17.98 inches. In October and November 1990, precipitation totaled 0.27 inches. There was only a trace of rain on December 21. In January 1991, 2.45 inches were recorded. In February 4.43 inches were recorded, and in March a total of 8.23 inches was measured. In April, 0.01 inches were recorded. Only 0.02 inches were measured in May and none in June. There was no precipitation in July or August, and 0.07 inches in September 1991.

Small amounts of base flow but no storm flow were recorded below Prado during October. A small increase in base flow and minor amounts of storm flow occurred in November, and a further small increase in base flow but no storm flow occurred during December at both Riverside Narrows and Prado. Storm runoff occurred intermittently from January 3 through January 10 at Prado and from February 27 through April 10 at both Prado and Riverside Narrows. No storm runoff occurred after April 10 at Prado and at Riverside Narrows. Base flow at Prado peaked at about 190 cfs in February and decreased to 108 cfs at the end of September 1991. Similarly, maximum base flow at Riverside Narrows was approximately 109 cfs early in February and decreased to a minimum of 34 cfs in September.

The 1990-91 discharge record for the USGS gaging station, "Santa Ana below Prado," is considered by the USGS to be a "good" record. Nine (9) direct discharge measurements, which ranged from about 127 to 3,580 cubic feed per second, were made during the year. For the period January 3 through 20, 1991, minor amounts of water were stored in and released from Prado Reservoir; the maximum amount in storage during this period was 3,446 acre-feet on January 6. From February 27, 1991, through April 26, 1991, the discharge was continuously regulated by Prado Reservoir with a maximum of 25,469 acre-feet in storage on March 27, 1991. The maximum average daily discharge after regulation by Prado Reservoir occurred on March 2, 1991, and amounted to 3,490 cubic feet per second. The mean annual discharge was approximately 270 cubic feet per second.

No State Water Project water was released by Metropolitan Water District of Southern California (MWDSC) from turnout OC-59 into San Antonio Creek.

The Arlington Desalter operated continuously in 1990-91 except during March 1991 and discharged 4,895 acre-feet of product water to the drainage tributary to the Santa Ana River below Riverside Narrows.

The overall 1990-91 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. The station was located at the MWDSC Upper Feeder Crossing for the entire year. The continuous downstream movement of sand deposits and vegetation growth affected the stage discharge

TABLE 1

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

October 1, 1990 to September 30, 1991

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT		USGS Cost
At Riverside Narrows (MWD Crossing)		
Water Quality Monitoring/TDS Samples	$805	$2,415
Surface Water Gage	2,057	6,170
WESTERN MUNICIPAL WATER DISTRICT		
Same as SBVMWD	2,861	
Cucamonga Creek Discharge	2,200	4,400
Chino Creek Discharge	1,467	4,400
CHINO BASIN MUNICIPAL WATER DISTRICT		
Same as WMWD	6,528	
ORANGE COUNTY WATER DISTRICT		
At Prado Dam		
Water Quality Monitoring/TDS Samples		
Water Quality Sampling & Conductivity Programs	6,350	5,350
Chino Creek		
Surface Water Gage	1,467	
TOTAL FOR PARTIES	$23,735	
UNITED STATES GEOLOGICAL SURVEY		$22,735
GRAND TOTAL		$46,470

relationship for the station. Twenty-seven (27) direct discharge measurements, which range from about 40 to 5,320 cubic feet per second, were made during the year. The mean annual discharge was approximately 103 cubic feet per second.

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 June 7, 1990, the Watermaster adopted a budget for the fiscal year 1990-91 in the amount of $16,000. Table 1 shows the items and amount included in said budget. The expenses for the fiscal year 1990-91 are also shown. At the request of the chairman, a budget for fiscal year 1991-92 was circulated among the Watermaster dated June 26, 1991. The membership of the Santa Ana River Watermaster was polled and the proposed budget in the amount of $16,000 unanimously adopted. The revised budget for fiscal year 1991-92 is shown in Table 2.

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 1990-91 is included herein as Appendix F.

TABLE 2

SANTA ANA RIVER WATERMASTER BUDGET AND EXPENSES

	July 1, 1990 to June 30, 1991 Budget	July 1, 1990 to June 30, 1991 Expenses	July 1, 1991 to June 30, 1992 Budget
Administration	$3,000.00	$1,183.00	$1,200.00
Support Engineering Services	10,000.00	10,657.67*	9,000.00
Reproduction of Annual Report	3,000.00	6,970.92*	5,800.00
TOTAL	$16,000.00	$18,811.59	$16,000.00

*Expenses incurred during fiscal year 1990-91 to be paid in 1991-92.

Summary Of Findings

A summary of findings by the Watermaster for the period 1970-71 through 1990-91 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	81.34	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	514	128,379	1,064,040

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	5,377
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

(1) Measured at San Bernardino County Hospital.
(2) Excludes Nontributary 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 accordance with agreement between Orange County Water District, Western Municipal Water District, 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 Orange County Water District under the Drought Emergency Exchange agreement discussed later 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 1990-91, as represented by rainfall measured at San Bernardino County Hospital, was about 86% of normal in terms of the Base Period average. The Total Flow of the Santa Ana River below Prado Dam during the 1990-91 water year was about 195,186 acre-feet as compared to a total flow of 144,817 acre-feet which occurred in the previous year. The unadjusted Base Flow amounts at Riverside Narrows and Prado, were 45,041 acre-feet and 111,151 acre-feet, respectively in 1990-91, which are 8,158 acre-feet and 7,998 less than the corresponding values for 1989-90.

Chino Basin Groundwater Storage Program

This program was described and its implications with respect to Watermaster responsibilities and activities discussed in the Sixteenth Annual Report. No water was stored underground in 1990-91.

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

This program also was described in the Sixteenth Annual Report. No ground water was pumped from San Bernardino Basin and discharged to the Santa Ana River in 1990-91.

Discharge of State Water Project Water Above Prado Ontario/MWD 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 1990-91 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 1990-91.

Discharge of Drought Emergency Exchange Water to Santa Ana River

To accommodate drought related shortages within the Metropolitan Water District of Southern California (MWDSC) service area, ground water from the Riverside, Colton and San Bernardino basins was pumped directly to the Santa Ana River pursuant to drought emergency related exchange agreements between Orange County Water District (OCWD), Municipal Water District Of Orange County (MWDOC), Metropolitan Water District of Southern California (MWDSC), Western Municipal Water District

(WMWD), and City of Riverside. Additional water pumped from the San Bernardino Basin Area by City of Riverside was made available by agreement between Western Municipal Water District and San Bernardino Valley Municipal Water District (SBVMWD) pursuant to paragraph VI(b) 6 of the Western-San Bernardino Judgement (Riverside County Case No. 87426).

These agreements provide for WMWD to acquire a portion of MWDOC's MWDSC allotment which had been in turn allocated to OCWD for replenishment purposes, in exchange for Western's delivery of a like amount of groundwater to the Santa Ana River for replenishment in Orange County. The exchange is in effect a delivery of non-tributary water by OCWD to WMWD above Prado Dam which is exchanged for groundwater pumped and released to the Santa Ana River.

More specifically the agreements provide that:

a) WMWD and SBVMWD agree that City of Riverside may produce more than its adjudicated right to water from the San Bernardino Basin Area;

b) City of Riverside agrees with WMWD to pump groundwater and deliver it through the Riverside Canal to the Santa Ana River;

c) OCWD agrees to replenish its groundwater basin with the pumped groundwater instead of MWDSC water and request MWDOC to make a like amount of its MWDSC allocation of water available to WMWD;

d) MWDOC agrees to request MWDSC to transfer to WMWD an amount of 10,000 acre-feet to be repaid by WMWD from pumped groundwater deliveries to the Santa Ana River.

e) MWDSC agrees that WMWD can take delivery of an amount of MWDSC water in excess of its allocation equal to the amount of groundwater to be pumped and delivered the river.

The agreements provide for delivery by May of 1992 of up to 10,000 acre feet of water to the Santa Ana River below Van Buren Boulevard through the Riverside Canal and the Monroe Street storm drain. Delivery to the river is measured by a calibrated continuous stage recorder on the Riverside Canal near the point at which the canal empties into the storm drain. However, due to Riverside Canal operating problems a minor amount of pumped water was released during June upstream of the flow recorder and delivered to the river upstream of Riverside Narrows. The amount of such water was computed on the basis of metered inflow to the canal. The agreements also provide for WMWD to deliver 5 percent more water to the river than the exchanged amount to compensate for any losses between the point of delivery and replenishment basins in Orange County.

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.

Arlington Desalter

The objective of this project is to extract poor quality groundwater from the Arlington sub-basin and treat it by the reverse osmosis process (RO) to produce a usable water. The movement of the brackish water with its salt loads into adjacent groundwater sub-basins, and thence in the Santa Ana River is reduced, and the usable basin supply is increased. Eventually, the Arlington sub-basin groundwater may be restored to a usable condition. A detailed description of this project is included in the Twentieth Annual Report.

The Arlington Desalter began operation in July 1990. In 1990-91 the Desalter delivered 4,895 AF 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 were ratified by all four Parties to the Judgment.

Lake Elsinore Project

Work on modifications to Lake Elsinore itself have been largely completed, but 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 next water year the Orange County Water District will be investigating the removal of nitrogen and total organic carbon in the Santa Ana River water as it flows through approximately 600 acres of constructed wetlands located in the Prado Basin. The study will make recommendations for wetlands modifications to enhance the natural water quality improvement processes. Modifications to the constructed wetlands could begin 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.

Precipitation During 1990-91

During the 1990-91 water year, the precipitation at the San Bernardino County Hospital amounted to 15.48 inches, which is 86% of the Base Period average. Most of the precipitation, 15.11 inches, 97%, occurred during the months of January through March. In October and November precipitation totaled 0.27 inches. No precipitation occurred in December. The maximum monthly precipitation of 8.23 inches occurred during March. In April and May, 0.03 inches were measured. There was no precipitation in June, July, or August, and 0.07 inches in September.

Figure 1 shows the seasonal precipitation from 1931-32 through 1990-91 and the accumulated departure from the 1934-35 through 1959-60 Base Period average.

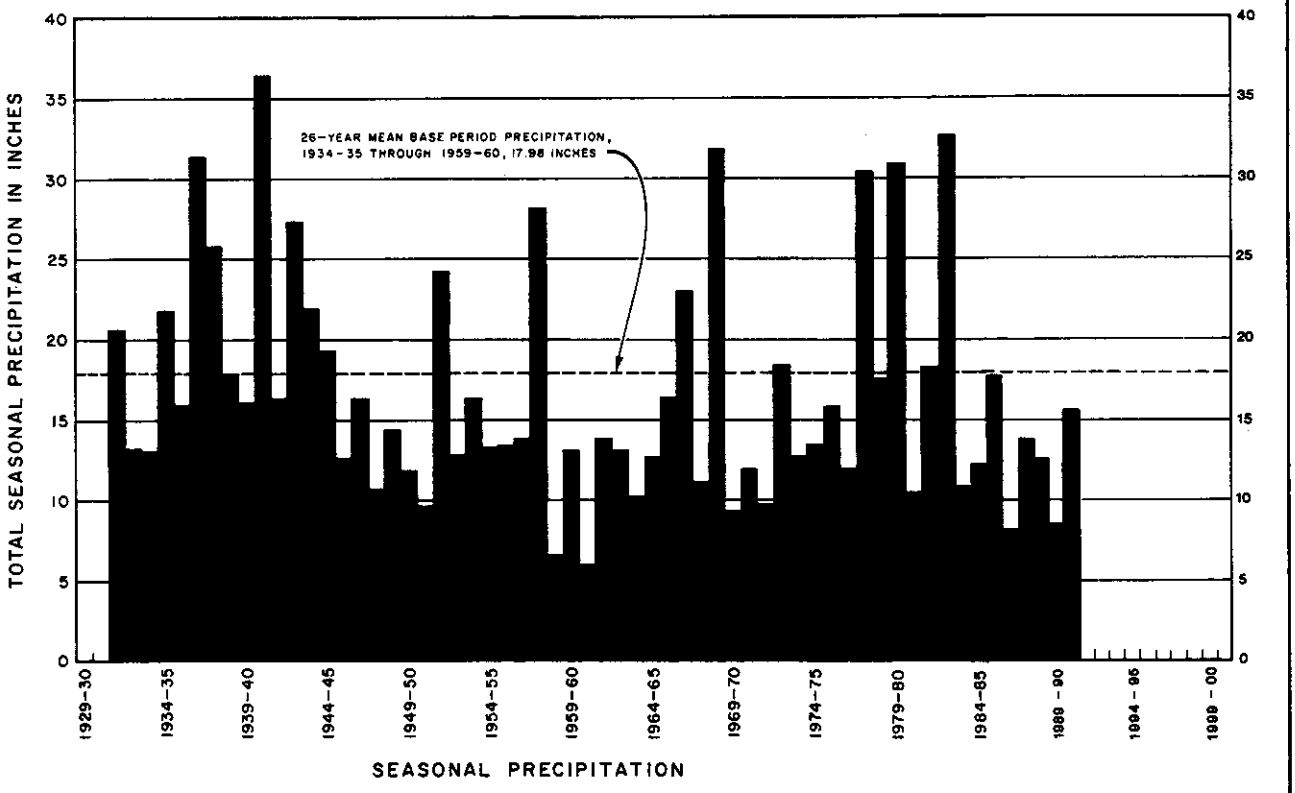
Runoff During 1990-91

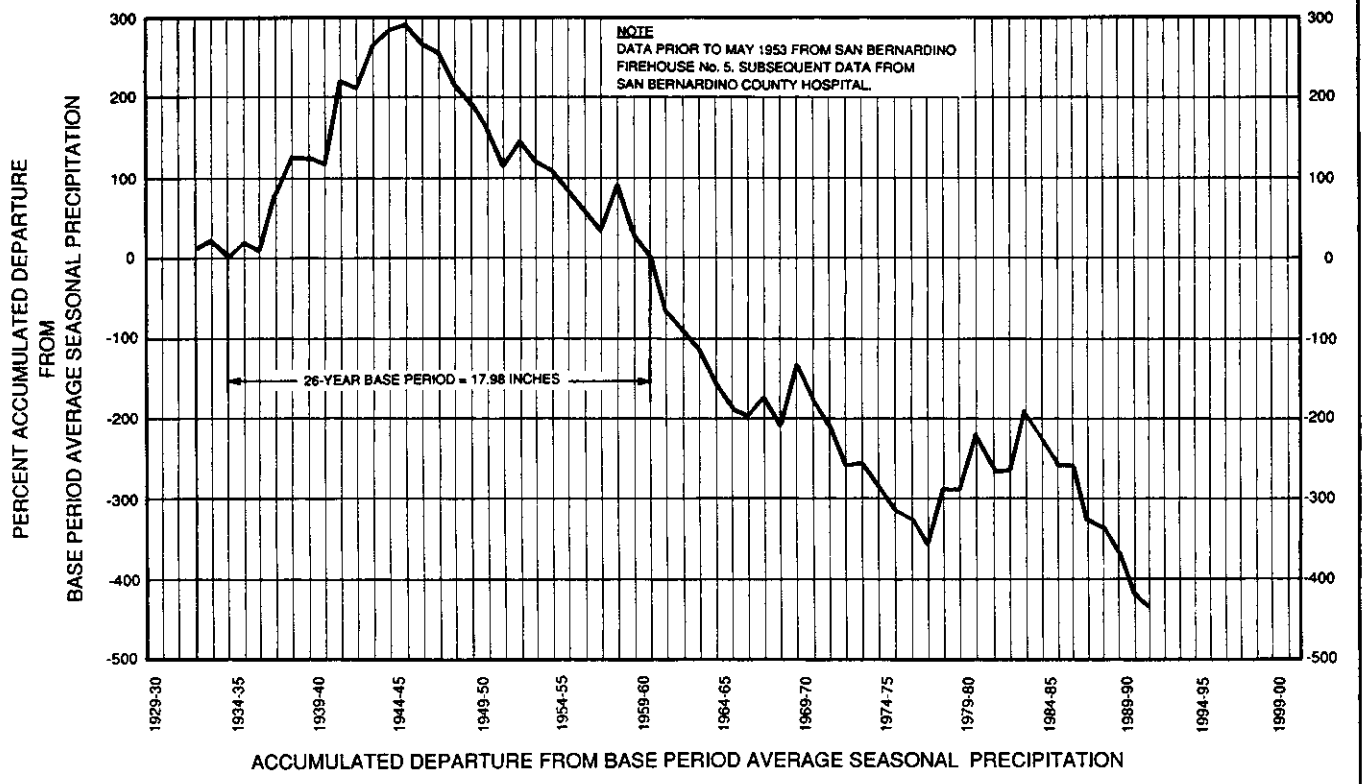
Below Prado

The calculated total seasonal inflow to Prado in 1990-91 was 195,186 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 1991, inflow amounted to 67,871, or 35% of the seasonal total. The recorded maximum storage in Prado Reservoir occurred on March 27, 1991, when 25,469 acre-feet (about 13% of the reservoir capacity at spillway level) was in storage. The maximum release of 3,490 cfs from Prado Reservoir occurred March 2, 1991.

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 21-year period (1970-71 through 1990-91) since the Stipulated Judgment went into effect, the Base Flow, unadjusted for quality, has averaged 83,391 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 1990-91 unadjusted Base Flow amounted to 111,151 acre-feet, an increase of 27,760 acre-feet over the 21-year average.

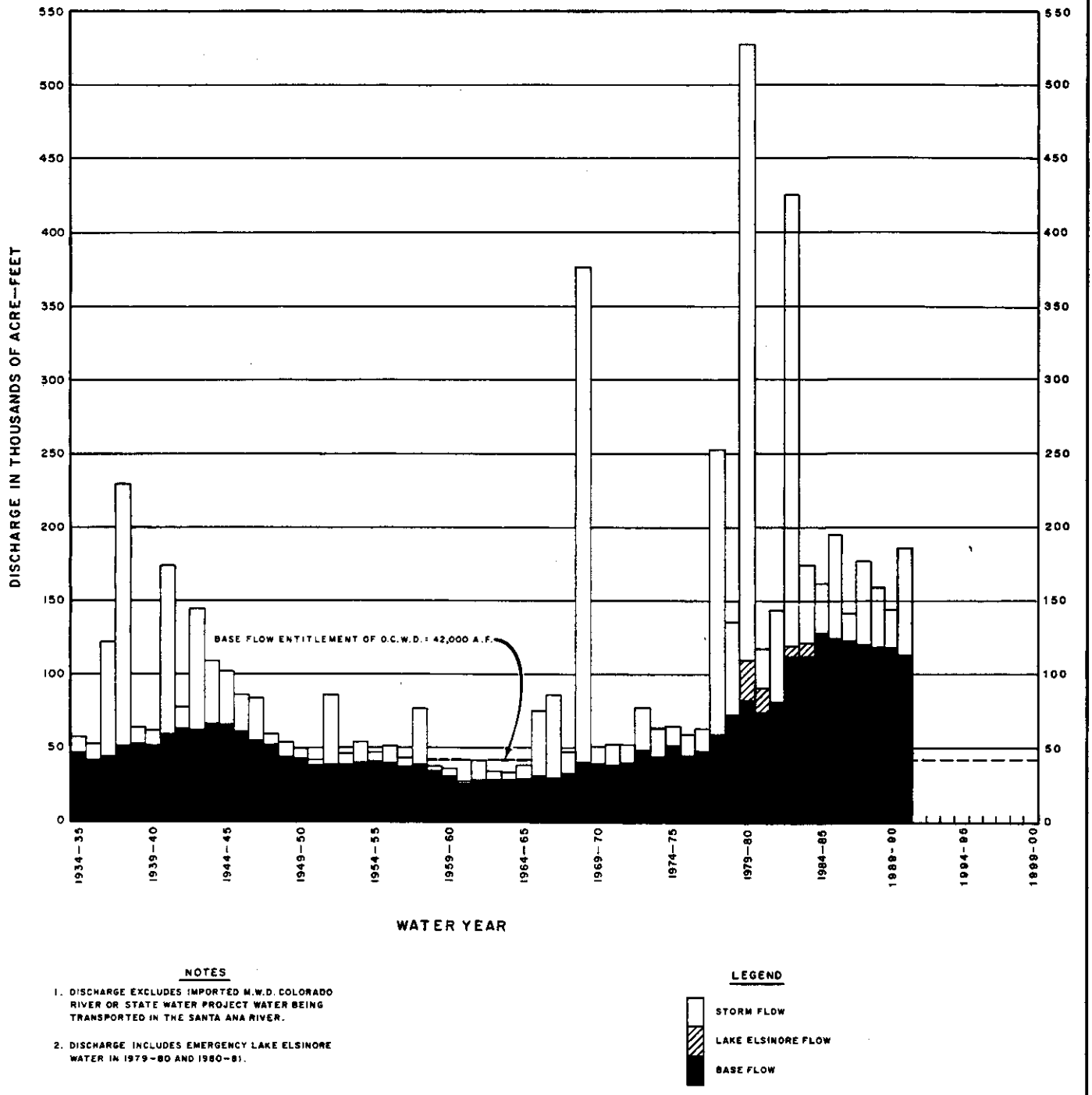
Figure 2 shows the Storm and Base Flow components of the Total Flow in the Santa Ana River below Prado Dam during the period 1934-35 through 1990-91.





VARIATION IN PRECIPITATION AT SAN BERNARDINO

FIGURE 1



NOTES

1. DISCHARGE EXCLUDES IMPORTED M.W.D. COLORADO RIVER OR STATE WATER PROJECT WATER BEING TRANSPORTED IN THE SANTA ANA RIVER.
2. DISCHARGE INCLUDES EMERGENCY LAKE ELSINORE WATER IN 1979-80 AND 1980-81.

LEGEND

- STORM FLOW
- LAKE ELSINORE FLOW
- BASE FLOW

DISCHARGE OF SANTA ANA RIVER BELOW PRADO DAM

FIGURE 2

At Riverside Narrows

The Total Flow of the Santa Ana River at Riverside Narrows for the 1990-91 water year was 74,529 acre-feet.

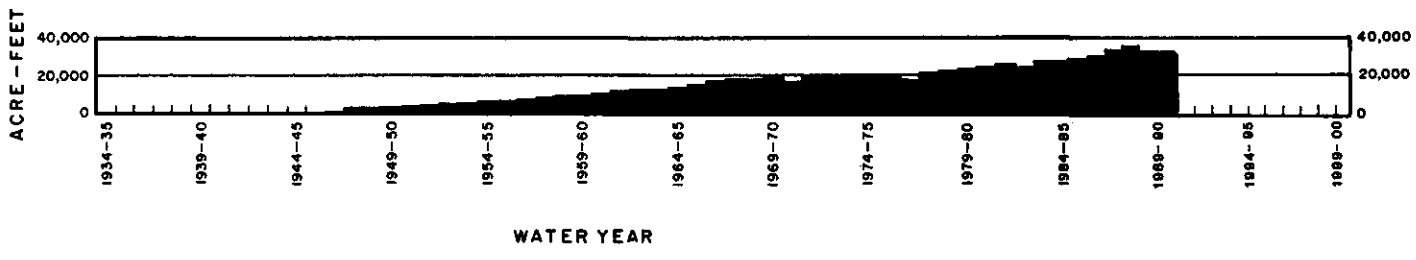
The unadjusted Base Flow at Riverside Narrows decreased from 27,120 acre-feet in 1943-44 to an all-time low of 13,450 acre-feet in 1965-66. Since that time, the Base Flow at Riverside Narrows has substantially increased. During the 21-year period 1970-71 through 1990-91, the Base Flow has averaged 36,312 acre-feet per year. The 1990-91 unadjusted Base Flow amounted to 45,041 acre-feet, an increase of 8,729 acre-feet over the 21-year average.

Figure 3 shows the components of Total Flow in the Santa Ana River at Riverside Narrows for the period from 1934-35 through 1990-91.

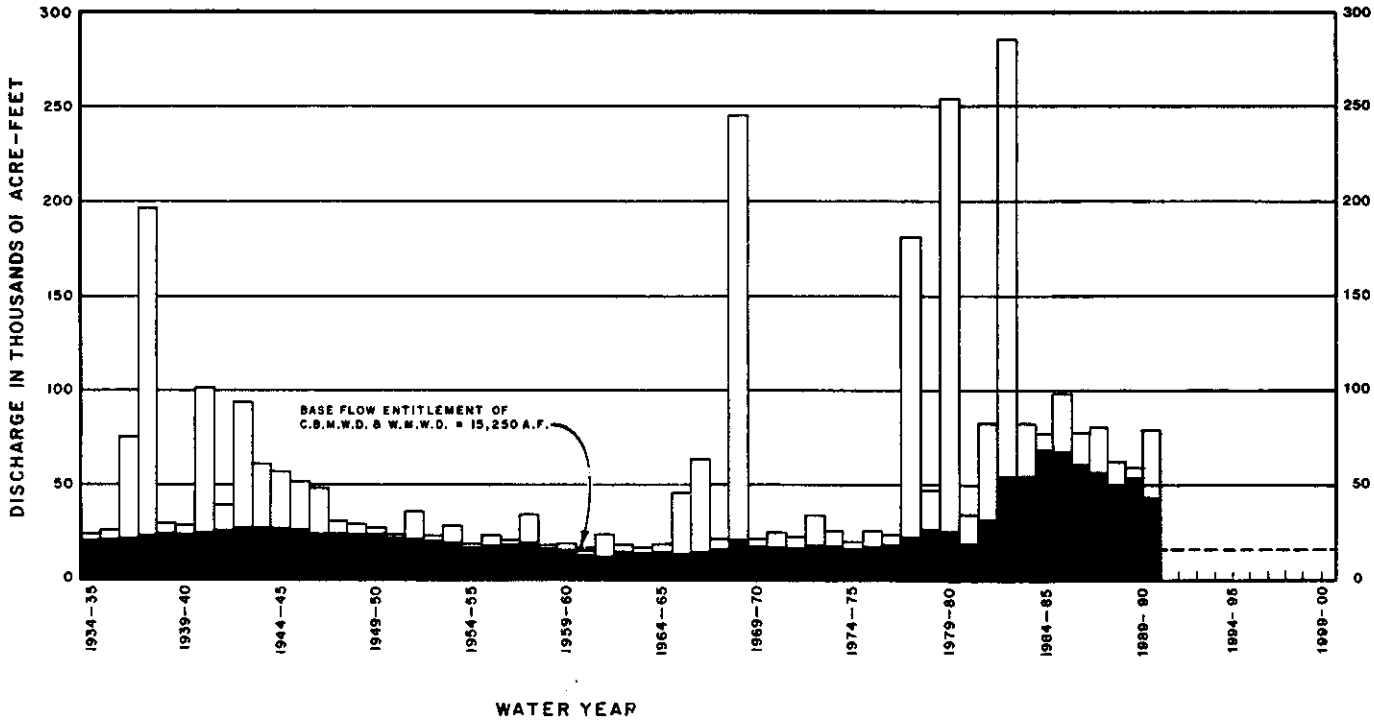
Wastewater Effluent Discharge

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 1990-91, about 130,450 acre-feet were discharged to the River 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	Red-lands	San. Bern.	Colton	Rialto	River-side	Corona	CBMWD #1	CBMWD #2	Total
1970-71	2,650	17,860	2,520	2,270	18,620	3,190	0	0	47,110
1971-72	2,830	16,020	2,230	2,400	19,010	3,230	6,740	0	52,460
1972-73	2,810	18,670	2,530	2,260	19,060	3,340	10,380	0	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

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 below Prado amounted to 195,186 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 111,151 acre-feet of Base Flow and 75,275 acre-feet of Storm Flow. Nontributary Flow during 1990-91 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 Product water releases to Temescal Creek and Drought Emergency Exchange Water during 1990-91 were 4,895 acre-feet and 3531 acre-feet respectivily. The components of flow of the Santa Ana River at Prado for each month in the 1990-91 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 basins 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 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 1990-91 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 1990-91

Month	USGS Measured Outflow	Storage Change [1]	Computed Inflow	Storm Flow	Nontributary Water Riverside Narrows[2]	Exchange Water [3]	Arlington Desalter	Base Flow
October	9,049	0	9,049	28	28	0	606	8,387
November	10,249	1	10,250	580	28	0	505	9,137
December	11,290	0	11,290	0	28	0	373	10,889
January	17,101	19	17,120	5,039	28	0	529	11,524
February	12,744	10,615	23,359	12,365	28	0	402	10,564
March	62,289	5,582	67,871	56,514	28	0	0	11,329
April	27,493	-16,216	11,277	681	28	0	101	10,467
May	11,058	-1	11,057	50	28	623	518	9,838
June	9,993	0	9,993	0	28	837	454	8,674
July	8,854	0	8,854	0	28	845	503	7,478
August	7,797	0	7,797	0	27	676	476	6,618
September	7,269	0	7,269	18	27	550	428	6,246
Total	195,186	0	195,186	75,275	334	3,531	4,895	111,115

(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 1990-91.

(3) Drought Emergency Exchange Water pumped from the San Bernardino, Colton and Riverside groundwater Basins and discharged into the Santa Ana River less an estimated loss of 5% for losses above Prado.

Releases to San Antonio Creek

There were no releases from OC-59 into San Antonio Creek during the water year 1990-91.

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, Western Municipal Water District and Orange County Water District, 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 operational in July 1990, with OCWD buying the product water delivered through the Santa Ana River. During the 1990-91 water year, 4,895 AF 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 1990-91, 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.

The combined amount of groundwater delivered by WMWD above Riverside Narrows and below Van Buren Boulevard during 1990-91 was 3,717 acre feet. Since 5 percent of the release was considered lost , the amount determined to reach Prado Dam was 3,531.

Since the exchange water is effectively non-tributary 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 490 feet which impounds about 5,000 acre-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, the District 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, US Fish and Wildlife Service and OCWD. The temporary agreement provided $900,000 for least Bell's vireo monitoring and habitat management. Additionally, OCWD agreed to convert 122 acres of its property behind Prado Dam into Vireo habitat. The agreement allowed OCWD to store flood waters to elevation 500 feet, which increased the water conservation pool by about 14,000 AF and resulted in the capture of several thousand acre-feet of water that would have been discharged to the ocean.

During the spring of 1991, the cowbird trapping program in Prado Basin was continued. The Orange County Water District funded cowbird trapping program was 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 begain on elements of the Santa Ana River Mainstream project, including the Seven-Oaks Dam, located on the Santa Ana River above Menton.

During the 1990-91 water year, more than 100 acre-feet of water were stored behind Prado during the periods January 3 - January 20 and February 27 - April 26. During those periods, the water stored in Prado Reservoir varied up to a maximum of 25,469 acre-feet and the maximum daily flow released to the Santa Ana River was 3,490 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 1990-91 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 510 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 21 grab samples and performed laboratory analyses for TDS. 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:

$$TDS = EC/[1.665 - (2.7227 \times 10^{-5} \times EC)]$$

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

Application of the equation EC to TDS provided hourly TDS values. Using hourly data, flow weighted average daily values for TDS were computed and are listed in Table B-2, Appendix B.

The plot of TDS on Plate 3 shows the daily average TDS concentration of the Santa Ana River flow passing Prado Dam. The daily average TDS concentration was calculated from the hourly EC measurements and the correlation of EC and TDS.

Water Quality Adjustment for Nontributary Flow

The weighted average annual TDS value of 510 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 the following determination of Base Flow plus Storm Flow TDS has been made.

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 1990-91 water year totaled 4,895 acre-feet at an average TDS of 334 mg/L (Appendix E). The flow weighted TDS of 334 mg/L was estimated from daily EC readings measured from the discharge into the channel.

Water Quality Adjustment for Exchange Water

During May 1991, the City of Riverside began pumping groundwater which was discharged into the Riverside Canal for delivery to OCWD. The amount of water discharged to the Santa Ana River during the 1990-91 water year totaled 3,531 acre-feet at an average TDS of 549 mg/L (Appendix G). The flow weighted TDS of 549 mg/L was estimated from periodic grab samples measured from the Riverside Canal gaging station near Jefferson Street.

		Annual Flow (acre-feet)	Average TDS (mg/L)	Annual Flow x Average TDS (acre-feet x mg/L)
1.	Total Flow	195,186	510	99,544,860
2.	Nontributary Flow a. Riverside Narrows	334	242	80,828
3.	Arlington Desalter	4,895	334	1,634,930
4.	Exchange Water	3,531	549	1,938,519
5.	Total Flow Less Nontributary Flow, Arlington Desalter Flow and Exchange Water	186,426		95,890,583
	Average TDS of Total Base and Storm Flows	95,890,583 ÷ 186,426 = 514 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 1990-91 was 514 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 514 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:

$$(111,151 \text{ ac-ft}) + \frac{35}{42,000}(111,151 \text{ ac-ft})(700 - 514) = 128,379 \text{ ac-ft.}$$

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 1990-91 required under the Stipulated Judgment are as follows:

1.	Total Flow at Prado	195,186 acre-feet
2.	Base Flow at Prado	111,151 acre-feet
3.	Annual Weighted TDS of Base and Storm Flow	514 mg/L
4.	Annual Adjusted Base Flow	128,379 acre-feet
5.	Cumulative Adjusted Base Flow	1,946,040 acre-feet
6.	Cumulative Entitlement of OCWD	882,000 acre-feet
7.	Cumulative Credit	1,064,040 acre-feet
8.	One-Third of Cumulative Debit	0 acre-feet
9.	Minimum Required Base Flow in 1991-92	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 74,529 acre-feet, measured at the USGS gaging station near the MWDSC Upper Feeder Crossing. Separated into its components, Base Flow was 45,041 acre-feet, Storm Flow was 30,815 acre-feet, Nontributary Flow due to a prior release of State Water Project water above Riverside Narrows was 341 acre-feet and 394 acre-feet of exchange groundwater. Included in Base Flow are 2,061 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 1990-91 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 1990-91 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 1990-91, drought emergency exchange water was delivered to the Santa Ana River upstream of the Riverside Narrows. The exchange plan is more fully described in Chapter II.

The amount of groundwater delivered by WMWD above the Riverside Narrows during 1990-91 was 394 acre feet. It was determined that none of the water was lost because it entered the river immediately above the Riverside Narrows. Since the exchange water is effectively nontributary water delivered upstream of Riverside

TABLE 6

COMPONENTS OF FLOW AT RIVERSIDE NARROWS

FOR WATER YEAR 1990-1991
(acre-feet)

		Total Flow USGS Measurement	Storm Flow	Non-tributary Flow	Exchange Water	Rubidoux Waste-water	Base Flow(1)
1990	October	3,372	0	29	0	187	3,530
	November	3,326	218	29	0	173	3,252
	December	4,493	0	29	0	178	4,642
1991	January	5,754	1,527	29	0	176	4,374
	February	11,090	6,502	29	0	155	4,714
	March	26,753	22,038	28	0	176	4,863
	April	5,205	530	28	0	165	4,812
	May	3,374	0	28	0	182	3,528
	June	3,782	0	28	394	165	3,525
	July	2,658	0	28	0	171	2,801
	August	2,404	0	28	0	168	2,544
	September	2,319	0	28	0	165	2,456
Total		74,525	30,815	341	394	2,061	45,041

(1) Base Flow includes Rubidoux wastewater discharged below Riverside Narrows

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

Narrows for the benefit of OCWD, the amount of pumped exchange groundwater reaching Riverside Narrows is excluded from the computation of Base Flow and Base Flow quality.

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 1990-91, in the amount of 2,061 acre-feet as shown in Appendix D, has been added to the streamflow as measured at the gaging station.

Water Quality

The determination of quality water 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 730 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 616 mg/L.

		Annual Flow (acre-feet)	Average TDS (mg/L)	Annual Flow x Average TDS (ac-ft x mg/L)
1.	Base Flow including Nontributary Flow	43,715	607	26,535,200
2.	Less Nontributary Flow	341	237	80,817
3.	Less Exchange Groundwater	394	534	210,396
4.	Plus Rubidoux Wastewater	2,061	730	1,505,431
5.	Average TDS of Base Flow	27,749,418 ÷ 45,041 = 616 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 1990-91 was 616 mg/L. Therefore, no adjustment is necessary, and the Adjusted Base Flow for 1990-91 is 45,041.

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 1990-91 required under the Stipulated Judgment are as follows:

1.	Base Flow at Riverside Narrows	45,041 acre-feet
2.	Annual Weighted TDS of Base Flow	616 acre-feet
3.	Annual Adjusted Base Flow	45,041 acre-feet
4.	Cumulative Adjusted Base Flow	761,057 acre-feet
5.	Cumulative Entitlement of CBMWD and WMWD	320,250 acre-feet
6.	Cumulative Credit	440,807 acre-feet
7.	One-Third of Cumulative Debit	0 acre-feet
8.	Minimum Required Base Flow in 1991-92	12,420 acre-feet

APPENDIX A

NONTRIBUTARY WATER RELEASED BY MWD TO SAN ANTONIO CREEK NEAR UPLAND

CONNECTION OC-59

1990-91

PREPARED BY

DONALD L. HARRIGER

TABLE A-1

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

WATER YEAR 1990-91

No water released during Water Year 1990-91
for the Orange County Water District.

APPENDIX B

WATER QUALITY
SANTA ANA RIVER BELOW PRADO DAM

1990-91

PREPARED BY

WILLIAM R. MILLS,JR.

TABLE B-1

USGS WATER QUALITY SAMPLES BELOW PRADO DAM
FOR WATER YEAR 1990-91

DATE	EC (micromhos/cm)	TDS (mg/L)	SOURCE
10/11	1170	700	USGS
10/24	1090	652	USGS
11/01	1100	670	USGS
11/28	1100	646	USGS
12/20	1120	660	USGS
1/02	1080	676	USGS
1/24	1130	695	USGS
2/07	1080	666	USGS
2/20	1090	700	USGS
3/26	613	366	USGS
4/08	714	443	USGS
4/18	858	518	USGS
5/31	1040	631	USGS
6/10	1040	626	USGS
6/27	1010	608	USGS
7/08	1010	643	USGS
7/30	1010	604	USGS
8/05	1000	619	USGS
8/13	995	633	USGS
9/04	1000	600	USGS
9/25	997	623	USGS

TABLE B–2

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990–91

OCTOBER 1990

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	145	1050	642	93039
2	146	1070	654	95496
3	144	1090	667	95981
4	143	1090	667	95314
5	141	1090	667	93981
6	138	1090	667	91981
7	148	1080	660	97725
8	144	1080	660	95084
9	136	1110	679	92342
10	137	1100	673	92168
11	136	1150	704	95734
12	142	1140	698	99072
13	143	1130	691	98878
14	147	1110	679	99811
15	151	1100	673	101587
16	153	1100	673	102932
17	151	1100	673	101587
18	151	1100	673	101587
19	158	1100	673	106296
20	165	1100	673	111005
21	159	1090	667	105979
22	160	1080	660	105649
23	153	1090	667	101979
24	150	1090	667	99980
25	147	1090	667	97980
26	143	1080	660	94424
27	143	1080	660	94424
28	146	1080	660	96405
29	148	1070	654	96804
30	144	1080	660	95084
31	150	1080	660	99046
TOTAL	4562			3049354
MONTHLY FLOW WEIGHTED TDS			668	

1. TDS = EC/[1.665–(2.7227E–5 x EC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990-91

NOVEMBER 1990

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	148	1080	660	97725
2	151	1080	660	99706
3	151	1080	660	99706
4	152	1080	660	100367
5	159	1090	667	105979
6	154	1090	667	102646
7	140	1120	685	95931
8	152	1100	673	102259
9	153	1100	673	102932
10	153	1090	667	101979
11	153	1090	667	101979
12	154	1090	667	102646
13	154	1090	667	102646
14	159	1090	667	105979
15	166	1090	667	110644
16	163	1100	673	109660
17	163	1100	673	109660
18	165	1100	673	111005
19	184	1090	667	122642
20	272	1100	673	182990
21	251	1140	698	175120
22	206	1110	679	139872
23	188	1110	679	127650
24	182	1110	679	123576
25	176	1100	673	118406
26	210	1020	623	130830
27	183	1090	667	121975
28	174	1100	673	117060
29	173	1100	673	116387
30	178	1090	667	118643
TOTAL	5167			3458600
MONTHLY FLOW WEIGHTED TDS			669	

1. TDS = EC/[1.665-(2.7227E-5 x EC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990-91

DECEMBER 1990

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	180	1090	667	119976
2	179	1080	660	118195
3	181	1080	660	119516
4	175	1090	667	116643
5	178	1090	667	118643
6	180	1090	667	119976
7	179	1100	673	120424
8	180	1100	673	121097
9	181	1110	679	122897
10	178	1110	679	120860
11	174	1110	679	118144
12	164	1110	679	111354
13	177	1100	673	119078
14	179	1100	673	120424
15	183	1100	673	123115
16	189	1110	679	128329
17	188	1100	673	126479
18	186	1100	673	125133
19	193	1100	673	129842
20	192	1110	679	130366
21	192	1100	673	129170
22	194	1090	667	129307
23	194	1100	673	130515
24	193	1090	667	128641
25	192	1090	667	127974
26	186	1090	667	123975
27	178	1100	673	119751
28	185	1090	667	123308
29	187	1090	667	124641
30	186	1090	667	123975
31	189	1090	667	125975
TOTAL	5692			3817722
MONTHLY FLOW WEIGHTED TDS			671	

1. TDS = EC/[1.665-(2.7227E-5 x EC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990-91

JANUARY 1991

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	191	1080	660	126119
2	185	1080	660	122157
3	211	1020	623	131453
4	285	848	516	147194
5	286	809	492	140826
6	292	837	510	148826
7	369	800	487	179647
8	372	817	497	185008
9	299	873	532	159043
10	339	912	556	188497
11	385	895	546	210025
12	381	912	556	211851
13	375	942	575	215481
14	368	945	576	212142
15	362	979	598	216314
16	344	1020	623	214312
17	330	1060	648	213795
18	322	1100	673	216628
19	311	1130	691	215042
20	297	1150	704	209066
21	272	1160	710	193165
22	231	1150	704	162607
23	205	1130	691	141748
24	202	1120	685	138414
25	202	1110	679	137156
26	202	1100	673	135897
27	202	1100	673	135897
28	201	1100	673	135225
29	199	1090	667	132640
30	199	1100	673	133879
31	203	1090	667	135306
TOTAL	8622			5245357
MONTHLY FLOW WEIGHTED TDS			608	

1. TDS = EC/[1.665-(2.7227E-5 x EC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990-91

FEBRUARY 1991

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	207	1090	667	137972
2	205	1080	660	135363
3	207	1080	660	136684
4	217	1070	654	141936
5	201	1060	648	130221
6	202	1060	648	130868
7	199	1070	654	130163
8	195	1090	667	129974
9	193	1090	667	128641
10	195	1080	660	128760
11	197	1080	660	130081
12	202	1080	660	133382
13	196	1080	660	129420
14	195	1090	667	129974
15	196	1090	667	130640
16	193	1080	660	127439
17	195	1080	660	128760
18	195	1080	660	128760
19	196	1080	660	129420
20	199	1090	667	132640
21	198	1090	667	131973
22	199	1090	667	132640
23	197	1090	667	131307
24	199	1080	660	131401
25	198	1080	660	130741
26	195	1080	660	128760
27	184	1050	642	118063
28	1070	548	332	355352
TOTAL	6425			3891333
MONTHLY FLOW WEIGHTED TDS			606	

1. TDS = EC/[1.665-(2.7227E-5 x EC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990-91

MARCH 1991

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	3160	486	294	929766
2	3490	424	256	894948
3	3000	428	259	776605
4	2000	515	312	623871
5	409	509	308	126083
6	474	533	323	153071
7	529	559	339	179242
8	518	661	401	207891
9	462	702	427	197051
10	437	776	472	206288
11	492	810	493	242563
12	476	796	484	230566
13	323	834	508	164027
14	345	854	520	179460
15	332	873	532	176596
16	446	801	487	217409
17	507	779	474	240269
18	301	809	492	148212
19	404	842	513	207157
20	371	843	513	190465
21	504	790	481	242264
22	527	727	442	232875
23	522	611	371	193489
24	519	606	368	190787
25	521	598	363	188969
26	526	611	371	194972
27	2360	645	392	923977
28	3440	498	302	1037346
29	2910	468	283	824252
30	600	465	281	168851
31	499	464	281	140124
TOTAL	31404			10629448
MONTHLY FLOW WEIGHTED TDS			338	

1. TDS = EC/[1.665-(2.7227E-5 x EC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990-91

APRIL 1991

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	498	471	285	141969
2	493	509	308	151978
3	491	538	326	160061
4	489	565	343	167484
5	494	604	366	180992
6	502	637	387	194078
7	499	666	404	201797
8	495	709	431	213256
9	490	740	450	220445
10	487	764	465	226291
11	484	775	471	228176
12	490	794	483	236743
13	500	812	494	247124
14	497	851	518	257606
15	492	860	524	257750
16	483	849	517	249753
17	498	843	513	255664
18	512	857	522	267279
19	504	879	536	269955
20	500	893	544	272141
21	495	912	556	275239
22	489	930	567	277352
23	489	950	580	283411
24	485	954	582	282295
25	480	956	583	279979
26	475	951	580	275591
27	422	876	534	225251
28	239	560	339	81127
29	198	544	330	65272
30	191	562	341	65067
TOTAL	13861			6511125
MONTHLY FLOW WEIGHTED TDS			470	

1. TDS = EC/[1.665-(2.7227E-5 x EC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990-91

MAY 1991

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	184	605	367	67527
2	185	668	406	75042
3	187	718	436	81598
4	183	706	429	78502
5	178	678	412	73295
6	168	655	398	66805
7	165	665	404	66625
8	170	691	420	71359
9	170	687	417	70941
10	174	767	467	81173
11	194	902	550	106671
12	176	813	495	87096
13	172	821	500	85966
14	179	980	598	107073
15	174	1050	642	111646
16	171	1060	648	110785
17	175	1050	642	112288
18	178	1040	635	113106
19	184	1040	635	116919
20	195	1040	635	123909
21	185	1030	629	116405
22	189	1030	629	118921
23	193	1030	629	121438
24	189	1030	629	118921
25	180	1030	629	113258
26	175	1030	629	110112
27	169	1030	629	106337
28	183	1020	623	114009
29	181	1020	623	112763
30	184	1020	623	114632
31	185	1020	623	115255
TOTAL	5575			3070379
MONTHLY FLOW WEIGHTED TDS			551	

1. TDS = EC/[1.665-(2.7227E-5 x EC)]

TABLE B–2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990–91

JUNE 1991

DAY	PRADO OUTFLOW (cfs–day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	172	1030	629	108225
2	170	1030	629	106966
3	172	1030	629	108225
4	171	1030	629	107596
5	165	1040	635	104846
6	163	1040	635	103575
7	165	1040	635	104846
8	167	1040	635	106117
9	180	1040	635	114377
10	170	1030	629	106966
11	169	1030	629	106337
12	170	1030	629	106966
13	168	1030	629	105708
14	170	1020	623	105910
15	176	1010	617	108555
16	176	1010	617	108555
17	170	1010	617	104854
18	169	1010	617	104238
19	178	1010	617	109789
20	163	1020	623	101549
21	157	1020	623	97811
22	158	1020	623	98434
23	159	1020	623	99057
24	160	1010	617	98687
25	174	1000	611	106241
26	171	998	609	104197
27	171	995	607	103879
28	167	995	607	101449
29	160	1000	611	97693
30	157	1000	611	95861
TOTAL	5038			3137510
MONTHLY FLOW WEIGHTED TDS			623	

1. TDS = EC/[1.665–(2.7227E–5 x EC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990-91

JULY 1991

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	153	1000	611	93419
2	153	1010	617	94369
3	153	1010	617	94369
4	157	1010	617	96836
5	151	1010	617	93135
6	142	1010	617	87584
7	144	1010	617	88818
8	148	1000	611	90366
9	148	1010	617	91285
10	151	1020	623	94073
11	152	1010	617	93752
12	147	1010	617	90668
13	142	1010	617	87584
14	139	1010	617	85734
15	136	1010	617	83884
16	135	1010	617	83267
17	137	1020	623	85351
18	142	1020	623	88466
19	147	1020	623	91581
20	144	1020	623	89712
21	142	1020	623	88466
22	141	1020	623	87843
23	141	1010	617	86968
24	143	1020	623	89089
25	144	1020	623	89712
26	143	1020	623	89089
27	137	1020	623	85351
28	135	1020	623	84105
29	137	1010	617	84500
30	138	1000	611	84260
31	142	995	607	86262
TOTAL	4464			2759902
MONTHLY FLOW WEIGHTED TDS			618	

1. TDS = EC/[1.665-(2.7227E-5 x EC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990-91

AUGUST 1991

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	142	1000	611	86703
2	137	996	608	83310
3	140	989	604	84526
4	135	988	603	81423
5	130	983	600	78004
6	139	982	599	83318
7	131	991	605	79255
8	121	1010	617	74632
9	127	1000	611	77544
10	126	988	603	75995
11	119	992	606	72068
12	122	983	600	73204
13	125	989	604	75469
14	128	987	603	77122
15	129	991	605	78045
16	123	996	608	74796
17	139	998	609	84698
18	129	1000	611	78765
19	125	983	600	75004
20	125	984	601	75082
21	126	979	598	75292
22	121	977	596	72154
23	118	973	594	70072
24	120	972	593	71185
25	128	973	594	76010
26	130	965	589	76553
27	120	973	594	71260
28	117	976	596	69696
29	116	981	599	69460
30	116	983	600	69604
31	127	985	601	76362
TOTAL	3931			2366611
MONTHLY FLOW WEIGHTED TDS			602	

1. TDS = EC/[1.665-(2.7227E-5 x EC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990-91

SEPTEMBER 1991

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	120	988	603	72376
2	113	987	603	68084
3	118	986	602	71024
4	119	985	601	71552
5	126	980	598	75370
6	126	976	596	75057
7	127	986	602	76441
8	126	988	603	75995
9	128	986	602	77042
10	129	984	601	77484
11	130	983	600	78004
12	129	983	600	77404
13	129	990	604	77965
14	132	996	608	80269
15	133	1000	611	81207
16	131	991	605	79255
17	132	988	603	79614
18	131	984	601	78686
19	130	983	600	78004
20	129	988	603	77804
21	125	986	602	75237
22	124	993	606	75174
23	125	993	606	75780
24	120	991	605	72600
25	112	986	602	67412
26	100	976	596	59569
27	105	981	599	62873
28	100	992	606	60562
29	113	983	600	67804
30	103	977	596	61420
TOTAL	3665			2207067
MONTHLY FLOW WEIGHTED TDS			602	

1. TDS = EC/[1.665-(2.7227E-5 x EC)]

TABLE B–3

ANNUAL SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1990–91

MONTH	MONTHLY FLOW (cfs–days)	MONTHLY WEIGHTED TDS (mg/L)	MONTHLY FLOW TIMES TDS
OCTOBER	4562	668	3049354
NOVEMBER	5167	669	3458600
DECEMBER	5692	671	3817722
JANUARY	8622	608	5245357
FEBRUARY	6425	606	3891333
MARCH	31404	338	10629448
APRIL	13861	470	6511125
MAY	5575	551	3070379
JUNE	5038	623	3137510
JULY	4464	618	2759902
AUGUST	3931	602	2366611
SEPTEMBER	3665	602	2207067
TOTAL	98406	-	50144410
WATER YEAR WEIGHTED TDS		510	

APPENDIX C

WATER QUALITY
SANTA ANA RIVER AT RIVERSIDE NARROWS

1990-91

PREPARED BY

DONALD L. HARRIGER

TABLE C-1

WATER QUALITY ANALYSES
SANTA ANA RIVER AT RIVERSIDE NARROWS

WATER YEAR 1990-91

Date Sampled	EC Micromhos/cm	TDS mg/L	Source
1990			
10-02	895	585	C of R
10-04	904	562	DWR
10-04	918	566	USGS
10-11	870	586	C of R
10-16	900	586	C of R
10-25	880	592	C of R
10-25	920	572	USGS
10-30	899	573	C of R
11-06	900	562	C of R
11-06	920	566	USGS
11-08	916	572	DWR
11-15	940	574	C of R
11-20	930	628	C of R
11-21	904	550*	USGS
11-29	900	604	C of R
12-04	910	567	C of R
12-05	882	583	DWR
12-10	950	578	USGS
12-13	900	645	C of R
12-18	920	554	C of R
12-20	970	601	USGS
12-27	880	590	C of R
1991			
01-02	920	575	USGS
01-04	910	591*	C of R
01-08	950	522	DWR
01-10	770	513	C of R
01-24	950	612	C of R
01-22	986	608	USGS
01-29	920	593	C of R
02-07	900	610	C of R
02-07	980	592	USGS
02-12	940	589	C of R
02-20	968	585	USGS
02-21	950	604	C of R
02-26	960	611	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

Date Sampled	EC Micromhos/cm	TDS mg/L	Source
1991			
03-07	900	563*	C of R
03-12	980	622*	C of R
03-20	165	111*	USGS
03-21	575	-	C of R
03-26	380	240*	C of R
04-04	900	570*	C of R
04-08	848	547*	USGS
04-09	910	560*	C of R
04-17	975	600	USGS
04-18	1020	624	C of R
04-23	1050	621	C of R
05-02	1000	623	C of R
05-07	1110	661	C of R
05-10	982	632	DWR
05-16	1040	650	C of R
05-17	980	-	USGS
05-21	1015	652	C of R
05-28	954	-	USGS
05-30	1010	646	C of R
06-04	1020	651	C of R
06-06	1030	673	DWR
06-10	975	630	USGS
06-13	720	627**	C of R
06-18	920	637**	C of R
06-27	990	652	C of R
06-27	970	590	USGS
07-02	1004	605	DWR
07-02	990	754	C of R
07-08	950	602	USGS
07-11	980	633	C of R
07-16	1010	760	C of R
07-22	936	598	USGS
07-25	1105	642	C of R
08-05	945	596	USGS
08-07	1050	650	DWR
08-07	660(?)	639	C of R
08-13	1000	645	C of R
08-13	962	603	USGS

* Data not used in determining monthly averages, storm flow.
** Data not used, includes pumped groundwater.
C of R City of Riverside
USGS United States Geological Survey
DWR Department of Water Resources

TABLE C-1

Date Sampled	EC Micromhos/cm	TDS mg/L	Source
1991			
08-22	1020	630	C of R
08-27	930	625	C of R
09-04	974	595	USGS
09-05	980	640	C of R
09-10	930	638	C of R
09-19	880	628	C of R
09-24	1000	612	C of R
09-24	960	596	USGS

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 1990-91

Month	Acre-feet (1)	TDS (2) mg/L	Acre-feet times TDS
October	3,372	578	1,949,016
November	3,108	584	1,815,072
December	4,493	588	2,641,884
January	4,227	570	2,409,390
February	4,588	599	2,748,212
March	4,715	607	2,862,005
April	4,675	615	2,875,125
May	3,374	644	2,172,856
June	2,658	637	1,693,146
July	3,782	642	2,428,044
August	2,404	627	1,507,308
September	2,319	618	1,433,142
	43,715		26,535,200

Flow weighted TDS $\frac{26,535,200}{43,715} = 607$ 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

1990-91

PREPARED BY

DONALD L. HARRIGER

TABLE D-1

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

WATER YEAR 1990-91

Month	Acre-feet	TDS mg/L	Acre-feet times TDS
1990			
October	187.26	737	138,014
November	172.84	714	123,408
December	178.09	720	128,224
1991			
January	175.79	691	121,469
February	154.92	700	108,443
March	176.12	744	131,030
April	165.29	759	125,458
May	181.62	757	137,489
June	164.89	723	119,217
July	170.90	754	128,857
August	168.30	713	119,997
September	165.32	749	123,824
	2,061		1,505,431

Flow Weighted TDS of Wastewater = 730 mg/l

APPENDIX E

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

1990-91

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 1990-91

1990	Acre Feet Discharged
October	606
November	505
December	373
1991	
January	529
February	402
March	0
April	101
May	518
June	454
July	503
August	476
September	428
Total	4,895

TABLE E-2

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

OCTOBER 1990
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	8
2	8
3	7
4	7
5	9
6	11
7	11
8	10
9	11
10	9
11	11
12	11
13	11
14	11
15	11
16	11
17	11
18	11
19	9
20	9
21	8
22	9
23	10
24	10
25	10
26	10
27	11
28	10
29	10
30	10
31	11
Total in CFS DAYS	305
Total AF	606

TABLE E-2

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

NOVEMBER 1990
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	8
2	10
3	9
4	9
5	9
6	4
7	9
8	9
9	9
10	8
11	8
12	8
13	8
14	8
15	9
16	9
17	9
18	9
19	9
20	9
21	9
22	9
23	9
24	9
25	9
26	8
27	7
28	6
29	7
30	8
Total in CFS DAYS	255
Total AF	505

TABLE E-2

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

DECEMBER 1990
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	9
2	9
3	9
4	3
5	9
6	8
7	7
8	7
9	3
10	0
11	0
12	0
13	4
14	7
15	7
16	7
17	7
18	7
19	7
20	7
21	8
22	9
23	9
24	4
25	0
26	5
27	8
28	7
29	7
30	7
31	3
Total in CFS DAYS	188
Total AF	373

TABLE E-2

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

JANUARY 1991
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	0
2	5
3	9
4	9
5	9
6	9
7	8
8	8
9	7
10	8
11	9
12	9
13	9
14	9
15	9
16	9
17	9
18	9
19	9
20	9
21	9
22	9
23	9
24	9
25	9
26	9
27	9
28	9
29	9
30	9
31	9
Total in CFS DAYS	267
Total AF	529

TABLE E-2

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

FEBRUARY 1991
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	9
2	9
3	9
4	9
5	9
6	3
7	0
8	3
9	7
10	7
11	7
12	4
13	4
14	7
15	7
16	8
17	7
18	7
19	8
20	9
21	9
22	9
23	9
24	9
25	9
26	9
27	9
28	3
Total in CFS DAYS	203
Total AF	402

TABLE E-2

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

MARCH 1991
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

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

APRIL 1991
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	6
26	9
27	9
28	9
29	9
30	9
Total in CFS DAYS	51
Total AF	101

TABLE E-2

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

MAY 1991
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	9
2	9
3	9
4	9
5	9
6	9
7	9
8	9
9	9
10	9
11	9
12	9
13	8
14	9
15	8
16	8
17	8
18	8
19	5
20	8
21	8
22	8
23	8
24	8
25	9
26	9
27	9
28	9
29	9
30	9
31	9
Total in CFS DAYS	261
Total AF	518

TABLE E-2

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

JUNE 1991
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	9
2	9
3	9
4	9
5	9
6	9
7	9
8	9
9	9
10	9
11	9
12	8
13	8
14	8
15	8
16	8
17	8
18	7
19	6
20	2
21	0
22	5
23	9
24	9
25	9
26	9
27	8
28	6
29	8
30	8
Total in CFS DAYS	229
Total AF	454

TABLE E-2

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

JULY 1991
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	8
2	8
3	9
4	9
5	9
6	9
7	9
8	7
9	8
10	8
11	8
12	8
13	9
14	9
15	9
16	7
17	7
18	9
19	8
20	8
21	8
22	9
23	8
24	8
25	9
26	8
27	8
28	8
29	8
30	8
31	7
Total in CFS DAYS	253
Total AF	503

TABLE E-2

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

AUGUST 1991
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	
2	7
3	8
4	8
5	8
6	8
7	4
8	0
9	4
10	9
11	8
12	8
13	8
14	8
15	8
16	8
17	8
18	8
19	8
20	8
21	8
22	8
23	8
24	8
25	8
26	8
27	8
28	9
29	9
30	9
31	9
Total in CFS DAYS	240
Total AF	476

TABLE E-2

WATER DECHARGED FROM THE
ARLINGTON DESALTER
TO THE
ARLINGTON VALLEY DRAIN

SEPTEMBER 1991
IN CFS-DAYS

Day	Discharged to the Santa Ana River
1	9
2	9
3	9
4	9
5	8
6	8
7	9
8	9
9	9
10	9
11	5
12	0
13	0
14	0
15	0
16	5
17	9
18	9
19	9
20	9
21	9
22	9
23	9
24	9
25	9
26	9
27	9
28	9
29	9
30	9
Total in CFS DAYS	216
Total AF	428

TABLE E-2

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

WATER YEAR 1990-91

Month	Acre-feet	TDS mg/L	Acre-feet times TDS
1990			
October	606	300	181,695
November	505	330	166,604
December	373	350	130,438
1991			
January	529	370	195,741
February	402	396	159,335
March	0	-	0
April	101	280	28,277
May	518	291	150,822
June	454	306	139,043
July	503	320	160,896
August	476	346	164,575
September	428	372	159,298
	4,895		1,636,724

$$\frac{1,636,724}{4,895} = 334 \text{ mg/L}$$

Flow Weighted TDS of Desalter discharged to the river = 334 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, 1991

February 27, 1992

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, 1991, and the related statement of revenue collected, expenses paid and charges 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, 1991, 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

SANTA ANA RIVER WATERMASTER

STATEMENT OF ASSETS AND LIABILITIES
ARISING FROM CASH TRANSACTIONS

June 30, 1991

ASSETS

Cash in checking account (Note 3)	$ 8,936
Cash in savings account (Note 3)	4,428
TOTAL ASSETS	$ 13,364

FUND BALANCE

Fund balance	$ 13,364

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, 1991

		Actual	Budget	Over (Under) Budget
REVENUE COLLECTED:				
Water district contributions (Note 2):				
Orange County Water District		$ -	$ 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		224	-	224
TOTAL REVENUE COLLECTED		9,824	16,000	(6,176)
EXPENSES PAID:				
Professional engineering services		-	10,000	(10,000)
Administrative expenses:				
Office and bank service charges	$ 108			
Auditing services	1,075	1,183	3,000	(1,817)
Annual reports		-	3,000	(3,000)
TOTAL EXPENSES PAID		1,183	16,000	(14,817)
EXCESS OF REVENUE COLLECTED OVER EXPENSES PAID		8,641	$ -	$ 8,641
FUND BALANCE AT JULY 1, 1990		4,723		
FUND BALANCE AT JUNE 30, 1991		$ 13,364		

See independent auditors' report and notes to financial statements.

SANTA ANA RIVER WATERMASTER

NOTES TO FINANCIAL STATEMENTS

June 30, 1991

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.

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, 1991 consisted of the following:

Security Pacific National Bank:	
Checking account	$ 8,936
Savings account	4,428
	$ 13,364

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

1990-91

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 1990-91

	Discharged Above the Narrows	Discharged Below the Narrows	Discharged Total
1990			
October	-	-	0
November	-	-	0
December	-	-	0
1991			
January	-	-	0
February	-	-	0
March	-	-	0
April	-	-	0
May	0	656	656
June	394	487	881
July	0	889	889
August	0	712	712
September	0	579	579
Total	394	3,323	3,717

TABLE G-2

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

MAY 1991
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	5
11	10
12	8
13	7
14	5
15	6
16	10
17	12
18	19
19	20
20	19
21	19
22	19
23	19
24	19
25	20
26	20
27	20
28	19
29	20
30	20
31	15
Total in CFS DAYS	331
Total AF	656

TABLE G-2

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

JUNE 1991
IN CFS-DAYS

Day	Discharged above the Narrows	Discharged at Van Buren Blvd.	Discharged Total
1	-	17	17
2	-	10	10
3	14	0	14
4	13	0	13
5	14	0	14
6	1	0	1
7	13	0	13
8	13	0	13
9	14	0	14
10	13	0	13
11	13	0	13
12	14	0	14
13	1	0	1
14	13	0	13
15	13	0	13
16	14	0	14
17	13	0	13
18	13	0	13
19	9	0	9
20	-	20	20
21	-	20	20
22	-	19	19
23	-	19	19
24	-	20	20
25	-	20	20
26	-	21	21
27	-	21	21
28	-	20	20
29	-	20	20
30	-	19	19
Total CFS DAYS	198	246	444
Total AF	394	487	881

TABLE G-2

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

JULY 1991
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	18
2	19
3	17
4	13
5	14
6	14
7	15
8	15
9	16
10	15
11	15
12	15
13	14
14	10
15	18
16	18
17	12
18	11
19	14
20	13
21	12
22	12
23	14
24	14
25	11
26	10
27	13
28	17
29	17
30	16
31	16
Total in CFS DAYS	448
Total AF	889

TABLE G-2

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

AUGUST 1991
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	13
2	14
3	12
4	12
5	10
6	11
7	12
8	13
9	12
10	11
11	11
12	11
13	11
14	12
15	13
16	11
17	12
18	12
19	12
20	11
21	11
22	11
23	11
24	11
25	11
26	10
27	10
28	10
29	12
30	13
31	13
Total in CFS DAYS	359
Total AF	712

TABLE G-2

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

SEPTEMBER 1991
IN CFS-DAYS

Day	Discharged at Van Buren Blvd.
1	11
2	12
3	13
4	9
5	6
6	14
7	13
8	13
9	12
10	13
11	13
12	11
13	6
14	6
15	7
16	7
17	9
18	9
19	9
20	10
21	9
22	8
23	9
24	9
25	10
26	10
27	9
28	9
29	8
30	8
Total in CFS DAYS	292
Total AF	579

TABLE G-2

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

WATER YEAR 1990-91

Month	Acre-feet	TDS mg/L	Acre-feet times TDS
1990			
October	0	-	-
November	0	-	-
December	0	-	-
1991			
January	0	-	-
February	0	-	-
March	0	-	-
April	0	-	-
May	656	592	388,352
June	881	603	531,243
July	889	534	474,726
August	712	498	354,576
September	579	507	293,553
	3,717		2,042,450

$$\frac{2,042,450}{3,717} = 549 \text{ mg/L}$$

SANTA ANA RIVER WATERSHED

MT. SAN ANTONIO
ELEV. 10080'

CAJON SUMMIT
ELEV. 4259'

SAN GABRIEL MOUNTAINS

SAN BERNARDINO COUNTY

LOS ANGELES COUNTY

SAN ANTONIO WASH

CUCAMONGA CREEK

CAJON WASH

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT

CHINO BASIN MUNICIPAL WATER DISTRICT

POMONA
ELEV. 848'

ONTARIO
ELEV. 998'

CHINO
ELEV. 730'

CHINO CREEK

PRADO RESERVOIR

RIVERSIDE NARROWS GAGING STATION

RIVERSIDE NARROWS

PRADO GAGING STATION

PRADO DAM

CORONA
ELEV. 678'

TEMESCAL WASH

WESTERN MUNICIPAL WATER DISTRICT OF RIVERSIDE COUNTY

ELEV. 1049'
SAN BERNARDINO

EAST TWIN CREEK

BERNARDINO CREEK

WARM CREEK

CITY CREEK

SAN TIMOTEO CANYON

COLTON

SLOVER MOUNTAIN
ELEV. 980'

JURUPA MOUNTAINS

PEDLEY HILLS

LA LOMA HILLS

RIVERSIDE COUNTY

ELEV. 858'
RIVERSIDE

REDLANDS
ELEV. 1357'

MENTONE
ELEV. 1640'

CRAFTON HILLS

YUCAIPA PLAIN

YUCAIPA
ELEV. 2682'

YUCAIPA HILLS

BEAR CREEK

ELEV. 6738'
BIG BEAR LAKE

SANTA ANA RIVER

SAN GORGONIO MOUNTAIN
ELEV. 11502'

PIGEON PASS
ELEV. 1910'

BADLANDS

BEAUMONT PLAIN

ELEV. 2600'
BEAUMONT

SAN GORGONIO PASS
ELEV. 2616'

SAN JACINTO MOUNTAINS

SAN JACINTO FAULT

SANTIAGO CREEK

SANTA ANA MOUNTAINS

SANTIAGO PEAK
ELEV. 5687'

THE GAVILAN

TEMESCAL PLATEAU

PUENTE HILLS

BUENA PARK
ELEV. 75'

FULLERTON
ELEV. 164'

ANAHEIM
ELEV. 157'

SEAL BEACH

SANTA ANA
ELEV. 111'

NEWPORT BEACH

ORANGE COUNTY WATER DISTRICT

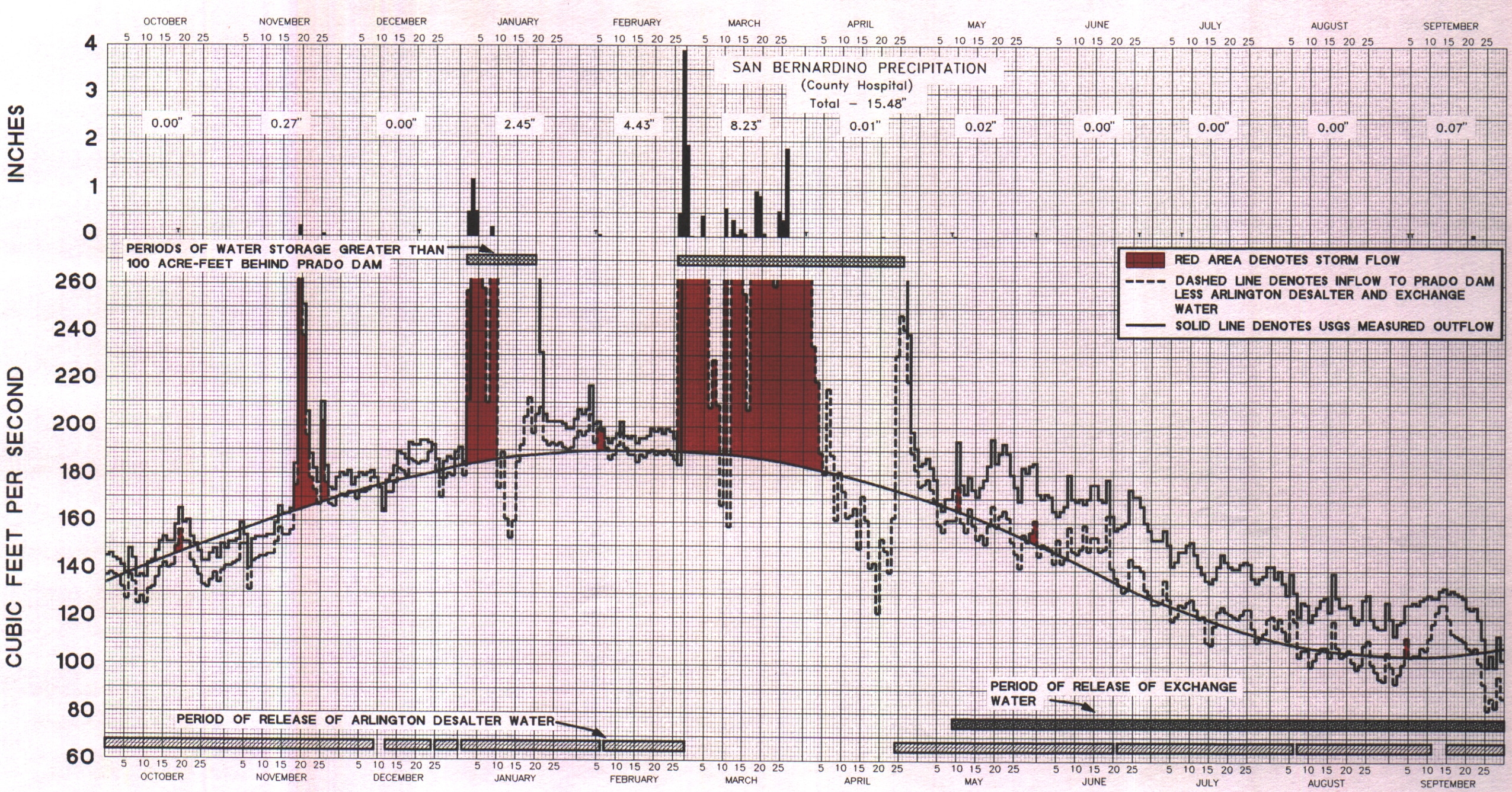
SAN JOAQUIN HILLS

PACIFIC OCEAN

N

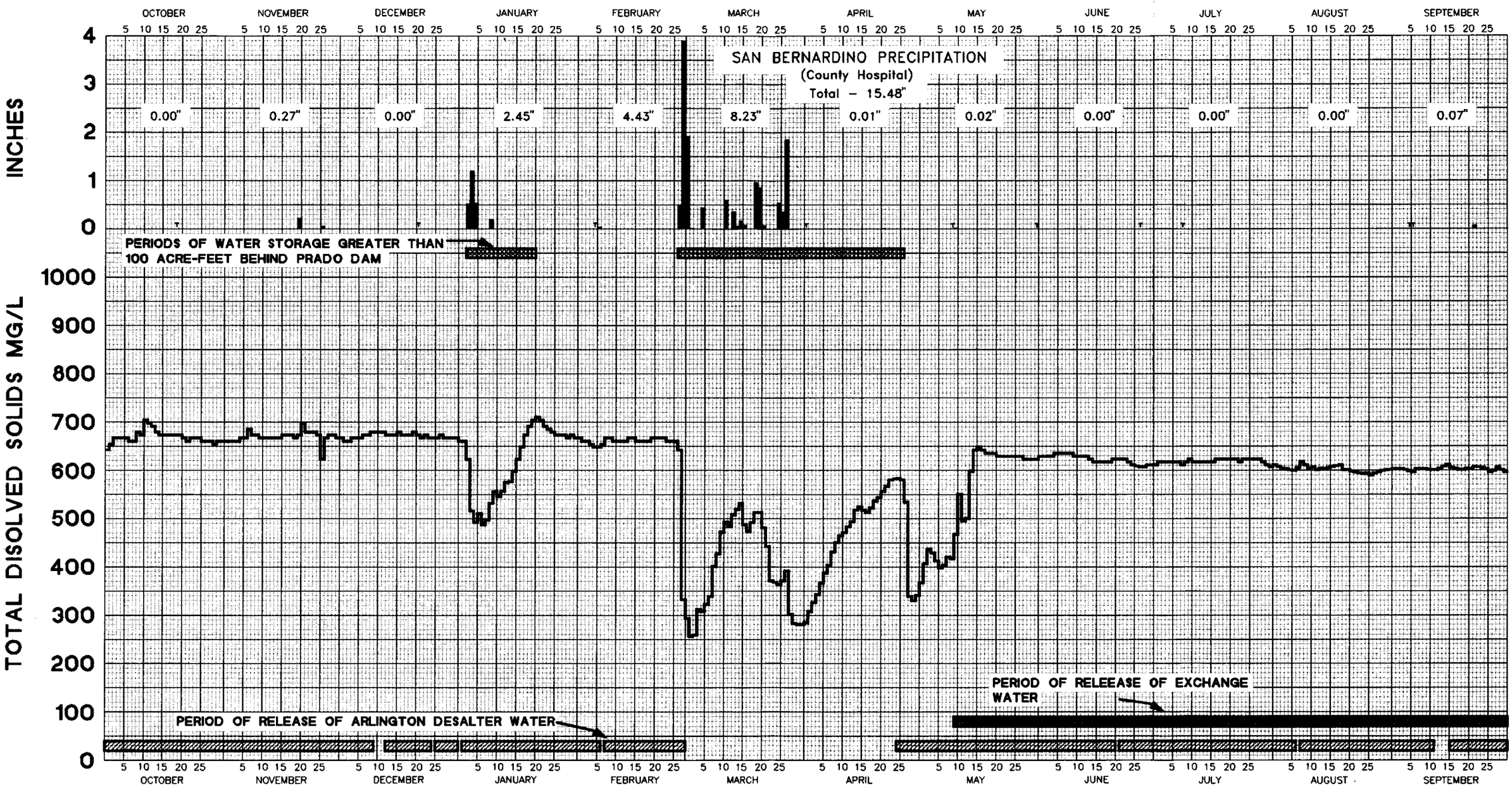
SCALE OF MILES
4 0 4 8

PLATE 1



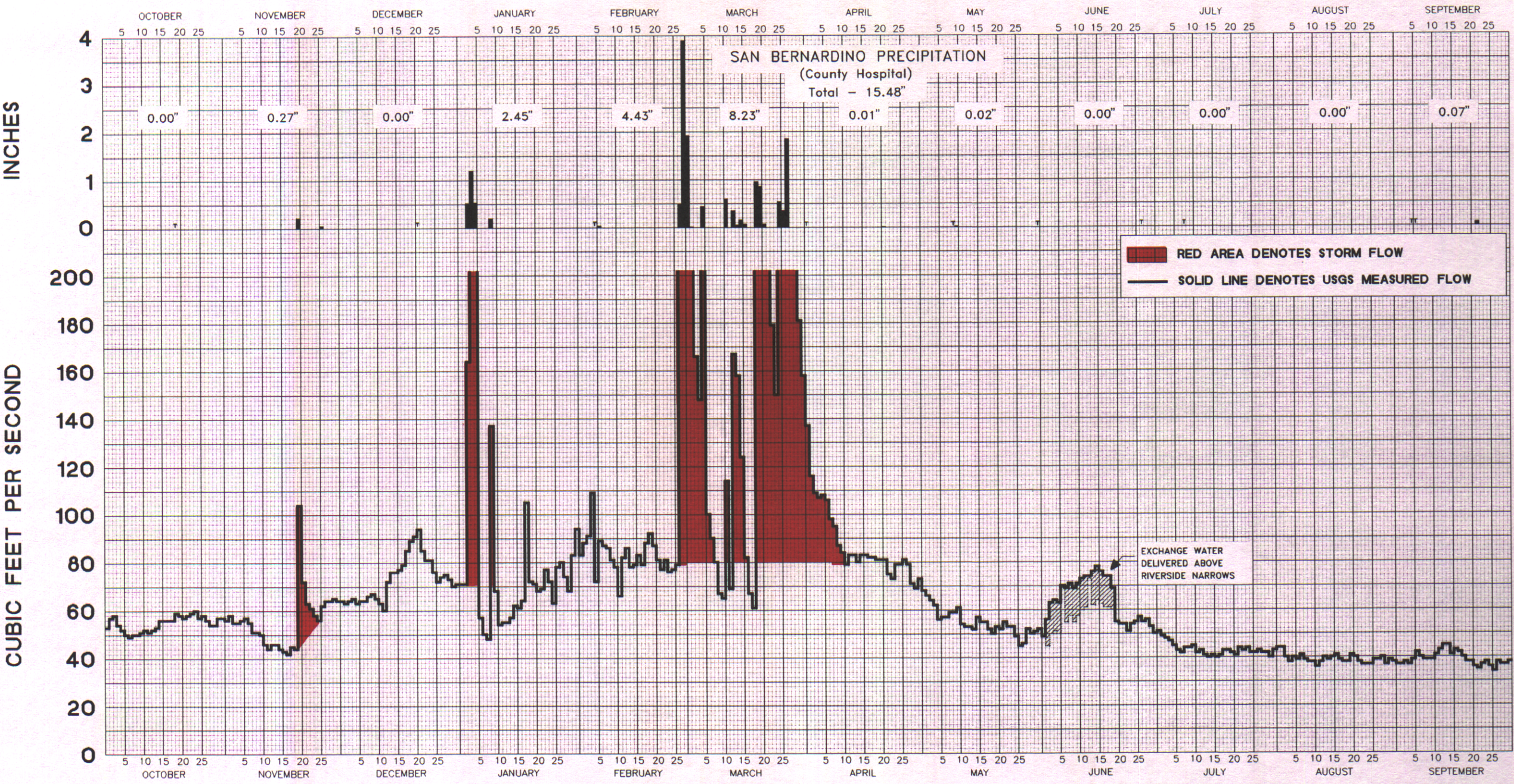
DISCHARGE OF SANTA ANA RIVER BELOW PRADO DAM & SAN BERNARDINO PRECIPITATION
WATER YEAR 1990-91

Plate 2



DISSOLVED SOLIDS IN SANTA ANA RIVER BELOW PRADO DAM
WATER YEAR 1990-91

Plate 3



DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS & SAN BERNARDINO PRECIPITATION
WATER YEAR 1990-91

Plate 4