SANTA ANA RIVER WATERMASTER

FOR

ORANGE COUNTY WATER DISTRICT Vs. CITY OF CHINO, et al

CASE No. 117628 - COUNTY OF ORANGE

SECOND

ANNUAL REPORT

OF THE

SANTA ANA RIVER WATERMASTER

1971-72

FEBRUARY 9, 1973

SANTA ANA RIVER WATERMASTER

FOR
ORANGE COUNTY WATER DISTRICT VS. CITY OF CHINO, ET AL
CASE NO. 117628 – COUNTY OF ORANGE

WATERMASTER
MAX BOOKMAN
WILLIAM J. CARROLL
JAMES C. HANSON
JOHN M. TOUPS
ALBERT A. WEBB

February 9, 1973

MAILING ADDRESS
3788 MC CRAY STREET
RIVERSIDE, CALIFORNIA 92506
TELEPHONE: (714) 686-1070

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

Re: Watermaster Report for 1971-72

Gentlemen:

We have the honor of submitting the second annual report of the Santa Ana River Watermaster.

The principal findings of the Watermaster for the water year 1971-72 are as follow:

At Prado

(1)	Base Flow at Prado	40,416 acre-feet
(2)	Annual Weighted TDS of Total Flow	707 ppm
(3)	Annual Adjusted Base Flow	40,416 acre-feet
(4)	Cumulative Adjusted Base Flow	78,818 acre-feet
(5)	Cumulative Entitlement of OCWD at Prado	84,000 acre-feet
(6)	Cumulative Debit (5)-(4)	5,182 acre-feet
(7)	One-third of Cumulative Debit	1,727 acre-feet
(8)	Minimum Required Base Flow in 1972-3	38,727 acre-feet

At Riverside Narrows

(1)	Base Flow at Riverside Narrows	16,157 acre-feet
(2)	Annual Weighted TDS of Base Flow at Riverside Narrows	712 ppm
(3)	Annual Adjusted Base Flow	16,017 acre-feet
(4)	Cumulative Adjusted Base Flow	33,029 acre-feet
(5)	Cumulative Entitlement of CBMWD and WMWD at Riverside Narrows	30,500 acre-feet
(6)	Cumulative Credit	2,529 acre-feet
(7)	One-third of Cumulative Debit	0 acre-feet
(8)	Minimum Required Base Flow in 1972-73	13,420 acre-feet

The above findings show that for the water year 1971-72 there exists a debit of 5,182 acre-feet in the obligations of Chino Basin Municipal Water District and Western Municipal Water District in the discharge of Base Flow downstream from Prado Dam. During the following water year, 1972-73, the minimum required Base Flow is 38,727 acre-feet. At Riverside Narrows, there exists a credit of 2,529 acre-feet. The obligation of San Bernardino Valley Municipal Water District during the water year 1972-73 is a minimum Base Flow of 13,420 acre-feet.

Sincerely yours,

Santa Ana River Watermaster

By: Max Bookman
Max Bookman

William J. Carroll
William J. Carroll

James C. Hanson
James C. Hanson

John M. Toups
John M. Toups

Albert A. Webb
Albert A. Webb

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CHAPTER I
INTRODUCTION

On April 17, 1967, the Superior Court in the County of Orange entered a Judgment in Case No. 117628, Orange County Water District versus City of Chino, determining the entitlements and obligations of the quantity and quality of the water supply in the Santa Ana River. The Court appointed a Watermaster composed of five persons to administer the provisions of the Judgment and to report annually to the Court and the Parties. This report for the water year 1971-72 is the second annual report to be issued since the Judgment became effective on October 1, 1970.

The Judgment established the entitlements and obligations of the four major public water districts within the Santa Ana River watershed, namely, the San Bernardino Valley Municipal Water District, Western Municipal Water District, Chino Basin Municipal Water District and Orange County Water District. The accomplishment of this action is now being followed by efforts of the public water agencies to develop plans which could be implemented to achieve the optimum management of the water resources within the watershed.

Many other important related activities took place during the year 1972 which will have a significant impact on the quantity and quality of the water resources of the Santa Ana River. Delivery of imported water from the State Water Project commenced. Construction was started on a desalination and reclamation plant. Comprehensive long-range plans for protection, enhancement and management of the water resources were nearing completion.

Scope of Report

Section 7(c) of the Judgment required the Watermaster to report to the Court and to each party not more than five months after the end of each water year starting with 1970-71. The items to be reported upon are as follow:

(a) Prado Accounting

  (1) Base Flow at Prado

  (2) Annual Weighted TDS of Total Flow at Prado

  (3) Annual Adjusted Base Flow

  (4) Cumulative Adjusted Base Flow

  (5) Cumulative Entitlement of OCWD at Prado

(6) Cumulative Credit or Debit

(7) One-third of Cumulative Debit

(8) Minimum Required Base Flow in Following Year

(b) Riverside Narrows Accounting

(1) Base Flow at Riverside Narrows

(2) Annual Weighted TDS of Base Flow at Riverside Narrows

(3) Annual Adjusted Base Flow

(4) Cumulative Adjusted Base Flow

(5) Cumulative Entitlement of CBMWD and WMWD at Riverside Narrows

(6) Cumulative Credit or Debit

(7) One-third of Cumulative Debit

(8) Minimum Required Base Flow in Following Year

The above listed items as determined by the Watermaster for the water year 1971-72 are hereinafter set forth. This first chapter is followed by Chapter II, "Prior Year Activities," Chapter III, "Water Supply Conditions," Chapter IV, "Base Flow at Prado." and Chapter V, "Base Flow at Riverside Narrows." As a matter of information, there will be found in the Appendices of this report a brief history of the litigation and a summary of the Judgment.

CHAPTER II

PRIOR YEAR ACTIVITIES

During the 1971-72 water year, the Watermaster consisted of Max Bookman, William J. Carroll, James C. Hanson, John M. Toups and Albert A. Webb.

The first Watermaster meeting during 1972 was held January 28, 1972 for the purpose of completing the annual report for the water year 1970-71. The report, dated February 15, 1972, was submitted to the Court and Parties. At a meeting held on May 16, 1972, there was prepared a work program and budget for the ensuing fiscal year. During the past year, Max Bookman served as Chairman and Albert A. Webb performed the functions of Secretary-Treasurer.

The program of activities undertaken by the Watermaster included principally the collection and analysis of data, maintenance of records and preparation of the annual report presenting the determinations and findings as required by the Judgment. This chapter will describe the Watermaster activities and briefly summarize important related activities of other major water supply agencies in the watershed.

Watermaster Service

Stream Flow and Water Quality Measurements

The most important data required in implementing the provisions of the Judgment relate to the operation of the necessary gaging stations for measurement of discharge and to the monitoring of water quality. The stream flow measurements at Prado Dam and Riverside Narrows had been included for many years in the cooperative program between the U.S. Geological Survey (USGS) and the State Department of Water Resources. In addition, there has previously been a program of stream flow measurements and water quality monitoring at a number of other stations by the USGS carried out in cooperation with the districts named as parties to the Judgment. This arrangement was continued following the initiation of watermaster service.

More recently, measurements were also added at three additional stations located on the Santa Ana River at Prado Park, Metropolitan Water District Upper Feeder crossing, and Mission Boulevard Bridge to assist the Watermaster. The program was also enlarged to include the gaging of Temescal Creek near Corona, Cucamonga Creek near Mira Loma and Chino Creek near Chino. The data

collected from these stations supplements the measurement made at Riverside Narrows and Prado Dam and have aided substantially in determining Base Flow and Storm Flows at these stations.

The collection of reliable data at the Riverside Narrows Pedley Bridge Station continues to be a problem. The culverts installed at Pedley Bridge to provide access for reconstruction of the bridge spans destroyed during the 1969 flood continue to provide a stable control section, and measurements obtained during the past year are considered good. However, it has been necessary to replace these culverts on several occasions as a result of high water.

Measurements which have been made at the crossing of the Metropolitan Water District Upper Feeder indicate a very close correlation with the Pedley Bridge measurements adjusted for the discharge of the Riverside Water Quality Control Plant, the difference being well within the limits of accuracy assigned to the two stations. The Watermaster has prepared plans and specifications for improving the channel and constructing a permanent control section at the MWD crossing. The estimated construction cost is $12,000, and right-of-entry has been obtained from Riverside County. Pending confirmation of the availability of funds for operation and maintenance of this station from the USGS and DWR, the Watermaster has continued to utilize data from both stations at the Riverside Narrows.

The water quality data utilized by the Watermaster to support the findings set forth in the report were obtained by the USGS from monitoring stations located at Prado Dam and the MWD crossing. In addition, the quality of the Riverside Water Quality Control Plant was also monitored by the USGS.

The costs incurred by the Parties for obtaining the stream flow and water quality data which data are then made available for use by the Santa Ana River Watermaster are set forth in Table 1.

Field Inspections

During the year a number of field inspections of the various gaging facilities were made by individual members of the Watermaster.

Compilation and Analysis of Basic Data

The Watermaster has established records and procedures for compiling and analyzing the basic data necessary in order to carry out the provisions of the Judgment. These records include the following:

TABLE 1

COSTS TO THE PARTIES AND USGS FOR MEASUREMENTS WHICH PROVIDE DATA USED BY THE SANTA ANA RIVER WATERMASTER
July 1, 1971 to June 30, 1972

San Bernardino Valley Municipal Water District		
At Riverside Narrows		
Surface Water Gage	$ 450.00	
At Riverside Water Quality Control Plant		
Surface Water Gage	250.00	
Water Quality Monitor	433.00	
TDS Samples	78.00	
At MWD Crossing		
Surface Water Gage	334.00	
Water Quality Monitor	450.00	
TDS Samples	78.00	
At Prado Park	270.00	
At Mission Boulevard	210.00	
Analysis, Data Preparation and Counsel to Santa Ana River Watermaster	500.00	$ 3,053.00
Western Municipal Water District		
Same as SBVMWD	$ 3,053.00	
Temescal Creek Discharge	450.00	
Cucamonga Creek Discharge	450.00	
Chino Creek Discharge	450.00	4,403.00
Chino Basin Municipal Water District		
Same as WMWD ($2.00 difference due to rounding)		4,401.00
Orange County Water District		
At Prado Dam		
Water Quality Monitor and Counsel to Santa Ana River Watermaster	$ 6,300.00	
TDS Determination	700.00	
At Prado Park	540.00	
At Mission Boulevard	420.00	7,960.00
Total for Parties		$19,817.00
United States Geological Survey		19,817.00
Grand Total		$39,634.00

(1) Daily precipitation at San Bernardino County Hospital.

(2) Flow of Santa Ana River at USGS gaging station below Prado Dam.

(3) Flow of Santa Ana River at USGS gaging station at Prado Park.

(4) Flow of the Santa Ana River at Riverside Narrows at Pedley Bridge (Van Buren Boulevard).

(5) Flow of the Santa Ana River at MWD crossing.

(6) Discharge of Riverside Water Quality Control Plant into the Santa Ana River.

(7) Flow of the Santa Ana River at Mission Boulevard Bridge.

(8) Specific conductance and TDS of the waters of the Santa Ana River below Prado Dam.

(9) Specific conductance and TDS of the waters of the Santa Ana River at MWD Crossing.

(10) Specific conductance and TDS of the discharge of the Riverside Water Quality Control Plant.

(11) Operation of Prado Reservoir.

Based on this compiled data, determinations were made of Base Flow, Storm and relationships between specific conductance and TDS. These determinations are explained in detail in Chapters IV and V.

Administrative Costs

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

Table 2 is a statement showing the income and expenses of the Santa Ana River Watermaster for the fiscal year 1971-72. The expenses as shown total $5,850.10 as compared to a budgeted amount of $23,000. The reason for the difference is that certain anticipated expenditures for construction and rehabilitation of gaging stations have not yet been made.

On June 5, 1972, the Watermaster advised the parties that the budget for the ensuing fiscal year 1972-73 would be $20,000. Table 3 shows the items and amounts included in said budget. Funds that may be needed for the improvement of gaging stations have been included in the budget.

TABLE 2

INCOME AND EXPENSES
July 1, 1971 - June 30, 1972

Income

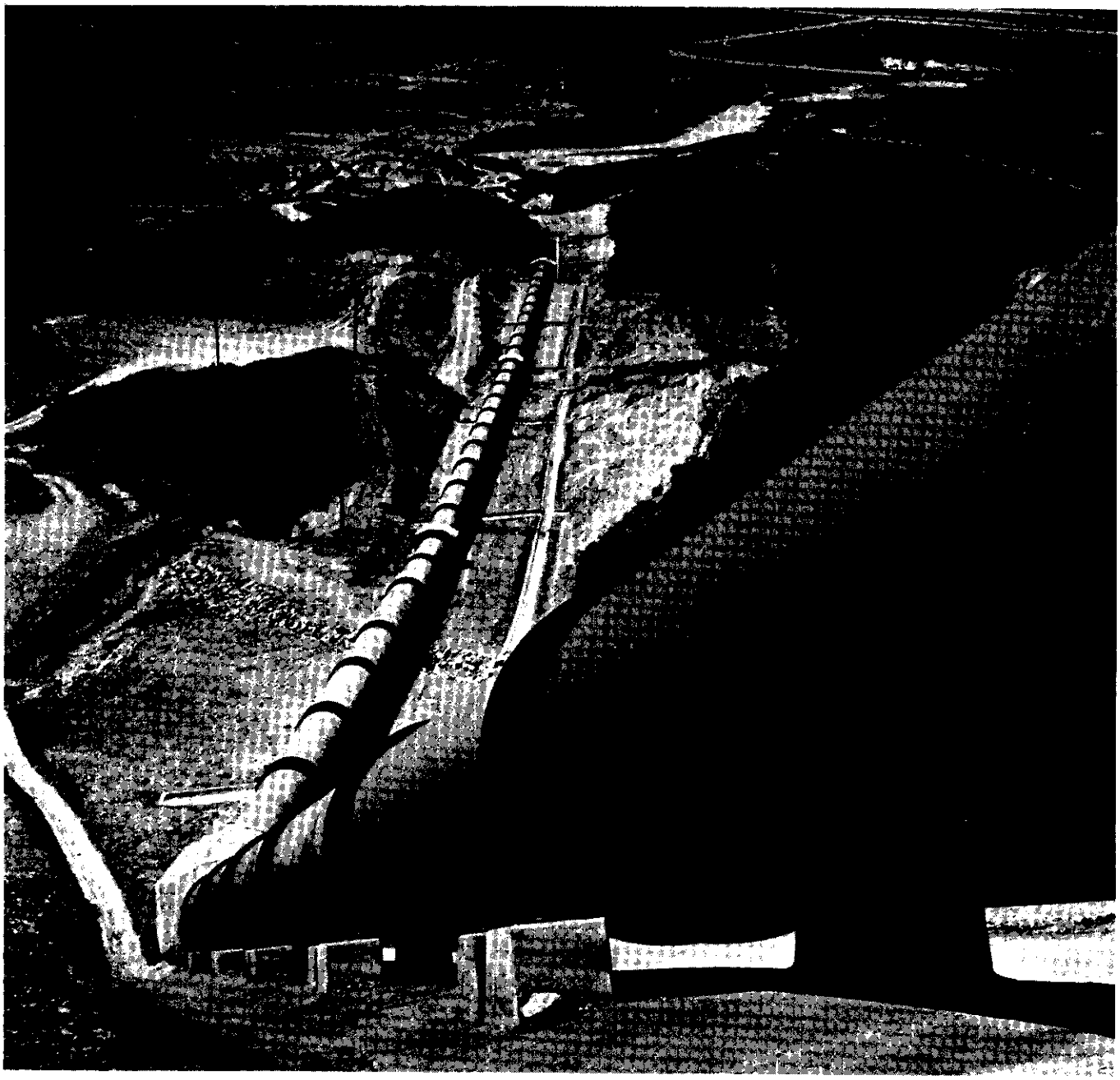
Balance June 30, 1971		$ 6,502.36
Payments by Parties for Fiscal 1971-72	$ 0	0
*Advance Payments received for Fiscal 1972-73		
San Bernardino Valley Municipal Water District	2,000.00	
Western Municipal Water District	2,000.00	4,000.00
Total Income Fiscal 1971-72		$10,502.56

Expense

Secretary-Office Expense 4/24/71 to 4/22/72	$ 1,331.26	
Toups Engineering, Inc. Meetings with USGS on collection and review of hydrologic data; updating Prado hydrograph; collection of rainfall runoff information; scalping 1970-71 flows at Prado and Riverside Narrows; basic EC on storm days; annual overage TDS value below Prado Dam; construct base flow curves; work on Annual Report, with necessary revisions and editing	2,411.25	
Bookman-Edmonston Engineering, Inc. Preparation of 1970-71 Annual Report, including graphs and diagrams	1,043.84	
James C. Hanson Flow of Santa Ana River at Prado to match all Watermasters; hydrologic data at Prado and Riverside Narrows; meeting with USGS; TDS at Prado	153.47	
Albert A. Webb Associates Preparation of data from U. S. Corps of Engineers for Prado Reservoir surface charts; work on Annual Report	910.28	5,850.10
Balance June 30, 1972		$ 4,652.46

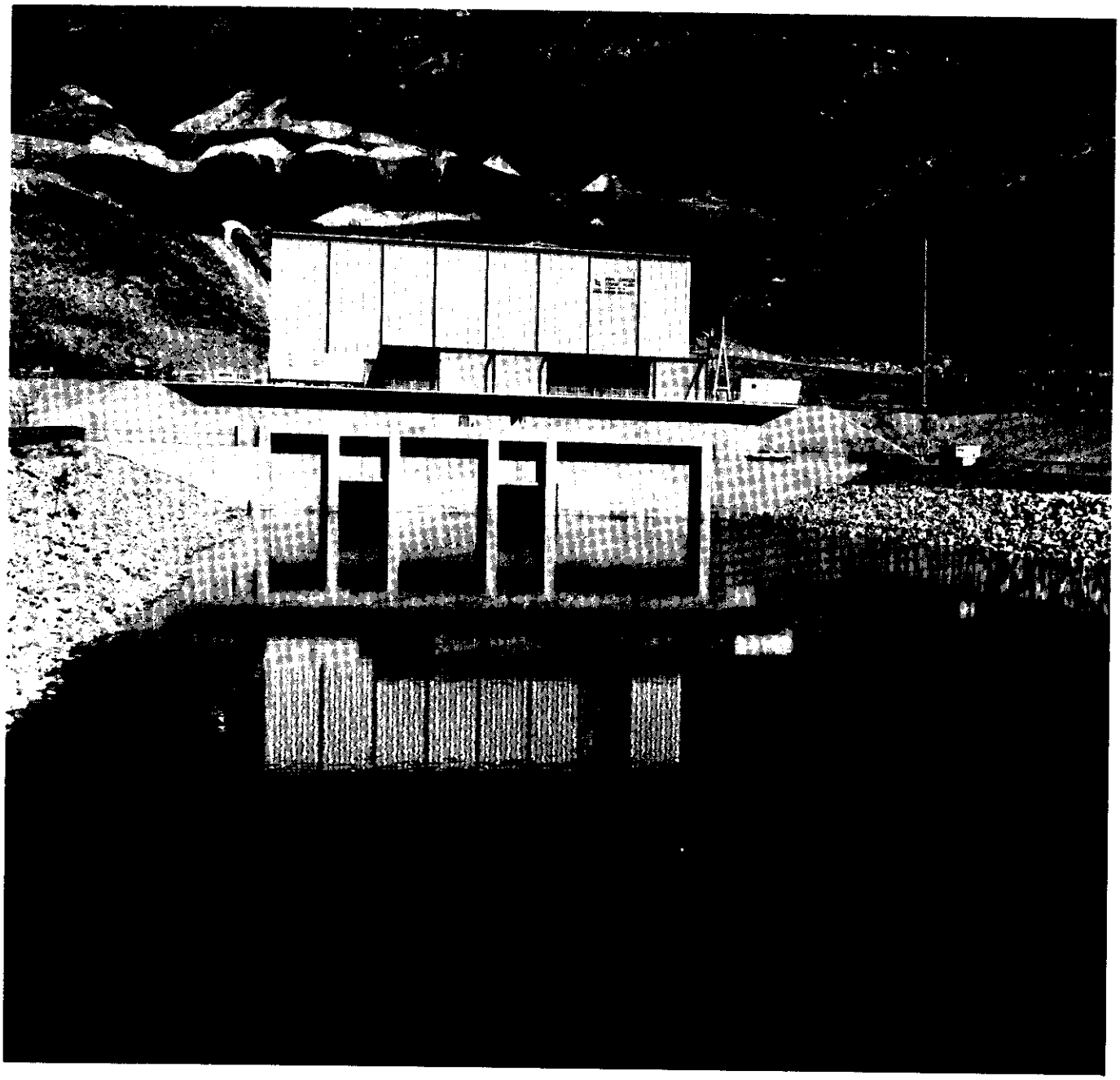
*These amounts are applicable to the 1972-73 budget but were received prior to June 30, 1972

NOTE: Invoice from James M. Montgomery, Consulting Engineers, Inc., dated 5/26/72 for printing of 1970-71 Annual Report was not paid until 9/27/72 - Amount $968.92



Devil Canyon Penstock for Delivery of State Project Water into San Bernardino Valley

Photograph No. 1



Devil Canyon Power Plant of State Water Project in San Bernardino County

Photograph No. 2

TABLE 3

SANTA ANA RIVER WATERMASTER BUDGET

	July 1, 1971 to June 30, 1972	July 1, 1972 to June 30, 1973
Administration	$ 3,000	
		$10,000*
Supporting Engineering Services	10,000	
Additional gaging and monitoring stations, including construction, operation, and maintenance	10,000	10,000
Total	$23,000	$20,000

*Includes both Administration and Supporting Engineering Services.

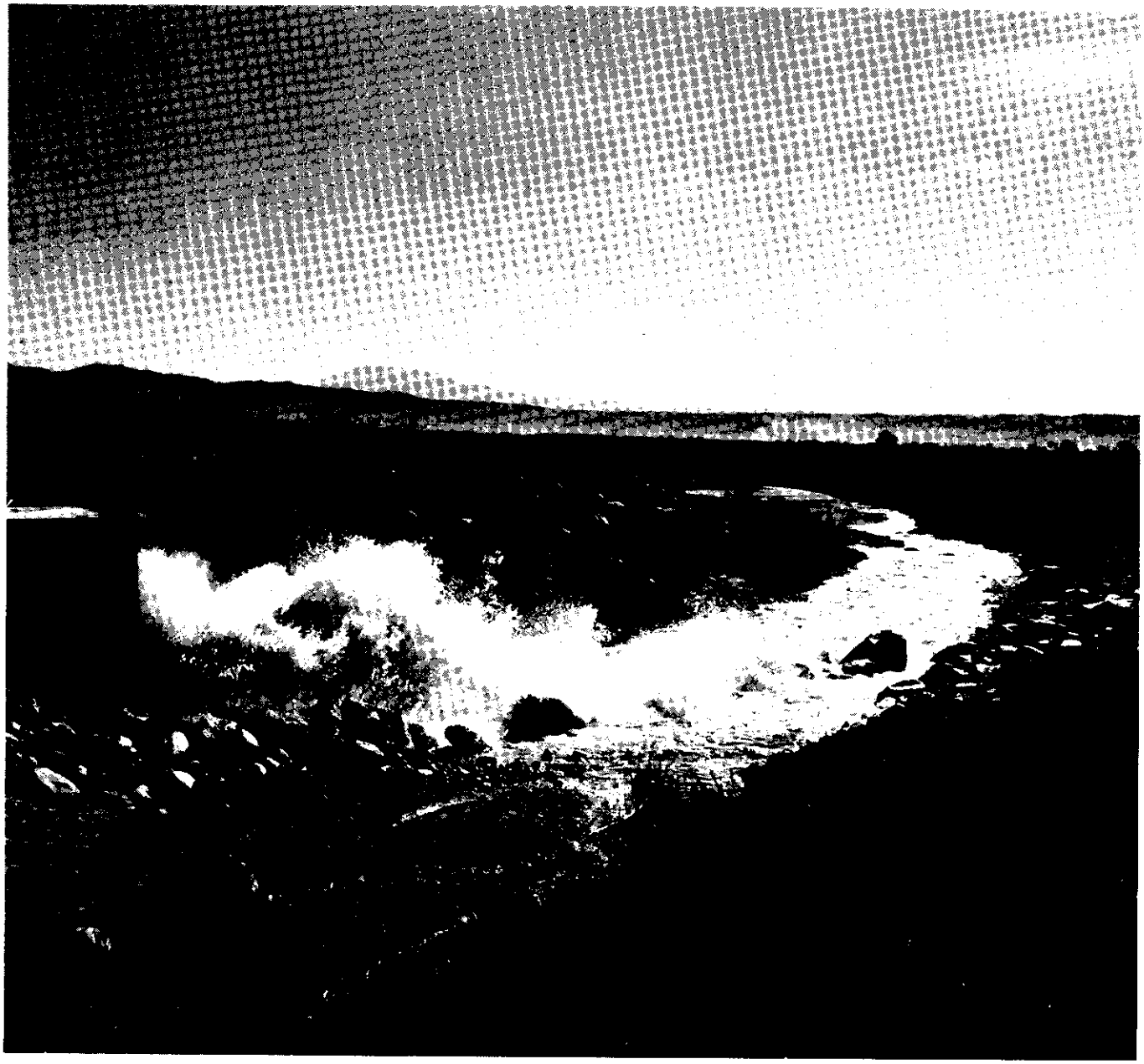
Related Activities of Other Agencies

San Bernardino Valley Municipal Water District

Construction was the key word in 1972 as State Project water moved farther south and the San Bernardino Valley Municipal Water District continued the construction of facilities to distribute the imported water. The San Bernardino Valley Municipal Water District's planning and construction schedule for its master distribution system enabled initial flows of project water to be put to beneficial use as soon as it was available at the Devil Canyon Powerplant afterbay.

On March 23, 1972, the last section of SBVMWD's Phase I pipeline was put into place, completing the first 4 miles of the water transmission system for State Project water from the Devil Canyon Powerplant afterbay to Waterman Canyon. The District ultimately plans to transmit water through three segments: the Foothill Pipeline to serve the area from San Bernardino east to the Santa Ana River; the Yucaipa Line to convey water from the terminus of the Foothill Pipeline near the Santa Ana River wash to the Yucaipa area; and the Lytle Pipeline to serve the Rialto and Bloomington areas.

Phase I transmission line runs parallel with and in close proximity to the base of the San Bernardino Mountains along most of its course. A noteworthy feature of the project is the installation of high-pressure fire control and water supply turnouts along the system. Provisions have been made for additional hydrants to enhance the Forest Service's ability to fight fires, as this



Delivery of Imported Water from State Water Project to San Bernardino Valley Municipal Water District

Photograph No. 3

is one of the most hazardous portions of its forest. The District also receives watershed protection benefits.

Most of the water to be taken by the San Bernardino Valley Municipal Water District will be spread for recharge of the ground water basins in San Bernardino Valley.

Northern California water from the California Aqueduct was first delivered to Devil Canyon Powerplant on December 7, 1972, and since that time water has been made available to SBVMWD on an incremental basis, according to the flow required by the State in the testing phase of its facility. Water was spread in the Devil Canyon (Sweetwater Canyon), Badger Basin and the Waterman Canyon spreading grounds. Controlled spreading in these three areas will continue as part of SBVMWD's operational plan. Regular deliveries will begin with continuous operation of Devil Canyon Powerplant.

The bonds for construction of the Foothill Line from Waterman Canyon to the Santa Ana River have been sold and design is in the final stages. Completion of this segment is scheduled for Spring, 1975.

Western Municipal Water District of Riverside County

In the latter part of 1966, the Western Municipal Water District of Riverside County made application to The Metropolitan Water District of Southern California for a connection to the California Aqueduct of the State Water Project near the confluence of Warm Creek and the Santa Ana River in San Bernardino County. The construction of this 40 cubic feet per second connection, which has the capability of breaking 450 pounds pressure to atmosphere through two newly developed pressure reducing canisters, was completed in 1973. The State Project water delivered from this connection will be used primarily for replenishment purposes and has the capability of delivering upward of 20,000 acre-feet annually.

The Interim Water Quality Management Plan for the Santa Ana River Basin, adopted in 1971, called for the upgrading of waste water treatment capability in Reaches II and III (17th Street in Santa Ana to Mission Boulevard Bridge in Riverside). The Board of Directors of Western Municipal Water District, with support from the City of Riverside, the Jurupa and Rubidoux Community Services Districts, and the California Regional Water Quality Control Board, prepared a feasibility study of methods to implement the recommendation of the Regional Board relative to possible construction of a regional tertiary treatment plant. The feasibility study was completed in April 1972, and Western's Board in August 1972 authorized that a project report along with an environmental impact statement be prepared. Both are to be released shortly. This report

recommends that the wastes from both community services districts be transmitted to the existing Riverside Treatment Plant and that a new 30 mgd advanced waste treatment plant be constructed just southerly of the existing Riverside plant by 1976.

Western's Board, carrying out further responsibilities in the water quality management field, approved the District's participation in the 30 mgd Santa Ana River Waste Water Interceptor and entering into contractual arrangements with Chino Basin Municipal Water District for 6.25 mgd of this pipeline capacity. This project is discussed further under the description of the current activities of Chino Basin Municipal Water District.

Chino Basin Municipal Water District

The Chino Basin Municipal Water District has been involved in four major activities this year which directly affect the Chino ground water basin and the Santa Ana River.

The first was the construction of a 20-mgd capacity tertiary treatment plant which treats the effluent from the Ontario-Upland sewage treatment plant by utilizing coagulation, sedimentation, filtration and chlorination. The tertiary treated effluent is conveyed to the Santa Ana River via a pipeline five miles in length. While the plant was not completed until October 1972, the pipeline was completed earlier, and secondary effluent has been discharged to the river since December 22, 1971.

The second major undertaking was the development of a Regional Sewerage Program under the control of the District. While this program has been under study for a period of years, it became a realization in August 1972, when the five cities of Ontario, Upland, Montclair, Chino and Fontana, and the Cucamonga County Water District entered into an agreement with the District, whereby the District purchased the treatment plants and interceptors of these agencies and took over all operational responsibilities.

A third project has been the implementation of a non-reclaimable wastewater line to serve the entire upper Santa Ana River Basin. The Orange County portion of the project is being constructed by the County Sanitation Districts of Orange County with CBMWD acting as the sponsoring agency for the upper basin. The County Sanitation District of Orange County is constructing a major interceptor, the Santa Ana River Interceptor to the Orange County line, to relieve domestic sewage loadings on their existing system of pipe lines. CBMWD has entered into a contract with the County Sanitation Districts of Orange County for an additional 30 mgd of peak capacity in that interceptor.

This 30 mgd of capacity is for the purposes of transporting highly saline wastes from the upper basin areas to the Pacific Ocean through the facilities of the CSDOC. The interceptor is being constructed in three segments and will be completed by 1975. CBMWD and the upper basin agencies will also have to construct additional facilities from the Orange County Line to their respective sources of saline wastes. This work will be accomplished during the next three years so that the collection and interceptor facility will be available for initial use by 1976. The project has qualified for funding under the EPA and Clean Water Grant Programs of the State of California.

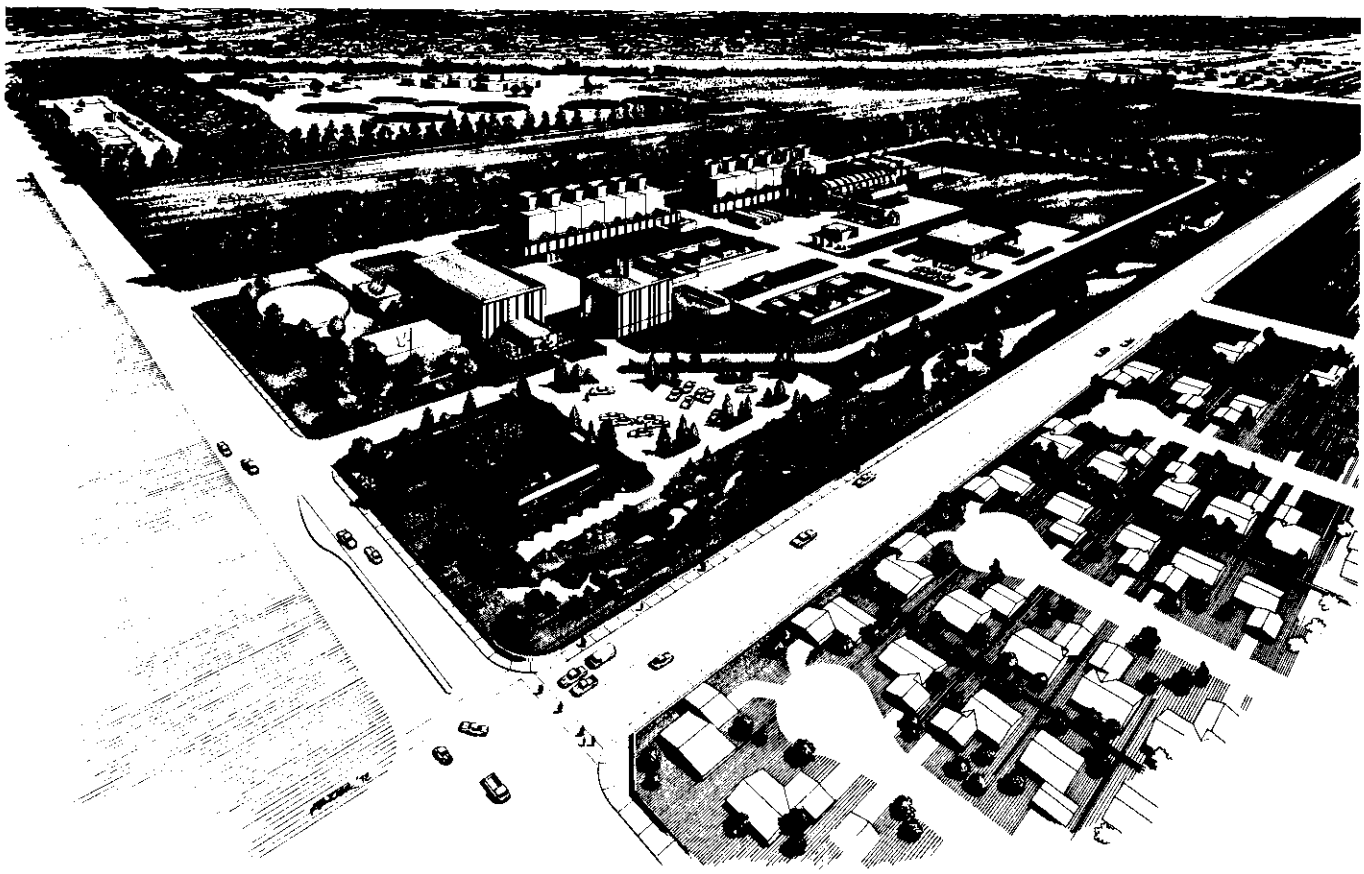
The fourth activity has been an activity involving the Chino Basin Water Users' Association. This Association has been studying, with the aid of the staff of the District, the possible adjudication of the water rights within Chino Basin for the purpose of developing a plan to finance the importation of water and its subsequent use through recharging of the basin. This activity has not been completed as of the date of the report.

Orange County Water District

To protect the County's ground water supply from sea water intrusion, and to develop greater flexibility in ground water utilization throughout the basin, the District is currently constructing a barrier system in the Fountain Valley area to be composed of 23 injection wells for the prevention of sea water intrusion. The water supply for the injection system will be provided from Water Factory 21, the District's innovative waste water reclamation - sea water desalting plant. At the present time, the desalting plant is 85 percent completed and 25 percent of the waste water reclamation plant is constructed. It is anticipated that the combined plants will be on line in the spring of 1974.

In response to the general public's requirements for multiple use of public land, the District has been expanding its environmental activities. Anaheim Lake, a 65-acre spreading basin used to sink imported water into the underground basin, is being used for a put-and-take fishing program. Over 100,000 people a year enjoy rainbow trout angling at the lake. Another parcel owned by the District is used as a golf driving range. For the past two years the District has leased a portion of the land it owns in Prado Reservoir for use as a pheasant hunting reserve, open from October through February. Approximately 40,000 pheasant will be taken by sportsmen in this area during the shooting season.

The District, in cooperation with the Orange County Flood Control District, is improving the flood channel of the Santa Ana River through Anaheim and Orange. During the year contracts were



**Proposed Wastewater Reclamation Plant - Sea Water Desalting Plant -
Fountain Valley, Orange County Water District**

Photograph No. 4

awarded for the construction of about 2-1/2 miles of new levees and a major diversion works. The work is approximately 85 percent completed at this time.

The OCWD is presently conducting preliminary studies to analyze the possibility of constructing a desalting plant in the forebay area of the county to demineralize either waste water, Santa Ana River water, or poor quality ground water. The proposed facility will dovetail with a waste water reclamation plant to be built by OCWD and Orange County Sanitation Districts to develop greater utilization of present water supplies and improve ground water quality in the forebay area.

Santa Ana Watershed Planning Agency

In 1968, the four major water districts in the Santa Ana River Watershed that were also parties to the Judgment formed the Santa Ana Watershed Planning Agency. The officers and Directors of the Agency are Howard A. Hicks, President (WMWD); Langdon W. Owen, Vice President (OCWD); Jack A. Beaver, Secretary (SBVMWD); and J. Andrew Schlange, Director (CBMWD). The Agency is charged with the responsibility of developing a comprehensive water quality management plan. In addition to financial support provided by the four districts, the Agency has received a planning grant from the Federal Government through the Environmental Protection Agency. A number of reports have been completed by the Agency, and at the present time the schedule calls for completing a report containing the recommended plan and an environmental assessment of the plan and alternatives during the latter part of February 1973. Public hearings will be scheduled after the release of the final report.

During 1971, the Santa Ana Watershed Planning Agency was awarded a contract by the State Water Resources Control Board for the purpose of preparing a comprehensive water quality control plan for the entire watershed, including San Jacinto Basin. The present schedule calls for completion of a final report to be submitted to the State Water Resources Control Board in August 1973.

CHAPTER III
WATER SUPPLY CONDITIONS

With the occurrence of another year of below normal precipitation, the flow of the Santa Ana River during the water year 1971-72 remained about the same as the prior two dry years, which is far below the Base Period (1934-35 through 1959-60) average annual quantity. However, the Base Flow at Prado increased over the prior year due principally to the commencement of discharge of sewage effluent into Prado Reservoir from the Ontario-Upland Treatment Plant in the Chino Basin. The Base Flow at Riverside Narrows during the water year 1971-72 was slightly less than in the prior year.

Precipitation During 1971-72

During the 1971-72 water year the precipitation at the San Bernardino County Hospital amounted to 9.62 inches, which is 53 percent of the Base Period average. Only two significant storms occurred during the season. The first storm commenced October 24, 1971 and continued intermittently for five days. The second and largest storm commenced December 22, 1972 and had a duration of about seven days.

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

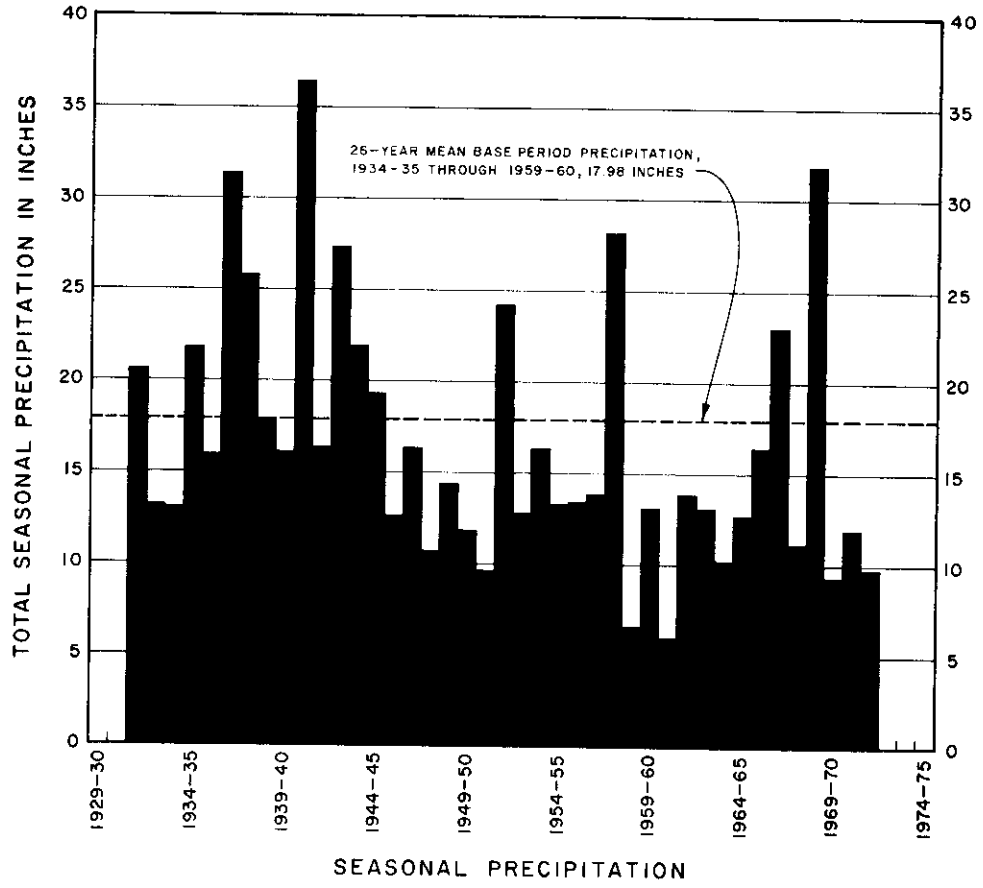
Runoff During 1971-72

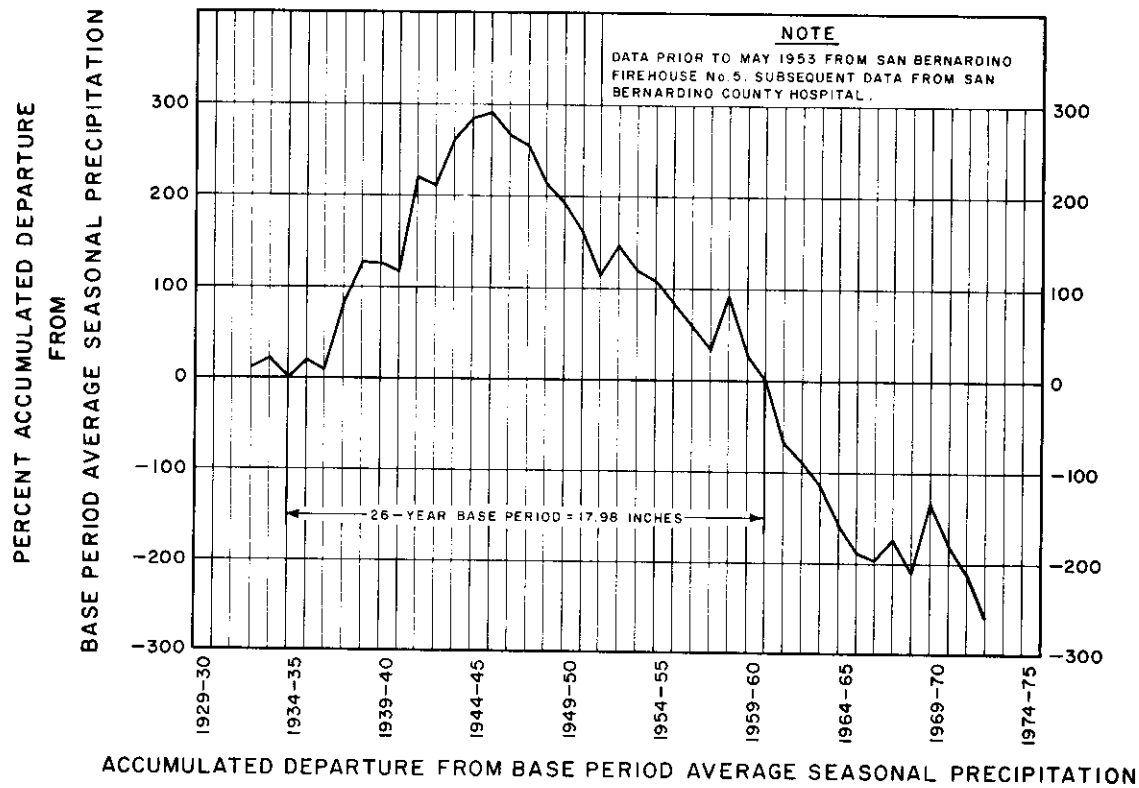
Below Prado Dam

Figure 2 shows the Storm and Base Flow components of the total flow in the Santa Ana River below Prado Dam.

The total flow of the Santa Ana River at Prado Dam during 1971-72 was below the 26-year Base Period (1934-35 through 1959-60) average, amounting to only 51,743 acre-feet, as compared to the Base Period average of 78,780 acre-feet per year.

The Base Flow below Prado Dam decreased progressively during the extended drought period and reached a low in 1960-61 of 26,190 acre-feet. Since that year, the Base Flow has generally increased. During 1969-70 the Base Flow amounted to 39,074 acre-feet. The below normal rainfall of the 1970-71 water year was evidenced by a decline in the Base Flow to 38,402 acre-feet;





VARIATION IN PRECIPITATION AT SAN BERNARDINO

FEBRUARY 1973

FIGURE 1

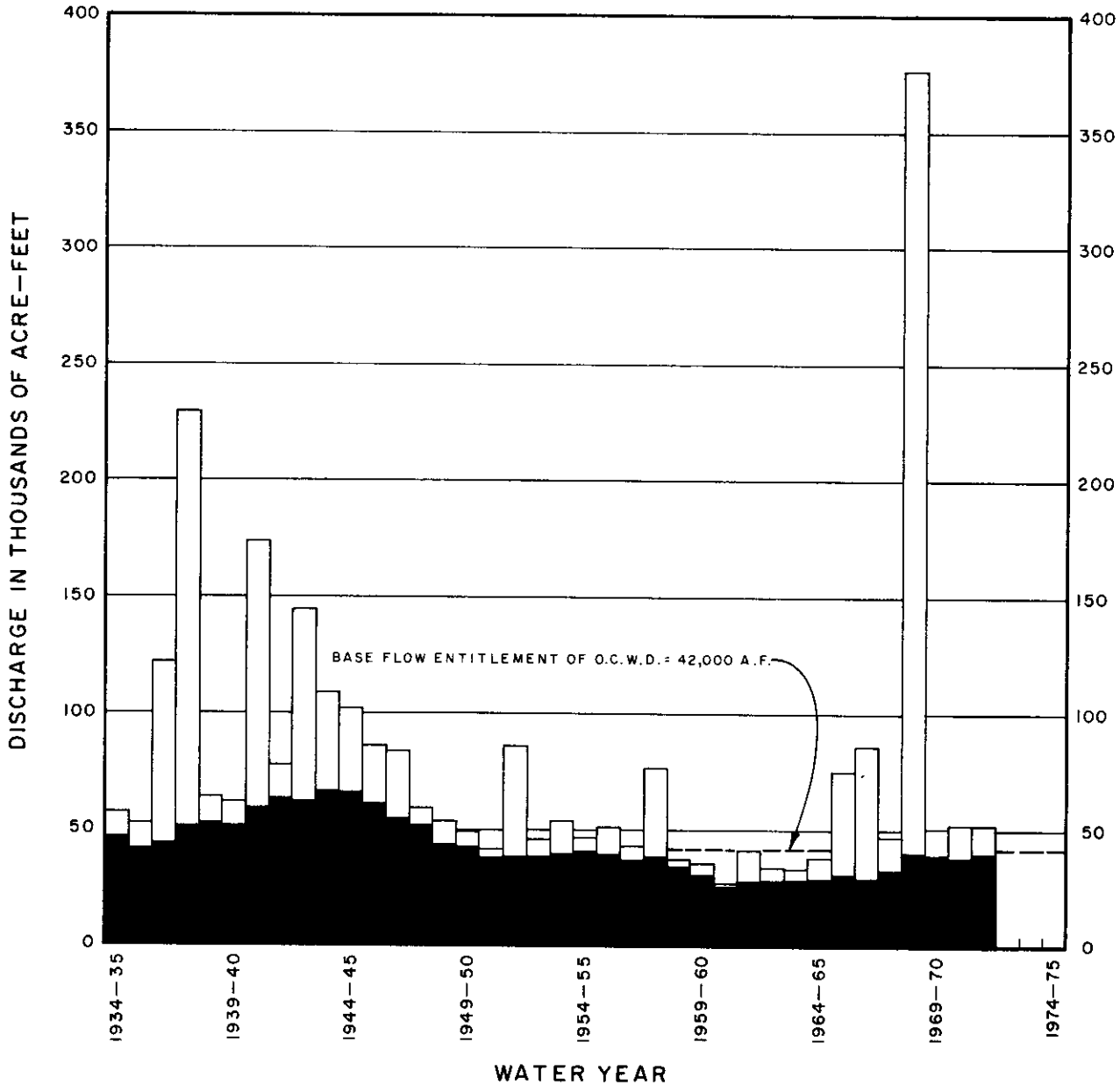
NOTE

DISCHARGE EXCLUDES IMPORTED M.W.D. WATER BEING TRANSPORTED IN THE SANTA ANA RIVER.

LEGEND

STORM FLOW

BASE FLOW



DISCHARGE OF SANTA ANA RIVER BELOW PRADO DAM

FEBRUARY 1973

FIGURE 2

however, during 1971-72 it had again risen to 40,416 acre-feet. This amount compares to a 26-year Base Period average of 47,470 acre-feet.

At Riverside Narrows

Figure 3 shows the components of natural flow in the Santa Ana River at Riverside Narrows and the sewage effluent from the Riverside Water Quality Control Plant for the period from 1934-35 through 1971-72.

The total natural flow (excluding City of Riverside's sewage effluent) at Riverside Narrows for the 1971-72 water year was below the 26-year Base Period average, amounting to 22,253 acre-feet as compared to the Base Period annual average of 44,650 acre-feet.

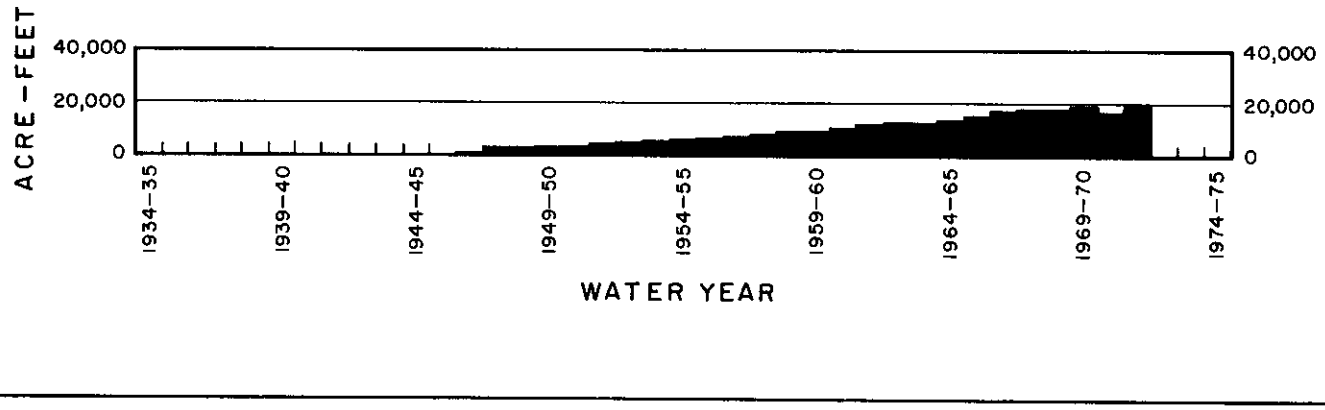
The Base Flow at Riverside Narrows decreased from 27,120 acre-feet in 1943-44 to 16,410 acre-feet in 1954-55, increased to 19,470 acre-feet in 1957-58, then decreased to an all-time low of 13,450 acre-feet in 1965-66. Since that time, the Base Flow at Riverside Narrows gradually increased to 17,223 acre-feet in 1969-70. The Base Flow at Riverside Narrows decreased to 17,061 acre-feet in 1970-71 and to 16,157 acre-feet in 1971-72 as compared to the 26-year Base Period annual average of 22,190 acre-feet.

Sewage Effluent from Riverside Water Quality Control Plants

Since prior to 1950 the sewage effluent from the Riverside Water Quality Control Plants, which is discharged at the Riverside Narrows, has been increasing in amount. In 1949-50, the amount of treated effluent from Riverside No. 1 and No. 2 plants was 3,960 acre-feet. By 1959-60, the discharge from these plants had increased to 9,900 acre-feet. By 1969-70, the discharge of sewage effluent from the combined treatment plants was 18,657 acre-feet. Thus the contribution of sewage effluent by the City of Riverside has been increasing at a rate of about 800 acre-feet per year. This trend is illustrated on Figure 3. The sewage discharge of the Riverside Water Quality Control Plants during 1971-72 was 19,004 acre-feet.

Effluent from Ontario-Upland Sewage Treatment Plant

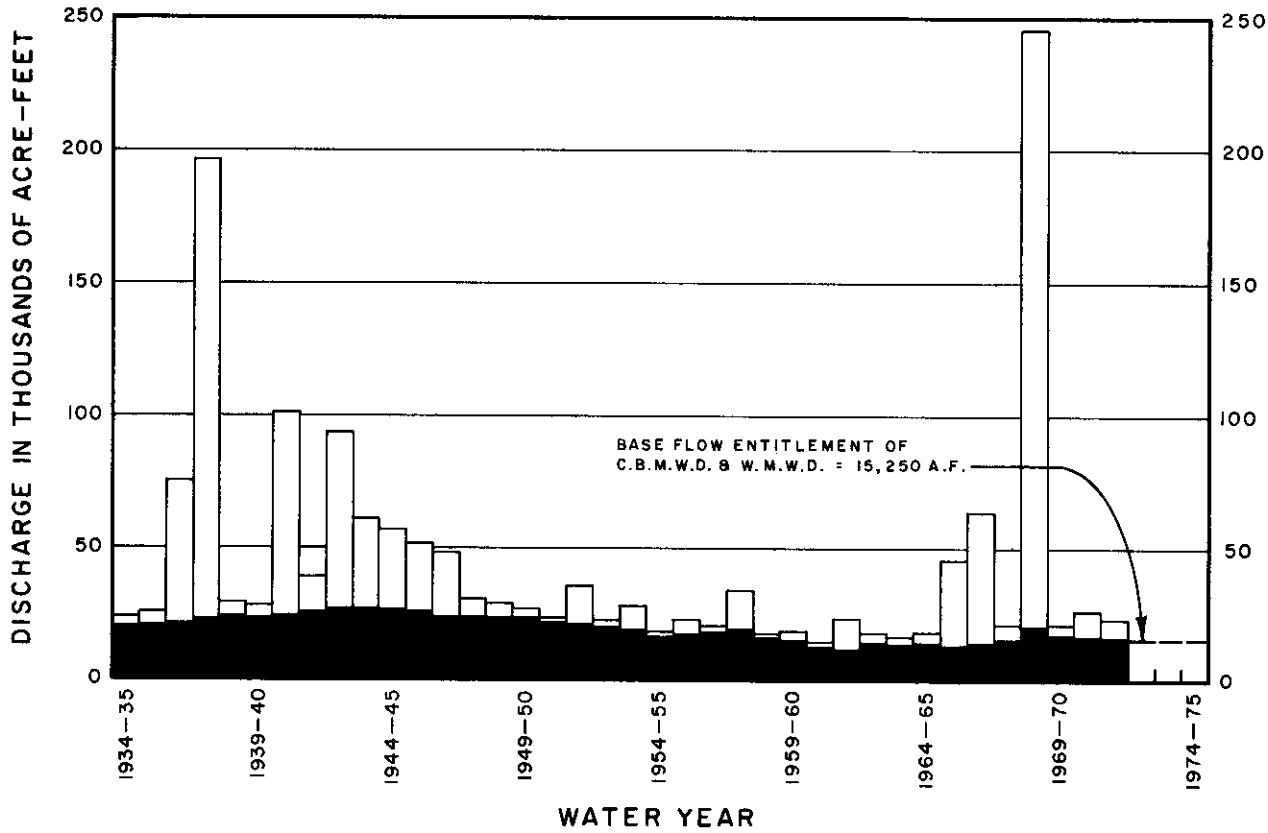
In late December 1971 and continuing through 1972, waste water effluent from the recently constructed tertiary plant serving Ontario and Upland has been discharged through a 30-inch pipeline and ditch to Prado Reservoir. The quantity of effluent discharged during the water year 1971-72 amounted to about 7,054 acre-feet.



SEWAGE EFFLUENT FROM RIVERSIDE WATER QUALITY CONTROL PLANTS

NOTE

DISCHARGE EXCLUDES SEWAGE EFFLUENT FROM THE RIVERSIDE WATER QUALITY CONTROL PLANTS AND IMPORTED M.W.D. WATER BEING TRANSPORTED IN THE SANTA ANA RIVER.



DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS

CHAPTER IV
BASE FLOW AT PRADO

This chapter deals with the analysis of the flow at Prado Dam, the calculation of the amount of Base Flow at Prado credited to CBMWD and WMWD and the calculation of the Adjusted Base Flow. The adjustment of Base Flow is made on the basis of the weighted average annual TDS of the total flow at Prado.

Total Discharge at Prado

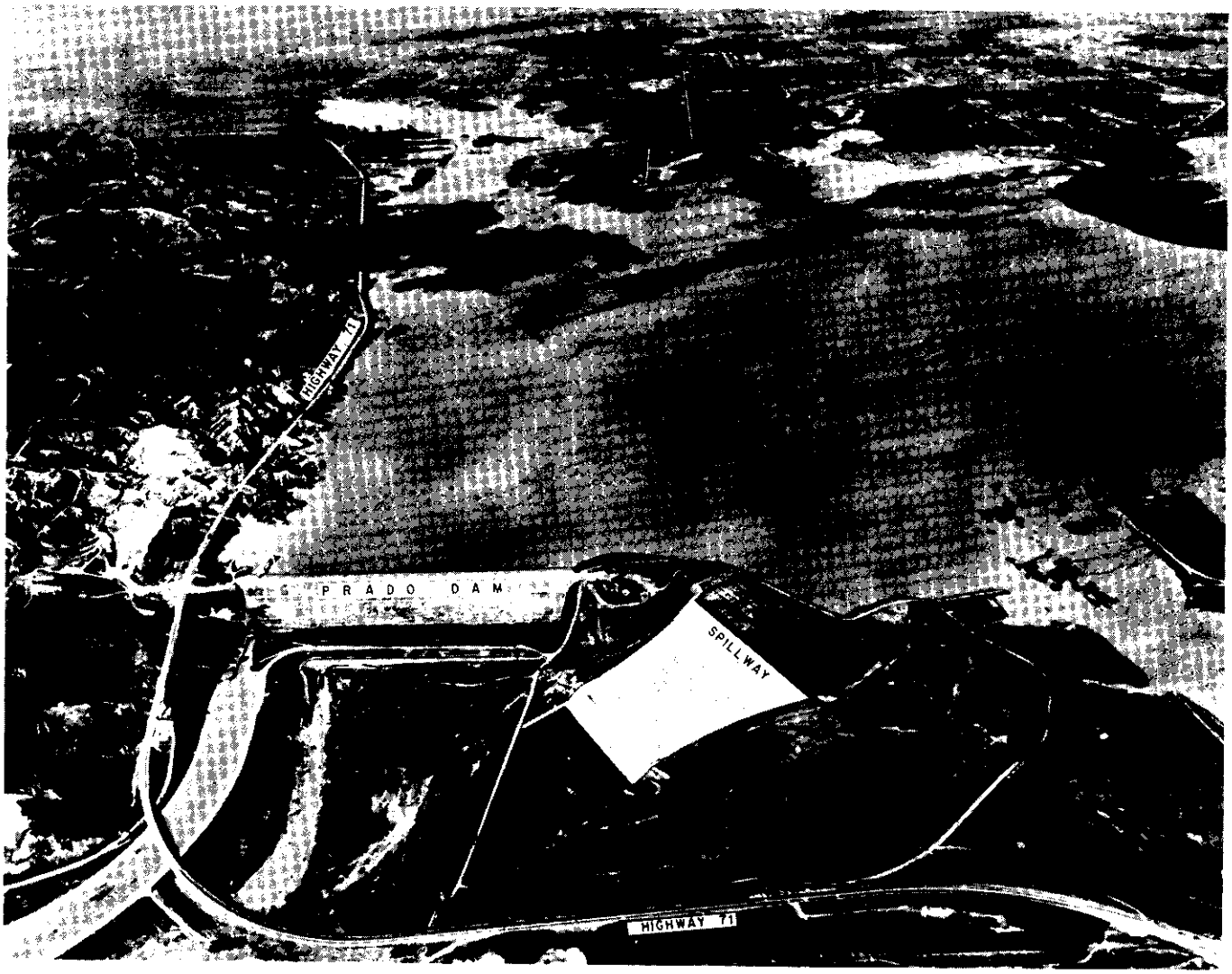
The total discharge of the Santa Ana River at Prado during 1971-72 water year amounted to 51,743 acre-feet as measured at the USGS gaging station below Prado Dam. This can be compared to the 26-year average annual flow of 78,780 acre-feet during the Base Period of 1934-35 through 1959-60. During the water year 1971-72, a minimum monthly discharge of 1,924 acre-feet was recorded in July and a maximum monthly discharge of 10,705 acre-feet occurred in January.

Components of Flow

Of the total discharge at Prado during the 1971-72 water year 40,416 acre-feet was Base Flow and 11,327 acre-feet was Storm Flow. The components of flow were independently determined by each of the five members of the Watermaster using the general procedure set forth in the Work Papers of the engineers for the parties in reaching the physical solution provided for in the Judgment. The Base Flow of 40,416 acre-feet represents an average value of the computations submitted by the five members of the Watermaster. Details of the scalping procedure are described in the following section and the results are graphically shown on Plate 2. The components of flow of the Santa Ana River at Prado Dam for each month in the 1971-72 water year are listed in Table 4.

Operation of Prado Dam and Reservoir

During the 1971-72 water year water was stored behind Prado Dam during the periods October 18, 1971 to October 26, 1971 and December 22, 1971 to January 13, 1972. The effect of gate operations at Prado Dam was to regulate total outflow as measured at the USGA stream gaging station downstream of Prado Dam. During these two periods the water stored in Prado Reservoir varied up to a maximum of 6,839 acre-feet and the maximum mean daily flow released to the lower Santa Ana River was 566 cfs.



Prado Dam and Reservoir Following the 1969 Storm

Photograph No. 5

TABLE 4

COMPONENTS OF FLOW AT PRADO DAM
FOR WATER YEAR 1971-72
(In Acre Feet)

Month	USGS Measured Outflow	Change In Storage	Regulated Storm Flow	Base Flow
Oct	2,257		215	2,042
Nov	3,314		108	3,206
Dec	8,702	+ 4,807	9,636	3,873
Jan	10,705	- 4,807	545	5,353
Feb	5,046		0	5,046
Mar	4,802		0	4,802
Apr	3,909		44	3,865
May	3,499		111	3,388
June	3,154		527	2,627
July	1,924		0	1,924
Aug	2,162		141	2,021
Sep	2,269		0	2,269
Total	51,743	0	11,327	40,416

Generally during storms the Corps of Engineers operated the Prado gates so that some of the storm runoff was temporarily held in storage behind the dam. As the storm ended, Prado Reservoir storage was gradually reduced by the controlled releases to the downstream water conservation facilities operated by Orange County Water District.

Base Flow

To facilitate the separation of the storm flow component from the Base Flow component, the daily inflow to Prado Reservoir was estimated. This was done by using reservoir stage records from the Corps of Engineers and dam outflow records from the USGS. Daily reservoir water surface elevations were converted to acre-feet of storage by use of Corps of Engineers' relationship between the water surface elevation and the storage capacity. Daily reservoir inflow was computed by use of the equation: Inflow = Outflow + Change in reservoir storage. The computed inflow was compared against the partially measured tributary inflows to insure that the computed inflow using a reservoir stage component was reasonable.

The general procedure used by the members of the Watermaster to separate the 1971-72 flow components is outlined below:

(1) The daily records of both calculated inflow to Prado Reservoir as described above and outflow at Prado Dam as measured by the USGS were plotted for the entire water year as shown on Plate 2.

(2) On this graph, the daily precipitation recorded at the San Bernardino County Hospital was plotted.

(3) On this same graph, the reciprocal of daily evaporation (in inches) at the Riverside Experimental Station was plotted.

(4) Using the above data, an initial determination was made of those days having no Storm Flow component. Non-storm periods exclude the time from commencement of rainfall until the end of the recession flow following each storm period. Use was made of the inflow hydrograph to determine base flow when discharge of stored water occurred during non-storm periods.

(5) Beginning December 22, 1971 an outfall line was utilized to convey effluent from the Ontario/Upland Wastewater Treatment Plant to Prado Dam. The beginning effects on the Base Flow were masked by the storms occurring at that time. This discharge modified the normal seasonal characteristics of the Base Flow. To account for this modification and to smooth out day-to-day fluctuations in Base Flow, two smooth curve segments were fitted adjacent to the non-storm day flows. One curve segment was drawn for the period prior to the discharge and another was drawn for the period after the discharge.

(6) Utilizing the above curve segments during non-storm periods, two smooth Base Flow curves were drawn and extended across the balance of the time when storms occurred. The lower curve represents the Base Flow without the flows from the Treatment Plant; and the upper curve represents the Base Flow with flows from the Treatment Plant. The shape of the curves is similar to that utilized in scalping of prior years and was developed from data on historical discharges during non-storm periods. During periods of Storm Flow when no storage change occurred in Prado Reservoir, the outflow hydrograph was used to determine the components, but when changes in storage occurred in Prado Reservoir, the inflow hydrograph was used. Storm Flow periods include the time not included in item (4) above.

(7) Arriving at an opinion of the location of the curve segments separating the two components of flow required the exercise of judgment, taking into consideration items (1)

through (6) above and, to some extent, the variation in Base Flow which occurred in the previous water year.

(8) The Base Flow curve segments were used for separation of components of flow during storm intervals. Mean daily storm flow, including stored daily storm flow releases was computed by subtracting the value of the Base Flow curve segment from the total mean daily flow as recorded at the USGS gaging station below Prado Dam. For these days, Base Flow was designated as the value shown on the Base Flow curve segment.

(9) For those days outside of the storm periods, and for those days when water was not stored behind Prado Dam, Base Flow was accepted as the total discharge measured at the USGS station below Prado.

Water Quality

During the water year 1971-72, the weighted average total dissolved solids (TDS) for the total flow passing Prado was found to be 707 ppm. This determination of the water quality at the USGS gaging station below Prado Dam was made using measurements obtained by the USGS which operates a multiple parameter water quality monitoring recorder at this station. A continuous stream of water from the Santa Ana River is pumped to the water quality monitor. A continuous record of data recorded on a punched tape is obtained for determination of specific conductivity, temperature, chlorides, dissolved oxygen and pH. Average daily values for TDS which were generated from specific conductance data recorded at this water quality station are shown on Plate 3.

Examination of the TDS plot provides an interesting insight to the reaction of Santa Ana River water quality to upstream events. A significant interruption of the TDS curve occurred on about October 16th. This was the first significant rainfall in the watershed after months of dry weather. As in the 1970-71 water year, runoff from this precipitation apparently flushed the accumulated debris in the watershed into the Santa Ana River, causing a jump in the TDS from the 850-900 ppm range to 1000 ppm. The storms that occurred in late December diluted normal flows and caused the TDS to drop to almost 300 ppm. This effect tapered off during early January, and the TDS returned to the 800 to 900 ppm level by mid-January. A significant change in the make-up of the Base Flow occurred in late December due to the release of effluent from the Ontario/Upland Wastewater Treatment Plant into the Prado Dam area. The effluent probably caused the TDS concentration to steadily drop until March when it plateaued at the mid-700 ppm level.

Personnel from the USGS make weekly inspections of the station to determine if equipment is operating satisfactorily and to secure grab samples of water from the river for laboratory determinations of total dissolved solids and for specific conductance. During periods of storm runoff the USGS visits the station at least once each day for the purpose of taking additional grab samples to provide a more detailed record of possible changes in water quality during periods of Storm Flow. These samples are analyzed for TDS and for specific conductance.

At the end of each month, the punched tape from the Prado monitoring unit is transmitted to Washington, D.C. for machine processing. A summary tabulation of data for all items is obtained. The summary also shows the maximum, minimum and the mean hourly reading each day of record. The results of the machine processing are returned to the USGS staff in Garden Grove, California for review and to eliminate inconsistent data. A corrected summary is then made available to the Watermaster, along with a more detailed record of specific conductances showing instantaneous values at two-hour intervals.

Utilizing the USGS water quality records, the following analyses were performed by the Watermaster to determine the annual weighted TDS:

(1) The specific conductivity of the Santa Ana River below Prado was relatively uniform for most days of the year. On these days, the mean hourly specific conductance, as computed by the USGS, was accepted as representative of the daily weighted value.

(2) During storm periods when the daily discharge varied, numerous flow measurements, together with the respective specific conductance measurement, were used to determine the weighted mean daily specific conductance value.

(3) Laboratory analyses of the 60 grab samples taken by the USGS below Prado Dam during the 1971-72 season were run to determine both specific conductance and TDS. Results of these analyses were used to prepare a correlation between specific conductance and the corresponding TDS. A detailed discussion of this statistical analysis is presented in the following section.

(4) The resulting equation from the curve fitting operation was then used to determine the mean daily TDS corresponding to the mean daily specific conductance values for each day of the year.

(5) The mean daily TDS values were then multiplied by the mean daily flow. These products were then summed and divided by the total flow for the year to determine the weighted

average annual TDS value for the water year. This value was 707 ppm of total dissolved solids for the 1971-72 water year.

Statistical Analysis of EC and TDS Relationships

An analysis of the correlation of electrical conductivity versus total dissolved solids in the Santa Ana River below Prado Dam for the water year 1971-72 was run through a statistical computer program. This is a linear regression program for data sets in two variables, x and y. From input data points, described by their x and y coordinates, an equation is produced that best fits these points, from a least squares viewpoint. The computer program calculates six different types of equations based on the assumption that y (TDS) is a function of the independent variable x (EC). The computer output results of the analysis of the 1971-72 data is shown below:

Form of the Equation	Curve Type	Index of Determination	Y-Intercept (A)	Slope (B)
(1) TDS = A+B (EC)	Linear	0.9248	-36.22	0.6730
(2) TDS = A[E x P (B x EC)]	Exponential	0.9325	180.88	11.99×10^{-4}
(3) TDS = A $(EC)^B$	Power Function	0.9575	0.3389	1.090
(4) TDS = A + B/EC	Hyperbolic	0.8927	1189.6	-49.44×10^{-4}
(5) TDS = 1/[A + B(EC)]	Hyperbolic	0.9050	40.87×10^{-4}	-22.97×10^{-7}
(6) TDS = EC/[A + B (EC)]	Hyperbolic	0.9783	1.786	-19.00×10^{-5}

Note that the value of the index of determination for equation (6) most nearly approaches 1.000 - the value which represents a perfect correlation between x and y data points. Further stisticical analysis of the data as analyzed by the linear regression program is given below for equation (6):

Correlation coefficient = 0.9891
Standard Error of Intercept (A) = 35.18×10^{-6}
Standard Error of Slope (B) = 34.91×10^{-3}

On the basis of these statistics, equation (6) was selected as the relationship for relating the 1971-72 USGS mean daily electrical conductivity values to mean daily TDS values. The equation used for this relationship was:

TDS = (EC)/ [1.786 - (0.0001900) (EC)]

Adjusted Base Flow

According to the Judgment, "The amount of Base Flow at Prado received during any year shall be subject to adjustment based on weighted average annual TDS in 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 ppm	$Q - \frac{35}{42,000} Q (TDS-800)$
700 ppm - 800 ppm	Q
Less than 700 ppm	$Q + \frac{35}{42,000} Q (700-TDS)$

Where: Q = Base Flow actually received."

As noted above, the Base Flow of the Santa Ana River below Prado Dam determined by the Watermaster amounted to 40,416 acre-feet for water year 1971-72. The weighted average annual TDS of the total flow was 707 ppm. No adjustment to the Base Flow of 40,416 acre-feet was necessary because the value of the weighted average annual TDS lies between 700 and 800 ppm.

Entitlement and Credit or Debit

From pages 12 and 13 of the Judgment, the following description of the 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...."

The Watermaster is required to maintain a continuing account of a list of permanent items at Prado for each year. A list of these items and the 1971-72 values are shown below:

(1)	Base Flow at Prado	40,416 acre-feet
(2)	Annual Weighted TDS of Total Flow	707 ppm
(3)	Annual Adjusted Base Flow	40,416 acre-feet
(4)	Cumulative Adjusted Base Flow	78,818 acre-feet
(5)	Cumulative Entitlement of OCWD at Prado	84,000 acre-feet
(6)	Cumulative Debit (5) - (4)	5,182 acre-feet
(7)	One-Third of Cumulative Debit	1,727 acre-feet
(8)	Minimum Required Base Flow in 1972-73	38,727 acre-feet

CHAPTER V

BASE FLOW AT RIVERSIDE NARROWS

As stated in Chapter I, the physical solution set forth in the Judgment requires that SBVMWD "....shall be responsible for an average annual Adjusted Base Flow of 15,250 acre-feet at Riverside Narrows." This chapter deals with the analysis of the flow at Riverside Narrows, the calculation of the amount of Base Flow received and credited to SBVMWD, and the calculation of the Adjusted Base Flow, the adjustment being made on the basis of the weighted average annual TDS in the Base Flow.

Total Discharge at Riverside Narrows

The surface flow of the river at the Riverside Narrows has been measured by the USGS since 1929, first at a gaging station located approximately one-half mile downstream from the Union Pacific Railroad Bridge, which was moved in 1943 to a downstream location at Pedley crossing, now known as Van Buren Boulevard. A flood which occurred during the 1968-69 water year washed out a portion of the bridge across the river at this location. This increased the difficulty of maintaining the surface water gage at Van Buren Boulevard, and led to the installation of a surface water gaging station upstream a short distance above the Metropolitan Water District Upper Feeder Bridge crossing, which is situated on the opposite side of the river from the original location of the Riverside Narrows surface water gaging station. This surface water gaging station, which is 1½ miles upstream from Van Buren Boulevard, also houses a monitor for the determination of electrical conductivity.

In 1947, the City of Riverside constructed a sewage treatment plant a short distance upstream from Van Buren Boulevard. This plant was enlarged in 1968 and the effluent was discharged directly to the Santa Ana River upstream from Van Buren Boulevard, with the result that the surface water flow at Van Buren Boulevard includes the sewage effluent from the Riverside Water Quality Control Plant.

A comparison of the surface flow and the Base Flow component at the two measuring stations shows that apparently the measurement made at the MWD crossing station is slightly higher than the measurement taken at Van Buren Boulevard. Dual measurements are still continuing, and for the year 1971-72 it was the Watermaster's decision that Base Flow at Riverside Narrows is defined as that portion of the total surface flow passing the point of measurement at Pedley Bridge which

remains after deduction of the sewage effluent discharged to the river by the City of Riverside above the measuring point and Storm Flow.

The total flow was measured by the USGS at Pedley Bridge. The sewage flow contributed to the river by the City of Riverside was measured both by the USGS and the City of Riverside, each utilizing a separate metering device. In computing the sewage flow, however, the measurements of the USGS were used.

The total surface discharge of the Santa Ana River at the Riverside Narrows (Pedley Bridge) for the water year 1971-72 amounted to 41,256 acre-feet, of which 19,005 acre-feet was sewage effluent discharge from the City of Riverside Water Quality Control Plant immediately upstream of Pedley Bridge.

Components of Flow

The components of the total flow of the Santa Ana River at Riverside Narrows at Pedley Bridge for the 1971-72 water year include sewage effluent, Storm Flow, and Base Flow. These components, by months, are listed in Table 5.

TABLE 5

COMPONENTS OF FLOW AT RIVERSIDE NARROWS FOR WATER YEAR 1971-72
(Acre-Feet)

Month	Total Flow	Sewage Flow	Total Flow minus Sewage Flow	Storm Flow	Base Flow
Oct.	3,090	1,608	1,482	80	1,401
Nov.	3,059	1,585	1,474	12	1,462
Dec.	8,910	1,567	7,343	5,932	1,411
Jan.	3,096	1,567	1,529	8	1,521
Feb.	2,815	1,484	1,331	0	1,331
Mar.	3,100	1,608	1,492	0	1,492
Apr.	2,930	1,555	1,375	0	1,375
May	2,912	1,672	1,240	0	1,240
June	2,975	1,616	1,359	25	1,334
July	2,816	1,636	1,180	0	1,180
Aug.	2,874	1,618	1,256	30	1,226
Sept.	2,680	1,488	1,192	8	1,184
Total	41,257	19,004	22,253	6,096*	16,157*

*The Base Flow of 16,157 acre-feet represents an average value derived from scalping conditions made by the five members of the Watermaster.

The total flow consists of 46% sewage flow, 15% Storm Flow, and 39% Base Flow.

Base Flow

The daily flow of the river, excluding the sewage flow from the City of Riverside, was plotted, together with the daily precipitation record at San Bernardino County Hospital. This hydrograph is shown on Plate 4. Based on this hydrograph and utilizing in general the same procedures as are reflected in the Work Papers of the engineers (as referenced in Paragraph 2 of the Engineering Appendix of the Judgment), a separation was made between Storm Flow and Base Flow and the two components calculated.

Each of the five members of the Watermaster independently made a determination of each component, based on his own judgment and his own interpretation of the method used in the previously referenced Work Papers. The value for Base Flow of 16,157 acre-feet, as shown in Table 5, is the mathematical average of the five determinations. Plate 4 is indicative of the scalping done by the Watermaster.

Water Quality

Under the terms of the Judgment it is necessary to determine the weighted average total dissolved solids (TDS) content of the Base Flow at Riverside Narrows.

To accomplish this, the USGS has installed a specific conductance measuring device and recorder immediately upstream from the river crossing of the Upper Feeder of MWD, which is also upstream from the point of discharge of the effluent from the Riverside Water Quality Control Board Plant to the river. The USGS operates and maintains this monitoring device in the same manner as the more complex one operated at Prado. The data collected from this monitor are augmented by periodic grab samples. Water quality data are collected and analyzed as described in Chapter IV.

During the water year 1971-72, 55 samples were taken from the waters of the Santa Ana River at the MWD crossing for laboratory analysis, to determine the TDS and EC of each sample. All 55 samples were used in a statistical analysis for the determination of the relationship of EC to TDS.

Statistical Analysis of EC and TDS Relationships

Six different types of equations were utilized, based upon the assumption that TDS was a function of the independent variable EC, to determine the equation providing the best correlation. The analysis was made utilizing a multiple regression computer program which determined the best curve fitting equation for the 55 laboratory samples.

The equations resulting from the computer analysis are shown as follows:

Form of Equation	Curve Type	Multiple Correlation Coefficient	Coefficient Term (A)	Constant Term (B)
(1) $TDS = A(EC)+B$	Linear	0.958	0.6338	18.1194
(2) $TDS = A \ln(EC) + B$	Logarithmic	0.951	419.4311	-2224.2402
(3) $TDS = \frac{1.0}{A(EC)+B}$	Hyperbolic	0.982	-3.493×10^{-6}	5.230×10^{-3}
(4) $TDS = A/EC+B$	Hyperbolic	0.934	-2.42483×10^{-5}	930.3458
(5) $TDS = \frac{EC}{A(EC)+B}$	Hyperbolic	0.227	1.12609×10^{-4}	1.42110
(6) $TDS = EC\ A(EC)+B$	Cubic	0.270	-5.4174×10^{-5}	0.709365

A perfect correlation between the TDS and EC values of the samples is represented by that formula in which the multiple correlation coefficient is equal to 1.000. The formula in which the multiple correlation coefficient most nearly approaches 1.000 is formula (3), which has been selected as representing the relationship of the mean daily electrical conductivity values to the adjusted daily values of TDS. Equation (3) for the determination of this relationship is stated as follows:

$$TDS = \frac{1.0}{-3.493 \times 10^{-6}\ (EC) + 5.230 \times 10^{-3}}$$

The equation was used with the mean daily electrical conductance (specific conductance) to calculate the daily adjusted TDS for the water year 1971-72.

The Judgment provides that only Base Flow at the Riverside Narrows shall be used for determining the weighted average annual TDS, and that during periods of Storm Flow, the TDS of Base Flow shall be estimated.

Based on discussions among the engineers during the period the Judgment was being formulated, it was generally agreed that the specific conductance and, hence, the TDS, would be the

average of the values of these quality indicators that were recorded immediately before Storm Flow commenced and immediately after Storm Flow ended. In the analysis for 1971-72, the values for the day before and the day after a Storm Flow period were used.

In the computation, the mean daily TDS values were multiplied by the mean daily Base Flow. The resultant products were then summed and divided by the total Base Flow for the year to yield the average annual TDS for the water year. This value was 712 parts per million for the water year 1971-72. The average annual TDS value of 712 parts per million is the average of the values computed by two Watermasters. The TDS, expressed in ppm, for each day during the 1971-72 water year, together with the rainfall occurring at San Bernardino, is shown on Plate 5.

Records of the quality of the Riverside Quality Control Plant effluent are also compiled by the Watermaster, and during the water year 1971-72 the TDS varied from a low of 576 ppm to a high of 806 ppm with a weighted average annual TDS of 689 ppm.

Adjusted Base Flow

Paragraph 5(b)(2) of the Judgment provides that "The amount of Base Flow at Riverside Narrows received during any year shall be subject to adjustment based upon the weighted average annual TDS in such Base Flow, as follows:

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

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 1971-72 was 712 ppm. Therefore, the Base Flow of 16,157 acre-feet must be adjusted by the equation above for TDS greater than 700 ppm. Thus, the Adjusted Base Flow is as follows:

$$(16,157) - \frac{11}{15,250} (16,157)(712-700) = 16,157 - 140 = 16,017 \text{ acre-feet}$$

Entitlement and Credit or Debit

Paragraph 5(b) of the 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...."

A list of the accounting items and the 1971-72 values for these items, as required by Paragraph 4 of the Engineering Appendix to the Judgment, is detailed below:

(1)	Base Flow at Riverside Narrows	16,157 acre-feet
(2)	Annual Weighted TDS of Base Flow at Riverside Narrows	712 ppm
(3)	Annual Adjusted Base Flow	16,017 acre-feet
(4)	Cumulative Adjusted Base Flow	33,029 acre-feet
(5)	Cumulative Entitlement of CBMWD and WMWD at Riverside Narrows	30,500 acre-feet
(6)	Cumulative Credit	2,529 acre-feet
(7)	One-third of Cumulative Debit	0
(8)	Minimum Required Base Flow in 1972-73	13,420 acre-feet

APPENDIX A

HISTORY OF LITIGATION

HISTORY OF LIGITATION

The complaint in this case was filed by the Orange County Water District on October 18, 1963 seeking an adjudication of water rights against more than 2,500 water users in the area tributary to Prado Dam within the Santa Ana River Watershed. Thirteen cross-complaints were filed in 1968 extending the adjudication to include an additional 1,500 water users in the area downstream from Prado Dam. Thus, there were involved in this case some 4,000 parties. It became obvious that every effort should be made to arrive at a settlement and a physical solution in order to avoid the enormous and unwieldy litigation that would be involved.

Efforts to arrive at a settlement and physical solution were pursued by public officials, individuals, attorneys, and engineers. Attorneys for the parties organized in order to further this objective. Among other things, they provided guidance for the formation and activities of an engineering committee to provide them with information on the physical facts.

An initial meeting of the engineers representing the parties was held on January 10, 1964. Agreement was reached that it would be beneficial to jointly undertake the compilation of basic data. Liaison was established with the Department of Water Resources, State of California, on requests for information to be obtained from the State's studies for use by the parties. Engineers representing the parties were divided into sub-committees which were given the responsibility of investigating such things as the boundary of the Santa Ana River watershed and its subareas, standardization of the terminology, the location and description of wells and diversion facilities, waste disposal and transfers of water between subareas.

On April 30, 1964, the joint engineering committee prepared a list of preliminary engineering studies directed toward settlement of the Santa Ana River water rights litigation. This list of basic information was in response to a request from the attorneys' committee at a meeting held April 17, 1964. Special assignments were made on selected items to individual engineers to provide information requested by the attorneys' committee.

The attorneys and engineers for the defendants then commenced a series of meetings separate from the representatives of the plaintiff in order to consolidate their position and to determine their course of action. On October 7, 1964 engineers for the defendants presented the results of the studies made by the joint engineering committee. The defendants' attorneys requested that additional information be provided on the methods of measuring flow at Prado and the historical supply and disposal of water passing Prado Dam segregated into the components of flow

and designating the amount of supply which was usable by the downstream area. On December 11, 1964, this supplemental information was presented to the defendants' attorneys.

During 1965, engineers and attorneys for the defendants held numerous conferences and conducted additional studies in an attempt to determine their respective positions in the case. Early in 1966, the plaintiff and defendants exchanged drafts of possible principles of settlement. Commencing March 22 and ending April 13, 1966, four meetings were held by the engineers to discuss the draft of principles for settlement.

On February 25, 1968 the defendants submitted a request to the Court that an Order of Reference be issued requesting the State Department of Water Resources to determine the physical facts. On May 9, 1968 the plaintiff's attorney submitted motions opposing the Order of Reference and requesting that a preliminary injunction be issued. In the meantime, every effort was being made to come to an agreement on a stipulated judgment. Commencing on February 28, 1968 and extending until May 14, 1968, six meetings were held to determine the scope of physical facts on which agreement could be reached so that if an Order of Reference were to be approved by the Court, the work under the proposed reference would not repeat the extensive basic data collection and compilation which had already been completed and on which engineers for both plaintiffs and defendants had reached substantial agreement. Such basic data were compiled and published in two volumes under date of May 14, 1968 entitled "Appendix A. Basic Data."

On May 21, 1968 an outline of a proposal for settlement of the case was prepared and a committee of attorneys and engineers for the parties commenced preparation of the settlement documents. On June 16, 1968, the Court held a hearing on the motions it had received requesting a preliminary injunction and an Order of Reference. The parties requested that the Court delay the hearings on these motions in view of the efforts toward settlement that were underway. The plaintiff, however, was concerned regarding the necessity of bringing the case to trial within the statutory limitation and, accordingly, on July 15, 1968 submitted a motion to set the complaint in the case for trial. On October 15, 1968 the trial was commenced and was adjourned after one-half day of testimony on behalf of the plaintiff. Thereafter, the parties filed with the Court the necessary Settlements Documents including a Stipulation for Judgment. The Court entered the Judgment on April 17, 1969. This terminated the many years of controversy over water rights along the Santa Ana River involving the issues and parties embraced in Orange County Water District versus City of Chino, et al.

APPENDIX B

SUMMARY OF JUDGMENT

SUMMARY OF JUDGMENT

Provisions of the Judgment became effective on October 1, 1970. The Judgment does not define the water rights of the individual claimants. Instead, it provides for a regional allocation of water supply of the Santa Ana River system and establishes entitlements and obligations among the four existing major public water districts overlying the aggregate of substantially all of the major areas of water use in the watershed. Dismissals were entered as to all defendants and cross defendants other than these four major public districts. These districts, the locations of which are shown on Plate 1, "Santa Ana River Watershed," are the remaining parties to the Judgment and are as follows:

(1) Orange County Water District (OCWD), representing all lower basin entities which are located within Orange County downstream from Prado Dam.

(2) Western Municipal Water District (WMWD), representing middle basin entities located within Riverside County on both sides of the Santa Ana River primarily upstream from Prado Dam.

(3) Chino Basin Municipal Water District (CBMWD), located in San Bernardino County Chino Basin area, representing middle basin entities within its boundaries and located primarily upstream from Prado Dam.

(4) San Bernardino Valley Municipal Water District (SBVMWD), representing all entities within its boundaries, and embraced within the upper portion of the Riverside Basin Area, the Colton Basin area (being an upstream portion of the middle basin) and the San Bernardino Basin area, being essentially the upper basin.

A physical solution under the stipulated Judgment provides, in general, that SBVMWD shall be responsible for the delivery of an average annual amount of Base Flow at Riverside Narrows and CBMWD and WMWD shall jointly be responsible for an average annual amount of Base Flow at Prado. Essential to the understanding of the provisions of the Judgment is the definition of certain important terms. The total surface flow passing a point of measurement is divided into components, which are defined in the Judgment as follow:

"(1) Storm Flow - That portion of the total surface flow passing a point of measurement, which originates from precipitation and runoff without having first percolated to ground water storage in the zone of saturation, calculated in accordance with procedures referred to in Exhibit B.

(2) Base Flow - That portion of the total surface flow passing a point of measurement which remains after deduction of storm flow.

(3) Adjusted Base Flow - Actual base flow in each year adjusted for quality as provided....."

The Judgment sets forth a declaration of rights. Briefly stated, the Judgment provides that the water users in the area downstream from Prado Dam have rights, as against the upstream users, to receive an average annual supply of 42,000 acre-feet of Base Flow at Prado Dam, together with the right to all Storm Flow reaching Prado Dam. Water users in the area upstream of Prado Dam, as against the downstream users, have the right to divert, pump, extract, conserve, store and use all surface and ground water supplies originating within the upper area, so long as the lower area receives the water to which it is entitled.

The physical solution set forth in the Judgment requires that SBVMWD shall be responsible for an average annual Adjusted Base Flow of 15,250 acre-feet at Riverside Narrows subject each year to the following:

(1) A minimum Base Flow of 13,420 acre-feet plus one-third of any cumulated debit.

(2) After October 2, 1986, if no cumulated debit exists, the minimum quantity shall be 12,420 acre-feet.

(3) Prior to 1986, if the cumulated credit exceeds 10,000 acre-feet the minimum quantity shall be 12,420 acre-feet.

(4) All cumulated debits shall be removed by the discharge of a sufficient Base Flow at Riverside Narrows at least once in every ten consecutive years following October 1, 1976. Any accumulated credits shall remain on the books of account until used to offset any subsequent debits or until otherwise disposed of by SBVMWD.

(5) The Base Flow at Riverside Narrows shall be adjusted using weighted average annual TDS in such Base Flow in accordance with the formula set forth in the Judgment.

The obligations under the physical solutions for meeting the Adjusted Base Flow of 42,000 acre-feet at Prado Dam for the benefit of the downstream water users as shared by CBMWD and WMWD are as follows:

(1) Minimum Base Flow at Prado shall not be less than 37,000 acre-feet plus one-third of any cumulated debit.

(2) After October 1, 1986, if no cumulated debit exists, the minimum quantity shall be 34,000 acre-feet.

(3) Prior to 1986, if the cumulated credit exceeds 30,000 acre-feet, the minimum quantity shall be 34,000 acre-feet.

(4) Sufficient quantities of Base Flow shall be provided at Prado to discharge completely any cumulated debits at least once in any ten consecutive years following October 1, 1976. Any cumulative credits shall remain on the books of account until used to offset any subsequent debits, or until otherwise disposed of by CBMWD and WMWD.

(5) The Base Flow at Prado during any year shall be adjusted using the weighted average annual TDS in the total flow at Prado (Base Flow plus Storm Flow) in accordance with the formula set forth in the Judgment.

The accounting provided for under the Judgment allows credit to be earned when the average annual Adjusted Base Flow exceeds 15,250 acre-feet at Riverside Narrows and 42,000 acre-feet at Prado. Debits accrue when the average annual Adjusted Base Flow falls below the above quantities at the respective locations. The adjustment of Base Flow for water quality is to provide an incentive to maintain a better quality water as a result of implementation of the physical solution. That is, when the water quality is improved over a certain amount, the quantitative amount of the obligation is decreased; but when that water quality is impaired beyond a specified limit, the quantity of the obligation is increased. This is one of the first comprehensive adjudications in Southern California which includes provisions applicable to the quality of water in addition to the determination of quantitative rights.

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

2.30" OCTOBER | 0.27" NOVEMBER | 5.87" DECEMBER | 0.00" JANUARY | 0.05" FEBRUARY | 0.00" MARCH | 0.13" APRIL | 0.22" MAY | 0.22" JUNE | 0.00" JULY | 0.25" AUGUST | 0.31" SEPTEMBER

INCHES

SAN BERNARDINO RAINFALL
(COUNTY HOSPITAL)

CUBIC FEET PER SECOND

INFLOW TO PRADO DAM

OUTFLOW BELOW
PRADO RESERVOIR

* OFFSET DUE TO ADDITIONAL BASE FLOW DISCHARGED TO RIVER BY CBMWD COMMENCING 22 DEC. 1971

RECIPROCAL OF EVAPORATION
AT RIVERSIDE EXP. STA.

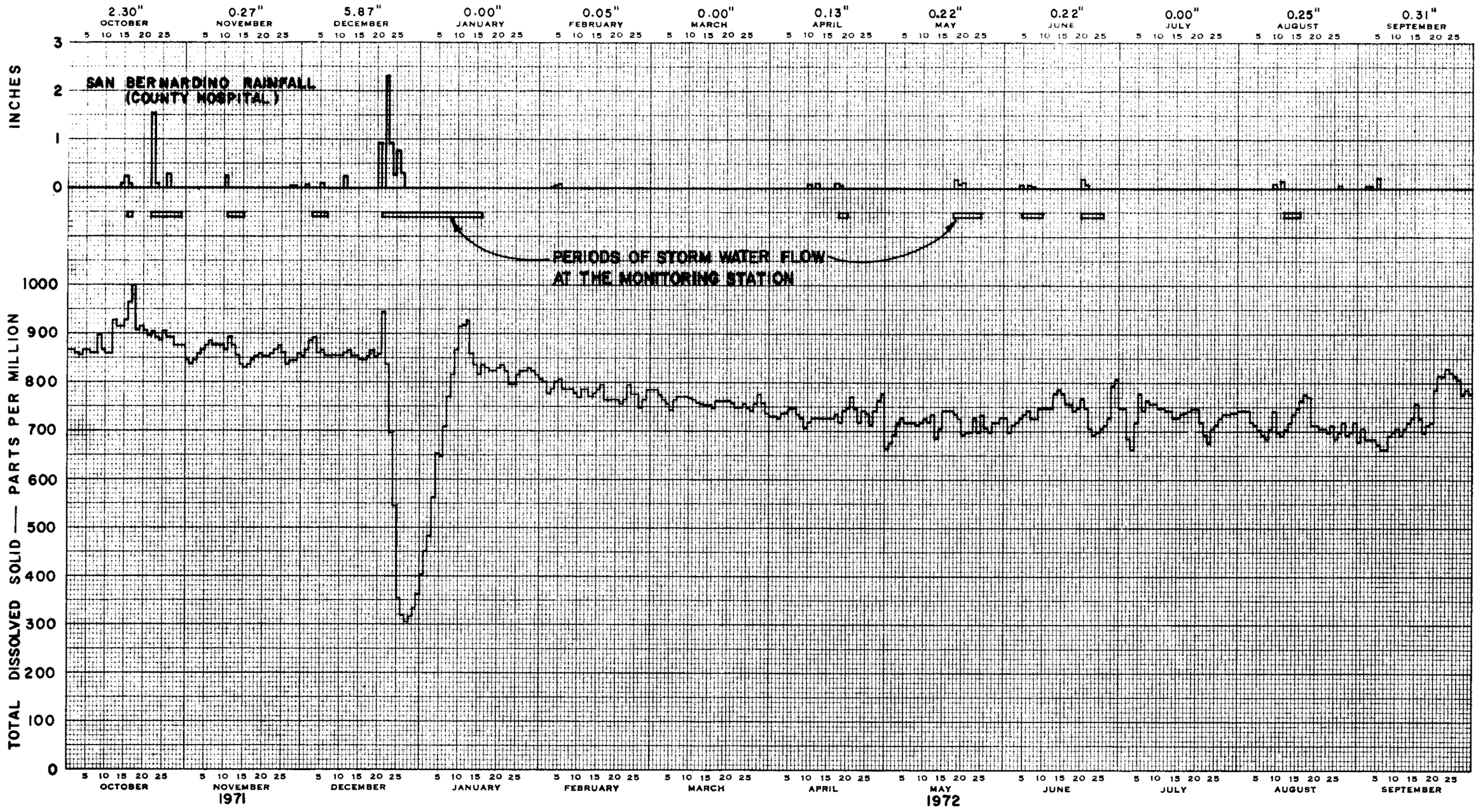
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER

1971 1972

DISCHARGE OF SANTA ANA RIVER *BELOW PRADO DAM

PLATE 2

(WATER YEAR 1971-72)



TOTAL DISSOLVED SOLIDS IN THE SANTA ANA RIVER BELOW PRADO DAM
AS DERIVED FROM SPECIFIC CONDUCTIVITY VALUES
MEASURED BY THE USGS MONITORING STATION

PLATE 3

(WATER YEAR 1971-72)

SAN BERNARDINO RAINFALL
(County Hospital)

INCHES

2.30 | 0.27 | 5.87 | 0.0 | 0.05 | 0.0 | 0.13 | 0.22 | 0.22 | 0.0 | 0.25 | 0.31

CUBIC FEET PER SECOND

850 / 1231 — 490 / 272

RECIPROCAL OF EVAPORATION AT RIVERSIDE EXPERIMENT STATION

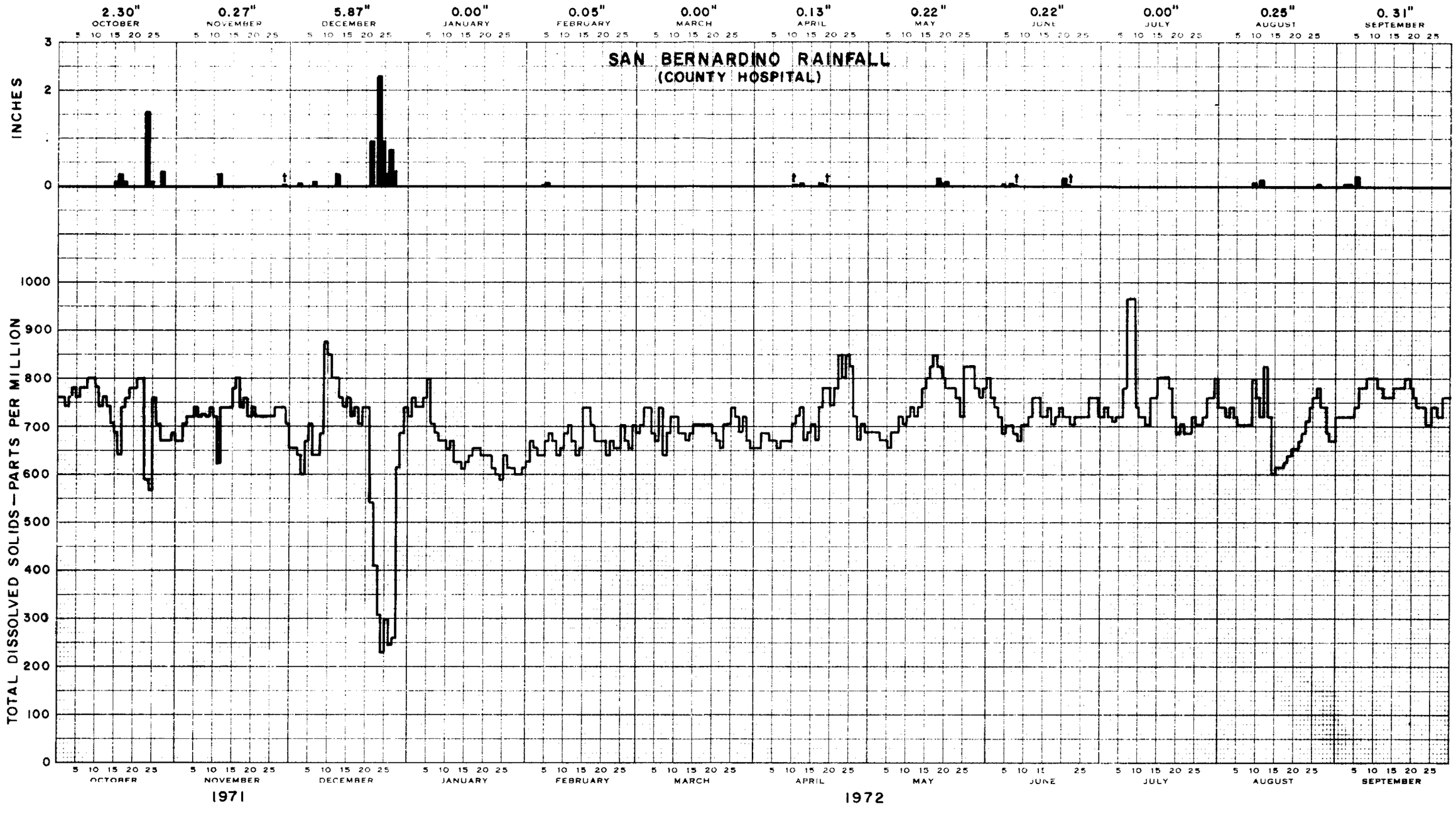
OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER

1971 — 1972

DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS & SAN BERNARDINO RAINFALL

PLATE 4

(WATER YEAR 1971-72)



TOTAL DISSOLVED SOLIDS IN THE SANTA ANA RIVER AT RIVERSIDE NARROWS
UPPER FEEDER CROSSING OF M.W.D. AS DERIVED FROM
SPECIFIC CONDUCTIVITY VALUES MEASURED BY THE U.S.G.S. MONITORING STATION

PLATE 5
(WATER YEAR 1971-72)