WATER QUALITY STANDARDS FOR SALINITY
INCLUDING
NUMERIC CRITERIA AND PLAN OF IMPLEMENTATION FOR SALINITY CONTROL

COLORADO RIVER SYSTEM

Prepared by
Colorado River Basin Salinity Control Forum

1975

NOTE – This Review is composed of two parts, namely:

1) Proposed *Water Quality Standards for Salinity Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System*, dated June 1975

2) Supplement Including Modifications to *Proposed Water Quality Standards for Salinity Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System, June 1975,* dated August 26, 1975

P R O P O S E D

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SUMMARY

The Federal Water Pollution Control Act Amendments of 1972, PL 92-500, in Section 303 require the adoption of water quality standards applicable to interstate waters. Pursuant to that requirement, the Environmental Protection Agency on December 18, 1974, issued a regulation requiring the states of the Colorado River Basin to adopt water quality standards for salinity, consisting of numeric criteria and plan of implementation for salinity control. The standards are to be submitted for approval to the Environmental Protection Agency on or before October 18, 1975.

This report, prepared by the 7-State Colorado River Basin Salinity Control Forum, presents in a single document the water quality standards for salinity submitted for adoption by each of the states in the Basin. The standards are to be reviewed at 3-year intervals and modified, if appropriate.

Consistent with the regulation, the recommended flow-weighted average annual numeric salinity criteria for three locations in the lower main stem of the Colorado River System are as follows:

	Salinity in mg/l
Below Hoover Dam	723
Below Parker Dam	747
Imperial Dam	879

The plan of implementation comprises a number of federal and nonfederal projects and measures to maintain the flow-weighted average annual salinity in the lower main stem at or below the recommended numeric criteria through 1990, as the Basin States continue to develop their compact-apportioned waters. The principal components of the plan are as follows:

1. Prompt construction and operation of the initial four salinity control units authorized by Title II of PL 93-320, the Colorado River Basin Salinity Control Act.

2. Construction of the 12 other units listed in Title II of PL 93-320 or their equivalent after receipt of favorable planning reports.

3. The placing of effluent limitations, principally under the NPDES permit program provided for in Section 402 of PL 92-500 on industrial discharges.

4. The reformulation of previously authorized, but unconstructed, federal water projects to reduce the salt loading effect.

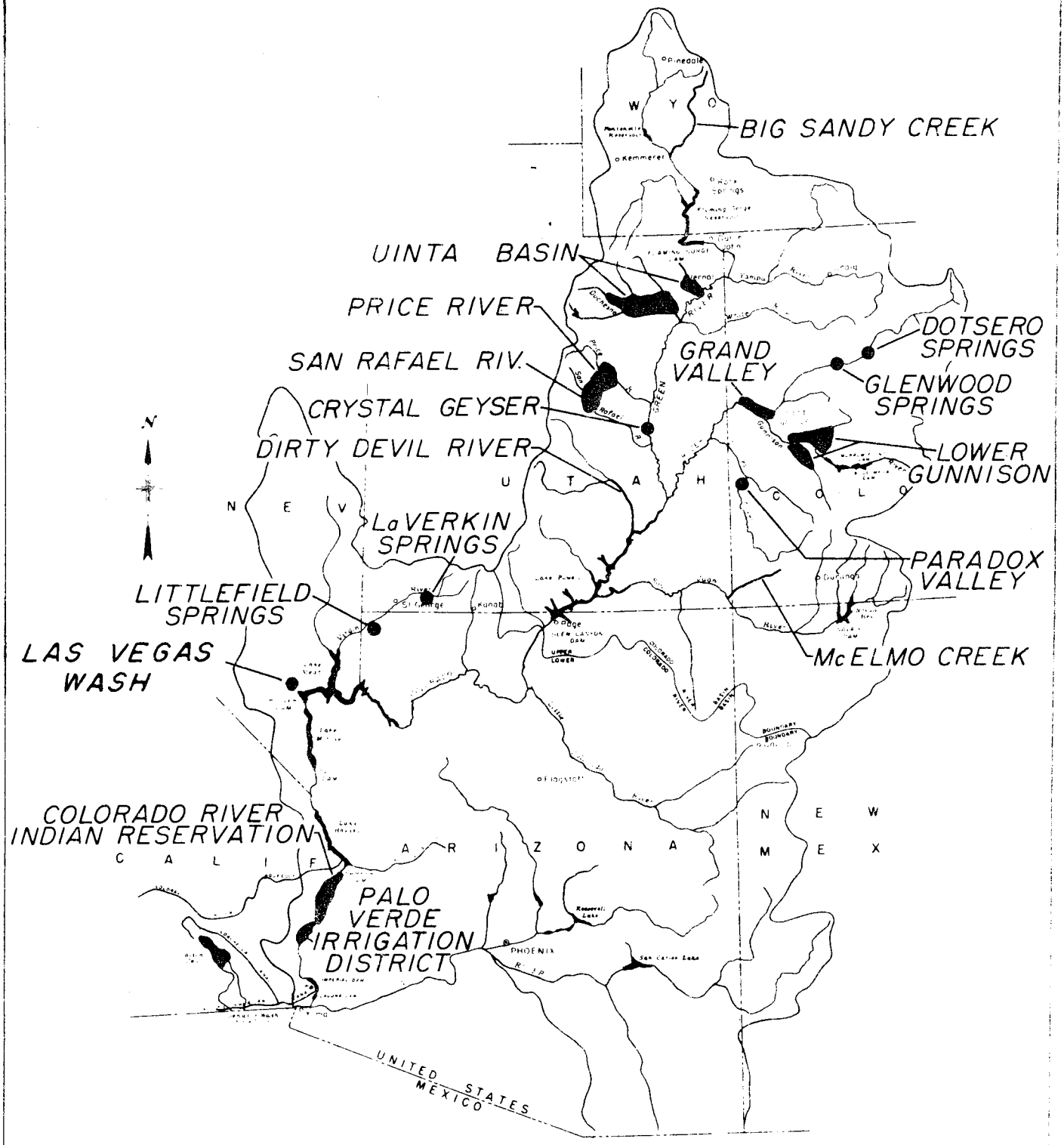
5. Use of saline water for industrial purposes whenever practical, programs by water users to cope with the river's high salinity, studies of means to minimize salinity in municipal discharges, and studies of future possible salinity control programs.

The report recognizes that many natural and man-made factors affect the river's salinity. Consequently, the actual salinity will vary above and below the recommended numeric criteria. However, under the assumptions of streamflow equivalent to the long-term average, a "moderate" rate of increase in water depletions and full implementation of needed salinity control measures, the average salinity can be maintained at or below 1972 levels during the study period of the next 15 years.

The federal regulations provide for temporary increases above the 1972 levels if control measures are included in the plan. Should

water development projects be completed before control measures are identified or brought on line, temporary increases above the criteria could result and these increases will be in conformance with the regulation. With completion of control projects, those now in the plan or those to be added subsequently, salinity would return to or below the criteria level.

Periodic increases above the criteria as a result of reservoir conditions or periods of below long-time average annual river flow also will be in conformance with the regulation. With satisfactory reservoir conditions and when river flows return to the long-time average annual flow or above, concentrations are expected to be at or below the criteria level.



LOCATION OF PROPOSED SALINITY CONTROL PROJECTS - COLORADO RIVER BASIN

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LIST OF ABBREVIATIONS USED IN REPORT

a.f.	acre-feet
ARS	Agricultural Research Service
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
cfs	cubic feet per second
CRSP	Colorado River Storage Project
CRWQIP	Colorado River Water Quality Improvement Program
DPR	Definite Plan Report
EPA	Environmental Protection Agency
IMS	Irrigation Management Services
maf/yr	million acre-feet per year
mg/l	milligrams per liter
NPDES	National Pollutant Discharge Elimination System
SCS	Soil Conservation Service
T/AF	Tons per acre-foot
TDS	Total Dissolved Solids
USBR	Bureau of Reclamation
USU	Utah State University
WSI	Water Systems Improvement

APPENDIXES

CHAPTER I

INTRODUCTION

The purpose of this report is to present water quality standards for salinity for the Colorado River System, as required by the Environmental Protection Agency regulation [40 CFR Part 120, Water Quality Standards], published December 18, 1974. As used in the report, the term "standards" is defined in accordance with Environmental Protection Agency terminology to include both numeric criteria and the plan of implementation for salinity control. The achievement of numeric criteria requires the full implementation of the plan and appropriate changes. The criteria are subject to revision upward or downward as provided in this report. The report was prepared by the Colorado River Salinity Control Forum, composed of water resource and water quality representatives from the seven Colorado River Basin States of Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming. It provides the states with the necessary information to meet the Environmental Protection Agency regulation, which requires the states to adopt water quality standards for salinity and submit them to the Agency for approval on or before October 18, 1975. While the complete regulation is presented in Appendix A, the most pertinent portion is incorporated in the text of Chapter IV, "Water Quality Standards for Salinity Control".

The report deals only with the portion of the Basin above Imperial Dam. Water quality control measures downstream from Imperial Dam are being carried out in accordance with the provisions of Minute 242 of the International Boundary and Water Commission, United States and Mexico, and Title I of PL 93-320, the Colorado River Basin Salinity Control Act.

Nothing in this report shall be construed to alter, amend, repeal, construe, interpret, modify, or be in conflict with the provisions of the Boulder Canyon Project Act [45 Stat. 1057], the Boulder Canyon Project Adjustment Act [54 Stat. 774], the Colorado River Basin Project Act [82 Stat. 885], the Colorado River Compact, the Upper Colorado River Basin Compact, or the Treaty with the United Mexican States [Treaty Series 994].

CHAPTER II

HISTORICAL ACTIONS RELATIVE TO SALINITY STANDARDS

Water Quality Act of 1965

With Congress' passage of the Water Quality Act of 1965, the states were required to establish water quality standards for interstate streams within their boundaries by June 30, 1967. The purposes of these standards were to protect and enhance the quality and productivity of the nation's interstate waters to serve a variety of beneficial uses, such as public water supply, recreation and propagation of aquatic life, and industrial and irrigation uses. Along with the water quality standards, the states were required to furnish a plan for putting the standards into effect and for enforcing them.

Standards, but without numeric criteria, were submitted by the states in accordance with this time schedule. Upon acceptance by the Secretary of the Interior, the standards became joint state-federal standards.

Early Sessions of the Conference in the Matter of the Pollution of the Interstate Waters of the Colorado River and Its Tributaries

Sustained attention to water quality problems in the Colorado River Basin dates back to 1960 when the Conference in the Matter of the Pollution of the Interstate Waters of the Colorado River and Its Tributaries was formed under the provisions of the Federal Water Pollution Control Act, as amended, PL 660, 84th Congress. Six sessions of the Conference were held from 1960 through 1967. The

long-range salinity problem was identified early in the deliberations, but the paucity of data cast doubt upon the ability to deal effectively with it until more data were collected and evaluated. The seven states have advocated and supported efforts to improve the data base as quickly as possible.

During a series of meetings of the Conferees held in 1966 and 1967, a framework known as "Guidelines for Formulating Water Quality Standards for the Interstate Waters of the Colorado System" was developed. These guidelines were adopted by the State Conferees and subsequently incorporated individually by each state as part of its water quality standards. The "Guidelines" contained numeric criteria for many parameters other than salinity. The "Guidelines" adopted by the states on January 13, 1967, are printed in full in the Appendix B.

Those guidelines say in part:

> "In order to develop practicable and reasonable quality standards for interstate waters in the Colorado River System, full consideration must be given to the numerous factors and variables connected with the control, development, utilization, conservation, and protection of the System's water resources. It is evident that future development and utilization of the System's water resources for expansion of irrigated agriculture, increases in population, and industrial growth will be accompanied by progressive increases in consumptive losses of water and attendant increases in concentration of dissolved solids.
>
> "The states served by the Colorado River System recognize that answers to important questions regarding total dissolved solids, chlorides, sulfates and sodium are lacking or are based on factors that are not yet well-defined. In respect of this recognition the states agree that pending the development of acceptable answers to enable the setting of criteria for total dissolved solids, chlorides, sulfates and sodium for the Colorado River System, such criteria should be stated in qualitative terms. At the same time it is agreed that all identifiable sources of water pollution will be managed and controlled to the maximum degree practicable with available technology in order to provide water quality suitable for present and potential future uses of the System's interstate waters."

Statements by Officials of the Department of the Interior

On January 30, 1968, Secretary of the Interior Stewart Udall testified at the hearings of the House Interior and Insular Affairs Subcommittee on Irrigation and Reclamation regarding water quality standards. At that time, he presented a statement that contained the following:

> "Before discussing this problem further, I would like to state that salinity standards will not be established (for the Colorado River) until we have sufficient information to assure that such standards will be equitable, workable, and enforceable."

The same position was reiterated by Assistant Secretary of the Interior Max Edwards in a letter dated February 12, 1968. This letter also stated that the Department of the Interior intended to pursue active programs to lay the foundation for setting numerical standards at some future time.

Report of Environmental Protection Agency

In December 1971, the Environmental Protection Agency released the results of an eight-year study relating to salinity of the Colorado River. This report, entitled "The Mineral Quality Problem in the Colorado River Basin", was prepared by the EPA based upon its work and the work of its predecessor agencies -- the Federal Water Quality Administration, April 1970 to December 1970; the Federal Water Pollution Control Administration, October 1965 to April 1970; the Division of Water Supply and Pollution Control, U. S. Public Health Service, prior to 1965. The report recommended

the adoption and enforcement of salinity criteria to hold the maximum mean monthly concentration of total dissolved solids at Imperial Dam at 1000 mg/l -- approximately the maximum mean monthly concentration then of record.

The 1971 EPA report was the major subject of the Seventh Session of the Conference in the Matter of Pollution of the Interstate Waters of the Colorado River, which was held under provisions of Section 10 of the Federal Water Pollution Control Act.

Seventh Session of the Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries

During the seventh session of the Conference which was held on February 15-17, 1972, and was continued and concluded on April 26-27, 1972, and at which all seven Basin States participated, testimony was presented by federal, state and local officials.

Commissioner of Reclamation Ellis Armstrong, representing the Secretary of the Interior, stated:

***

> "The Department of the Interior is pledged to pursue a program of salinity control for the benefit of all citizens to whom the Colorado River is a lifeline.
>
> ***
>
> "In recognition of the effects of the proposed developments on the salinity of the river, the Congress specifically directed the Secretary of the Interior to make water quality studies and to devise plans for improvement...."

***

At the February 17, 1972 Session, the Conferees representing the seven states unanimously concurred in the adoption of a resolution presented to the Conference. The resolution, which is reproduced more completely in Appendix C, states in part:

***

"NOW, THEREFORE, BE IT RESOLVED by the conferees of California, Arizona, Nevada, New Mexico, Colorado, Utah and Wyoming that:

"1) a salinity policy be adopted for the Colorado River system that would have as its objective the maintenance of salinity concentrations at or below levels presently found in the lower main stem;

"2) in implementing the salinity policy objective for the Colorado River system the salinity problem be treated as a basinwide problem that needs to be solved to maintain Lower Basin water salinity at or below present levels while the Upper Basin continues to develop its compact-apportioned water, recognizing that salinity levels may rise until control measures are made effective;"

***

"7) the adoption of numerical criteria be deferred until the potential effectiveness of Colorado River salinity control measures is better known;"

***

The Conferees, official representatives of the seven Basin States and the Environmental Protection Agency, at the reconvened seventh session on April 26-27, 1972, unanimously adopted conclusions and recommendations pertaining to the salinity problems of the Colorado River. These were in lieu of numeric criteria which were still thought to be premature. The conclusions and recommendations which were approved by Mr. William D. Ruchelshaus, Administrator of the Environmental Protection Agency in June 1972, also are shown in Appendix C. The most significant part of the conclusions and recommendations of the Reconvened Seventh Session is as follows:

***

"I. It is recommended that:

"A salinity policy be adopted for the Colorado River system that would have as its objective the maintenance of salinity concentrations at or below levels presently found in the lower main stem. In implementing the salinity policy objective for the Colorado River system, the salinity problem must be treated as a basinwide problem that needs to be solved to maintain Lower Basin water salinity at or below present levels while the Upper Basin continues to develop its compact-apportioned waters.

"II. The salinity control program as described by the Department of the Interior in their report entitled 'Colorado River Water Quality Improvement Program', dated February 1972, offers the best prospect for implementing the salinity control objective adopted herein...."

***

Establishment of Colorado River Basin Salinity Control Forum

Enactment of PL 92-500 in 1972 introduced a new factor into the salinity problem. The legislation has been interpreted by EPA as requiring that numerical criteria be set for salinity on the Colorado River. Consequently in the fall of 1973 EPA submitted to several of the Colorado River Basin States preliminary views regarding proposed requirements and procedures for salinity control in the Colorado River Basin, including the establishment of an interstate organization to develop a salinity control plan.

The Basin States, in response to EPA's submittal regarding the proposed requirements, and in consideration of several other questions that had been generated relative to certain sections of PL 92-500, met on November 8 and 9, 1973, and among other things formed the "Colorado River Basin Salinity Control Forum". A statement of position (see The Seven Colorado River Basin States Accord, Appendix D) for use in discussing the proposed

requirements and procedures for salinity control was adopted on November 9, 1973. It states in part:

***

"The States have established a mechanism for interstate cooperation (Colorado River Basin Salinity Control Forum) and for preparation of semi-annual reports on the development of numeric criteria and the adoption of such criteria by October 18, 1975.

"As was concluded by resolution of the Colorado River Basin States Conferees of the Conference in the Matter of Pollution of Interstate Waters of the Colorado River and Its Tributaries held in Las Vegas, Nevada and the Reconvened Seventh Session held in Denver, implementation of the Colorado River Salinity Control Program generally as described in the report of the Secretary of the Interior entitled, 'Colorado River Water Quality Improvement Program, February 1972' would carry out the most appropriate plan of implementation for salinity control for the Colorado River system. The appropriate objective of the project is the maintenance of salinity at or below levels found in the lower main stem as of April 1972, while the Upper Basin States continue to develop their compact-apportioned waters."

***

The Forum members at the November 8-9, 1973, meeting also agreed to request of EPA that:

***

"(b) the final statement on proposed water quality standards and plan of implementation for salinity control should be consistent for all seven States of the Colorado River Basin; and

"(c) opportunity should be provided for further direct discussion between representatives of the Environmental Protection Agency and the Forum before the proposed regulations are published in the Federal Register."

***

Recent Activities

Following formation of the Colorado River Basin Salinity Control Forum, meetings were held with representatives of the EPA in January, March and April 1974 to discuss a proposed regulation on Colorado River salinity which would require the states to adopt water quality standards for salinity and submit them to EPA by October 18, 1975. The Forum also immediately established procedures and a time schedule in cooperation with the Environmental Protection Agency for establishing the standards and initiated necessary studies in cooperation with the Bureau of Reclamation.

The proposed regulation was published in the Federal Register on June 13, 1974. After hearings in Las Vegas, Nevada, and Denver, Colorado, in August 1974, the final regulation was published on December 18, 1974, in the Federal Register. The regulation sets forth the salinity control policy, procedures and requirements for establishing water quality standards for salinity in the Basin.

CHAPTER III

SALINITY OF THE RIVER

The Colorado River Basin covers an area in the United States of 242,000 square miles, approximately one-twelfth of the conterminous United States, and 2,000 square miles in Mexico. It extends 1,400 miles from the Continental Divide in the Rocky Mountains to the Gulf of California. Historically, the river, from both natural causes and man's activities, has carried a large dissolved mineral load resulting in salinity concentrations higher than for most other major rivers.

The Colorado River Basin has a population of about 2.25 million and through export projects, its water provides either full or supplemental supplies to about 12 million people in the Southern California, Denver, Salt Lake City, Cheyenne, and Albuquerque areas. With the completion of the Central Arizona Project now underway, the Phoenix and Tucson areas will be served from the lower main stem. Within the Basin, the regional economy is based on irrigated agriculture, mining, forestry, manufacturing, oil and gas production and tourism. Approximately 2½ million acres are irrigated within the Basin, and hundreds of thousands of acres are also irrigated with water exported from the Basin. About one-half million people and 425,000 irrigated acres in Mexico are served with Colorado River water.

Sources of Salinity

Generally, salinity of the river increases from its headwaters to its mouth. This increase is the result of two basic processes -- salt loading (adding salts) and salt concentrating (reducing water supply). Salt loading results from both natural conditions and

man's activities. Salt concentrating results when water is lost through evaporation or transpiration within the Basin or when water of lower salinity than that of downstream points is diverted from the Basin. The result is an increase in downstream salinity due to the remaining amount of salt being carried in less water.

Studies of the effects of salt loading and salt concentrating within the Colorado River Basin have been conducted for about 20 years. Although adequate information is lacking to accurately identify all contributing sources of salinity, the studies have identified the major sources of increasing salinity in the river as it flows from the headwaters to the Gulf of California. However, present understanding of the cause and effect relationships is limited with respect to natural and man-caused salinity in irrigated areas.

The relative effects of salt loading and salt concentrating factors on salinity in the river at Hoover Dam for the period 1942-61, as estimated by the Environmental Protection Agency in its 1971 report, "The Mineral Quality Problem in the Colorado River Basin", are shown in Table 1. Some of the estimates in EPA's report are being investigated and brought up to date by USBR studies currently underway.

Source: "The Mineral Quality Problem in the Colorado River Basin, Summary Report", EPA, 1971

TABLE 1

EFFECTS OF VARIOUS FACTORS OF SALT LOADING
AT HOOVER DAM

(1942-61 Period of Record Adjusted to 1960 Conditions)

Factor	Salt Load (in Millions of Tons)	Percent of Salt Load	Salinity Concentration at Hoover Dam Ascribable to Each Source 1/ mg/l	Portion of Salinity Concentration at Hoover Dam Ascribable to Each Source 1/ Percent
Natural Diffuse Sources	5.41	50.4	275	39
Natural Point Sources	1.28	11.9	59	8
Irrigated Agriculture	3.54	33.0	253	37
Salt Loading	(3.54)	(33.0)	(178)	(26)
Salt Concentrating	(0)	(0)	(75)	(11)
Municipal and Industrial	0.15	1.4	10	1
Exports Out of the Basin	-0.04	-0.4	20	3
Evaporation and Phreatophytes	0.00	0.0	80	12
Storage Release From Hoover 2/	0.39	3.7	0	0
TOTAL	10.73	100.0	697	100

1/ In addition to increases in salinity from salt loading, some factors also cause salinity increases by removal of dilution water. The changes shown may result from either or both.

2/ Computed annual values for balancing based upon the net drawndown over the 1942-61 period.

Salinity From Natural Causes

Natural salinity increases result from accretions from natural sources and water lost to the river system from consumption by phreatophytes and other riparian vegetation and by evaporation from the river water surface and backwater areas.

As summarized in Table 1, the Environmental Protection Agency in its report estimated that almost two-thirds of the average annual salt load and one-half the concentration at Hoover Dam for the period 1942-61 was caused by natural sources. Almost the same results were shown in the report for the 1963-66 period. Of the portion that is from natural sources, a computation based on Table 1 shows that about 82 percent is from diffuse sources and about 18 percent from point sources.

Natural diffuse pickup of mineral salts by surface runoff and ground water inflow takes place throughout the Colorado River Basin. The headwaters area, which makes up only a small part of the total Basin, is composed of weather resistant crystalline rocks containing constituents of very low solubility; as a result, the runoff from the high mountain area has a low salinity. The watersheds of the lower elevations are made up of materials generally having a relatively high solubility which results in runoff from these lands having a higher salinity.

Natural discrete, or point, salinity sources also occur throughout the Basin. Many springs and other natural point sources discharge highly saline flows into the Basin's streams. While their combined flow is relatively small, their effect on the river salinity is significant. Table 1 of Appendix E lists the major point sources

in the Basin as presented by EPA in its report, "The Mineral Quality Problem in the Colorado River Basin," with revisions from later studies by the USBR. Additional studies may indicate the need for further revisions.

The loss of water to phreatophyte and other riparian vegetation and to evaporation from the river water surface and backwater areas is sizeable, particularly in the river reach below Hoover Dam.

Salinity Resulting From Man's Actions

River salinity has increased through salt loading and salt concentrating as a result of man's beneficial use of the Basin's waters.

Irrigation is the major consumer of water in the Basin and is responsible for the largest of the increases in salinity caused by man's activities. Irrigation contributes to both salt loading and salt concentration. Water is removed through evaporation and consumption by the plants, but practically all of the dissolved salt is returned to the river, concentrating the salts in a smaller volume of water. In many areas, return flows also leach salts from the soil and underlying geologic formations which adds to the river's salt load.

Reservoir evaporation also contributes to increasing the salt concentration because evaporation removes water and the salt load is concentrated in a smaller volume of water. Out-of-basin exports and in-basin uses which do not return salt to the system also affect the salinity concentration.

Diversions from the Upper Colorado River Basin into surrounding basins occur at or near the headwaters where the river's water has a very low salt content. This removal of high quality water, even though some salt is also removed from the Basin, results in a salt concentrating effect downstream.

Most industrial plants in the last few years, particularly large coal-fired thermal electric generating plants, have been designed to eliminate the return of cooling tower blowdown water to the Colorado River. As water is circulated through the cooling towers, a part of it evaporates and the dissolved solids in the remaining water become more and more concentrated. As cooling water must be maintained at or below specific levels of salinity, a portion of the concentrated water is removed or "blown down" and replaced with fresh water. When this blowdown is not returned to the river system, the salt load in the water diverted is removed from the river. Even though these no-return uses remove salt from the river, the river's concentration of dissolved solids usually increases below the point of use because of the reduced flow resulting from the beneficial use. The effects on river salinity of a no-return consumptive use are similar to those of an out-of-basin export.

Historically, salt loads contributed by municipal and industrial sources have been minor, totaling about 1 percent of the Basin salt load for the period 1942-61. With the exception of concentrated returns from the Las Vegas, Nevada, area most municipal and industrial wastes in the Basin are relatively low in total salt load.

Past, Present and Projected Salinity Levels

Records and Basic Data

Evaluations of the salinity of the Colorado River have been made by the Bureau of Reclamation, Geological Survey, Environmental Protection Agency, and the Colorado River Board of California based on streamflow and water quality data largely collected by the Geological Survey in cooperation with other federal and state agencies. The water quality data are being obtained on a daily, weekly, monthly, or quarterly basis on streams throughout the Basin by the Geological Survey. Gaging stations in the Upper Basin that are of significance to this study for which streamflow and water quality records are available are described below. Figure 1 shows graphically the streamflow and quality data that are available at each of the stations during the study period 1941-73. Where breaks in the water quality sampling record occurred during the 1941-73 period, the missing data have been estimated by correlation with records at other stations. Continuing studies will serve to refine these data.

Colorado River near Cameo, Colorado. Stations is located 5.9 miles upstream from Grand Valley Project Diversion Dam and 7 miles northeast of Cameo. Streamflow data are from October 1933 to the current year. Water quality data are for the same period.

Colorado River near Cisco, Utah. The station is a mile downstream from the Dolores River and 11 miles south of Cisco, Utah. Streamflow data are from 1911 to the current year. Water quality data are available from August 1928 to the current year.

FIGURE 1

COLORADO RIVER BASIN
Flow and Quality of Water Data
1941-73

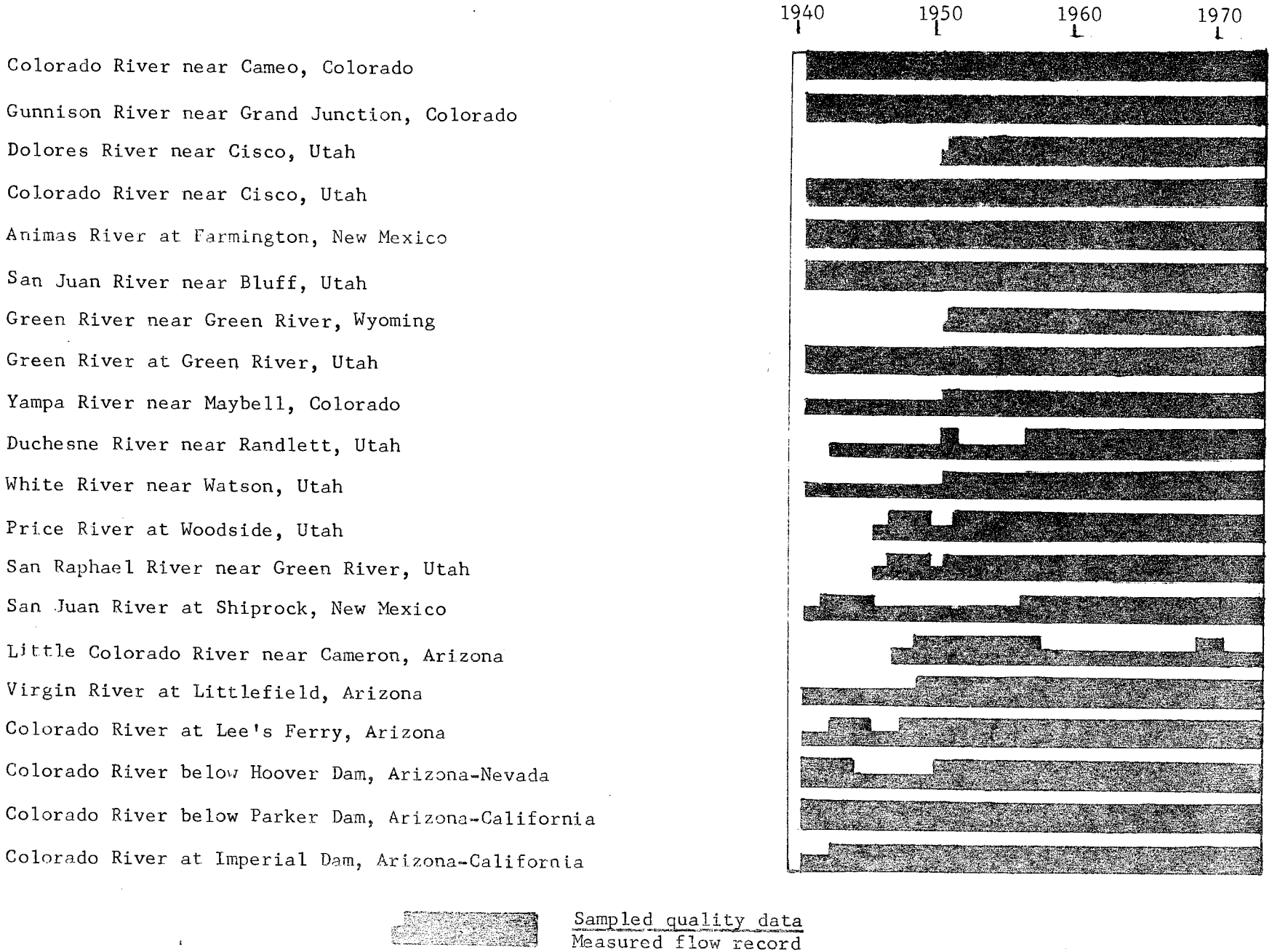


Figure 1

Gunnison River near Grand Junction, Colorado. Station is located 8 miles southeast of Grand Junction. Streamflow data are from October 1916 to the current year. Water quality data are from October 1931 to the current year.

Dolores River near Cisco, Utah. Station is located 13.5 miles downstream from the Colorado-Utah stateline and 9 miles upstream from the mouth. Complete data on streamflow and water quality are available from the period 1951 to the current year.

Animas River at Farmington, New Mexico. Station is located 1.3 miles upstream from mouth of the river. Streamflow data are from September 1912 to the current year. Water quality data are from June 1940 to the current year.

San Juan River at Shiprock, New Mexico. The station is 3 miles west of Shiprock, New Mexico, and about 25 miles upstream from the stateline. Streamflow data are from January to October 1911 and February 1927 to the current year. Water quality data are from February 1941 to September 1945 and July 1957 to the current year.

San Juan River near Bluff, Utah. Station is located 1800 feet upstream from highway bridge, 20 miles southwest of Bluff. Streamflow data are from October 1914 to current year. Water quality data are from October 1929 to current year.

Green River near Green River, Wyoming. Station is located 1 mile southweast of town of Green River and 4 miles upstream from high water line of Flaming Gorge Reservoir. Streamflow data are from April 1951 to the current year. Water quality data are from May 1951 to the current year.

Green River at Green River, Utah. Station is located 500 feet upstream from railroad bridge, 1 mile southeast of Green River. Streamflow data are from October 1904 to current year. Water quality data are from October 1929 to current year.

Yampa River near Maybell, Colorado. Station is located 2 miles downstream from Ray Creek and 3 miles east of Maybell. Streamflow data are from April 1916 to the current year. Water quality data are from November 1950 to the current year.

Duchesne River near Randlett, Utah. Station is located 0.2 mile downstream from Uinta River, about 1.2 miles southeast of Randlett. Streamflow data are from October 1942 to the current year. Water quality data are from December 1950 to September 1951 and from November 1956 to the current year.

White River near Watson, Utah. Station is located about 1 mile downstream from Evacuation Creek and 7 miles north of Watson. Streamflow data are from April 1923 to the current year. Water quality data are from December 1950 to the current year.

Price River at Woodside, Utah. Station is located 200 feet downstream from railroad bridge at Woodside, 22 miles upstream from mouth. Streamflow records are from November 1945 to the current year. Water quality data are from December 1946 to September 1949 and from February 1951 to the current year.

San Rafael River near Green River, Utah. Station is located 15 miles southeast of Green River and 35 miles upstream from mouth. Streamflow records are from October 1945 to the current year. Water quality data are from November 2946 to September 1949 and from November 1950 to the current year.

The gaging stations on the Colorado River and its tributaries below Glen Canyon Dam that are of particular significance to the Forum studies and for which data are available are described as follows:

Colorado River at Lee's Ferry, Arizona. Data on streamflow are available at this station for the years since 1922, but water quality data are lacking for years 1941, 1942, 1946, and 1947. The data for these years were estimated by extensive multiple correlations using data for the Colorado River near Cisco, Utah, and near Grand Canyon, Arizona; the Green River at Green River, Utah; and the San Juan River near Bluff, Utah.

Little Colorado River near Cameron, Arizona. The station is 45 miles upstream from its confluence with the Colorado River and 9.5 miles northwest of Cameron, Arizona. Streamflow records are from June 1947 to the current year. Only partial water quality data are available, chemical analyses for the period 1950 to 1958 and 1970-71, and specific conductance from 1964 to 1969.

Virgin River at Littlefield, Arizona. The station is 0.4 mile upstream from Littlefield, Arizona, and 36 miles upstream from Lake Mead. Streamflow records are available from 1929 to the current year. Water quality records are from July 1949 to the current year.

Colorado River below Hoover Dam, Arizona-Nevada. Discharge data are available for 1941 to current year. Water quality data are available except for the period November 1944 through September 1950. Water quality data for this period are based on specific conductance with chemical analysis only at intermittent intervals.

Colorado River below Parker Dam, Arizona-California. Flow data are available for the period 1941 to the current year. The water quality data are available for the period January 1964 through the

current year. The water quality data for the period January 1941 through December 1963 were adjusted by correlation with the samples taken by The Metropolitan Water District of Southern California at the Lake Havasu Intake Pumping Plant.

Colorado River at Imperial Dam, Arizona-California. The streamflow data for this station were obtained from a combination of several stations. Data from January 1941 through September 1942 are from the Colorado River near Picacho, California, gaging station; data from October 1942 through September 1960 are based on the combined discharges at gaging stations on the Colorado River at Yuma, All-American Canal near Imperial Dam, Gila Gravity Main Canal at Imperial Dam, Yuma Main Canal at Laguna Dam, and North Gila Valley Canal at Laguna Dam less the Gila River near Dome, Arizona. Data after September 1960 are based on the combined daily discharge of the Colorado River below Imperial Dam, the All-American Canal near Imperial Dam, and the Gila Gravity Main Canal at Imperial Dam.

Water quality data from 1943 through October 1970 were obtained from Geological Survey records based on data for the Yuma Main Canal below the Colorado River Siphon. Water quality data following October 1970 were obtained from Geological Survey records taken at Imperial Dam.

Present and Historical Salinity Levels and Salt Loads

Historical annual streamflow and quality of water data for the Colorado River near Cisco, Utah; the Green River near Green River, Utah; the San Rafael River near Green River, Utah; the San Juan River near Bluff, Utah; and the Colorado River at Lee's Ferry.

Arizona, for the period 1941-72 are presented in Tables 1 to 5 in Appendix F. Similar historical data are available for the Colorado River below Hoover Dam, Arizona-Nevada; below Parker Dam, Arizona-California; and at Imperial Dam, Arizona-California. The data obtained at these stations are the means of estimating the salt contributions to the Colorado River Basin. The salinity level and salt load at the latter three stations are shown in Table 2 for selected periods. The data are presented in greater detail in Tables 6 to 8 in Appendix F. The annual streamflows, total dissolved solids (TDS), and the salinity level (mg/l) are also shown graphically for these three stations in Figures 1 to 3 of Appendix F.

Salt Routing Studies

A series of salt routing studies were conducted to provide estimates of the future flow-weighted average salinity levels for each year at selected points in the Basin under differing assumptions as to both the available water supply and future water uses. The studies were designed to provide estimates of salinity under conditions with and without salinity control measures during the period 1974 through 1990. They were carried out through the use of a salt routing computer model developed by the Bureau of Reclamation.1/

All known natural and existing man-made water use and salt loadings were identified for the river reach extending from Lake Powell to Imperial Dam. No attempt was made to model the river system above Lake Powell, since only the sum of the individual uses, including exports from the Basin, and salt loading were required.

1/ Detailed information on the model is presented in: Ribbens, Richard and Wilson, Robert F., Bureau of Reclamation, U. S. Department of the Interior, Denver, Colorado (1973), "Application of a River Network Model to Water Quality Investigations for the Colorado River".

TABLE 2

SALINITY LEVELS AND SALT LOADS FOR SELECTED PERIODS AND LOCATIONS IN LOWER COLORADO RIVER BASIN

Colorado River Station	Period	Flow (1000 AF)	TDS (Tons)	Concentration 1/ (T/AF)	(Mg/l)
Imperial Dam	1941-72 Avg.	8,697	9,016	1.04	762
	1972	5,797	6,929	1.20	879
Below Parker Dam	1941-72 Avg.	9,375	8,867	0.95	695
	1972	6,789	6,897	1.02	747
Below Hoover Dam	1941-72 Avg.	10,352	9,754	0.94	693
	1972	8,099	7,962	0.98	723

1/ Flow-weighted average annual salinity.

The river below Lake Powell was divided into distinct reaches to determine future salinity levels. Future estimates of water use and salt loading for each appropriate reach of the river below Lake Powell and the accumulative effect above Powell were superimposed upon historical conditions for each year of the study. The changes were routed downstream with the accumulated impact reflected at downstream stations.

The studies were made on a monthly basis using a range of water supply conditions and future depletion rates.

Projections of Future Water Use

The use of Colorado River water by the Upper Basin States in 1973 was 2,976,000 acre-feet. A number of water development projects are either now under construction or have been completed and water use is building up to project capacities. Several other projects have been authorized for construction. In addition, studies are being made of numerous in-basin projects that would develop water for irrigated agriculture, oil shale, thermal-electric generation, and municipal and industrial purposes. Some of the projected future developments will provide for increasing transmountain diversions to the eastern slopes of the Rocky Mountains in Colorado, to the Bonneville Basin in Utah, and to the Rio Grande Basin in New Mexico; there also may be new transbasin diversions in Wyoming. Actual depletions by year 1990 in the Upper Basin, exclusive of main stem reservoir evaporation, will be dependent on many variables, including physical and legal restraints. In the studies to estimate future salinity levels, three possible rates of 1990 water usage were projected. These

varied from a low of about 4,111,000 acre-feet per year to a high of 5,464,000 acre-feet per year. Not included in these figures is the annual main stem reservoir evaporation, estimated by the USBR to average about 520,000 acre-feet per annum. These three projected possible future rates of depletion were not based on institutional or physical limitations on water supply.

Projected consumptive use[1/] from the mainstream in the Lower Basin by year 1990 was based upon the "Law of the River". The highest use in 1990 was assumed to be 7,500,000 acre-feet. The low 1990 estimate is only slightly less -- 7,461,000 acre-feet.

Estimates of both 1973 water use and projected future use through the year 1990 for each of the seven states were furnished by the Basin States. Since projected water development is subject to many influences and uncertainties, a range of future water depletion rates was used. These were identified as low, moderate, and high. In all cases, the states' projections fall within the range of projections used in the study.

Table 3 presents a summary of the projected water use in the Colorado River Basin. Presented in Appendix G are data on 1973 base conditions by specific categories of use. These categories are: out-of-basin exports, in-basin agricultural use, in-basin coal development which includes water for mining operations and cooling of coal-fired electrical power stations and coal gasification, and in-basin oil shale and other in-basin uses which include miscellaneous municipal and industrial use and fish and wildlife uses.

1/ Consumptive use as defined by the U. S. Supreme Court means diversions from the stream less such return flow therto as is available for consumptive use in the United States or in satisfaction of the Mexican Treaty obligation.

TABLE 3

SUMMARY OF ESTIMATED WATER USE
IN COLORADO RIVER BASIN[1]
(1,000 acre-feet)

	1973 Base Condition	Assumption as to Rate of use	1980	1985	1990
Upper Basin[2]	2,976	Low	3,426	3,686	4,111
		Moderate	3,576	4,176	4,594
		High	4,021	4,589	5,464
Lower Basin[3]	6,143	Low	5,813	6,238	7,461
		Moderate	5,953	6,838	7,476
		High	6,203	8,168	7,500
TOTAL	9,119	Low	9,239	9,924	11,572
		Moderate	9,529	11,014	12,070
		High	10,224	12,757	12,964

1/ Does not include deliveries to Mexico.

2/ Does not include CRSP reservoir evaporation estimated by the USBR to average 520,000 acre-feet per year.

3/ Diversions from the main stem less returns. Does not include main stem reservoir evaporation and stream losses estimated by the Forum to average 1,400,000 acre-feet per year.

Water Supply Assumptions

To evaluate future possible salinity conditions, five water supply conditions were employed -- a virgin flow of 12, 13, 14, 15, and 16 million acre-feet per year at Lee Ferry, Arizona.[1/] It was considered that within the time frame of the study, this range of flows would most likely encompass the actual future flow. It should be noted that each water supply condition (e.g., 12, 13, 14, 15, and 16 million acre-feet) was considered to be a constant flow each year of the 17-year study period. The 1896-1974 average annual virgin flow at Lee Ferry is 14.9 million acre-feet.

It should also be noted that to regulate the erratic flows of the Colorado River, a large volume reservoir storage system has been constructed. It is currently at about 75 percent capacity. This reservoir system will dampen the variation in both the annual flow and salinity in the lower main stem.

Projected Salt Load and Salinity Concentration

Projections of future salinity levels in the lower main stem were made for the full range of assumed water supply conditions and the three projected water use rates assuming that no salinity control measures would be undertaken. Future salinity levels for 1980, 1985, and 1990, shown by Tables 4, 5, and 6, respectively, are

---

1/ The Colorado River Compact defines the Upper Basin as the parts of the Basin "within and from which waters naturally drain into the Colorado River System above Lee Ferry", and the Lower Basin as that part of the Basin "within and from which waters naturally drain into the Colorado River System below Lee Ferry". Lee Ferry is defined as a point on the mainstream of the Colorado River one mile below the mouth of the Paria River.

directly related to the water supply, the amount of reservoir storage, and the rate of water use. For example, with a long-term average virgin flow at Lee Ferry of 15 maf/yr and a moderate water use rate, the 1990 salinity at Imperial Dam in the absence of any salinity control measures would be 995 mg/l.

Reduction in Projected Salinity Required to Maintain 1972 Levels

The policy set forth in the EPA regulation [40 CFR Part 120, Water Quality Standards], published on December 18, 1974, calls for maintenance of salinity in the lower main stem of the river at or below the average value found during 1972 while the Basin States continue to develop their compact-apportioned waters. The 1972 average value is understood to be the flow-weighted average. If the 1972 levels are to be maintained, salinity control measures must be undertaken.

The projected salinities, both with and without salinity control measures, assuming no increase in water supply, are presented in Tables 4, 5, and 6 for Hoover, Parker and Imperial Dams. The water supply and depletion rate assumptions were described earlier. Salinity control measures consist of a number of federal and nonfederal actions. These are described in detail in subsequent chapters.

Using the salt routing model, analyses were made to determine the impact on salinity in the lower main stem for the full range of water supply and depletion rates combined with full implementation of salinity control measures. These measures include no salt return for electrical generating station cooling, the coal gasification and coal development industries and the oil shale industry; reformulation

of three authorized Upper Basin water development projects (Animas-La Plata, Dolores and Dallas Creek); and the sixteen salinity control projects specified in Title II of PL 93-320. The initial year of operation of the salinity control projects was determined after considering the time required for planning, authorization and construction. The individual projects and year of initial operation are described in Chapters V and VI.

Figures 2-19 show the projected salinities from selected analyses at three stations -- Hoover, Parker and Imperial Dams. Future flow-weighted annual salinity concentrations at these locations depend not only upon man's activities, but upon natural phenomena, including periods of high and low annual precipitation, variations in distribution of precipitation over the Basin, variations in the time of year precipitation falls, vairations in natural evapotranspiration, etc. Also, within the major storage reservoirs, salts precipitate, dissolve, and are mixed with results largely beyond the control of man. Consequently, future adherence to the 1972 numeric criteria will be affected by factors beyond the control of man as subsequently explained in Chapters IV, V and VIII. Except for deviations caused by factors beyond the control of man, annual average salinity levels can be maintained at or below the 1972 levels at the following lower main stem stations through 1990 with full implementation of salinity control measures for the following water supply and depletion rates:

Hoover Dam -- Virgin flow at Lee Ferry of 14 million acre-feet/year or more with low and moderate depletion rates.

Parker Dam -- Virgin flow at Lee Ferry of 14 million acre-feet/year or more with a low depletion rate and 15 million acre-feet/year or more with low and moderate depletion rates.

Imperial Dam -- Virgin flow at Lee Ferry of 14 million acre-feet/year or more with a low depletion rate and 15 million acre-feet/year or more with a moderate depletion rate.

TABLE 4

PROJECTED SALINITY LEVELS
With & Without Salinity Control Measures 1/

Year 1980

Depletion Range / Average Annual Virgin Flow	Colorado River Below Hoover Dam, Az-Nv 1972 Flow-weighted salinity 723		Colorado River Below Parker Dam, Az-Ca 1972 Flow-weighted salinity 747		Colorado River at Imperial Dam, Az-Ca 1972 Flow-weighted salinity 879	
	conc.-mg/l without controls	conc.-mg/l with controls	conc.-mg/l without controls	conc.-mg/l with controls	conc.-mg/l without controls	conc.-mg/l with controls
Low Depletion Average Annual Flow						
12 maf	764	757	782	774	941	928
13 maf	746	741	764	757	919	906
14 maf	730	723	744	739	877	868
15 maf	703	697	717	711	810	802
16 maf	681	675	695	688	773	765
Moderate Depletion Average Annual Flow						
12 maf	769	761	791	783	957	944
13 maf	750	744	772	764	932	920
14 maf	733	727	754	747	912	901
15 maf	708	702	725	719	828	818
16 maf	686	679	701	696	788	780
High Depletion Average Annual Flow						
12 maf	782	777	806	801	981	971
13 maf	760	756	783	779	953	944
14 maf	740	737	763	759	929	921
15 maf	722	719	741	737	868	859
16 maf	699	696	717	714	822	816

1/ Salinity control measures include: assumed no industrial salt return and 16 salinity control projects (P.L. 93-320).

TABLE 5

PROJECTED SALINITY LEVELS
With & Without Salinity Control Measures 1/

Year 1985

Depletion Range / Average Annual Virgin Flow	Colorado River Below Hoover Dam, Az-Nv		Colorado River Below Parker Dam, Az-Ca		Colorado River at Imperial Dam, Az-Ca	
	1972 Flow-weighted salinity 723		1972 Flow-weighted salinity 747		1972 Flow-weighted salinity 879	
	conc.-mg/l without controls	conc.-mg/l with controls	conc.-mg/l without controls	conc.-mg/l with controls	conc.-mg/l without controls	conc.-mg/l with controls
Low Depletion Average Annual Flow						
12 maf	810	755	834	776	1,020	944
13 maf	788	741	810	761	991	927
14 maf	752	709	771	725	902	847
15 maf	719	677	736	693	844	792
16 maf	692	651	708	666	800	748
Moderate Depletion Average Annual Flow						
12 maf	829	768	857	793	1,056	968
13 maf	802	751	830	775	1,019	947
14 maf	771	727	794	748	967	899
15 maf	737	693	759	713	898	839
16 maf	710	666	729	685	844	788
High Depletions Average Annual Flow						
12 maf	871	810	900	837	1,113	1,033
13 maf	835	785	862	811	1,067	1,000
14 maf	804	762	831	787	1,028	971
15 maf	771	732	794	753	969	918
16 maf	741	703	763	724	907	858

1/ Salinity control measures include: assumed no industrial salt return and 16 salinity control projects (P.L. 93-320).

PROJECTED SALINITY LEVELS
With & Without Salinity Control Measures 1/

Year 1990

Depletion Range / Average Annual Virgin Flow	Colorado River Below Hoover Dam, Az-Nv 1972 Flow-weighted salinity 723		Colorado River Below Parker Dam, Az-Ca 1972 Flow-weighted salinity 747		Colorado River at Imperial Dam, Az-Ca 1972 Flow-weighted salinity 879	
	conc.-mg/l without controls	conc.-mg/l with controls	conc.-mg/l without controls	conc.-mg/l with controls	conc.-mg/l without controls	conc.mg/l with controls
Low Depletion Average Annual Flow						
12 maf	850	735	884	763	1,098	940
13 maf	823	726	856	755	1,064	931
14 maf	781	693	811	719	995	879
15 maf	745	659	773	684	933	824
16 maf	716	634	740	656	873	769
Moderate Depletion Average Annual Flow						
12 maf	892	761	931	791	1,155	970
13 maf	854	746	890	776	1,103	949
14 maf	821	726	856	756	1,063	925
15 maf	783	694	813	720	995	871
16 maf	751	666	778	691	928	814
High Depletion Average Annual Flow						
12 maf	978	848	1,020	884	1,305	1,148
13 maf	919	813	958	846	1,185	1,044
14 maf	877	787	913	819	1,131	1,012
15 maf	841	760	874	789	1,083	976
16 maf	804	727	834	753	1,014	918

1/ Salinity control measures include: assumed no industrial salt return and 16 salinity control projects (P.L. 93-320).

PROJECTED SALINITY AT HOOVER DAM

14 M. Af. / Yr. Supply

LOW DEPLETION RATE

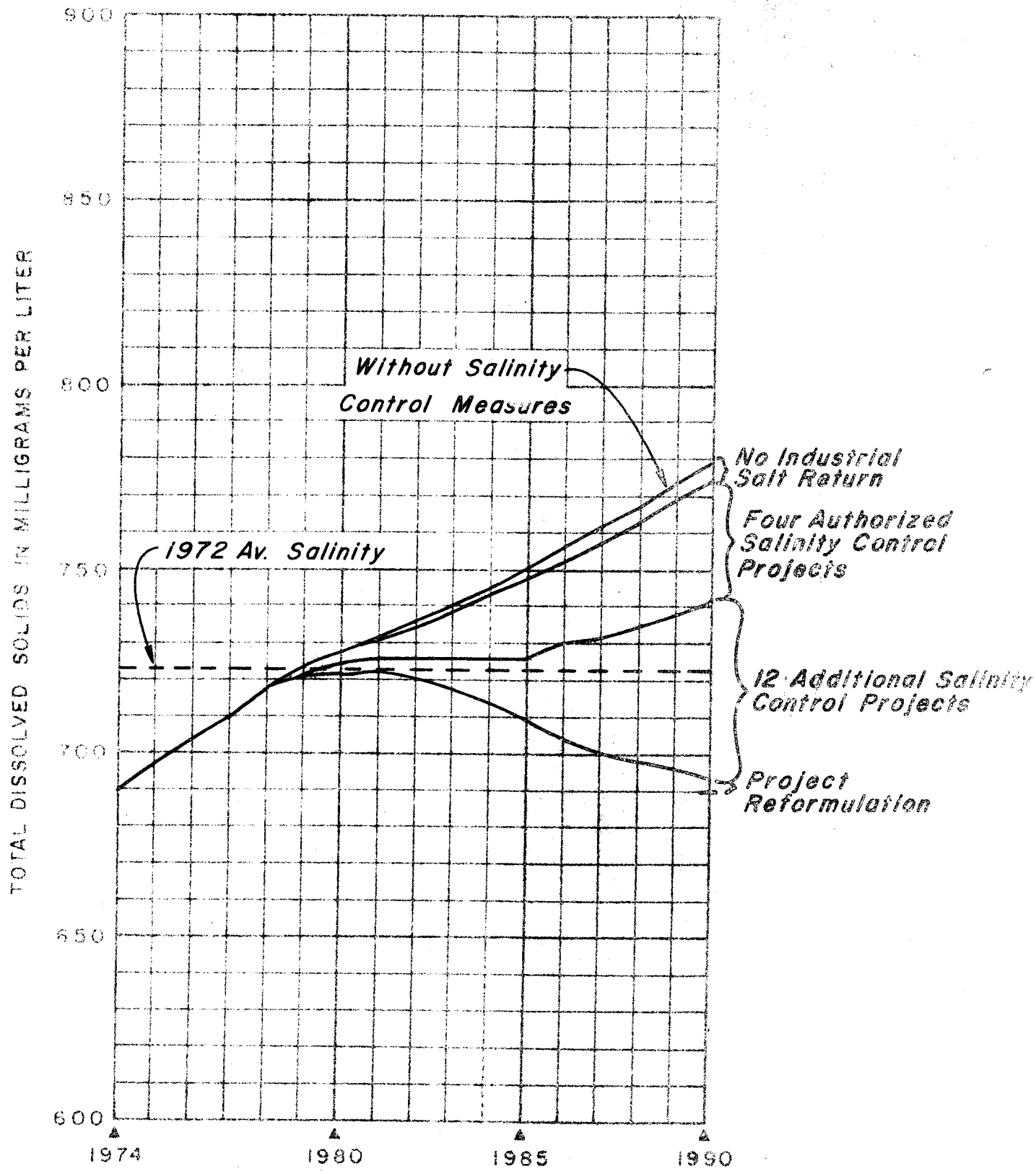


Figure 2

PROJECTED SALINITY AT PARKER DAM

14 M. Af. / Yr. Supply

LOW DEPLETION RATE

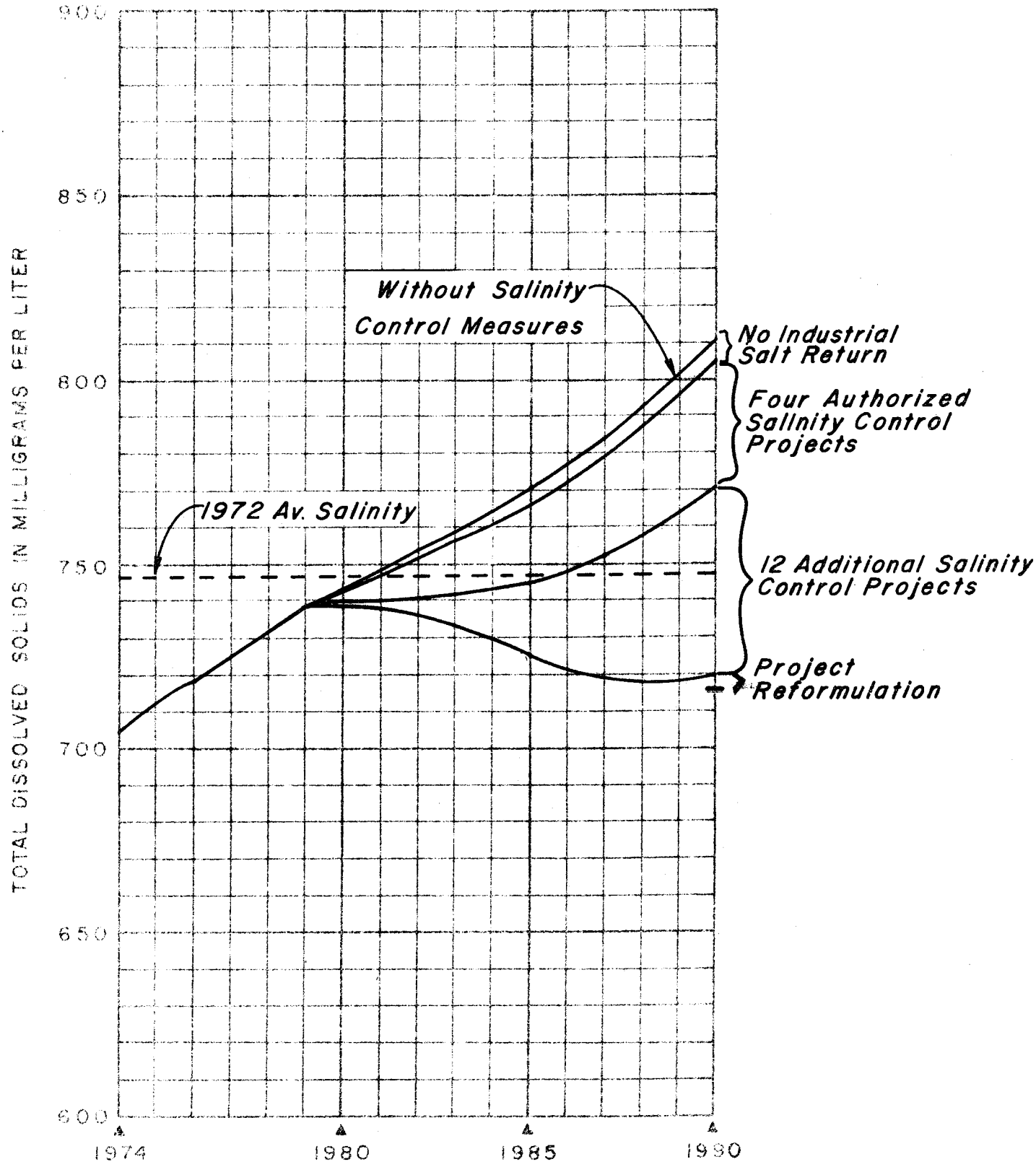


Figure 3

PROJECTED SALINITY AT IMPERIAL DAM

14 M. Af. / Yr. Supply

LOW DEPLETION RATE

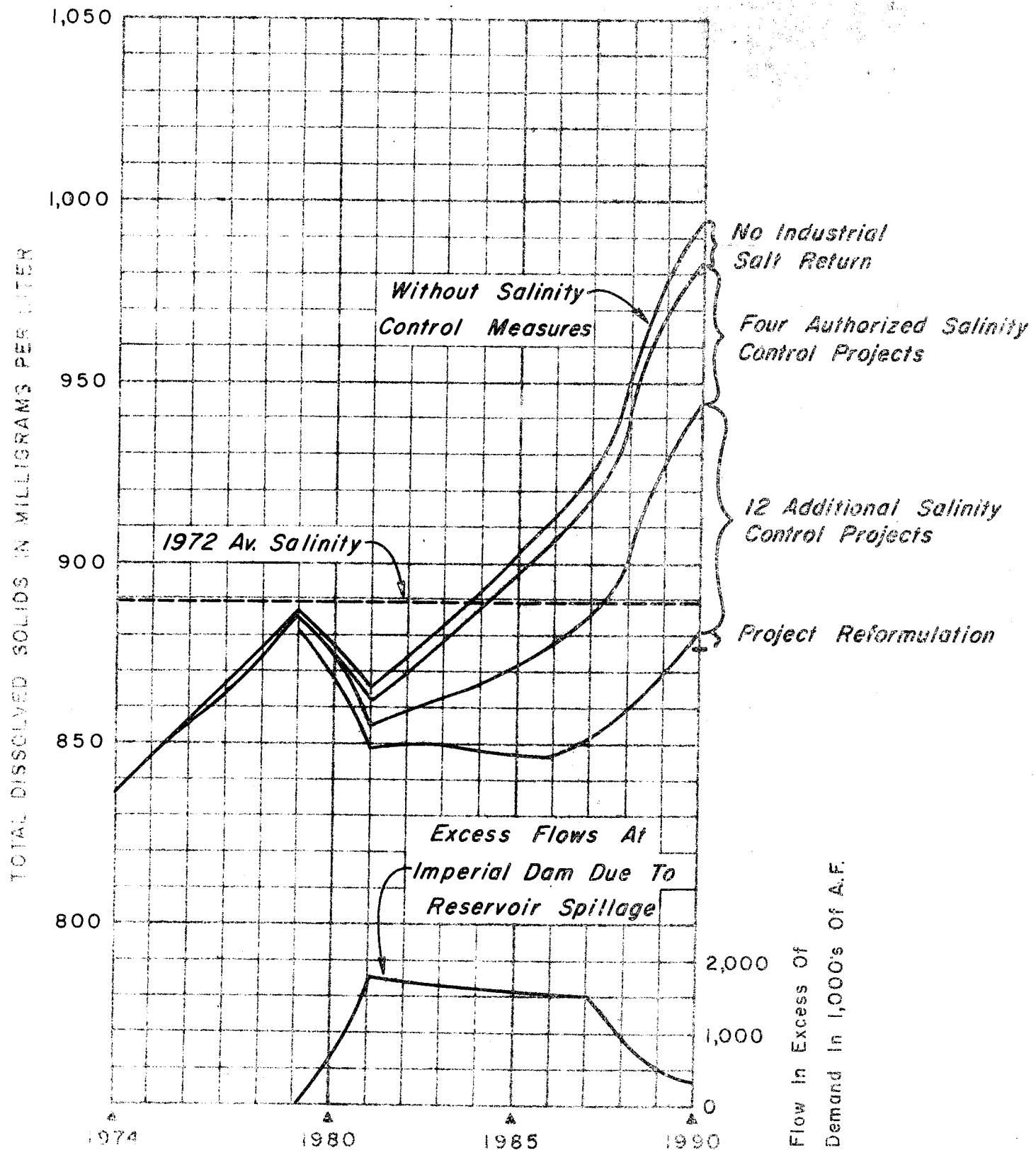


Figure 4

PROJECTED SALINITY AT HOOVER DAM

14 M. Af. / Yr. Supply

MODERATE DEPLETION RATE

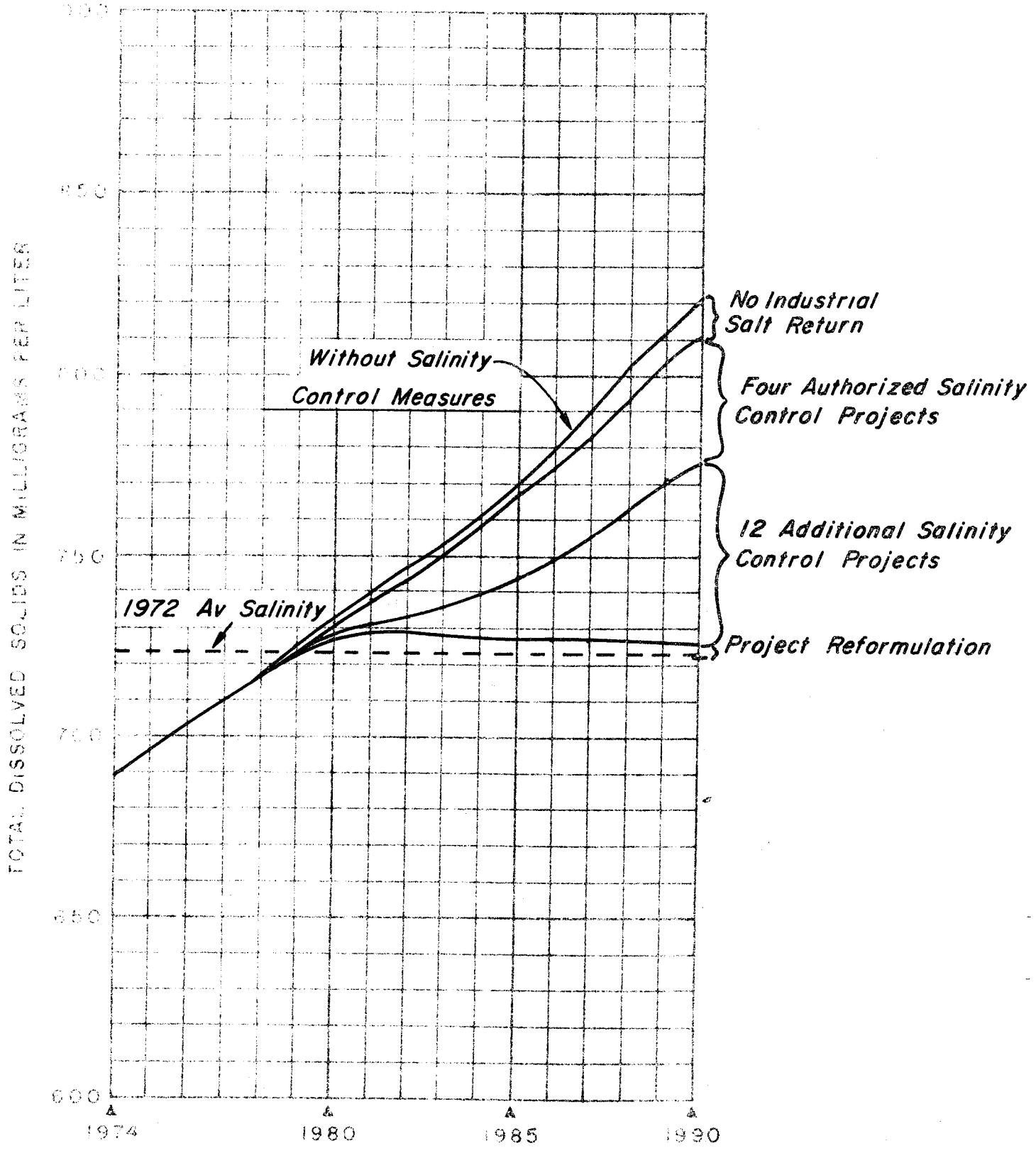


Figure 5

PROJECTED SALINITY AT PARKER DAM

14 M. Af. / Yr. Supply

MODERATE DEPLETION RATE

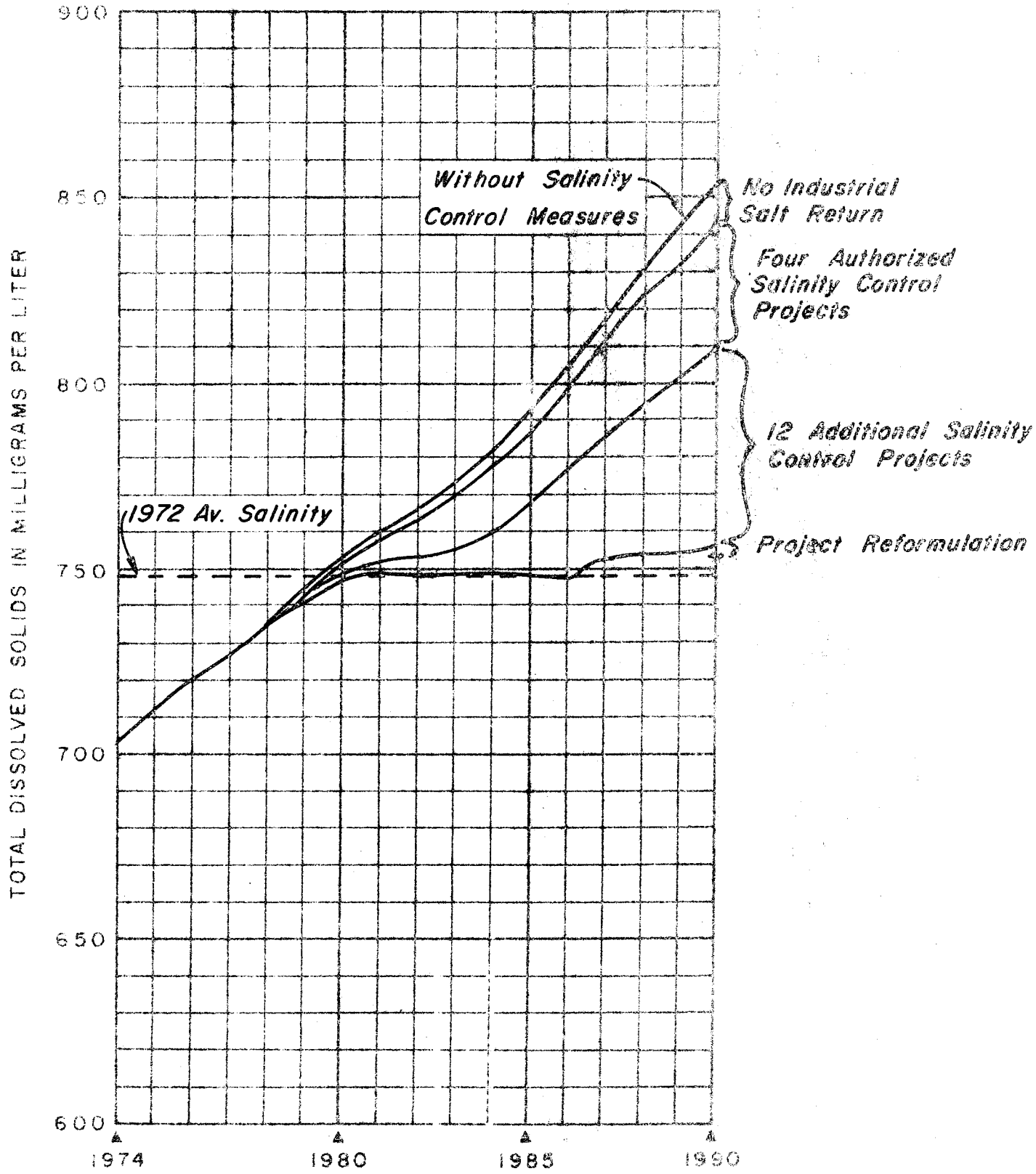


Figure 6

PROJECTED SALINITY AT IMPERIAL DAM

14 M. Af. / Yr. Supply

MODERATE DEPLETION RATE

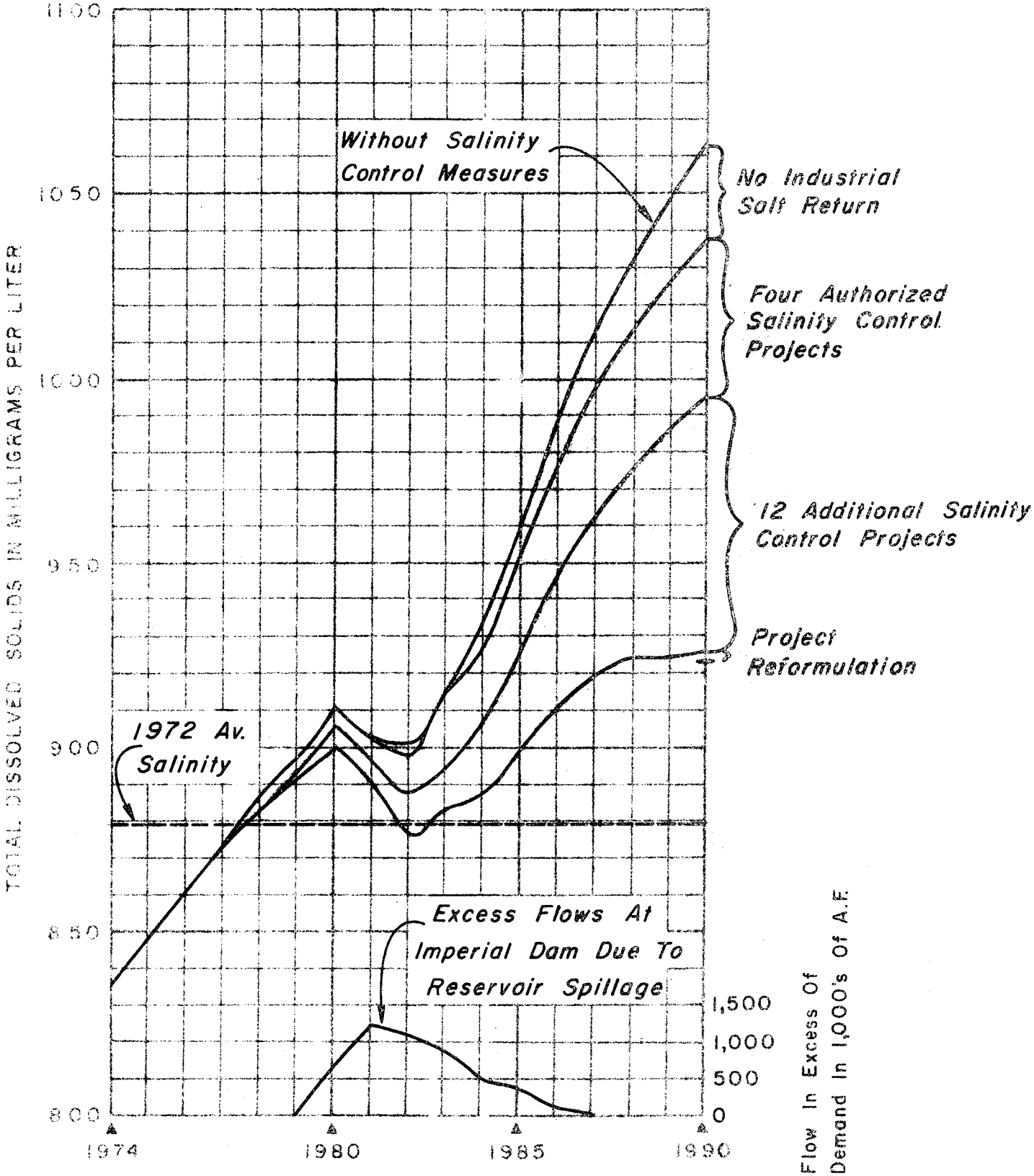


Figure 7

PROJECTED SALINITY AT HOOVER DAM

14 M. Af. / Yr. Supply

HIGH DEPLETION RATE

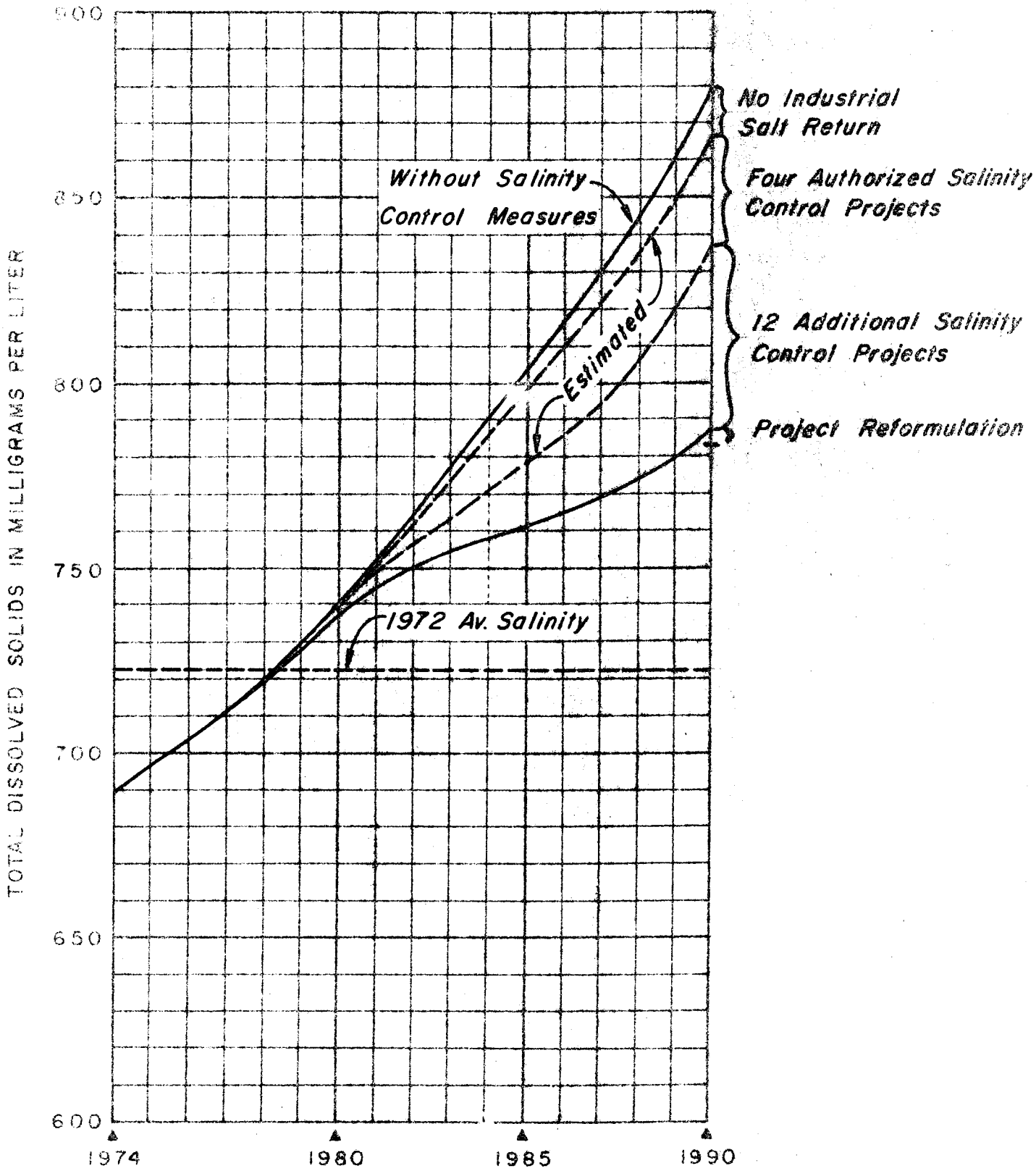


Figure 8

PROJECTED SALINITY AT PARKER DAM

14 M. Af. / Yr. Supply

HIGH DEPLETION RATE

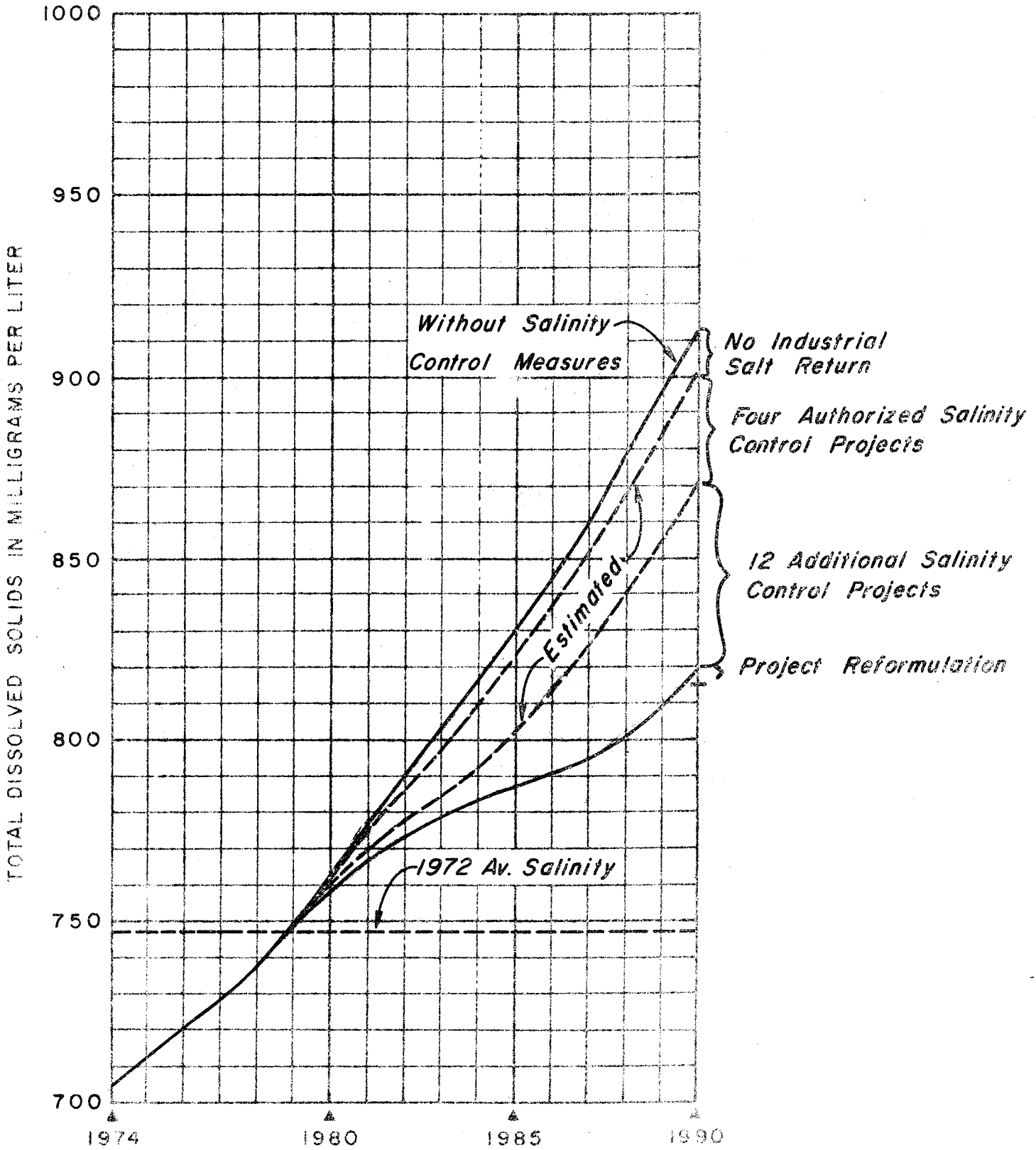


Figure 9

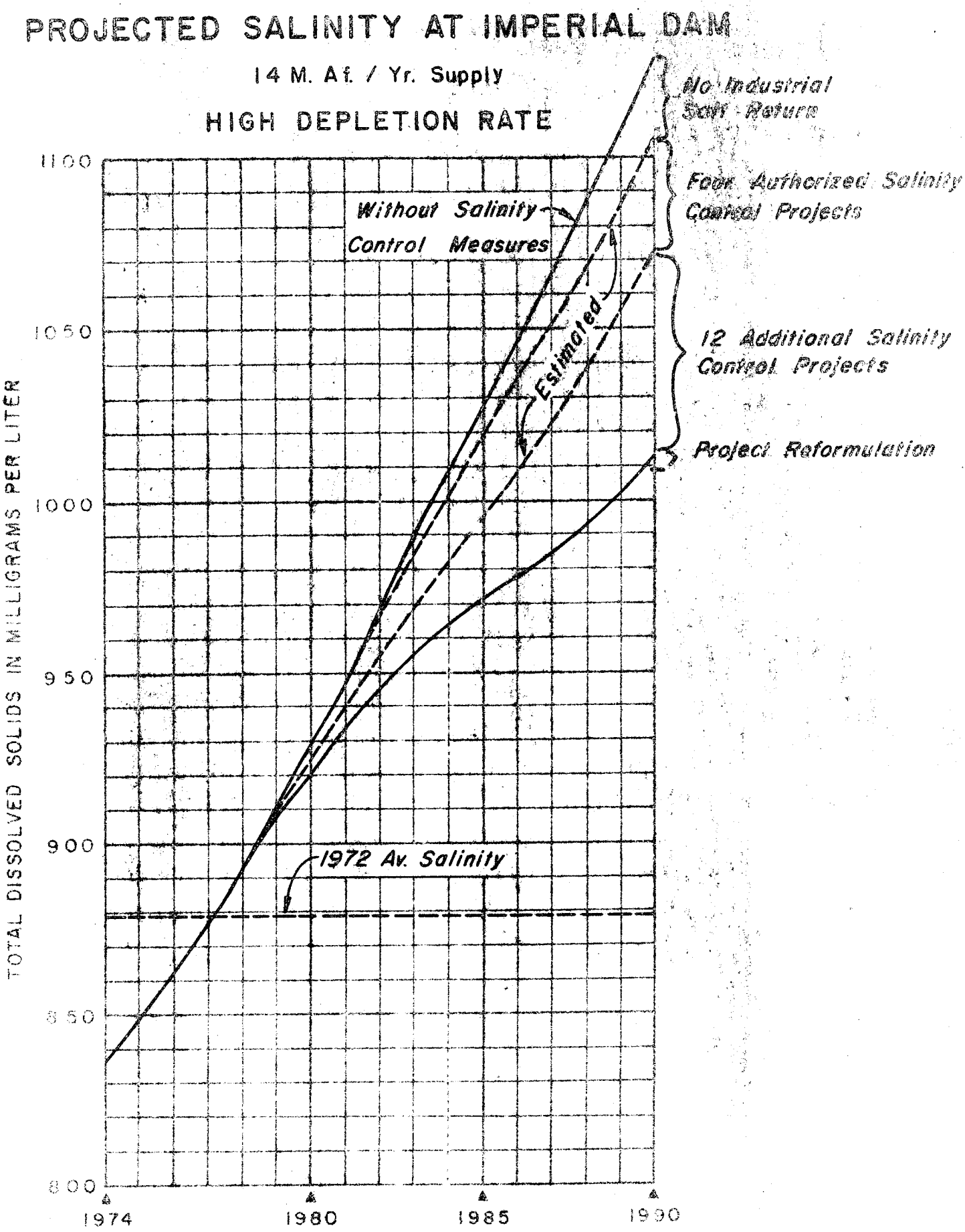
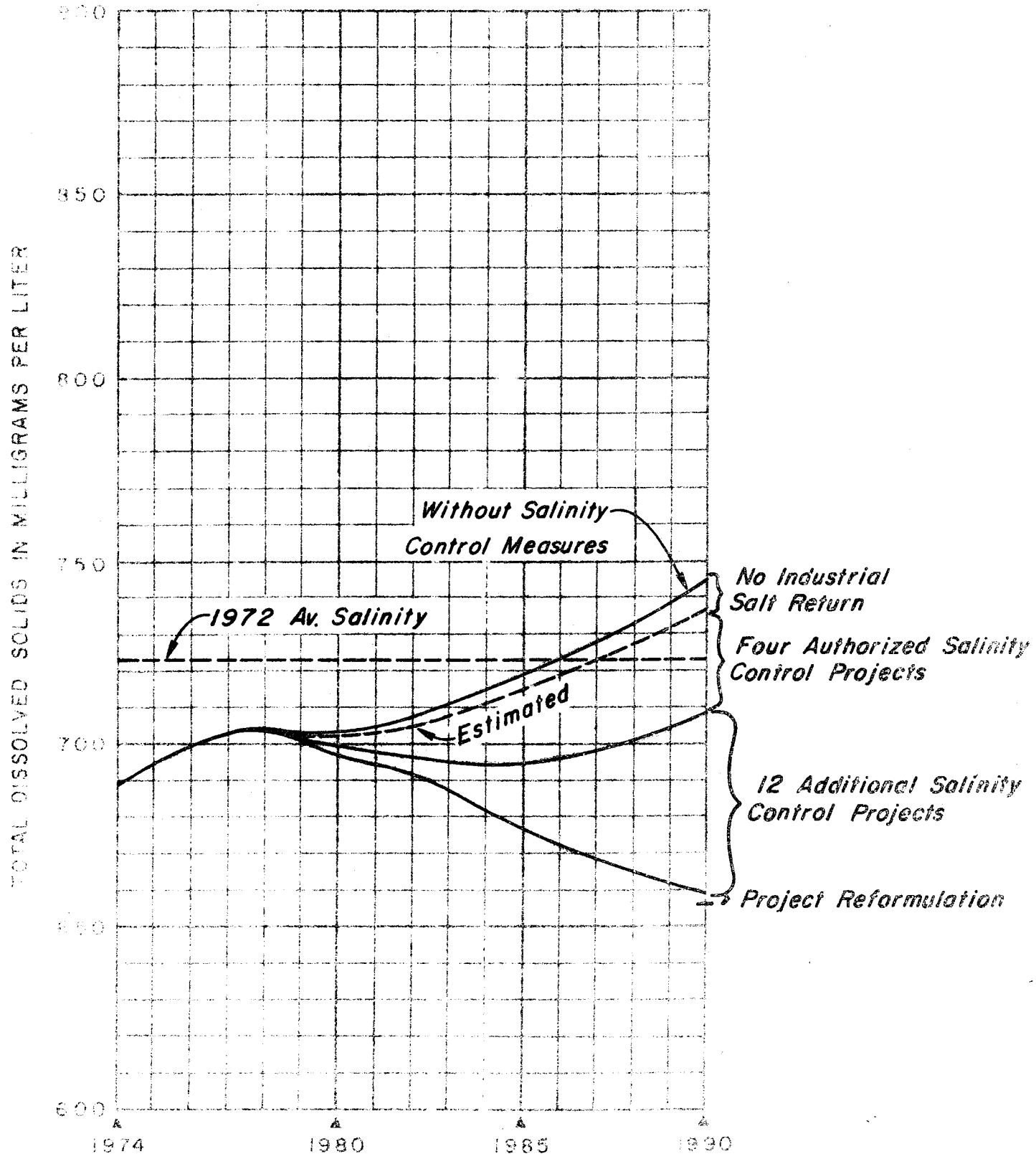

PROJECTED SALINITY AT IMPERIAL DAM
14 M. Af. / Yr. Supply
HIGH DEPLETION RATE
No Industrial Salt Return
Four Authorized Salinity Control Projects
12 Additional Salinity Control Projects
Project Reformulation
Without Salinity Control Measures
Estimated
1972 Av. Salinity
TOTAL DISSOLVED SOLIDS IN MILLIGRAMS PER LITER
1100
1050
1000
950
900
850
800
1974
1980
1985
1990

Figure 10

PROJECTED SALINITY AT HOOVER DAM

15 M. Af. / Yr. Supply

LOW DEPLETION RATE



PROJECTED SALINITY AT PARKER DAM

15 M. Af. / Yr. Supply

LOW DEPLETION RATE

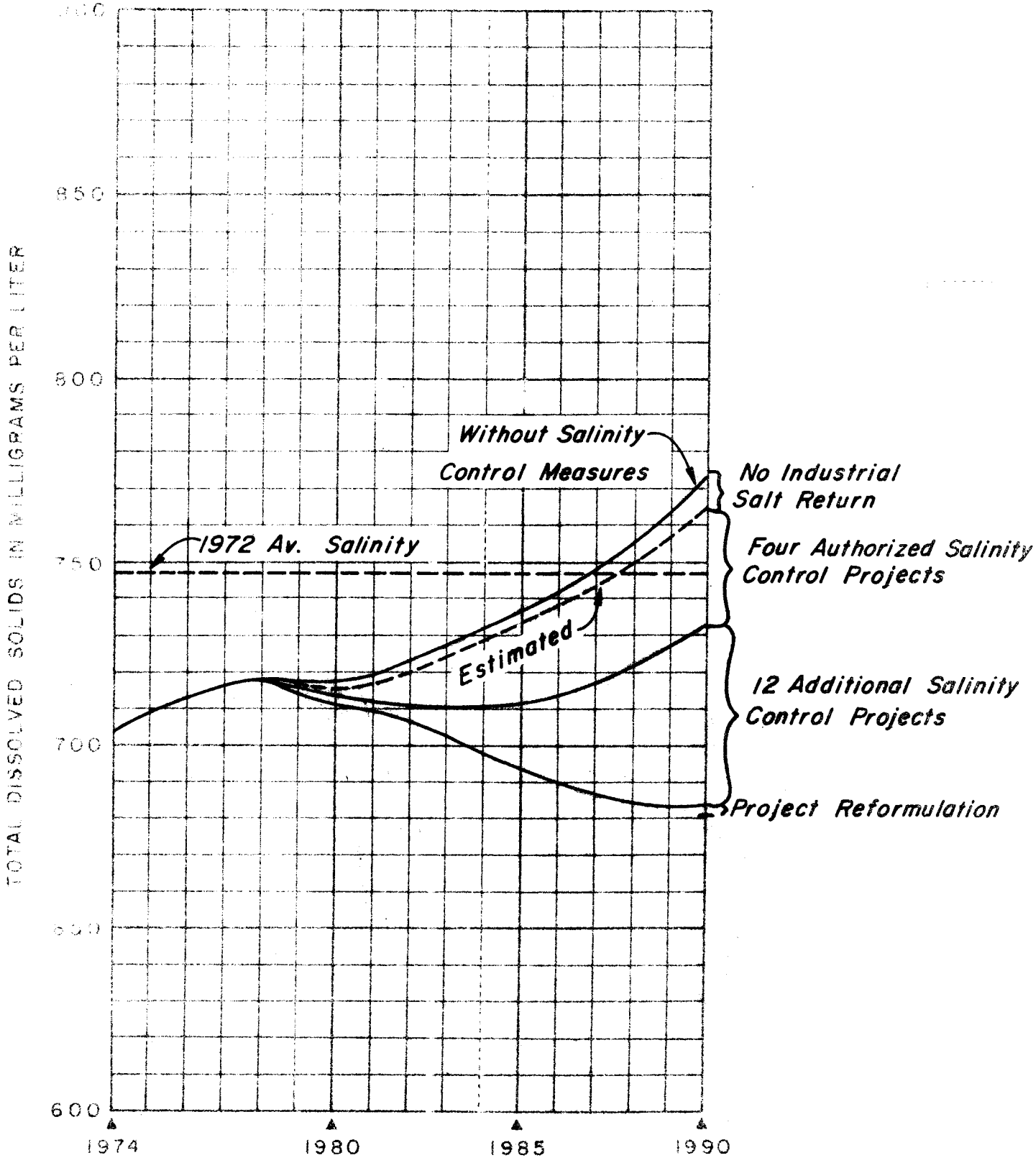


Figure 12

PROJECTED SALINITY AT IMPERIAL DAM

15 M. Af. / Yr. Supply

LOW DEPLETION RATE

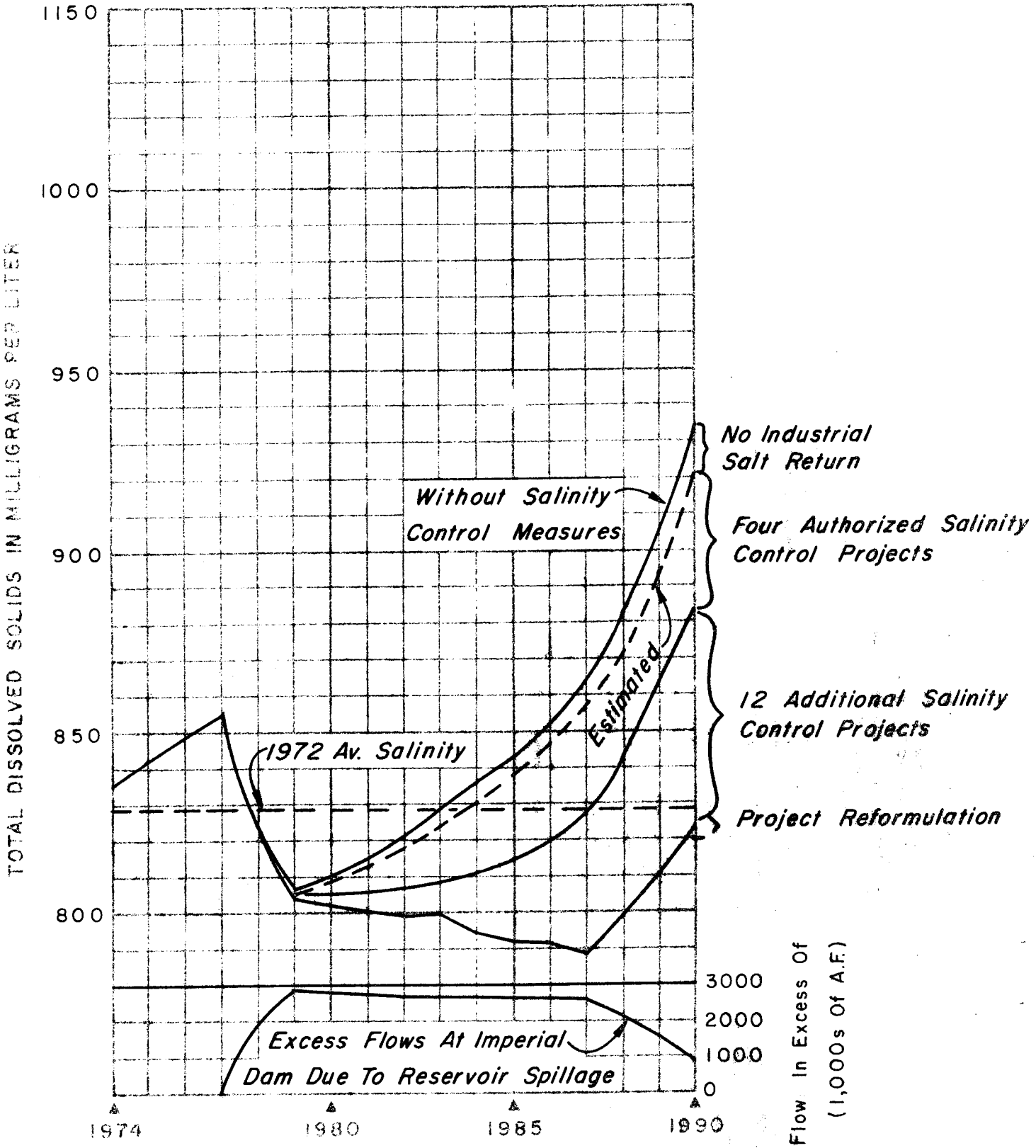


Figure 13

PROJECTED SALINITY AT HOOVER DAM

15 M. Af. / Yr. Supply

MODERATE DEPLETION RATE

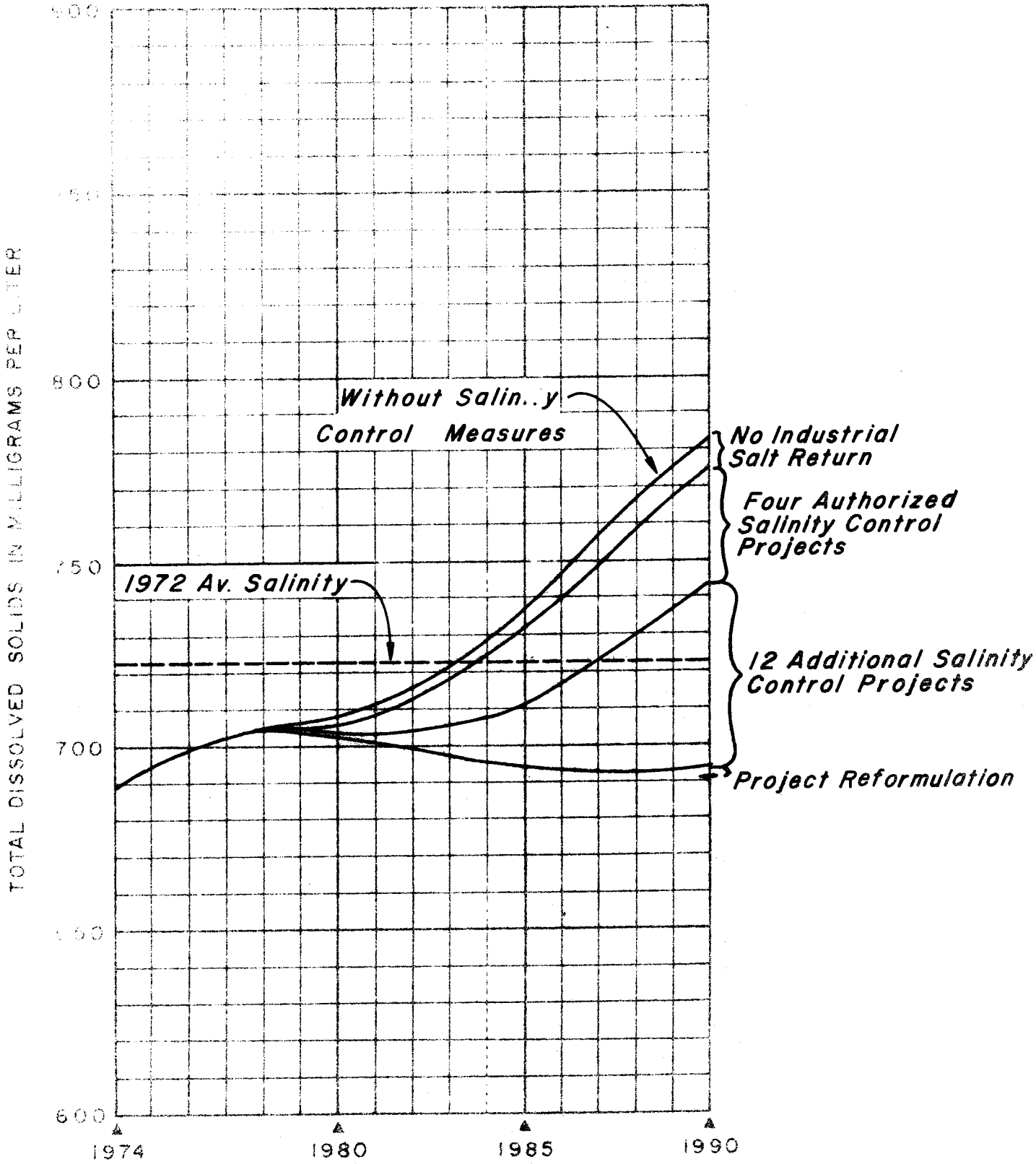


Figure 14

PROJECTED SALINITY AT PARKER DAM

15 M. Af. / Yr. Supply

MODERATE DEPLETION RATE

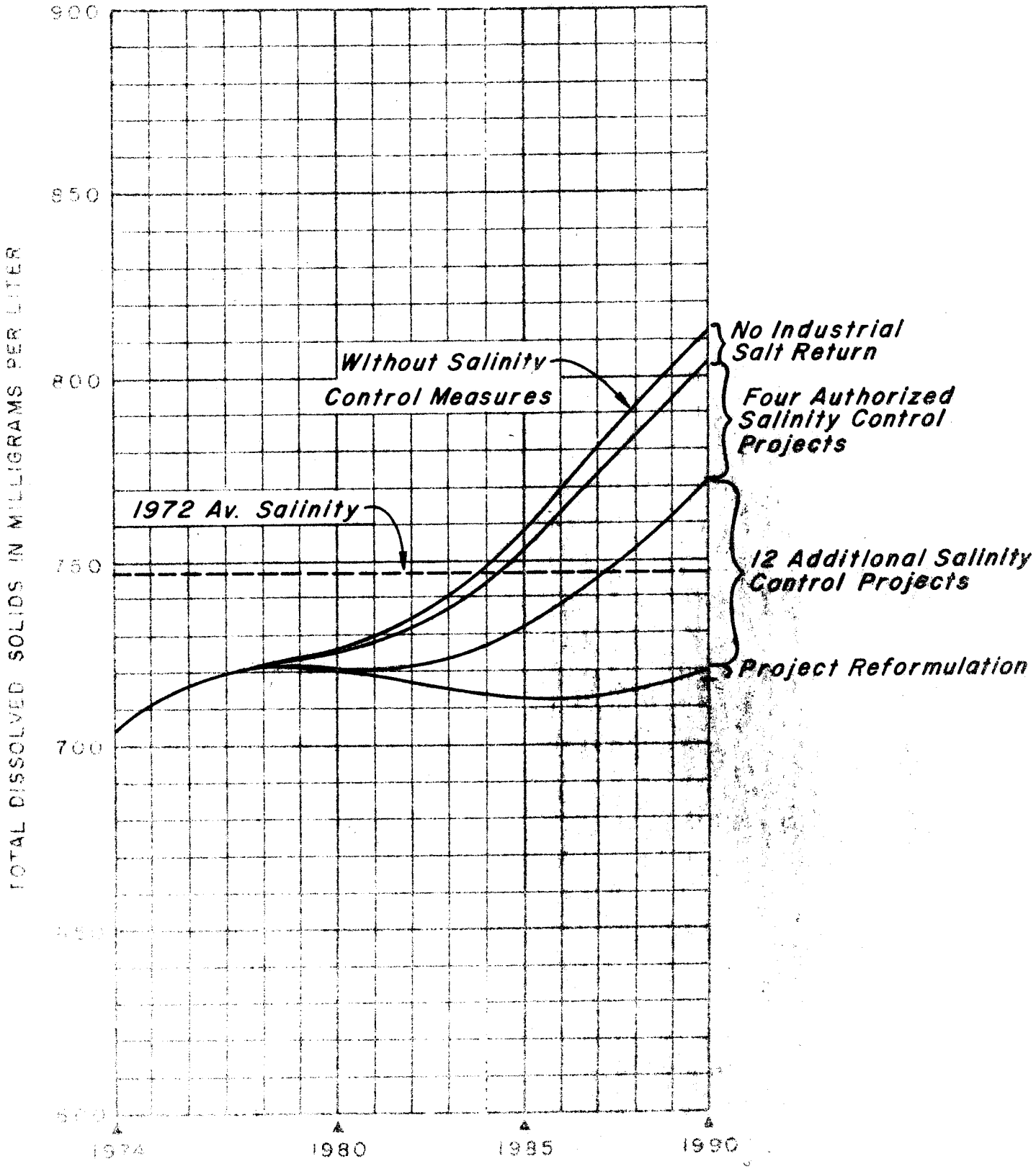


Figure 15

PROJECTED SALINITY AT IMPERIAL DAM

15 M. Af. / Yr. Supply

MODERATE DEPLETION RATE

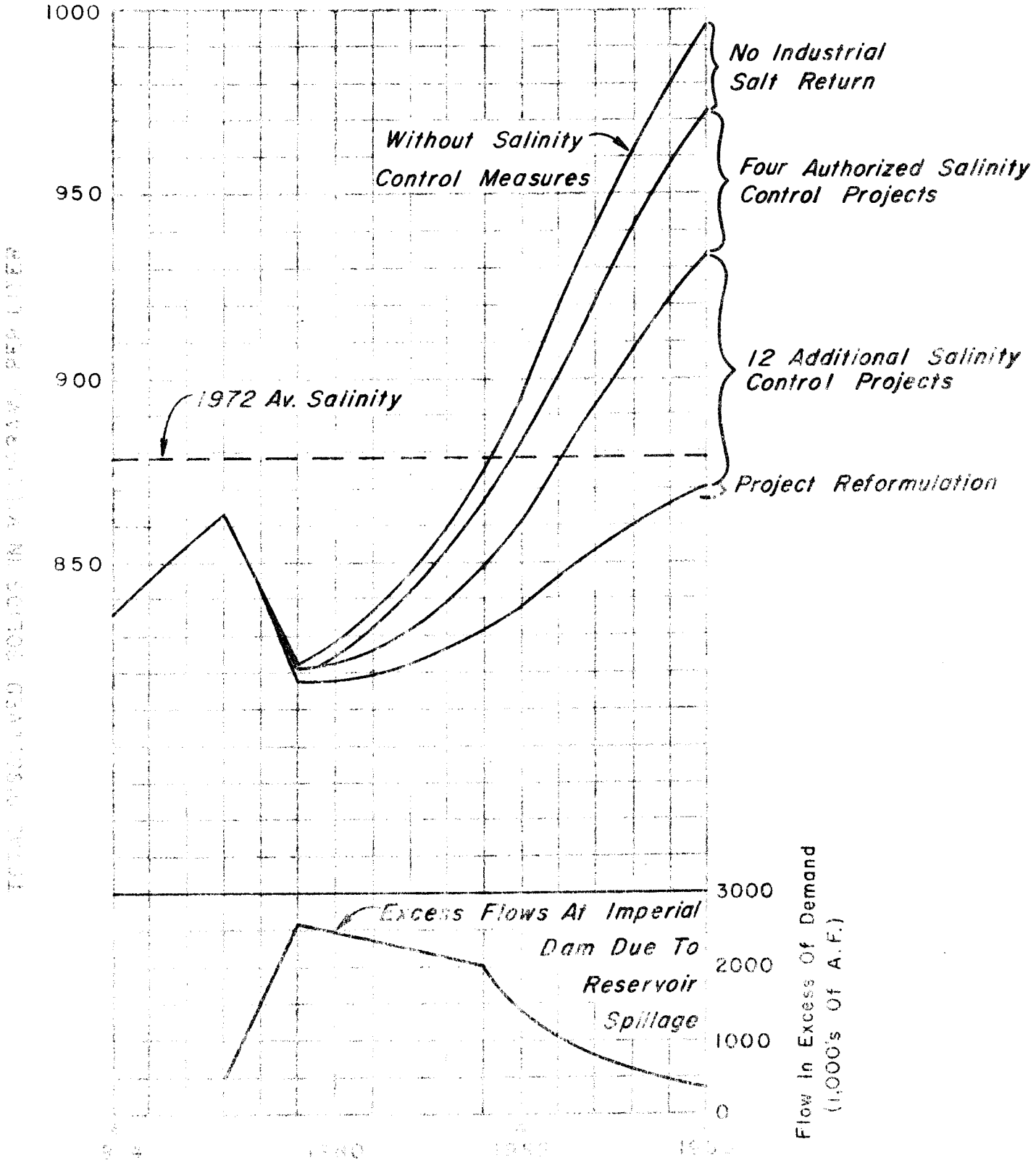


Figure 17

PROJECTED SALINITY AT HOOVER DAM

15 M. Af. / Yr. Supply

HIGH DEPLETION RATE

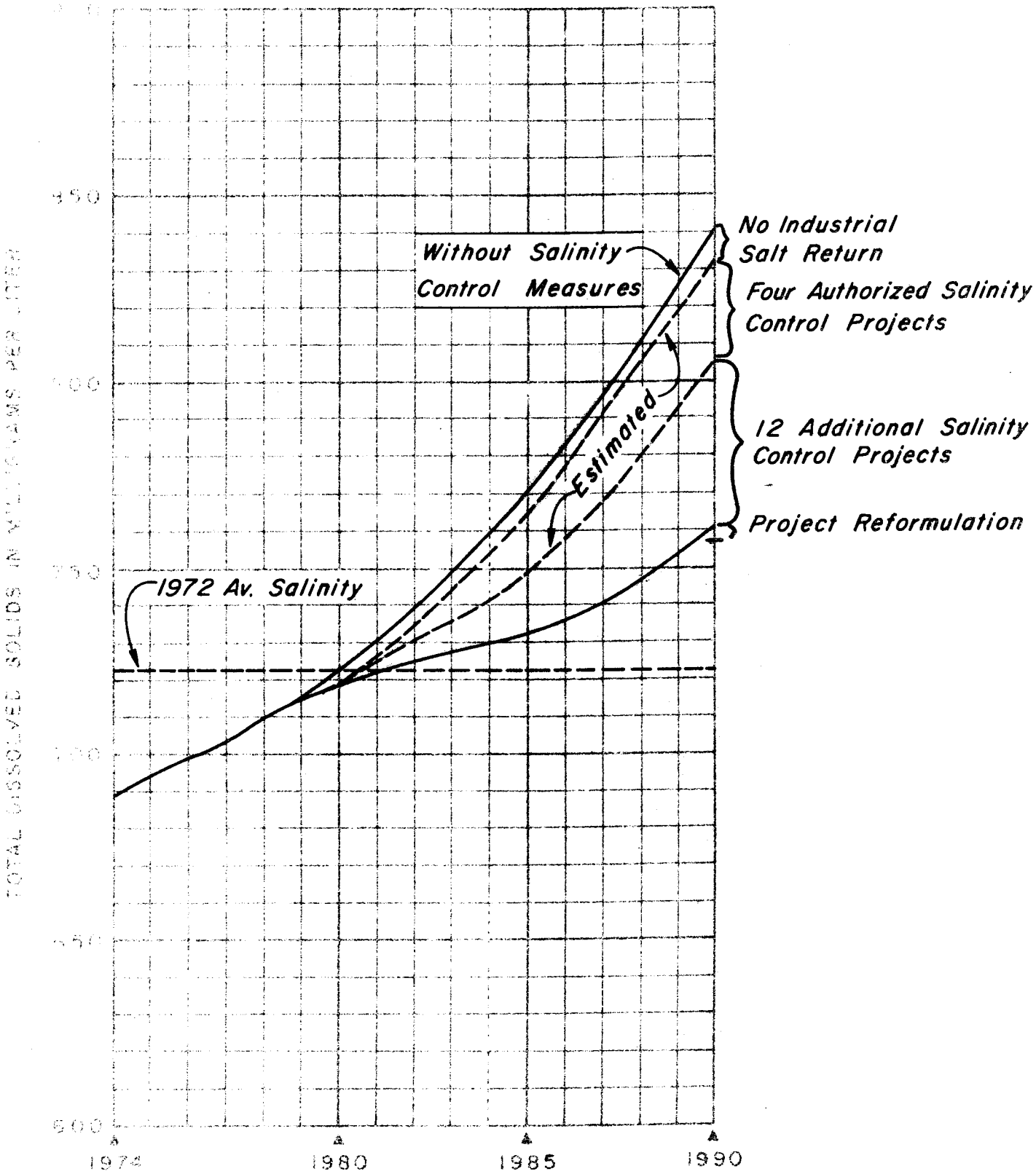


Figure 17

PROJECTED SALINITY AT PARKER DAM

15 M. Af. / Yr. Supply

HIGH DEPLETION RATE

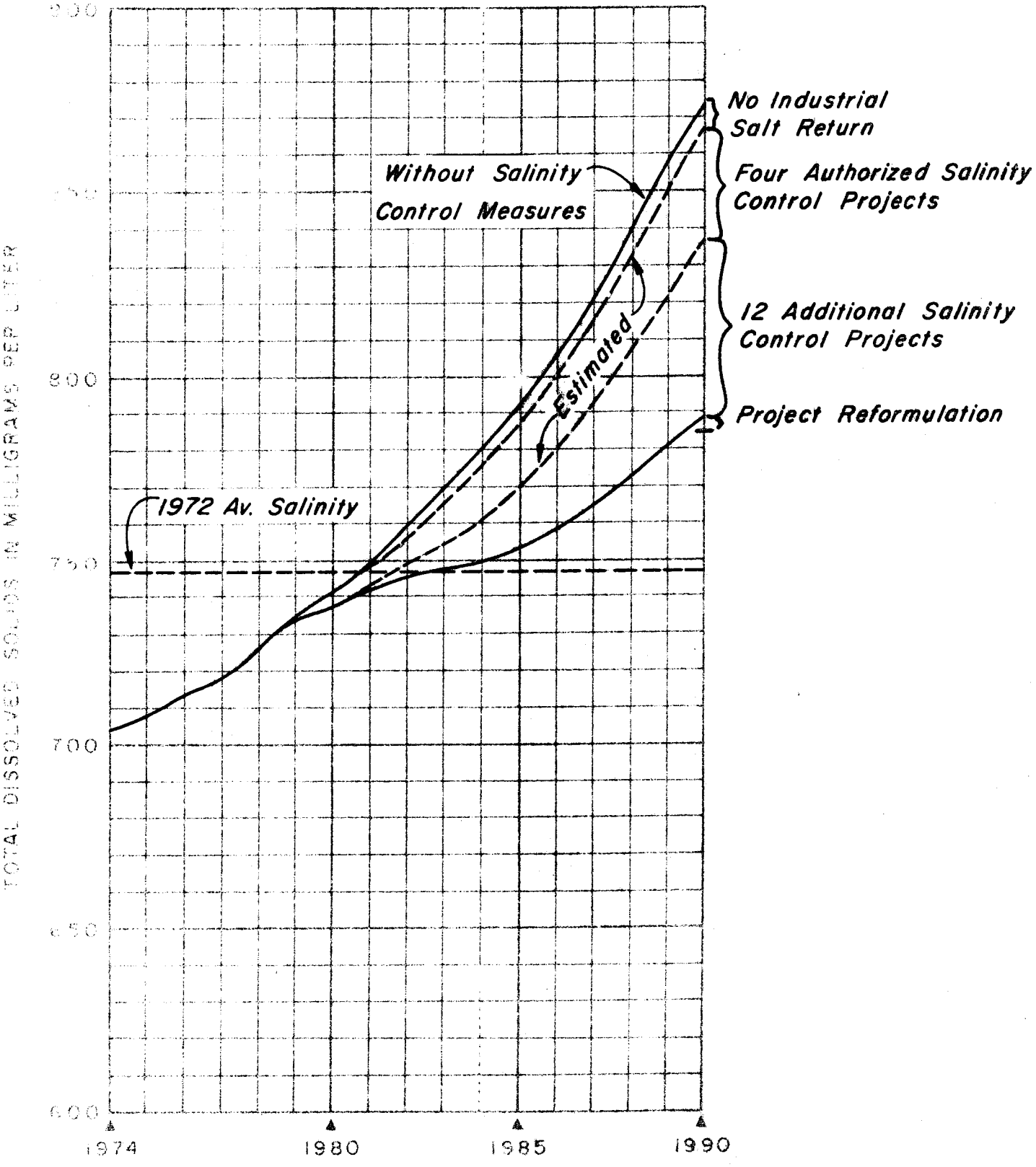


Figure 18

PROJECTED SALINITY AT IMPERIAL DAM

15 M. Af. / Yr. Supply

HIGH DEPLETION RATE

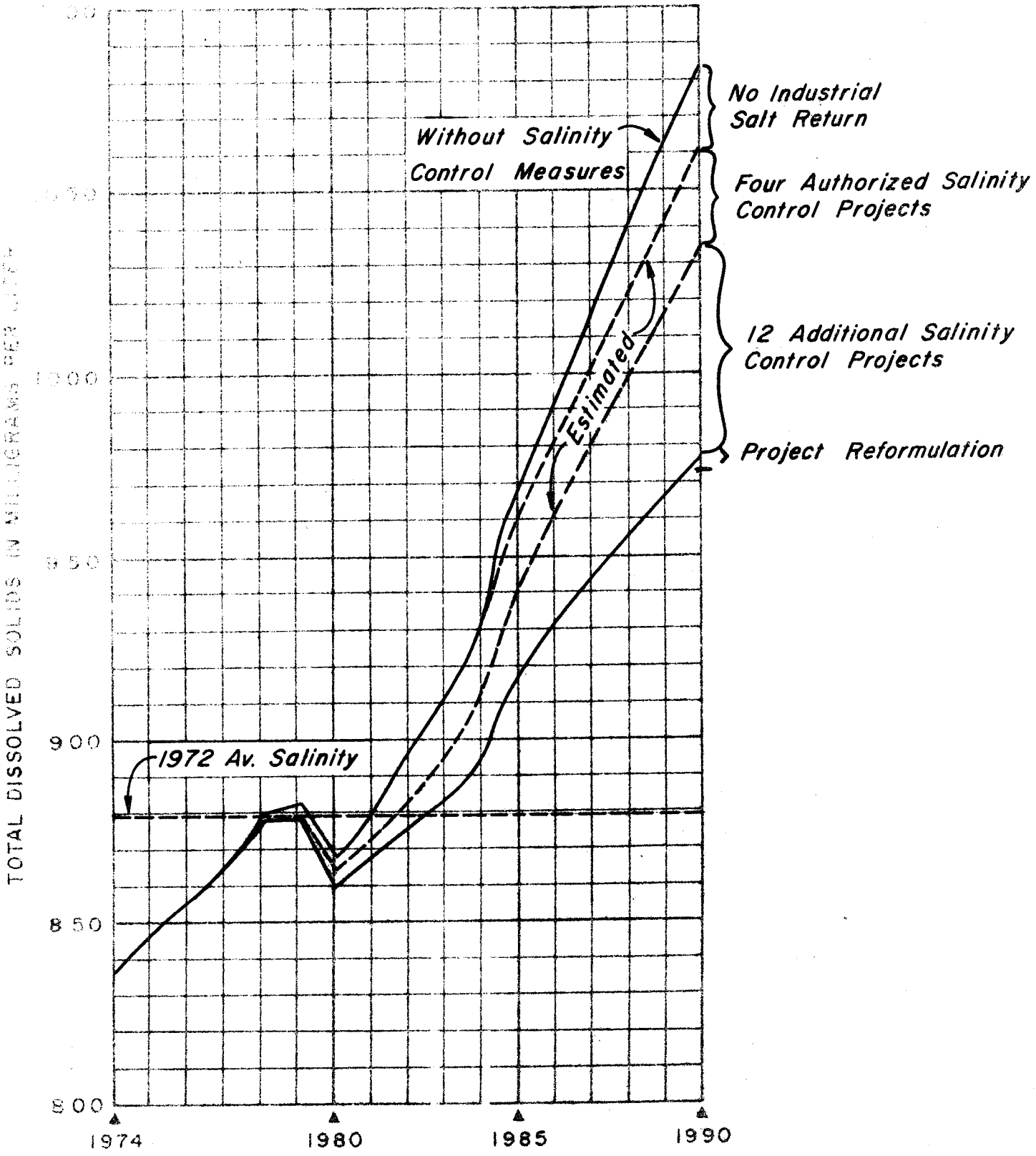


Figure 19

CHAPTER IV

WATER QUALITY STANDARDS FOR SALINITY

Public Law 92-500 established guidelines for setting effluent limitations for point source discharges into the nation's water courses, and directed the Administrator of EPA to notify each state and specify the changes needed in each state's water quality standards to meet the requirements of the Act (Section 303). Pursuant to that requirement, EPA promulgated in the Federal Register on December 18, 1974, a regulation establishing Colorado River System salinity control policy and standards procedure [40 CFR, Part 120, Water Quality Standards]. The complete regulation is presented as Appendix A. The immediately pertinent part of the regulation is as follows:

***

"(b) It shall be the policy that the flow weighted average annual salinity in the lower main stem of the Colorado River System be maintained at or below the average value found during 1972. To carry out this policy, water quality standards for salinity and a plan of implementation for salinity control shall be developed and implemented in accordance with the principles of paragraph (c) below.

"(c) The States of Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming are required to adopt and submit for approval to the Environmental Protection Agency on or before October 18, 1975:

"(1) Adopted water quality standards for salinity including numeric criteria consistent with the policy stated above for appropriate points in the Colorado River System; and,

"(2) A plan to achieve compliance with these standards as expeditiously as practicable providing that:

"(i) The plan shall identify State and Federal regulatory authorities and programs necessary to achieve compliance with the plan.

"(ii) The salinity problem shall be treated as a basinwide problem that needs to be solved in order to maintain lower main stem salinity at or below 1972 levels while the basin States continue to develop their compact apportioned waters.

"(iii) The goal of the plan shall be to achieve compliance with the adopted standards by July 1, 1983. The date of compliance with the adopted standards shall take into account the necessity for Federal salinity control actions set forth in the plan. Abatement measures within the control of the States shall be implemented as soon as practicable.

"(iv) Salinity levels in the lower main stem may temporarily increase above the 1972 levels if control measures to offset the increases are included in the control plan. However, compliance with 1972 levels shall be a primary consideration.

"(v) The feasibility of establishing an interstate institution for salinity management shall be evaluated."

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Numeric Criteria for Salinity

Consistent with the policy enunciated in the December 18, 1974, regulation, the numeric criteria for the Colorado River System are to be established at levels corresponding to the flow-weighted average concentrations in the lower main stem during calendar year 1972. Each year, the flow-weighted average salinity will be computed and compared to the 1972 criteria. In addition, it is the explicit position of the Forum that:

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"...The plan of implementation shall be reviewed and modified as appropriate from time to time, but at least once each 3 years. At the same time, the [numeric] standards, as required by Section 303(c)(1) of PL 92-500 shall be reviewed for the purpose of modifying and adopting standards consistent with the plan so that the Basin States may continue to develop their compact-apportioned waters while providing the best practicable water quality in the Colorado River Basin." 1/

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1/ Adopted by the Forum on September 20, 1974.

This would require a review of the following projections based upon the most recent information: (1) future salinity control measures, (2) future water depletions, (3) future salinity with control measures, and (4) salt routing studies. Depending upon the results of this review, the plan of implementation may be revised and the numeric criteria may be revised upward or downward.

For the purpose of this report, the lower main stem of the Colorado River System is defined as that portion of the main river from Hoover Dam to Imperial Dam. Below Imperial Dam, the river's salinity will be controlled in order to comply with the agreement with Mexico on salinity in Minute 242 of the International Boundary and Water Commission, entitled "Permanent and Definitive Solution to the International Problem of the Salinity of the Colorado River". This agreement states that measures will be taken to assure that the waters delivered to Mexico upstream from Morelos Dam will have an annual average salinity of no more than 115 ppm $\pm$ 30 ppm TDS greater than the annual average salinity of Colorado River water arriving at Imperial Dam.

In order to provide for sound water quality objectives, numeric criteria are to be established at three key stations (i.e., below Hoover, below Parker, and at Imperial Dams). The State of Nevada diverts Colorado River main stem water from Lake Mead for use in the Las Vegas area, and the returns enter the Lake just upstream from Hoover Dam. The gaging station below Parker Dam is immediately downstream of the major Lake Havasu diversion for The Metropolitan Water District of Southern California. Also, the Central Arizona Project now under construction will divert from Lake Havasu.

The large agricultural areas in the Imperial and Coachella Valleys in California and the Yuma area in Arizona and California are served by diversions at Imperial Dam.

The flow-weighted average annual salinity for the year 1972 was used. These values were determined by the Bureau of Reclamation from daily flow and salinity data collected by the U. S. Geological Survey and the Bureau of Reclamation. They are as follows:

Below Hoover Dam	723 mg/l
Below Parker Dam	747 mg/l
Imperial Dam	879 mg/l

It should be recognized that the river system is subject to highly variable annual flow. The frequency, duration and availability of carryover storage greatly affect the salinity of the lower main stem and, therefore, it is probable that salinity levels will exceed the numeric criteria in some years and be well below the criteria in others. However, under the above assumptions, the average salinity will be maintained at or below 1972 levels.

The federal regulations provide for temporary increases above the 1972 levels if control measures are included in the plan. Should water development projects be completed before control measures are identified or brought on line, temporary increases above the criteria could result and these increases will be in conformance with the regulation. With completion of control projects, those now in the plan or those to be added subsequently, salinity would return to or below the criteria level.

Periodic increases above the criteria as a result of reservoir conditions or periods of below long-time average annual river flow also will be in conformance with the regulation. With satisfactory reservoir conditions and when river flows return to the long-time average annual flow or above, concentrations are expected to be at or below the criteria level.

Salinity Monitoring Points

The salinity control program includes a water quality monitoring and analyses program that will provide information on a basinwide basis for plan evaluation. This system is essential to establish a data base for future studies, support state and regional planning activities, and evaluate the effectiveness of salinity control measures. The monitoring points are not locations at which numeric criteria are now set, except for those at below Hoover, below Parker and at Imperial Dam. The program of water quality monitoring consists of three levels: (1) monitoring for evaluation of individual salinity control measures, (2) stateline monitoring, and (3) monitoring for determination of annual average flow-weighted concentration in the lower main stem.

The monitoring program includes the collection, analysis, and reporting of data from the existing USGS monitoring stations described on pages 17-22. These are the lowest points near statelines at which measurements are taken on major tributaries. The stations are listed below and shown on Figure 20. These stations will continue to be financed as in the past.

Although not specifically identified in this section, monitoring points will be established and financed as an integral part of each control unit to measure the effectiveness of the salinity control projects and programs. The latter points will be selected in the definite plan reports of the four authorized projects and of other projects as they are developed.

Monitoring Points

1. Colorado River near Cameo, Colorado
2. Gunnison River near Grand Junction, Colorado
3. Dolores River near Cisco, Utah
4. Colorado River near Cisco, Utah
5. Animas River at Farmington, New Mexico
6. San Juan River near Bluff, Utah
7. Green River near Green River, Wyoming
8. Green River at Green River, Utah
9. Yampa River near Maybell, Colorado
10. Duchesne River near Randlett, Utah
11. White River near Watson, Utah
12. Price River at Woodside, Utah
13. San Rafael River near Green River, Utah
14. San Juan River at Shiprock, New Mexico
15. Little Colorado River at Cameron, Arizona
16. Virgin River at Littlefield, Arizona
17. Lee Ferry, Arizona
18. Below Hoover Dam, Arizona-Nevada
19. Below Parker Dam, Arizona-California
20. Imperial Dam, Arizona-California

The determination of quantity and composition of total dissolved solids requires relatively expensive laboratory analyses. To have a continuous record, it is proposed that specific conductance measurements be made on a continuous basis as soon as adequate measuring and recording equipment is perfected. Until then, periodic measurements will have to suffice.

At this time, the stations listed are considered to include appropriate stateline stations. During the next three-year review period, analyses will be made of the monitoring program to determine the adequacy of the selected stations for the establishment of baseline values as discussed in Chapter VI.

MONITORING POINTS

1 Colorado River near Cameo, Colorado
2 Gunnison River near Grand Junction, Colorado
3 Dolores River near Cisco, Utah
4 Colorado River near Cisco, Utah
5 Animas River at Farmington, New Mexico
6 San Juan River near Bluff, Utah
7 Green River near Green River, Wyoming
8 Green River at Green River, Utah
9 Yampa River near Maybell, Colorado
10 Duchesne River near Randlett, Utah
11 White River near Watson, Utah
12 Price River at Woodside, Utah
13 San Rafael River near Green Rover, Utah
14 San Juan River at Shiprock, New Mexico
15 Little Colorado River at Cameron, Arizona
16 Virgin River at Littlefield, Arizona
17 Lee Ferry, Arizona
18 Below Hoover Dam, Arizona-Nevada
19 Below Parker Dam, Arizona-California
20 Imperial Dam, Arizona-California

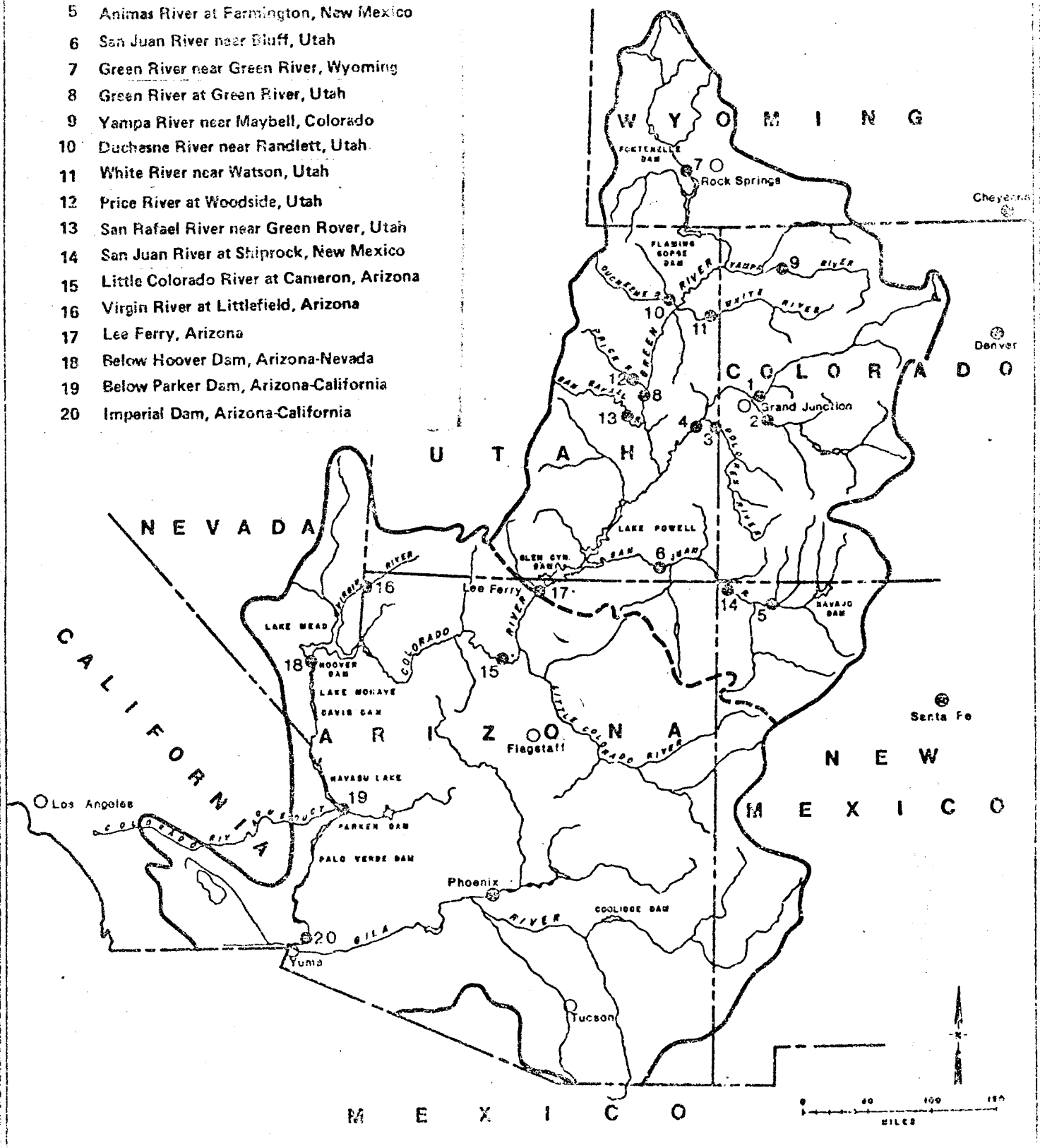

Figure 20

In addition, the states and federal agencies over the next few years will jointly evaluate a larger network to:

1. More accurately determine natural salinity levels so that the "background" will not obscure changes in man-made salinity.

2. Isolate and evaluate changes in man-caused salinity, including the distinction between salt loading and concentrating effects.

Since the Colorado River System is a large, complex, heterogeneous system, salt loading and concentrating effects are difficult to validate from the data now available. An attempt at this time to apportion salinity contributions or salinity control projects or programs to individual states would not be useful in meeting numeric criteria for salinity in the lower main stem because:

1. The Basin is sufficiently extensive so that there are large differences in flow in the various parts of the Basin. In 1967, for instance, the Green River was flowing 102 percent of the 1941-72 average, and the San Juan River was 54 percent. In terms of salinity concentration, the Green River was 124 percent of the average, and the San Juan was 173 percent. In the preceding year of 1966 and in 1960, a reverse situation occurred. The data do not show a good correlative pattern so that an attempt to arrive at appropriate numeric criteria on the Green and San Juan Rivers in relation to the lower main stem criteria would be impractical.

2. Attempts to identify effects on tributaries upstream from Lake Powell in order to apportion to each upstream project

a portion of the downstream effect are not technically possible now, even if a complex, computerized relationship were developed. Current data indicate the cause and effect of salinity relationships are not linear and are extremely difficult to model without making questionable assumptions as to the physical relationships.

3. The impact of rising salinity has been and will continue to be felt primarily only for uses from Lake Mead and below.

4. The lag factors due to the mixing in major reservoirs and the added effects of the precipitation and solution of salts are complicated and not fully understood.

5. Much of the available water quality data are based on monthly samples, much of which may not be amenable to flow-weighting.

Additional water quality monitoring that may go beyond the minimum specified above has been proposed for each state. On August 28, 1974, the Environmental Protection Agency published in the Federal Register its proposed rules for "Water Quality and Pollutant Source Monitoring" [40 CFR Part 35]. The objectives of these rules were:

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> "... to determine compliance with permit terms and conditions, to develop and maintain an understanding of the quality (and causes and effects of such quality) of all waters in the State for the purpose of supporting all State water pollution control activities, to report on such quality and its causes and effects, and to assess the effectiveness of the State's water pollution control program."

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More specific objectives relating to the water quality planning process were spelled out in paragraph H(1):

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"H. Planning process support. (1) Water quality conditions including causes and effects, must be measured where needed to support the State's continuing planning process. Monitoring for this purpose must be conducted in such a manner as to enable prediction of environmental changes in receiving water resulting from pollution control actions, changes in pollution loads, and changes in hydrologic regimes. After implementing pollution controls, measurements of causes and effects of pollution, including the physical, chemical, and biological conditions involved, are required to determine the extent to which the control actions taken were successful, and to update or redirect pollution control plans."

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The proposed rules require that the full monitoring program in each state will be in operation by June 30, 1977, and that the monitoring strategy will be submitted by each state to EPA by June 15, 1975. It is understood, however, that because of the comments on the proposed regulation, EPA is revising it extensively. The revised regulation and required schedule for instituting the program are not yet available.

It is anticipated that as monitoring experience expands and data accumulate, it will become more apparent at which locations monitoring frequency should increase.

CHAPTER V

PLAN OF IMPLEMENTATION

The plan of implementation is predicated upon several principles. First, each of the states has the right to use the water to which it is entitled under the "Law of the River". Second, use of the water for beneficial purposes within the various states usually entails water consumption by evaporation, transpiration, or incorporation into product, and the return of the effluent by point or nonpoint discharges. Third, the result of such use is that the salt concentration tends to increase with the increase in water consumption. Fourth, salt concentration can be kept at or near a constant value as uses increase only by reducing the salt load or increasing the supply of better quality water.

The plan of implementation is designed to reduce the salt load of the river and minimize future increases in salt loading by the most cost-effective means (environmentally, economically, and socially) at a rate coordinated with the expected increase in future basin water consumption. It also includes measures that water users have adopted or will adopt to ameliorate the effects of using relatively saline water.

The plan of implementation consists of a number of federal, state, and local projects, programs, and effluent limitations. The principal components of the plan are listed below. Those identified by specific location are shown on the map following the summary in the front of this report.

1. Prompt construction and operation of the initial four salinity control units authorized by Section 202, Title II of PL 93-320.

2. Construction of the 12 units listed in Section 203(a)(1), Title II of PL 93-320, or their equivalent after receipt of favorable planning reports.

3. The placing of effluent limitations, principally under the National Pollutant Discharge Elimination System (NPDES) permit program provided for in Section 402 of PL 92-500 on industrial discharges.

4. The reformulation of previously authorized, but unconstructed, federal water projects to reduce the salt loading effect of return flows.

The plan also contemplates the use of saline water for industrial purposes whenever practicable, programs by water users to cope with the river's high salinity, improvements in irrigation systems and management to reduce salt pickup, studies of means to minimize salinity in municipal discharges, and studies of future possible salinity control programs.

Segments of the Salinity Control Implementation Plan

Components of the salinity control implementation plan are categorized as follows:

(1) Control of Existing Point Sources -- diversion of salt from a localized source such as springs, geysers, wells, or mine drainages; by desalting; diversion and solar evaporation; collection and diversion for special types of use; plugging of wells; and deep well injection.

(2) Diffuse source control -- removal of salt from unlocalized water sources covering relatively large areas such as minor tributary subbasins, by collection and desalting, collection and solar evaporation, and collection and special use.

(3) Irrigation source control -- reduction of salt loading and concentrating effects caused by solution of salts in the soil and substrata and the consumptive use of water, by improved water conveyance system management, more efficient on-farm irrigation practices, collection and utilization of return flows for special purposes, and by careful selection of new lands.

(4) Control of New Point Sources -- control of highly saline flows created by concentration of less saline water (such as powerplant blowdown) or of salt loads created by a new activity.

Federal Programs

In the authorizing legislation for the Colorado River Storage Project (PL 84-485), the San Juan-Chama and Navajo Indian Irrigation Projects (PL 84-483), and the Fryingpan-Arkansas Project (PL 87-590), the Congress directed the Secretary of the Interior to study the quality of water of the Colorado River System and to investigate all possible means of improving the quality of such waters. The USBR accordingly began to evaluate water quality data. It has published seven reports on a biennial basis, covering its analyses. The comprehensive 10-year Water Quality Improvement Program, presented by the USBR in its 1972 report on the program, was initiated in 1971 based on the authorization contained in these acts. The program was integrated with others involving weather modification, geothermal resources, desalting, and basinwide water resources management. The Secretary of the Interior was given specific authority by PL 93-320 for conducting Colorado River salinity studies and a salinity control program. By reference to the 1972 Enforcement Conference recommendations, the legislation establishes the program objective that the salinity problem shall be treated as a basinwide problem that needs to be solved in order to maintain salinity concentrations at or below 1972 levels in the lower main stem of the river while the Basin States continue to develop their compact-apportioned waters.

An array of potential measures to control salinity from point, diffuse, and irrigation sources has been inventoried by the Bureau of Reclamation and is described in the Secretary's report, "Colorado River Water Quality Improvement Program, February 1972". The

Colorado River Basin Salinity Control Act, Public Law 93-320, authorized the construction, operation and maintenance of certain works in the Colorado River Basin to control the salinity of water delivered to users in the United States and Mexico. Title II of the Act pertains to measures upstream from Imperial Dam and authorizes the initial stage construction of four of the units described in the Secretary's "1972 Report"; i.e., the Paradox Valley Unit in Montrose County, Colorado; the Grand Valley Unit in Mesa County, Colorado; Crystal Geyser Unit in Emery County, Utah; and Las Vegas Wash Unit in Clark County, Nevada.

In addition to the four initial stage units, the Secretary was authorized and directed to expedite completion of planning reports on the following salinity control units:

(1) Irrigation source control:

Lower Gunnison Unit
Uinta Basin Unit
Colorado River Indian Reservation Unit
Palo Verde Irrigation District Unit

(2) Point source control:

LaVerkin Springs Unit
Littlefield Springs Unit
Glenwood-Dotsero Springs Unit

(3) Diffuse source control:

Price River Unit
San Rafael River Unit
Dirty Devil River Unit
McElmo Creek Unit
Big Sandy River Unit

Feasibility reports on the remaining units are scheduled to be completed by 1979 which means that the states will be in their second 3-year review period before definitive results will be available for all units of the federal program. Salt routing studies indicate that all of these units or the equivalent need to be in operation by 1990, so every effort must be made to expedite the studies.

Major emphasis for control of salinity from irrigation sources is placed on improved irrigation management and improved control of water flow in canals, laterals, and drainage systems. This will be accomplished through the Irrigation Management Services (IMS) and the Water Systems Improvement (WSI) Programs. These programs already are in progress and are programmed to be extended to 557,000 acres in the Colorado River Basin, slightly more than one-fourth of the irrigated area excluding that in the Gila Subbasin. Included in this total are five major irrigation districts (i.e., Grand Valley, Colorado; Uinta Basin, Utah; Palo Verde, California; Lower Gunnison Basin, Colorado; and Colorado River Indian Reservation, Arizona and California.

The IMS Program is a nonstructural management technique to increase on-farm irrigation water efficiency. Benefits derived from the irrigation management services include increased crop yields, water savings, reduced leaching of soils, and reduced drainage requirements.

The WSI, on the other hand, involves a structural water management tool to improve water conveyance systems in order to reduce drainage and salinity pickup. The lining of canals and laterals as well as installation of field drainage systems can result in reduced losses and percolation, thereby reducing water contact with high saline soils, shales, and ground water aquifers.

Initial Stage -- Federal Programs

Paradox Valley Unit (Point Source Control)

The Paradox Valley Unit area consists of a valley three to five miles wide located near Bedrock in southwestern Colorado. The Dolores River meanders in a northerly direction across the middle of the Valley. Flows in the river vary from one cfs to over 10,000 cfs at flood stages. Geologic investigations show that Paradox Valley is situated along the axis of a collapsed salt anticline of pure salt and salt-rich shales over 14,000 feet in depth. It is estimated that the Paradox Valley contributes about 200,000 tons of salt per year to the Colorado River System via the Dolores River.

Feasibility investigations of the Paradox Valley Unit were initiated late in FY 1972. The plan being investigated involves lowering the fresh water/brine interface by pumping from about eight wells located along the Dolores River to prevent the brine from entering the river. The brine would be pumped through a pipeline to Radium Reservoir, an evaporation and salt storage reservoir located on the West Fork of Dry Creek about 20 miles

to the southwest. It is estimated that the control project would deplete the stream by about 5,800 acre-feet annually, and reduce the salt contribution to the Dolores River about 180,000 tons per year. The storage capacity of Radium Reservoir would be about 70,000 acre-feet, which would be sufficient to store accumulated salts for a period of 600 years. Considerable work has been accomplished in the collection of basic water quantity and quality data, drilling and testing of test wells; analysis of aquifer characteristics; preliminary designs and estimates; and preparation of the environmental impact statement. Feasibility investigations were continued through FY 1974. The Definite Plan Report is scheduled for completion in June 1976 and initiation of a 3-year construction program is now tentatively scheduled for FY 1977, with the first year of operation scheduled for FY 1979.

Grand Valley Unit (Irrigation Source Control)

The Grand Valley is located at the confluence of the Colorado and Gunnison Rivers. Grand Junction, the principal city in the valley, is the industrial and commercial center of northwestern Colorado. Irrigation companies presently operating in the area irrigate a combined total of 76,000 acres by means of 200 miles of canals and 500 miles of laterals. Most of this land has been irrigated for over 50 years. The majority of the canals and laterals are unlined. It is estimated that the Grand Valley contributes between 500,000 and 600,000 tons of salt annually to the Colorado River. It is believed that a large part of these salts are leached from the soil and underlying mancos shale and are washed into the

river by deep percolation of irrigation water and water delivery system losses. The source of this salt and the extent to which the salt load is contributed by the activities of man are being investigated in analyses currently underway.

Feasibility investigations of the Grand Valley Unit were initiated in FY 1972. Studies were made to determine the amount and source of salt contribution and to devise plans to alleviate the problem. The principal investigation activities are centered on consolidating and lining the canals and laterals, rehabilitation or replacing canal and lateral structures, construction of adequate measurement and control structures, and improving on-farm irrigation systems. These measures and provisions for irrigation scheduling are expected to reduce the salt contribution to the Colorado River by 200,000 tons per year. Initiation of a 10-year construction program is now tentatively scheduled for FY 1977. The first year of effective salt removal is estimated to be 1978 as a result of the irrigation scheduling program.

Crystal Geyser Unit (Point Source Control)

The Crystal Geyser is a privately owned, abandoned oil test well located on the east bank of the Green River, 3.5 miles south of Green River, Utah. It contributes approximately 150 acre-feet of water and 3,000 tons of salt to the Green River annually. The saline water erupts in the form of a geyser at about 5-hour intervals due to carbon dioxide accumulations. The Geyser is presently a very minor tourist attraction.

Feasibility investigations have been completed on this unit under contract with the Brigham Young University. The basic plan of control consists of a dike to be constructed around the point of eruption to collect the discharges and then convey the water by pipeline to an evaporation pond three miles away. A plan to plug the well was rejected because the well is situated in a known area of eruptive activity, Little Grand Wash Fault, and plugging would probably cause eruption at other nearby locations, possibly in the bed of the Green River.

The control measures will deplete the river 150 acre-feet annually and reduce the salt contribution by about 3,000 tons per year.

Advance planning studies are underway with the Definite Plan Report scheduled for completion in September 1975 and initiation of a one-year construction program tentatively scheduled for FY 1977, with initial salt removal in 1978.

Las Vegas Wash Unit (Point Source Control)

The Las Vegas Wash is a natural drainage channel which empties into the Las Vegas Bay arm of Lake Mead in southern Clark County, Nevada. The Wash drains Las Vegas Valley which is approximately 50 miles long, from 5 to 25 miles wide, and has a drainage area of about 2,200 square miles. The population growth rate in the Valley has averaged about 10 percent per year since 1940, which is among the highest in the United States.

The annual discharge from Las Vegas Wash into Lake Mead is increasing with growth of Las Vegas. A discharge to Lake Mead of 36,000 acre-feet and a salt load of 208,000 tons of dissolved

solids were used in early studies to represent 1971-72 conditions. In Water Year 1973, the discharge was 46,000 acre-feet with an estimated salt load of 220,000 tons.

Advanced planning studies were initiated in FY 1975 and the Definite Plan Report is scheduled to be completed in FY 1976. One plan investigated for the Las Vegas Wash Unit would remove salt from the ground water component of the Wash discharge by means of an interception facility, a delivery system, a brine discharge and evaporation system, and a surface flow bypass system.

In normal operations under this alternative, ground water flows which are presently forced to the surface by a natural barrier would be collected by a system composed of a grouted curtain wall and a series of perforated pipes (french drains) surrounded by pervious materials. The collected flows would be directed by the drains to a main sump box where they would be pumped to evaporation ponds for total in-valley evaporation of the ground water. Such a scheme would require an area of about 2,300 acres of land for lined evaporation ponds. The salt removal would amount to about 131,000 tons per year and the stream depletion would be about 15,000 acre-feet annually.

In the other alternative, the collected flows would be directed by the drains to a main sump box where they would be pumped to a reverse osmosis desalting plant. The product stream of water with a salinity of about 500 mg/l would be returned to the Wash, and the brine stream would be delivered to a disposal pond where it would be evaporated. With a brine discharge of approximately 1,900 af/yr, about 283 acres of ponds would be required to evaporate the brine water. This plan would remove about 138,000 tons of salt per year from the salt load discharged by the Wash to Lake Mead.

Advance planning studies are underway with the Definite Plan Report scheduled for June 1976; the initiation of a 3½-year construction program is tentatively scheduled for FY 1977. The first year of salt removal is estimated to be 1979.

The full evaporation disposal alternative was used in the salt routing studies.

Future Stages -- Federal Programs

Future stages of the Federal Salinity Control Program will include the units listed above that are not included in the initial stage program. It should be noted that feasibility studies are now being made or will be commenced soon on them. Therefore, until completed, the costs and accomplishments of the units must be considered to be of a reconnaissance level of reliability. These units are described below:

Lower Gunnison Basin Unit, Colorado (Irrigation Source Control)

The Lower Gunnison Basin Unit encompasses the Gunnison River drainage area below the Curecanti Unit, a feature of the Colorado River Storage Project, and will include both water systems improvement and irrigation scheduling programs. There are a number of private and federal irrigation projects within the area irrigating a total of about 160,000 acres. An additional 17,000 acres are scheduled for irrigation under authorized projects. Irrigation scheduling began on a limited scale in 1974 and is scheduled to continue through FY 1980.

The Lower Gunnison area is estimated to contribute an average of about 1,100,000 tons of salt annually to the Colorado River. It is believed that much of this salt load is leached from the soil by excessive application of irrigation water and losses from

the irrigation conveyance systems. By implementing an Irrigation Scheduling and Water Systems Improvement Program, it is estimated that the salt contributions from the area could be reduced by approximately 300,000 tons annually.

Feasibility grade studies on the Lower Gunnison Basin Unit are in progress with a feasibility report on the WSI Program scheduled to be completed in June 1978. Operation of the IMS Program is expected to be assumed by the water users in 1980.

Uinta Basin Unit (Irrigation Source Control)

The Uinta Basin Unit lies between the Uinta Mountains on the north and the Tavaputs Plateau on the south in northeastern Utah. Agricultural lands in the Basin are located primarily on alluvial materials adjacent to the river and on benches and mesas. The Uinta Mountains, several peaks of which rise above 13,000 feet in elevation, are the principal source of water for the Basin. The water in the streams above the irrigated lands is high quality water with dissolved solids ranging from 30 to 350 mg/l. Concentrations in the Duchesne River below most irrigated land, however, range from 200 to 3,400 mg/l, with an average of 680 mg/l.

The Uinta Basin contributes about 450,000 tons of salt annually to the Colorado River, much of it being derived from irrigated lands. It is estimated that a combined Irrigation Scheduling and Management and System Improvement Program for this unit could remove 100,000 tons of salt annually.

A Feasibility Report on the unit is scheduled to be completed in June 1978 covering the WSI program. Operation of the IMS Program is expected to be transferred to the water users in 1978.

Colorado River Indian Reservation Unit (Irrigation Source Control)

The Colorado River Indian Reservation Unit is located along the Colorado River below Parker Dam. Water has been allocated to irrigate 107,588 acres, of which 99,375 acres are in Arizona and 8,213 acres are in California. Under full development a maximum diversion of 717,148 acre-feet per year will be permitted. In 1972, however, there were only 60,000 acres irrigated with Colorado River water diverted at Headgate Rock Dam. It is estimated that the return flows from these lands contribute about 30,000 tons of salt annually to the Colorado River. Under full development, it is estimated that about 50,000 tons will be contributed.

An Irrigation Scheduling and Management Program was initiated on the Colorado River Indian Irrigation Project in 1973. A development period of about four years is planned, during which the program will be demonstrated throughout the project. The demonstration stage will be concluded by June 30, 1978. The Bureau of Indian Affairs and the Colorado River Tribal Council will continue the program provided it has proved its value during the demonstration period.

A Water Systems Improvement Plan has been initiated. Concrete lined distribution systems are presently being installed to serve newly irrigated lands, and portions of the old distribution system will be rehabilitated to reduce losses. With the full implementation of the Irrigation Scheduling and Management Service and the Water Systems Improvement Plan, it is expected that the present salt load of 30,000 tons can be reduced by 7,000 tons. Feasibility reports are scheduled for completion on the System Improvement Program in December 1975; on the Irrigation Scheduling and Management Program in June 1977; and on a program to utilize irrigation return flows in June 1978. The water users are expected to assume responsibility for the IMS Program in 1977.

Palo Verde Irrigation District Unit (Irrigation Source Control)

The Palo Verde Irrigation District is located in Riverside and Imperial Counties, California. In 1973, a contract was executed by the Bureau of Reclamation and the Palo Verde Irrigation District for conducting a cooperative Irrigation Scheduling and Management Program. The demonstration phase of this program is scheduled to be completed in 1978. Following 1978, the District will be urged to assume operation of the program if its value has been demonstrated.

The Irrigation Scheduling and Management Program, combined with a Water Systems Improvement Program, is estimated to reduce the salt load in the Colorado River by 23,000 tons of salt annually. The federal Irrigation Scheduling and Management Demonstration Program is scheduled for completion in June 1977. A local agency is expected to assume administration of the program at that time. A feasibility report is scheduled for March 1978 on the Irrigation Systems Improvement Program.

LaVerkin Springs Unit (Point Source Control)

The LaVerkin Springs are located in a 1,800-foot reach of the Tempoweap Canyon of the Virgin River in southwestern Utah. The Springs discharge about 8,300 acre-feet of water and 109,000 tons of salt annually. Studies indicate that 103,000 tons of the salt could be removed each year.

The plan of development involves the construction of a diversion dam upstream from the springs to divert the normal river flows around the spring area. A second dam would be located just below the spring area to form a storage pool from which the spring water would be pumped to the LaVerkin Desalting Plant. The product water would be returned to the Virgin River through a 1,600-foot pipeline.

The brine or residue water would be conveyed about 19,000 feet through a 12-inch pipeline to a 440-acre evaporation pond formed by diking a natural depression. The dikes would be rolled earthfill embankments lined with a 10-mil polyvinyl chloride. The entire pond would be lined with 10-mil polyvinyl chloride sheeting covered with 12 inches of earth. A feasibility report on the unit was completed in December 1974.

Littlefield Springs Unit (Point Source Control)

The Littlefield Springs are a widely scattered group of springs located along the south side of the Virgin River about one mile upstream from Littlefield, Arizona. The springs have a combined outflow of about 5.7 cfs and contribute about 16,000 tons of salt to the river system annually.

Alternative methods for collecting and disposing of the springs' discharge are being studied. The most promising alternative appears to be the collection of the spring flows in a ditch, desalting the water, and returning the product water to the river. The brine water would be conveyed to a lined evaporation pond. The Unit would reduce the salt contribution to the river by about 16,000 tons per year. Feasibility investigations of the unit are scheduled for completion in June 1976.

Glenwood-Dotsero Springs Unit (Point Source Control)

The largest point source contributors of dissolved salts to the Upper Colorado River are springs in the river between the mouth of the Roaring Fork River at Glenwood Springs, Colorado, and the mouth of the

Eagle River near Dotsero, Colorado. These contributions are from thermal springs rising in or near the bed of the river and from ground water discharging into this reach of the river. It is estimated that the inflow from the springs and ground water is about 25,000 acre-feet annually, and the total salt contribution is about 500,000 tons.

Preliminary studies indicate that a desalting plant or plants may be the most feasible method of controlling salinity from this source and should be planned to remove 200,000 tons of salt annually. A feasibility report on the selected plan is scheduled for completion in June 1979.

Price River Unit (Diffuse Source Control)

The Price River heads on the eastern slopes of the Wasatch Plateau and is tributary to the Green River in east central Utah. The river contributes about 240,000 tons of salt annually to the Colorado River System. Selective removal of 50 cfs of water during low flow periods could remove about 100,000 tons of salt annually.

A feasibility study of the unit plan is scheduled for completion in June 1978.

San Rafael River Unit (Diffuse Source Control)

The San Rafael River also heads in the Wasatch Plateau in east central Utah and is tributary to the Green River. It drains an area of about 1,670 square miles. The average annual discharge of the river is about 95,000 acre-feet which carries approximately 190,000 tons of salt. Selective withdrawal of 75 cfs during low water periods could remove as much as 90,000 tons a year. Completion of a feasibility report on the unit plan is scheduled for June 1979.

Dirty Devil Unit (Diffuse Source Control)

The Dirty Devil River heads in the mountains northeast of Hanksville, Utah, and is tributary to the Colorado River in east central Utah. The river drains an area of about 4,200 square miles in southeastern Utah and joins the Colorado River at Lake Powell. About 60 percent of the drainage area is composed of mudstones, claystones and shales which are the main sources of salt loading in the river.

The Dirty Devil River discharges about 72,000 acre-feet of water and 200,000 tons of dissolved solids into the upper end of Lake Powell annually. It is estimated that there exists a potential for removal of 80,000 tons of salt annually. The plan of control is similar to the plan proposed for the Price and San Rafael Rivers. Feasibility investigations are scheduled for completion in June 1979.

McElmo Creek Unit (Diffuse Source Control)

McElmo Creek is tributary to the San Juan River and drains an area of 350 square miles, including the irrigated area in Montezuma Valley in southwestern Colorado. It flows into the San Juan River a few miles below the Colorado-Utah state line. The lands in Montezuma Valley are irrigated with water diverted from the Dolores River. The salt loading in the river is estimated to be 130,000 tons per year of which about 40,000 tons could be removed by selective withdrawal and evaporation or desalting.

Consideration of mitigation measures for the Dolores Irrigation Project has included investigation of a possible impoundment and evaporation of Mud Creek, a tributary of McElmo Creek. It is estimated that a 9,800 acre-foot reservoir could remove up to

14,000 tons of salts annually. Feasibility studies for McElmo Creek are scheduled for completion in June 1979.

Big Sandy River Unit (Diffuse Source Control)

The Big Sandy River heads in the Wind River Mountains of northwestern Wyoming and flows southerly to the Big Sandy Reservoir from which water is diverted to the Eden Irrigation Project. From Big Sandy Dam the river flows southwesterly to the Green River several miles downstream from Eden, Wyoming.

The Big Sandy River contributes about 180,000 tons of salt annually to the Green River. Most of this salt enters the Big Sandy from numerous seeps in a stretch of the river below Big Sandy Dam between Simpson Gulch and Gasson Bridge. It is estimated that about 80,000 tons could be removed by treatment of the more saline flows during periods of low stream discharge.

The potential of applying natural freezing methods during the winter months to desalt the water is being studied by the University of Wyoming. Small scale experiments have been conducted in which sprinklers were used to spray water into the air where it freezes and falls forming an ice pile. The ice crystals which separate out are nearly pure water leaving a highly concentrated, unfrozen brine solution.

While the theory of this method is sound, problems encountered in pilot operations raise serious questions as to its practical application. A feasibility report which will consider freezing and other methods of reducing the salt load of Big Sandy River is scheduled for completion in June 1978.

Reformulation of Authorized Projects

The Bureau of Reclamation is reformulating presently authorized but unconstructed projects within the Upper Colorado River Basin to determine what changes in project features can be made to minimize salinity impacts of the projects. Involved are analyses of lands to receive irrigation water to assure the selection of lands where the least amount of leaching of salt is expected, planning on-farm irrigation facilities to improve irrigation efficiencies, converting the use of project water from irrigation to municipal and industrial uses which may contribute less salt to the system, etc. The current status and indications from the Bureau studies are as follows:

Project	Authorized		Reformulated		Salt Reduction
	Depletion (a.f.)	Tons Salt	Depletion (a.f.)	Tons Salt	Tons Salt
Animas-LaPlata	146,400	+90,000	133,800	+ 5,800	84,200
Dallas Creek	37,000	- 1,000	46,000	-13,100	12,100
Dolores	87,300	+37,000	90,600	+12,400	24,600
Fruitland Mesa	27,000	+ 5,600	27,000 1/	+ 5,600	0
San Miguel	85,000	---			
Savery-Pot Hook	26,600	+12,550	26,600	12,550	0
Upalco Unit	10,300	0	10,300 1/	0	0
West Divide	76,400				

1/ Reformulation studies are underway but have not been completed

It should be noted that the salt routing analyses used in this report included assumptions of future depletions for the Animas-La Plata, Dallas Creek and Dolores Projects that reflect reductions in salt loading from the projects as a result of reformulation.

Department of Agriculture Program

The Department of Agriculture, in cooperation with the Bureau of Reclamation, is conducting research on irrigation application rates in relation to salinity output from lands in the Grand Valley, Colorado. This research is aimed at evaluating the potential of increasing irrigation efficiency through use of high-frequency, low-volume irrigation sprinkler applications and advanced gravity application methods and relating the results to the salinity output from the irrigated areas.

In addition to this research activity, the Department of Agriculture has also undertaken the examination of the magnitude of program inputs needed to provide definitive appraisals of present and potential contributions to the reduction of the salt load of the Colorado River System. Evaluations proposed or underway by the Department of Agriculture include:

1. showing the relationships of erosion and sediment production to salt loading;

2. identifying land areas having the highest potential to affect salt loading through erosion and sedimentation;

3. identifying watershed areas where management and treatment practices will reduce salt loading;

4. identifying areas where improved irrigation system and management practices can be utilized;

5. showing relationships between improved practices in Item 4 and salt loading; and

6. identifying the impacts of alternative salt load reduction programs on the agriculture, livestock, and forest industries.

The information developed by the Department of Agriculture in its evaluation program can be highly significant in planning irrigation salinity control projects.

EPA Program

Many of the authorities under PL 92-500 can be delegated in large degree by EPA to the states, provided state laws and administration are satisfactory to meet the requirements of the Act, and provided also that the state requests the delegation. Although several Colorado River Basin States have received such delegation, others have not. However, to avoid redundancy in this report, steps to be taken under PL 92-500 are covered under the heading of "State Programs" rather than under this heading. Whether under federal or state leadership, effective utilization of the authorizations and appropriations of PL 92-500 require full state-federal partnership.

State Programs

As used here, the term "state programs" refers to programs actively directed by state agencies and those that could be delegated to the states under the provisions of Public Law 92-500 even if such delegation has not yet been made by the Environmental Protection Agency. At present, there is variation in the states' authority

to regulate saline discharges to the Colorado River System. The state programs which are identified herein are those which can be carried forward under present authorities. Implementation of the state programs is already underway.

Effluent Limitations

The cornerstone of the state authority to control point sources is the ability to regulate existing or potential discharges. That authority takes different forms among the states having statutory authority and, as stated before, if there is no statutory state authority, there is federal authority arising from Section 402 of PL 92-500 which can be exercised by EPA or delegated to the state. The plan of implementation contemplates that effluent limitations designed to fit local conditions will be established under Section 301(b)(1)(A), 301(b)(1)(B) and 301(b)(2)(A), and will be applied equitably for salinity control throughout the Basin.

Industrial Discharges -- As each state adopts the plan of implementation, the objective for industrial discharges shall be a no-salt return policy wherever practicable.

NPDES Permits for Irrigation -- Under EPA guidelines of July 5, 1973, NPDES requirements apply to discharges of irrigation return flow (such as tail water, tile drainage, surface ground water flow or bypass water) operated by public or private organizations or individuals if: (1) there is a point source of discharge (e.g., a pipe, ditch or other defined or discrete conveyance, whether natural or artificial); and (2) the return flow is from land areas of more than 3,000 contiguous acres or 3,000 noncontiguous acres which use the same drainage system. If an agricultural point source, which would be excluded under these criteria, is a significant contributor of pollution, however, the EPA guidelines provide

that such source also may be required to comply with NPDES filing and application requirements. On March 24, 1975, the United States District Court for the District of Columbia ruled that all point sources of a discharge must obtain a permit under Section 402 of PL 92-500 and that the Agency has no discretion to exempt classes or categories of sources from the NPDES permit program. The effect of the decision is to nullify exclusions from the permit program for smaller feedlots, storm sewers, agricultural and silvicultural discharges contained in the NPDES regulations. EPA may appeal and until the question is settled, the implementation plan will be predicated upon meeting the current EPA guidelines. Application of the NPDES permit program to agriculture has only recently been initiated and the number of permits to be issued and the acreage to be covered by them are not yet known. Tentative indications are that much of the irrigated land in the Basin will not be covered under present guidelines.

At present, a practicable and effective technology for controlling salinity in irrigation return flows cannot be defined. Consequently, the initial NPDES permit program will be one which is designed to provide data upon which informed judgments may be made as to the type of control measures which should be taken.

Initially permits are being issued in accordance with EPA guidelines for a 2-year period. The permits, in essence, provide for a monitoring program carried out by each discharger and require data at least on the amount of discharge, the quantity of suspended solids, and the specific conductance of the discharge.

At the end of the initial 2-year permit period, it is expected that the permits will be either modified to include more specific effluent limitations or reissued depending on a number of factors.

It is recognized that regulation of irrigated agriculture awaits technical studies and evaluation that will take a considerable number of years. Experience from the Grand Valley Project; results of the program to reuse Palo Verde Drain water; and the Wellton-Mohawk experiments and desalting plan program implementation, operation and evaluation will provide important insights.

Continuing Planning Process

Each of the Basin States has initiated a continuing planning process as required by Section 303(e) of Public Law 92-500. It is designed to provide a definitive program of actions to preserve and enhance water quality and protect beneficial uses.

During the conduct of the planning activities required by Section 303(e), the states will give particular attention to the need for salinity control and to potential salinity control measures. These studies will be carried on in close coordination with the Forum in order that the plans for individual states will be consistent with the Forum's basinwide plan and program A major premise of the plans is that they will be maintained in a current status with revisions as necessary to keep pace with technology, evolving policies and physical changes in the Basin.

The plans to be developed through the continuing planning process also will incorporate the elements of applicable areawide waste management plans prepared under Section 208 of PL 92-500.

Education

Improving irrigation water application technology and practices may prove to be an effective salinity control measure in some cases. Institutional changes may be helpful to facilitate such improvements, but the present plan proposes only a stepped-up educational program to encourage desirable changes in technology and practices.

Other Nonfederal Measures to Control Salinity

Entities and agencies throughout the Colorado River Basin have initiated programs to minimize the increases in salinity. These practices are part of the plan of implementation for salinity control in the Colorado River Basin. They include the control of effluent from thermal-electric powerplants and from other industries, and the plugging of abandoned oil wells in Colorado and Utah.

Minimizing Salinity Increases Caused by Powerplants

Large quantities of water are used to cool thermal-electric powerplants. As cooling water evaporates, the dissolved salt in the remaining water becomes more and more concentrated. The cooling water must be maintained at or below specific levels of concentration; to accomplish this, a portion of the concentrated water is discharged, or "blown down", and replaced with fresh water. In order to reduce the salinity impact of these powerplants, entities involved in the design and construction of thermal-electric powerplants have, since 1970, taken actions to eliminate the return of cooling tower blowdown water to the Colorado River, thus removing the salt diverted with the cooling water from the river system.

At the present time, there are five large coal-fired, thermal-electric generating plants either in operation or under construction within the Colorado River Basin that will be disposing of their blowdown water away from the river, thereby removing dissolved salts from the Colorado River System. In an analysis made of these plants, the effect of not returning the blowdown water was found to be the removal of about 72,000 tons a year of dissolved salts and 125,000 acre-feet of water from the river system.

The estimated annual removal of salt by the five plants, under projected 1985-1990 operations, is as follows:

Powerplant	Annual Salt Removal in Tons
Jim Bridger - Wyoming	12,000
Huntington Canyon - Utah	5,000
San Juan - New Mexico	12,000
Navajo - Arizona	26,000
Mojave - Nevada	17,000

Use of Agricultural Drainage Water for Powerplant Cooling

The San Diego Gas and Electric Company plans to construct, by 1985, a 1,150 megawatt nuclear powerplant in the Colorado Desert near Blythe, California. As a water supply for cooling in the water-short Southwest, the Company was encouraged to utilize saline agricultural drainage water in order to reduce salinity in the lower main stem. It is planning to use drainage water from the Palo Verde Irrigation District and not return the cooling tower blowdown water to the Colorado River.

Metropolitan Water District has agreed, in principle, to furnish up to a total of 100,000 acre-feet of Colorado River water each year to sites in the Mojave Desert area for powerplant cooling and related purposes. The water is to be distributed as follows: San Diego Gas and Electric Company - 17,000 acre-feet; Los Angeles Department of Water and Power - 33,000 acre-feet; and Southern California Edison Company - 50,000 acre-feet. Metropolitan and the affected parties have executed letters of intent formalizing such allocation, and the terms and conditions under which Metropolitan would furnish this water. In the future, it is anticipated that these letters will be executed as contracts.

The 17,000 acre-feet per year allocated to San Diego Gas and Electric Company are only sufficient for one unit, but the Company's plan calls for installation of second and third units, each with a capacity of 1,150 megawatts, in the late 1980's and early 1990's. The Company has other plans to obtain a water supply for the second and third units which would still involve the use of drainage water from the Palo Verde District. The Company has purchased about 7,000 acres of irrigated farm lands. In the future, it plans either to take a portion of the land out of production or reduce the intensity of crop production. The reduction in demand caused by the above use of the land will be equal to the drainage water taken for cooling plant purposes and no additional demand will be placed on the Colorado River System. The drainage water used by the three units will reduce the tonnage of salt by 89,000 tons per year, equivalent to about 12 mg/l at Imperial Dam.

This approach to the use of saline water is consistent with a 1974 act of California's Legislature amending Section 131 of the Metropolitan District Act to permit such districts to enter into contracts for the sale of water for use in connection with the generation of electric power. The amendment states in part:

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"b. . . Every such contract shall provide that agricultural waste water, brackish ground water, or other water not suitable for domestic, municipal, or agricultural purposes shall be utilized for powerplant cooling to the extent practicable, and if not immediately available, such waste or brackish water, as it becomes available and to the extent practicable, shall replace the fresh water then being used for such purpose. . . ."

***

Other states in the Basin also will encourage use of saline water for cooling purposes, although complicated water rights or location problems often must be solved to permit such use. This will take time.

Other Uses Associated With Energy Development

Coal Gasification. Two large coal gasification plants are being planned for construction in the Four Corners area, New Mexico. These plants, one by Western Gasification Company (WESCO) and the other by El Paso Natural Gas Company, will have initial capacities of 250 million cubic feet per day. Current plans are for none of the used water to be returned to the river system. In this report, it is estimated that the salt load of the river will be reduced by about 23,000 tons[1/] per year during the 1985-1990 period as a result of this use.

Oil Shale. The nation's increasing energy problems, particularly those with respect to oil, have caused both industry and government to take significant steps toward development of the tremendous oil shale reserves of the Upper Colorado River Basin, including leases and planning prototype facilities. However, there are major economic, environmental and technical problems to be overcome before the oil shale industry becomes a reality. The unrestrained discharge of effluents from mining and waste deposition could cause significant increases in downstream salinity. State and federal agencies involved in development or regulation will implement measures to control discharge of salts to prevent their return to the river system. The industry expects this goal can be met by carefully using its waste saline water for compacting the spent shale and in plant processing operations. Compaction will minimize salt

1/ The Wesco EIS indicates the reduction would be approximately 34,000 tons by the year 2005.

pickup from precipitation on the spent shale deposition areas. Drainage water from spent shale deposits also is to be controlled to prevent salt return from this source. As with the previously described uses wherein water is consumptively used and the salts in the water are removed from the river system, the use of Colorado River water in an oil shale industry with indicated safeguards should lead to reductions in the dissolved salt load of the Colorado River and relatively small increases in downstream concentrations.

In the analyses of the oil shale industry, the salt routing studies were based on the assumption of overland flow control on the shale disposal areas. The program for oil shale development calls for the control of overland flow on spent shale piles through a system of dikes, land contouring and stream channelization. Also, the plans include provision for the pickup and disposal of all surface runoff resulting from direct precipitation on the disposal areas and measures to prevent the return of salt to ground water.

Nonfederal Efforts to Cope With Salinity of Colorado River Water Supply

The Lower Basin users of Colorado River water have, over the years, spent and will continue to spend large sums of money to cope with increasing river water salinity.

Land Drainage

Farmers in Arizona and California have been applying various management practices in order to continue using Colorado River water. Most of the irrigated lands receiving Colorado River water in these states have man-made drainage facilities to carry away the volume of saline water required to keep the soil water salinity at acceptable levels for farming.

For example, the Imperial Irrigation District and its individual farmers have, during the period between 1929 and 1972, installed over 17,800 miles of tile drains at a total cost of over $40 million. In addition, over $26 million have been spent in the District to concrete line nearly 2,400 miles of laterals and farm ditches to reduce seepage and thereby reduce drainage problems. These facilities were required for water drainage and to control root zone salinity. In recent years, a major portion of the cost was considered to be attributable to the high salinity of the water. The drainage facilities installed during the last five years, at a cost of about $3.5 million annually, were primarily to cope with salinity of irrigation water. It is estimated that an additional $84 million within that District alone will have to be expended to combat current levels of salinity. Coachella Valley farmers, irrigating about 1/7 of the acreage of Imperial Valley, have installed 1,900 miles of tile drains through 1972 at an estimated cost of $9 million.

Treating and Blending of Colorado River Water to Reduce Salinity

Both individual urban water users and water distributing entities have adopted measures that reduce to some extent the harmful impacts of high salinity water. The Metropolitan Water District of Southern California operates central softening plants.

With the 1972 completion of the first stage of the California State Water Project, the District has available to it added quantities of Northern California water with about one-third the salinity of Colorado River water. In order to reduce the salinity of the water delivered to its service area and because of favorable power

contracts, the District has initiated a program of early construction of facilities which will enable it to blend the two waters starting in 1975. This operation will require a step-up in the rate of delivery of water to the District from Northern California over that previously planned and a substantial overall increase in electric power consumption.

Research and Analysis on Salinity Control in the Colorado River Basin

An effective continuing research and analysis program is an essential component of long-range salinity control in the Basin. The Basin States recommend a stepped-up, federally applied research and analysis effort by EPA, Agricultural Research Service, the Office of Water Research and Technology, and other agencies. Advice and participation by state agencies and research institutions, particularly with respect to the control of salinity from natural nonpoint sources and from agricultural return flows also will be supported.

Studies Currently Underway

Research on irrigation application rates in relation to salinity output is underway in the Grand Valley of Colorado and the Wellton-Mohawk area of Arizona. This work is being conducted by the ARS in cooperation with the USBR and EPA. The research is aimed at evaluating the potential of increasing irrigation efficiency through use of high-frequency, low-volume irrigation sprinkler applications and advanced gravity application methods and relating the results to the salinity output from the irrigated areas. Preliminary findings in the Colorado area, where the study is more advanced, have resulted in an agreement to conduct additional investigations to: (1) determine the volume of water entering the ground water system as deep percolation from surface irrigated fields; (2) ascertain which sections of natural washes are influent or effluent, estimate the

rate of water and salt exchange with the ground water, and quantify the contribution of canal seepage; (3) determine how CO_2 concentrations affect solution precipitation of salts in the soil; and (4) learn if aquifer characteristics are such that pumping from a series of wells would intercept saline ground water.

Closely related to the research in Grand Valley are the irrigation management services program of the USBR and the EPA-Colorado State University and Colorado Water Conservation Board research and demonstration projects in that area.

Underway is a reconnaissance-level investigation by Bresler and Associates under contract with USBR directed primarily at the feasibility and cost of recycling and reusing saline waste water and river water. Conceptual studies will examine ion exchange applications to treat saline irrigation return flows for reuse by using waste chemical products available from coal gasification or oil shale development. Other opportunities for ion exchange applications will be examined as a means of supplying improved water quality via existing river diversions to representative municipal, industrial and agricultural water users in the Basin. The USBR also is conducting research on the application of solar distillation to agricultural return flows.

Under contract with USBR, the University of Arizona prepared in April 1, 1975, a detailed plan of research to determine the amount of calcium carbonate or other salts which may precipitate in reservoirs along the Colorado River, identify the chemical and physical processes involved, and evaluate the ultimate disposition of the precipitated salts. Proposals for conducting this research have been requested.

Under a cooperative contract with the Bureau of Land Management, Utah State University is conducting a research project on land processes contributing to salt production from the diffuse sources. The project is funded jointly by BLM, USBR, and USU, and the studies are being conducted on national resource lands in the Price River Basin. This project will evaluate the influence of vegetation, overland flow, erosion, and geology on the salt production and the relative worth of selected treatments on control of salt movement. The USBR also is proposing to fund a contract on channel processes contributing to diffuse salt production. The contractor will seek to determine the effect of intermittent flood flows on stream salinity; the effects and extent of chemical and mechanical erosion on stream salinity; and the effects of bank storage exchange, channel seepage loss, ground water inflows, and evaporation on stream salinity. This is expected to be a 2-year study on the Price River or another diffuse source area in eastern Utah.

The University of Wyoming Geology Department is conducting a study to interpret both new and existing data as it relates to the natural interaction of water and rocks in the Green River Basin of Wyoming. The results of this study will be used to evaluate the impact of future water development on salinity in the Colorado River System.

In the Lower Basin several studies by the Universities of California and Arizona and the ARS are underway to determine the effect on various crops of water of differing but relatively high salt concentrations. Various methods of application are being used

along with differing degrees of irrigation efficiency. Other salinity control research is being conducted by the basin agricultural experiment stations.

The Office of Water Research and Technology and the National Science Foundation also have contributed to the financing of needed research.

Additional Studies Needed

While the currently ongoing studies will provide useful data, some additional studies will be needed.

Control of salinity from nonpoint sources probably will require a number of approaches, but before an effective program can be undertaken, the source of salts must be known. For each tributary which produces a significant salt load from nonpoint sources, there must be a detailed study including careful monitoring, geological and soils analyses, evaluation of residual salts in the soil profile and the rate of release of salts from the weathering of soil particles, and a determination of the salt loading from the erosion of naturally saline surface soils and from water passing through the soil profile.

Studies similar to those in the Grand Valley of Colorado should be undertaken in other areas to ascertain the extent to which increases in irrigation efficiency will be effective in reducing salt loading.

The states, through the Forum, will identify their on-going administrative, water resources management programs and policies and assess them for the purpose of identifying appropriate areas where they should be redirected toward the goal of achieving more efficient use of the water supply and thus toward the policy identified in

40 CFR 120.5. This phase should be completed prior to or by October 18, 1977. Based on the results of that study, each state will, prior to or by October 18, 1978, identify recommended changes in its water resources management programs and policies for the purpose of adopting new policies, regulations or legislation directed toward the goal of more efficient use.

While salinity from municipal discharges represents a small part of the total, future studies will include an examination of the salt contribution from this source and of possible control measures.

Evaluation of the Plan

Impact on Salinity

If the plan of implementation is carried out as described, the salt routing studies indicate that the average annual salinity would be at or below 1972 levels from 1975 through 1990 under the conditions described in Chapter III, page 28, of this report.

Tables 7 and 8 show the impact of the plan in terms of the estimated reduction in salt load and concentration from that which would be expected in the absence of specific salinity control measures. The measures considered were: no industrial salt return, the 16 salinity control projects listed in Title II of PL 93-320, and the reformulation of authorized federal water projects.

In addition, but not shown on the tables, the impact on salinity of projected depletions for fish and wildlife enhancement were estimated. To permit preparing this estimate, it was assumed that water which would be depleted for this use otherwise

TABLE 7

PROJECTED REDUCTION IN SALT LOAD
DUE TO SALINITY CONTROL MEASURES 1/

(in 1000 tons)

15 maf/yr Supply - Moderate Depletion Rate

Year 1990

Control Measures	Lee Ferry (Salt Load)	Below Hoover Dam (Salt Load)	Below Parker Dam (Salt Load)	Imperial Dam (Salt Load)
No Industrial Salt Return				
Power Plant Cooling (incl. attendant coal devel)	79	53	60	149
Coal Gasification Industry	13	13	10	8
Oil Shale Industry	66	40	40	33
Subtotal	145	106	124	173
Salinity Control Projects				
Four Authorized Projects	341	424	330	320
12 Additional Projects	769	645	505	520
Subtotal	1,110	1,069	835	840
Reformulation	53	27	10	16
Totals	1,308	1,202	969	1,029

1/ The table shows the reduction in the mean annual salt load passing the four listed stations in 1990. The differences between Lee Ferry and below Hoover Dam will be essentially eliminated when all the control measures have been implemented and their effects fully reflected at the gaging stations below Hoover Dam. The variations between Hoover Dam and Imperial Dam are due to a combination of varying implementation dates of control measures and the salts removed with out-of-basin diversions and non-return uses.

TABLE 8

PROJECTED REDUCTION IN SALINITY
DUE TO SALINITY CONTROL MEASURES 1/

(in mg/l)

15 maf/yr Supply - Moderate Depletion Rate

Year 1990

Control Measures	Lee Ferry (Concentration)	Below Hoover Dam (Concentration	Below Parker Dam (Concentration)	Imperial Dam (Concentration
No Industrial Salt Return				
Power Plant Cooling (incl. attendant coal devep)	6	4	6	18
Coal Gasification Industry	1	1	1	1
Oil Shale Industry	5	3	4	4
Subtotal	12	8	11	23
Salinity Control Projects				
Four Authorized Projects	26	32	33	39
12 Additional Projects	59	49	51	64
Subtotal	85	81	84	103
Reformulation	4	2	1	2
Totals	101	91	96	128

1/ Concentration reduction reflects dilution within system reservoirs, variations in completion dates of control measures, and salt removed with out-of-basin diversions and non-return uses.

would remain in the river system for dilution purposes and not be allocated to some other use. It was found that the increased depletion for this purpose under these assumptions would increase the salinity at Imperial Dam by 2 mg/l, 4 mg/l, and 7 mg/l in the years 1980, 1985, and 1990.

Comparison Between Costs and Economic, Social and Environmental Impacts

During the Forum's studies leading to development of the water quality standards for salinity presented herein, it was premature to attempt overall comparisons of the costs of the salinity control measures and the economic, social and environmental accomplishments of those measures. Much of the available cost and benefit data are of a very preliminary nature and subject to very substantial revision as the studies progress. An evaluation now could be highly misleading. Moreover, an extensive review and reanalysis is being made of past estimates of the economic effects of salinity increases. This reanalysis is being conducted by representatives of the Bureau of Reclamation and a consortium of western universities including the University of Arizona, University of California, Colorado State University, University of Colorado, and Utah State University. The results of this reanalysis were not available.

However, to provide an indication of the favorable net benefits involved for the initial phase of the program, reference is made to the Bureau of Reclamation's January 1974 Status Report on the Colorado River Water Quality Improvement Programs. It includes a comparison of the financial cost with the economic effects of the 4 authorized salinity control units as shown in the following tabulation:

Unit	Total Annual Equivalent Economic Cost Including OM&R	Potential Annual Range in Value of Economic Effects
Paradox Valley	$1,600,000	$3,100,000 to $6,300,000
Grand Valley	4,900,000	3,700,000 to 7,500,000
Crystal Geyser	30,000	60,000 to 120,000
Las Vegas Wash	4,000,000	2,300,000 to 4,700,000

The status report also discussed the immediate environmental effects of the units. Each of the units will have some locally unfavorable environmental effects in terms of the removal of natural vegetation, changes in surface land configuration by construction and the addition of facilities and creation of permanent surface salt deposits. On the other hand, the facilities will reduce local low flow salt concentrations and salt encrustation along certain streams. Reductions in salinity will have some desirable environmental effects throughout the balance of the Basin.

At this time, and if all elements proceed together on a basin-wide basis, it appears clear to the states that the social and environmental impacts of the plan of implementation will be beneficial. Every effort will be made to keep the localized environmental effects, where construction is necessary, to the minimum. Stopping the upward trend in salinity while the Basin States continue to develop and use their compact-apportioned water will provide the greatest social benefits achievable.

Salinity control will result in increased depletions and/or consumptive use from limitations on point source discharges or from natural source control aspects of the plan of implementation over that which would occur in the absence of such control. On the other hand, better water management practices such as on irrigated crop land may result in decreased depletions and/or consumptive use. These aspects will be examined in future revisions of the plan of implementation as more experience and data become available.

The states will continue to advise and comment on the USBR proposals and other data and evaluations as they are developed and will support only those measures that are justified. These analyses will involve comparisons of cost and benefits in terms of economic, environmental and social perspectives. Cost effectiveness of alternatives within each unit will be appraised. Multi-objective analyses and environmental impact statements are essential parts of the analysis of any federal salinity control program.

CHAPTER VI

MEANS OF MAKING PLAN OPERATIONAL

The plan of implementation for salinity control will require additional legislative authorization for the installation of control units, a means of financing measures requiring substantial investments, a clear delineation of responsibility on the part of the various participants, and the establishment of a monitoring program.

Legislation Needed to Carry Out Programs

Federal Programs

USBR Water Quality Improvement Program. All units of the Water Quality Improvement Program of the Bureau of Reclamation other than those authorized by Title II of PL 93-320 will require specific construction authorization by Congress. It is expected that all of the units, or their equivalent, will need to be in operation by 1990, approximately in accordance with the following schedule:

Unit	Date of Initial Operation
Palo Verde Irrigation District	1978 (IMS in 1976)
Colorado Indian Reservation	1978 (IMS in 1976)
Lower Gunnison	1976 (for IMS)
Uinta Basin	1976 (for IMS)
LaVerkin Springs	1983
Glenwood-Dotsero Springs	1983
Littlefield Springs	1984
Price River	1986
San Rafael River	1987
Dirty Devil River	1987
McElmo Creek	1987
Big Sandy River	1987

Delays, revisions, and substitutions no doubt will occur. These will have to be evaluated with revisions in the plan and/or numeric criteria being made as appropriate. It is apparent that good progress in terms of legislative authorizations and appropriations will be needed for all 16 units or their equivalent by 1980 if the numeric criteria are to be met in 1990. The specific timing for requesting authorization for each unit will be determined during the successive three-year reviews by the Forum of depletions and salt concentrations in the Basin. Considering the time required for obtaining authorization and appropriation of funds, a lead time of about 3 years will need to be allowed prior to beginning construction or installation of each future unit. As in the case of Title II of PL 93-320, authorizing legislation will specify the financing, cost-sharing, and repayment arrangements in accordance with the principles discussed subsequently in this chapter.

Department of Agriculture Program -- The participation by the Department of Agriculture in the Colorado River Basin Salinity Control Program is in the process of being developed. An overall cooperative agreement between the Department of the Interior and the Department of Agriculture sets forth the USDA role under PL 93-320. Additional agreements specific to the work to be carried out under Title I and Title II have been executed also. USDA intends to appraise existing authorities and funding levels within the next few months to determine whether legislative or funding limitations exist that will preclude meeting the objectives of the Colorado River Basin Salinity Control Act. A report of this appraisal is needed soon to permit timely action relative to needed legislative changes and budget requests.

Federal Lands -- Lands under the control of the Bureau of Land Management and the Forest Service contribute to the total salt load of the river. The present plan does not provide for specific action or legislation relating to controlling salinity from such lands, other than the units of the Bureau of Reclamation program which include public lands. However, as the studies of nonpoint sources progress, it is quite likely that there will be a need for legislation, either in terms of authorization or appropriations, involving such lands. The plan of implementation does not include any measures involving Indian lands, except for USBR studies being done in collaboration with representatives of Indian interests.

State and Local Programs

The plan of implementation identified in this report can be pursued with existing legislation by or on behalf of the states and local entities. However, not all states have authority to accept responsibility for the NPDES program. As the studies, research, and implementation proceed, the desirability of other authorizations may become apparent.

Interstate Organizations for Salinity Management

Salinity in the Colorado River Basin is recognized as a basinwide problem that must be dealt with on a basinwide basis. Because of the nature of the problem, some type of basinwide organization is needed. Recognition of that need led to the establishment of the Colorado River Basin Salinity Control Forum in 1973, and to the requirement in the proposed regulation for an evaluation of the feasibility of establishing an interstate institution for salinity management.

Several forms of regional organization might be adapted to the Colorado River. Such regional organizations could be intrastate or interstate or some combination of both. Individual states could establish regional organizations such as the basin authorities in Texas for the portion of the basin within the state and join the state authorities into some type of interstate body. Interstate organization might consist of a state-federal, essentially coordinating, group; an interstate compact commission similar to Ohio River Valley Water Sanitation Commission (ORSANCO) or the Upper Colorado River Basin Commission; an interstate-federal river basin commission similar to the Delaware River Basin Commission; or an interstate or interstate-federal regional government corporation drawing upon experience gained with the Tennessee Valley Authority, The Communications Satellite Corporation (Comsat) and other federal corporations.

The states of the Basin have considered these possible organizational arrangements. All have potential advantages and disadvantages.

Without going into detail, the disadvantages are persuasive for not establishing a statutory interstate salinity control institution. Experience with the several types of interstate basin institutions listed above show mixed results. Many were established only to coordinate planning and policy making. Only TVA has had a major implementation program, although the federal-state river basin commissions, such as the Delaware River Basin Commission, have exercised some authority.

Adequate coordination can be achieved without a statutory interstate organization provided the states and the pertinent federal agencies are not only desirous, but willing, to work

together. If they aren't, statutory institutions likely will not be successful either.

These factors have been weighed against the alternative of continuing to use the Forum as the vehicle for providing coordination between the states and the federal agencies, while the states provide the regulatory function through existing state bodies. From this review, the states have concluded that the advantages of another type of possible organizational arrangement do not justify a change at this time.

Financing Salinity Control Projects

The salinity of the Colorado River has local, state, national, and international aspects, and governing bodies at each level will contribute either directly or indirectly to solving the problem. While there are many entities and levels of government concerned with the salinity of the Colorado River, only the Federal Government is involved in all major basinwide aspects of the salinity problem, and a solution is only possible in a basinwide context. The Federal Government, under Minute 242, has the objective of a permanent and definitive solution to the problem of the salinity of the water delivered to Mexico. Without upstream salinity control, the problem may not remain solved.

Federal lands are the source of most of the naturally occurring salts in the river. Lands of Indian reservations are also involved. Accordingly, it is believed that the Federal Government is the appropriate unit of government to initially finance the salinity control projects, and to be allocated a major share of repayment costs.

Sharing of Costs

In enacting PL 93-320 which included consideration of many factors, including those mentioned above and the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), the Congress adopted a cost-sharing formula which provides that 75 percent of the costs of the four salinity control projects authorized by Title II of PL 93-320 shall be nonreimbursable.

The allocation of costs for the twelve salinity control projects authorized for study in the Act will be accomplished when these projects are ready for authorization.

Additional costs that are not part of the salinity control projects mentioned in Title II of PL 93-320 will be incurred by the Federal and State Governments and by private and local governmental entities in implementing measures that will control the river's salinity. These measures include on farm improvements to reduce salinity increases such as farm land sloping or leveling and ditch lining; additional costs will be incurred in the adoption and administration of an effluent limitation program to control the salinity of discharges. The cost sharing on each particular action will have to be individually determined.

Repayment of Allocated Costs

The major portion of the salt loading in the Basin is from natural sources. However, persons have been using Colorado River water and causing salinity increases ever since the West was settled over 120 years ago. Now there are large numbers of farmers and businesses in and out of the Basin who rely on diversions from the Colorado River, as do many villages, towns, and cities that use

Colorado River water under a complicated system of water rights developed over a half a century of study and negotiations, and thereby cause incremental salinity increases.

Fortunately, Congress has been willing to use mechanisms in hand that will enable the reimbursable costs of the first four federally constructed salinity control units allocated to the Basin to be collected in a fairly equitable manner and repaid to the General Fund of the Treasury without having to develop the complex administrative machinery that would be required to collect charges from each water user within the Colorado River Basin. These mechanisms are the Upper Colorado River Basin Fund and the Lower Colorado River Basin Development Fund. Title II of PL 93-320 provides that repayment of the reimbursable portions of the first four salinity control units be from the two funds.

The Act directs the Secretary to analyze the authorized salinity control projects, considering the factors of benefits to each Basin; causes of salinity; availability of revenues in the respective basin funds; and to set the cost allocations based on his analyses, with a maximum allocation to the Upper Basin Fund not to exceed 15 percent of the total allocated to the two Basin Funds for any unit, the remainder to be allocated to the Lower Basin Fund.

In order to obtain the revenues necessary to repay the General Fund of the Treasury, the electric power rates will have to be raised by a small charge in the case of the Upper Colorado River Basin Fund. The Lower Colorado River Basin Development Fund was established

by the Colorado River Basin Project Act of 1968 for the purpose of repaying the costs of any project that may be built to augment the flow of the Colorado River. The problems of the river's salinity are so pressing that it was concluded that a portion of the power revenues accruing to this Fund should be used for repaying allocated costs of salinity control. Again, the power (and thereby water) users of the Lower Basin will be paying charges into the Fund that will be directly used in the repayment to the General Fund of the Treasury.

Responsibility for Accomplishing Salinity Control Measures

The plan of implementation recognizes that the Forum, the several federal agencies, and the Basin States each have specific responsibilities for furthering the salinity control program. Table 9 presents in summary form the elements of the plan of implementation, including actions to be taken, the time schedule and the responsible entities.

The Forum will provide overall coordination and a continuing review of salinity changes and of program effectiveness. Every 3 years and more often if necessary, the Forum, in light of existing depletions and salt concentrations, will reconsider and, where necessary, revise the schedule for installing salinity control measures and/or modify the numeric criteria. The review will include both federal and nonfederal programs.

Appropriate federal agencies will complete planning reports and seek authorizations and funding for salinity control in accordance with Title II of PL 93-320. The Basin States will lend their support to requests for authorization and funding.

TABLE 9
TIMING AND RESPONSIBILITY FOR ACCOMPLISHING IMPLEMENTATION PLAN

Activity or Source of Salinity	Action to be Taken	Timing	Entities Responsible for Taking Action
Paradox Valley Unit	Complete Definite Plan Report and Environmental Statement	June 1976	USBR 1/
	Provide the leadership and resources required to maintain local and Basin support for project implementation	October 1975 through construction	USBR, State of Colorado; Forum
	Install pumps and pipeline; construct reservoir	1977-1980	USBR
Grand Valley Unit			
Water Systems Improvement	Complete Definite Plan Report and Environmental Statement	June 1976	USBR; SCS 1/
	Improve canals, laterals, and on-farm irrigation systems	1977-1987	USBR; SCS; State of Colorado
Irrigation Management Services	Complete demonstration program; expand program to full area; arrange for local agency to finance and administer program	Demonstration underway; transfer to water users - 1977	USBR; SCS; State of Colorado; local entities
General	Provide the leadership and resources required to maintain local and Basin support for project implementation	October 1975 through construction	USBR; SCS, State of Colorado; Forum
Crystal Geyser Unit	Complete Definite Plan Report and Environmental Statement	June 1976	USBR 1/
	Install pipe and construct evaporation pond	1977	USBR
	Provide the leadership and resources required to maintain local and Basin support for project implementation	October 1975 through 1977	USBR; State of Utah; Forum

TABLE 9 (Continued)
TIMING AND RESPONSIBILITY FOR ACCOMPLISHING IMPLEMENTATION PLAN

Activity or Source of Salinity	Action to be Taken	Timing	Entities Responsible for Taking Action
Las Vegas Wash Unit	Complete Definite Plan Report and Environmental Statement	June 1976	USBR)1/
	Install collection and bypass facilities and construct the evaporation or desalting facilities facilities	1977-1980	USBR
	Provide the leadership and resources required to maintain local and Basin support for project implementation	October 1975 through 1980	USBR; State of Nevada; Forum
Lower Gunnison Basin Unit			
Water Systems Improvement Uncompahgre Project Portion	Complete Feasibility Report	FY 1977	USBR; SCS; State of Colorado)1/
Balance of Lower Gunnison Basin Area	Complete Feasibility Report	June 1978	USBR; SCS; State of Colorado)1/
Irrigation Management Services	Complete demonstration program; expand program to full area; arrange for local agency to finance and administer program	Ongoing 2/ transfer to water users FY 1980	USBR; SCS; State of Colorado; local entities
Uinta Basin Unit			
Water Systems Improvement	Complete Feasibility Report	June 1978	USBR; SCS; State of Utah)1/
Irrigation Management Services	Complete demonstration program; expand program to full project area; arrange for local agency to finance and administer program	Ongoing 2/ transfer to water users FY 1978	USBR; SCS; State of Utah; local entities

TABLE 9 (Continued)
TIMING AND RESPONSIBILITY FOR ACCOMPLISHING IMPLEMENTATION PLAN

Activity or Source of Salinity	Action to be Taken	Timing	Entities Responsible for Taking Action
Colorado Indian Reservation Unit			
Water Systems Improvement	Complete Feasibility Report	December 1975	USBR; BIA; Colorado River Tribal Council)1
Irrigation Management Services	Complete demonstration program; expand program to full area; arrange for permanent financing and an agency to administer program	Ongoing[2] transfer to water users FY 1977	USBR; BIA; Colorado River Tribal Council)1
Utilization of Irrigation Return Flows	Complete Feasibility Report	June 1978	USBR; BIA; Colorado River Tribal Council
Palo Verde Irrigation District Unit			
Irrigation Management Services	Complete demonstration program; expand program to full area; arrange for local agency to finance and administer program	Ongoing[2] transfer to water users FY 1977	USBR; State of California; Palo Verde Irrig. Dist.
Water Systems Improvement	Complete Feasibility Report	March 1978	USBR; State of California; Palo Verde Irrig. Dist.)1
LaVerkin Springs Unit	Feasibility Report Completed	Draft, 12/74 Final FY 1975	USBR; State of Utah)1
Littlefield Springs Unit	Complete Feasibility Report	June 1976	USBR; State of Arizona)1
Glenwood-Dotsero Springs Unit	Complete Feasibility Report	June 1979	USBR; State of Colorado)1

TABLE 9 (Continued)
TIMING AND RESPONSIBILITY FOR ACCOMPLISHING IMPLEMENTATION PLAN

Activity or Source of Salinity	Action to be Taken	Timing	Entities Responsible for Taking Action
Price River Unit	Complete Feasibility Report	June 1979	USBR; State of Utah)1/
San Rafael River Unit	Complete Feasibility Report	June 1979	USBR; State of Utah)1/
Dirty Devil Unit	Complete Feasibility Report	June 1979	USBR; State of Utah)1/
McElmo Creek Unit	Complete Feasibility Report	June 1979	USBR; State of Colorado)1/
Big Sandy River Unit	Complete Feasibility Report	June 1979	USBR; State of Wyoming)1/
Reformulation of Authorized Projects	Develop revised plan to reduce salinity contribution; prepare revised Definite Plan Reports	Ongoing 2/	USBR; affected states and local entities)1/
Industrial Discharges	As each state adopts the plan of implementation, the objective for industrial discharges shall be a no-salt return policy wherever practicable.	Nov. 1975	Each state or EPA
Agricultural Discharges	Issue permits for agricultural point discharges in accordance with EPA guidelines of July 5, 1973, and amendments thereto	Ongoing 2/	Affected state and/or EPA
	Conduct stepped-up educational program	1975 through 1978	Affected state

TABLE 9 (Continued)
TIMING AND RESPONSIBILITY FOR ACCOMPLISHING IMPLEMENTATION PLAN

Activity or Source of Salinity	Action to be Taken	Timing	Entities Responsible for Taking Action
Measures to Cope With Salinity	Expand land drainage system in Lower Basin	Ongoing[2/]	Local agencies
	Treating and blending Colorado River water	Ongoing[2/]	Local agencies
Research and Special Studies	Research on irrigation water application in relation to salinity output, Grand Valley, Colorado, and Wellton-Mohawk, Arizona, areas	Ongoing[2/]	ARS; USBR; EPA; States of Colorado and Arizona
	Other research and demonstration projects in the Grand Valley area	Ongoing[2/]	Colorado State University; Colorado Water Conservation Board
	Study of the feasibility and cost of recycling and reusing saline waste or river water	Ongoing[2/]	USBR
	Studies of using waste chemical products in desalting by ion exchange and application of ion exchange process; research on the application of solar distillation	Ongoing[2/]	USBR
	Studies of salt precipitation in reservoirs	Not yet scheduled	USBR
	Land processes contributing to salt production from diffuse sources	Ongoing[2/]	BLM; USBR; Utah State University
	Studies of channel processes contributing to diffuse salt production	Not yet scheduled	USBR
	Study of the natural interaction of water and rocks in the Green River Basin	Ongoing[2/]	University of Wyoming

TABLE 9 (Continued)
TIMING AND RESPONSIBILITY FOR ACCOMPLISHING IMPLEMENTATION PLAN

Activity or Source of Salinity	Action to be Taken	Timing	Entities Responsible for Taking Action
Research and Special Studies (continued)	Studies of the effect of differing but relatively high salt concentrations on various crops	Ongoing[2/]	Universities of Arizona and California; ARS
	Studies of other areas where production of salts from non-point sources is significant (the scope and makeup of this study will depend on results from the research already underway)	Not yet scheduled	USBR; BLM; EPA; affected states
	Studies in other areas of the extent to which increases in irrigation efficiency will be effective in reducing salt loading (the scope and makeup of this study will depend on results from the research already underway)	Not yet scheduled	USBR; EPA; affected states
	Identify and evaluate state water resources management programs, policies and regulations and assess them for the purpose of identifying where they can be redirected toward salinity control policy	October 1977	Each Basin State
	Identify recommended changes in water resources programs, regulations and policies	October 1978	Each Basin State
	Examination of municipal discharges as a source of salinity and of possible control measures	Not yet scheduled	Each Basin State

TABLE 9 (Continued)
TIMING AND RESPONSIBILITY FOR ACCOMPLISHING IMPLEMENTATION PLAN

Activity or Source of Salinity	Action to be Taken	Timing	Entities Responsible for Taking Action
Other Activities	Analyze the monitoring program to determine the adequacy of the selected stations for the establishment of baseline salinity values	1978	Seven States
	Develop baseline salinity values for the specified monitoring points	1977	Seven States
	Prepare annual report on salinity control program and effect of other activities having an influence on salinity	1977 and annually thereafter	Seven States
	Reconsider and where necessary revise schedule for installing salinity control measures and/or modify the numeric criteria	1978 or before; at least each 3 years thereafter	Seven States
	Investigation of measures for limiting salinity in addition to those now in the plan of implementation to be applied after about 1990	1978 and thereafter	Seven States
	Appraise existing authorities and funding levels available to SCS to evaluate its ability to participate adequately in the installation of on-farm measures	Nov. 1975	SCS; Seven States

1/ States will review and comment on research and special studies, feasibility reports, environmental impact statements, and definite plan reports.

2/ Some ongoing programs will continue indefinitely; others will have dates assigned for either completion or significant action after they have progressed further.

Identifying and Evaluating Progress in Program of Salinity Control

Progress in the salinity control program will be monitored and evaluated on a continuing basis. Amendments to the plan of implementation will be considered annually (i.e., addition or deletion of control units and program elements). Also annually, the states, acting through the Forum, will prepare a report which will summarize the results attained by the salinity control program and the effect of other actions in the Basin having an influence on salinity. This report will be transmitted to the Environmental Protection Agency, to state water resource and pollution control agencies, and be available to others interested in the salinity control program.

As part of the process of identifying and evaluating progress in salinity control, baseline salinity values will be computed for monitoring points on the main stem and major tributaries. These baseline values will be computed and included in at least preliminary form in the initial progress report in 1977. The makeup of the baseline values is yet to be determined.

Procedures for Adopting Standards

Prior to state adoption of standards, public review and discussion will be sought through public meetings held at two levels. The Forum proposes to hold two regional meetings -- one at Las Vegas, Nevada, and one at Grand Junction, Colorado -- to stress the basinwide nature of the salinity problem and the control program and to solicit views, particularly of a regional nature.

In accordance with the provisions of the regulation [40 CFR Part 120, Water Quality Standards], each of the states in the Basin plans to adopt the Forum's report, including the numeric criteria and plan of implementation for salinity control, as its salinity standards for the Colorado River Basin, and transmit the standards to the Environmental Protection Agency by October 18, 1975. Adoption by each state will be accomplished through such state agency and by such procedures as are required by the laws and regulations of each state.

CHAPTER VII

FUTURE POSSIBLE SALINITY CONTROL PROGRAMS

Since the implementation plan presented herein includes all of the salinity control projects authorized or identified for further study by Title II of PL 93-320 as part of the Colorado River Water Quality Improvement Program of the Bureau of Reclamation, other means of limiting the salinity level must be sought after about 1990. A number of possible means have been identified and are discussed below. Only a few have been studied in any depth, and their effectiveness or feasibility do not show promise at this time. The others have undergone only the most preliminary investigation and their feasibility is not really known. Because of the relatively short period before some of them may be required, it is important that a state-federal program to examine these and other possibilities be initiated in the near future and be carried steadily forward over the next ten years. Obviously these investigations will need to be conducted concurrently with the detailed studies and construction program required to carry out the plan of implementation.

Additional Salinity Control Projects

Return Flow Utilization

Increasing demands for energy in and adjacent to the Colorado River Basin has focused attention on the need for water to meet projected cooling requirements for energy conversion and power production. A potential source of water for cooling and other industrial purposes is the return flow from irrigated agriculture

which occurs in substantial quantities throughout the Colorado River Basin. Investigations to evaluate systems for collecting agricultural return flows are scheduled for the following areas:

Grand Valley Collector System, Colorado. Investigations are scheduled to commence in FY 1976 to devise a system to collect the highly saline return flows from about 76,000 acres of land in the Grand Valley area and use the water for industrial purposes. It is estimated that the return flow from this area would be about 150,000 acre-feet annually, part of which would appear as surface runoff and the balance as ground water effluent. The flows from ground water are more highly saline than the surface flows. For this reason selective collection of the water may be desirable with the less saline water being returned directly to the river. The saline water may be stored at a site in the lower end of the valley and used for cooling in a thermal generating plant, coal conversion plant, oil shale plant, or it may be put to other industrial use. It is expected that feasibility studies will be completed in 1977.

San Juan Collector System, New Mexico. A San Juan Collector System investigation has been programmed to evaluate the concept of collection of water of impaired quality and delivery to suitable locations for use in coal gasification, power production, or other industrial processes. Possible sources in the San Juan Basin include natural waters and irrigation return flows. The latter will be of large magnitude, estimated to be about 100,00 acre-feet. The principal difficulties associated with a collector and treatment system would be the long distance involved, the numerous points of collection, the likely sediment-laden condition of the drainage water, and the match-up of the supply and demand for this water. Investigations for the San Juan Collector System are scheduled to be completed in FY 1976.

Meeker Dome Unit, Colorado

Prior to August 1968, an abandoned exploratory oil well located about 3 miles east of Meeker, Colorado, and on the south toe of Meeker Dome was discharging about 3 second-feet of 19,200 ppm water (57,000 tons of salt per year) to the White River. Plugging of this well was completed August 3, 1968. Subsequently, seeps have developed around the flanks of Meeker Dome with most of the salt contribution again entering the White River.

A plan to control the seeps from Meeker Dome has not been developed at this time. Investigations to determine a plan to remove the salt contribution will begin in FY 1976 with a feasibility report on the unit scheduled for September 1978.

Weather Modification

The Bureau of Reclamation has now completed 12 years of weather modification research. During this period significant progress has occurred in planning, operating, monitoring, and evaluating both winter and summer experimental field programs. Analysis and understanding have been improved by the development of research tools such as computer models, satellite telemetry and imagery, isotopic snow profilers, diffusion tests, improved ice nuclei counters, and remote-controlled instrumentation. The major program emphasis and advances have taken place in the modification of winter orographic storms.

The largest winter orographic cloud seeding experiment in the U. S., the Colorado River Basin Pilot Project, has been conducted by the Bureau in the San Juan Mountains of southwest Colorado. The pilot project has been coordinated through the fifth and final year

ending May 15, 1975. An independent private contractor, Aerometric Research, Inc., will prepare a final evaluation of project results by June 1976.

A large-scale demonstration operational cloud seeding program is proposed in the Colorado River Basin for the production of new water to meet the essential national needs and to sufficiently firm-up state supplies. A range of design alternatives with staggered starting dates for the separate proposed areas is possible. With authorization and funding in FY 1977 seeding can be started in the fall of 1978.

There are six main potential cloud seeding areas in the Colorado River Basin Region. The potential flow available to the Colorado River from the demonstration operational cloud seeding program is estimated by the USBR to be 700,000 acre-feet annually. The demonstration program would exercise constraints on the operation when increased snowpack levels would result in hazards such as avalanches or floods.

The implementation of the demonstration program may be effected by a number of external factors. Cloud seeding in wilderness and primitive areas has not been generally accepted with the Forest Service or the National Park Service. Either a clear administrative definition or separate legislation is required. Ongoing and future large-scale seeding operations such as those in Utah will require a high degree of coordination and cooperation. Recognition of claims for real or alleged disbenefits from persons in the project area and in the area receiving increased runoff must be reconciled for a successful program. A balanced policy and legal precedent will need to be formed and implemented.

It is axiomatic that if the flow of the Colorado River is increased through weather modification, there will result an increase in the tonnage of salt that must be carried by the river. So long as all or a substantial part of the augmented supply is allowed to flow directly down the river system to increase the supply to the Lower Basin, the water quality in the Lower Basin will be improved. On the other hand, when and if the augmented supply is consumptively used by projects having return flow in the Upper Basin, the quality to the Lower Basin will be degraded.

The weather modification research program should be continued because of its potential for augmentation with a favorable benefit-cost ratio.

Phreatophyte Control

Phreatophyte control has been suggested as a means for salinity control in the Colorado River Basin. Phreatophytes are water-loving plants which consume large quantities of fresh water and exist along stream channels and flood plains. Any reduction in phreatophytes would result in corresponding reductions in loss of fresh water and improvements in the river's salinity. Some species of wildlife may benefit from selective thinning of phreatophytes while the population of other species may be reduced.

Thus, while there exists the possibility of eliminating many thousands of acres of phreatophytes in the Lower Colorado River flood plain which would thereby reduce water losses and improve downstream salinity somewhat, the benefits therefrom must be balanced

against any losses to wildlife habitat through reduction. The Bureau of Reclamation has begun a study of the impacts on fish and wildlife of various types of phreatophyte removal programs in the Lower Colorado River flood plain and an analysis of the water salvage and salinity improvement that would result from each such removal program.

Until the USBR study is completed, it will not be known how serious will be the impacts of such removal on fish and wildlife, nor what will be the water salvage and salinity improvement possibilities.

Desalting Sea Water

Desalting of sea water has been suggested as a possible means for augmenting the water supply of the Colorado River, which would also improve the quality of the water in the river.

In a reconnaissance report of January 1968, the Bureau of Reclamation studied the delivery of 2 maf/yr of desalted water to Lake Mead, to be produced by a dual-purpose power and desalting plant, located on the Southern California Coast. The construction cost for the power and water plant and pipeline was estimated at $2.784 billion (1968 prices). The Comprehensive Framework Study for the Lower Colorado Region, published in June 1971, also reported on the desalting of sea water, with the desalted water to be delivered to Lake Mead and with costs of the same general order of magnitude. Because of the extremely high cost and other factors, major augmentation of the Colorado River lower main stem by means of sea water conversion, exclusively for water quality improvement, does not appear to be practicable in the foreseeable future.

Importing Water From Outside Basin

Importing water of low mineral content directly into the lower main stem would reduce the Colorado River's salinity. The degree of improvement depends on numerous factors, most important of which are the quantity and salinity of the imported water; and the types, magnitudes, and locations of new uses.

The cost of all importation schemes that have been proposed would be huge and the schemes are complicated by legal and political uncertainties. Factors other than water quality would have to be the motivating factor to place importation in the category of even a reasonably long-range alternative. Such a program would take a minimum of 25 years to plan, authorize, construct and place in operation.

Desalting River Flows

Desalting Colorado River flows is another potential means of salinity control in the Colorado River Basin. It is possible, technically, to utilize desalting plants in several situations. Plants might be sited to desalt point source or collected nonpoint source discharges, such as irrigation return flows. Plants could be located to desalt the flows of some of the more saline tributaries. Desalting of the Colorado River flows would be possible at some appropriate point in the Lower Basin, such as shortly above the Lake Havasu or Imperial Reservoirs. Finally, the quality of water being diverted for use might be improved by being desalted in whole or in part. None of these alternatives have been given more than the most cursory attention because of the indicated relatively high cost as compared to other means of salinity control.

Three processes have been considered most often for desalting brackish waters: reverse osmosis (RO), eletrodialysis (ED), and ion exchange (IX). The three methods are quite competitive economically for the removal of dissolved solids from the range 1,000 ppm to 2,000 ppm down to 500 ppm. Cost of different methods will vary for different locations. In general, the constituents of intake brines, the water quality specifications of users, the cost of desalting processes, the cost of brine or chemical disposal, the plant capacity, the cost of delivered power, chemicals, cost of maintenance, and cost of water conveyance must be considered together to formulate the cost evaluation in any particular application. Using any one of the three approaches with a 10 mgd plant capacity, the cost of product water at 500 ppm from 2,000 ppm feed water would be approximately 50 cents per 1,000 gallons ($165/acre-foot).

The reverse osmosis and electrodialysis processes have been more widely used commercially for desalting and ion exchange has been used more for polishing the water for higher quality specifications. The major cost for the ion exchange process relates to chemical regenerants. The media for the exchange of ions are usually made of acid or base resins. Undesirable ions contained in the feed water are exchanged with other ions while passing through the resin bed. It takes chemical regenerants to rejuvenate the resin. The amount of regenerants required is proportioned to the amount of water treated. In the Western States, the delivered cost of regenerants, such as sulfuric acid and ammonia, may be minimized by using waste materials from processes of coal gasification and oil shale development.

The Office of Saline Water has been conducting a parametric study of the preliminary feasibility of a large-scale ion exchange system to solve the salinity problem of the Colorado River Basin. Preliminary studies have been made at four sites: Davis Dam, California; Gallup, New Mexico; La Junta, Colorado; and Artesia, New Mexico. The studies show that ion exchange could be competitive economically with reverse osmosis and electrodialysis, and the combined use of different processes may result in greater economic benefits than single systems. The method should be determined by local circumstances of feed water composition, cost of power, chemicals, membranes, brine disposal, and labor.

Vegetation Management

A possible way in which the water supply of the Colorado River could be augmented (and thus decrease the salinity) is through large-scale manipulation of vegetation cover. It has long been realized that natural vegetation has a significant effect on runoff and streamflow. Numerous studies and experiments have been performed over the past few decades to establish exact relationships; some of the largest of these were in the Colorado Rocky Mountains under the direction of agencies of the U. S. Department of Agriculture.

The National Water Commission in 1970 contracted for a report on Watershed Management (Sopper, 1971), and summarized the information relating to increased water yields in its final report (National Water Commission, 1973). The following discussion is taken from that summary.

The net loss of water through evaporation and transpiration from the vegetative cover on a watershed varies with the amount and kind of vegetation present, and in forested areas with the forest cutting practices employed. Harvesting timber tends to increase

runoff. Experiments with total forest cover removal have resulted in first-year increases in runoff ranging from 1.3 to 18.0 inches. Partial removal of vegetative cover produces smaller increases and, in some cases, no increase at all. Generally, forest management which involves harvesting all of the trees in selected areas tends to produce greater increases in runoff than are produced by comparable reductions in vegetative cover by harvesting timber on an individual tree selection basis. In the West most of the increased water yield occurs during the winter and spring. Data indicate a steady decline in increased annual water yield after the first year of vegetative cover removal. The rate of decline depends upon the rate of revegetation.

Conversion of one type of vegetal cover to another in forests and brushlands has produced mixed results. In the Southwest, conversion from trees to grass on moist sites has significantly increased runoff. Similarly, in the West, substituting grasses for chaparral has been found to increase water runoff.

It is possible to manage forest areas to increase snow accumulation or delay or advance melt for the purpose of regulating the amount of water yield and the timing of delivery. In many cases, man-made barriers can affect the distribution of snow.

At least in some areas, it appears that land management to attain small increases in water supply can be accomplished without lowering water quality, degrading the watershed, or deteriorating the forest environment. But in planning the use of land management techniques to increase water supplies, balances must be struck. Although the concept has been studied for decades, increased water production has been insignificant because of seeking that balance. Significant changes in salinity due to watershed and vegetative

cover management are not expected by 1990. Moreover, an increase in water supply by this means would lead to some of the same kind of questions regarding use of the water as were discussed in the Section on "Weather Modification".

Transfers of Water From One Use or One Area to Another in the Same State

Changes in the place and purpose of use can have an effect on future salinity. The most recent indication that large transfers of use might occur stems from reports on the national energy situation. When agricultural water is changed to industrial water, salinity downstream can be reduced by eliminating the saline return flows and eliminating salt pickup.

Another possible beneficial means in terms of salinity control is a change in location of irrigation. If irrigation is presently being carried out on poor quality land, a change in location to irrigate land with a lower salt production potential could result in a reduction in the salinity level to downstream users.

Measures to Control Nonpoint Sources

Salinity from nonpoint sources, both naturally occurring and resulting from man's activities, is important as a contributor to the total salt load of the Basin. Research such as that now underway in the Grand Valley of Colorado appears to suggest canal and lateral lining and increased irrigation efficiency are effective as means of reducing salt loading from nonpoint sources in some areas. However, this research is still in progress and there is much yet to be learned. Also, the USBR is studying diffuse natural salinity contributions and by the late 1970's is scheduled to complete feasibility-level studies.

As these studies progress, it will be determined if the implementation plan can be modified to include specific provisions for nonpoint source contributions, but it is premature to do so now. Some of the salinity control projects discussed in Chapter V could include measures to control salinity from nonpoint as well as point sources should ongoing research and investigation indicate the likelihood of success.

CHAPTER VIII

PROVISION FOR REVISING AND UPDATING STANDARDS INCLUDING NUMERIC CRITERIA AND PLAN OF IMPLEMENTATION

The plan of implementation and the numeric criteria are to be continuously reviewed in the light of changed conditions or new information. Revisions to the plan of implementation and upward or downward changes to the numeric criteria will be considered at three-year intervals.

The Colorado River Basin Salinity Control Forum in its statement of "Principles and Assumptions for Development of Colorado River Salinity Standards and Implementation Plan", approved by the Forum on September 20, 1974, included Principle 7 as follows:

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> "7. The plan of implementation shall be reviewed and modified as appropriate from time to time, but at least once each 3 years. At the same time, the [numeric] standards, as required by Section 303(c)(1) of PL 92-500 shall be reviewed for the purpose of modifying and adopting standards consistent with the plan so that the Basin States may continue to develop their compact-apportioned waters while providing the best practicable water quality in the Colorado River Basin."

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The Forum took this position because the Colorado River is a large and complex area with many problems. A wide range of research, technical studies, and actions are underway and much knowledge is yet to be gained. Usable procedures for dealing with much of the salinity of irrigation return flows are not yet available. Even the 4 authorized units in the USBR salinity control program are still being studied. There are as yet no

firm procedures for the financing or cost sharing of salinity control works other than for the 4 authorized units of the USBR program.

A permanent Work Group, under the authority of the Forum as the states' representatives, will be established and charged with the responsibility of keeping current with events and suggesting revisions. The Work Group will operate under a schedule which will enable the states to take action on any potential revisions by October 1$, 1978. The official salinity levels will be those determined annually by the Bureau of Reclamation.

A P P E N D I X A

EPA Regulation - 40 CFR, Part 120,
Water Quality Standards (Colorado
River System; Salinity Control Policy
and Standards Procedures)

Title 40—Protection of Environment

CHAPTER I—ENVIRONMENTAL PROTECTION AGENCY

[FRL 298–5]

PART 120—WATER QUALITY STANDARDS

Colorado River System; Salinity Control Policy and Standards Procedures

The purpose of this notice is to amend 40 CFR Part 120 to set forth a salinity control policy and procedures and requirements for establishing water quality standards for salinity and a plan of implementation for salinity control in the Colorado River System which lies within the States of Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming pursuant to section 303 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1313). A notice proposing such policy and standards procedures was issued on June 10, 1974 (39 FR 20703, 39 FR 24517).

High salinity (total dissolved solids) is recognized as a significant water quality problem causing adverse impacts on water uses. Salinity concentrations are affected by two basic processes: (a) Salt loading—the addition of mineral salts from various natural and man-made sources, and (b) salt concentrating—the loss of water from the system through stream depletion.

Studies to date have demonstrated that the high salinity of stream systems can be alleviated. Although further study may be required to determine the economic and technical feasibility of controlling specific sources, sufficient information is available to develop a salinity control program.

Salinity standards for the Colorado River System would be useful in the formulation of an effective salinity control program. In developing these standards, the seven States must cooperate with one another and the Federal Government to support and implement the conclusions and recommendations adopted April 27, 1972, by the reconvened 7th Session of the Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and its Tributaries.

Public hearings on the proposed regulation were held in Las Vegas, Nevada, on August 19, 1974, and in Denver, Colorado, on August 21, 1974. Public comments were provided at the hearings and also by letter during the review period. A summary of major comments and Environmental Protection Agency response follows:

(1) The Colorado River Basin Salinity Control Forum stated that it did not object to the proposed regulation, and believed that it satisfied the requirements of section 303(b)(2) of P.L. 92–500 until October 18, 1975. The Forum reported that the seven Colorado River Basin States were actively working on the development of water quality standards and a plan of implementation for salinity control.

(2) The Colorado River Water Conservation District inquired as to whether the definition of the Colorado River Basin contained in Article II(f) of the Colorado River Compact of 1922 would be followed in the development of salinity standards and the salinity control plan.

The requirement for establishing water quality standards and an implementation plan apply to the Colorado River System as defined in Part 120.5(a) of this regulation. This definition is consistent with the definition of the Colorado River System contained in Article II(a) of the Compact. The regulation states that the salinity problem shall be treated as a basinwide problem. Articles II(f) and II(g) define the Basin to include the System plus areas outside the drainage area which are served by the Colorado River System. The Environmental Protection Agency (EPA) will require that the standards and implementation plan consider the impacts of basinwide uses, e.g., transmountain diversions, on salinity effects in the System, but the establishment of standards and implementation plans pursuant to this regulation will not be required for streams located outside the System.

The District also questioned the feasibility of relying on irrigation improvement programs as a means of alleviating the salinity problem.

EPA believes that adequate information is available to initiate controls for irrigated agriculture, yet at the same time acknowledges that additional work is needed to demonstrate the efficacy of certain control measures. Projects presently being supported by EPA and others should demonstrate the adequacy of various control measures including management and non-structural techniques. These measures will be considered during the development of the implementation plan.

(3) The Environmental Defense Fund (EDF) testified that it believed that EPA was not complying with the requirements of the Federal Water Pollution Control Act, as amended, chiefly because of EPA's late response to the timetable delineated in the Act for establishing standards, and also because numerical standards still have not been set for the Colorado River System. EDF called upon EPA to withdraw the proposed regulation and promptly promulgate numerical limits for salinity.

EPA believes that a move to promulgate numerical standards at this time could cause even further delays in controlling salinity due to the problems involved with obtaining interstate cooperation and public acceptance of such a promulgation.

(4) The Sierra Club raised a number of objections to the proposed regulation, principally because, in its opinion, it permits further development of the waters of the Colorado River without requiring that adequate salinity controls be on line prior to development. Specific suggestions are:

(a) Section 120.5(c)(2). Shorten the deadline for submission of the standards and implementation plan to May 30, 1975.

EPA believes that this would not allow adequate time due to the complexities of the problem, the interstate coordination needed and the time requirements for public hearings. The October 18, 1975, date is consistent with the requirements of the Federal Water Pollution Control Act, as amended, for the three year review and revision of standards. The schedule set forth by the Colorado River Basin Salinity Control Forum calls for development of draft standards and an implementation plan by February 1975 in order to allow time for public participation prior to promulgation.

(b) Section 120.5(c)(2). Delete "as expeditiously as practicable."

The date of July 1, 1983, remains the goal for accomplishment of implementation plans as stated in § 120.5(c)(2)(iii). It is the purpose of this language to accelerate progress by the States toward this goal where possible.

(c) Section 120.5(c)(2)(ii). Delete "while the basin States continue to develop their compact apportioned waters."

In recognition of the provisions of the Colorado River Compact of 1922 and until such time that the relationship between the Compact and the Federal Water Pollution Control Act, as amended, is clarified, EPA believes that development may proceed provided that measures are taken to offset the salinity increases resulting from further development.

(d) Section 120.5(c)(2)(iv). Add language to describe conditions under which temporary increases above the 1972 levels will be allowed.

EPA believes that this matter should be addressed in further detail in the formulation, review and acceptance of the implementation plan, not in the regulation.

(e) Add a new subsection on financing of control measures.

EPA believes that this, too, is an issue that should be handled as part of the implementation plan.

(f) Add a new subsection delineating requirements for evaluating control plans and restricting consideration of controls for the Blue Spring on the Little Colorado River.

EPA believes these issues should also be addressed as part of the implementation plan. It should be noted that nothing in this regulation removes the requirement for assessing environmental impacts and preparing environmental impact statements for control measures.

(g) Add a new section requiring public hearings.

EPA's public participation regulations appear at 40 CFR 105 and apply to all actions to be taken by the States and Federal Government pursuant to the Act. States have provided for public participation throughout the initial water quality standards review process. We expect the States to do so in this situation and see no need to set forth additional requirements.

(h) Add a new section stating that the implementation plan will be published in the FEDERAL REGISTER.

EPA expects there will be substantial public participation at the State and local level prior to adoption of the plan. The salinity standards are expected to be published in the FEDERAL REGISTER, but the size and complexity of the plan may militate against its publication. At the very least, the plan will be available for review at appropriate EPA and State offices. Notice of its availability will be published in the FEDERAL REGISTER, and 60 days will be allowed for public review and comment.

(i) Add a new subsection stating that EPA will promulgate standards if the States fail to do so as prescribed in this regulation.

Section 303 of the Federal Water Pollution Control Act provides for promulgation by EPA where the States fail to adopt standards requested by the Administrator, or where the Administrator determines Federal promulgation is necessary to carry out the purposes of the Act. EPA's responsibility to promulgate standards if the States fail to do so is thus expressed in the statute itself; the Agency does not believe that recitation of the statutory duty in this particular rulemaking is necessary.

(5) The American Farm Bureau Federation, California Farm Bureau Federation, Nevada Farm Bureau Federation, and the New Mexico Farm and Livestock Bureau believe that standards should not be set until further evaluation of the problems and opportunities for control are completed.

EPA believes that adequate information is available for setting standards and formulating controls, and while it recognizes that additional work is needed on specific aspects of solutions, it believes that further delay without any action is not appropriate.

Records of the hearings and comments received by letter during the review period are available for public inspection at the regional offices of the Environmental Protection Agency at 1860 Lincoln Street in Denver, Colorado, at 100 California Street in San Francisco, California, at 1600 Patterson Street in Dallas, Texas, and at the Environmental Protection Agency Freedom of Information Center at 401 M Street SW in Washington, D.C.

This regulation sets forth a policy of maintaining salinity concentrations in the lower main stem of the Colorado River at or below 1972 average levels and requires the Colorado River System States to promulgate water quality standards and a plan for meeting the standards. The first step will be the establishment of procedures within 30 days of the effective date of these regulations which will lead to adoption on or before October 18, 1975, of water quality standards for silinity including numeric criteria and an implementation plan for salinity control.

Except as provided in this regulation, the interstate and intrastate standards previously adopted by the States of Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming and approved by the Environmental Protection

Agency are the effective water quality standards under section 303 of the Act for interstate and intrastate waters within those States. Where the regulations set forth below are inconsistent with the referenced state standards, these regulations will supersede such standards to the extent of the inconsistency.

In consideration of the foregoing, 40 CFR Part 120 is amended as follows:

1. Section 120.5 is added to read as set forth below:

§ 120.5 Colorado River System Salinity Standards and Implementation Plan.

(a) "Colorado River System" means that portion of the Colorado River and its tributaries within the United States of America.

(b) It shall be the policy that the flow weighted average annual salinity in the lower main stem of the Colorado River System be maintained at or below the average value found during 1972. To carry out this policy, water quality standards for salinity and a plan of implementation for salinity control shall be developed and implemented in accordance with the principles of paragraph (c) below.

(c) The States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming are required to adopt and submit for approval to the Environmental Protection Agency on or before October 18, 1975:

(1) Adopted water quality standards for salinity including numeric criteria consistent with the policy stated above for appropriate points in the Colorado River System; and,

(2) A plan to achieve compliance with these standards as expeditiously as practicable providing that:

(i) The plan shall identify State and Federal regulatory authorities and programs necessary to achieve compliance with the plan.

(ii) The salinity problem shall be treated as a basinwide problem that needs to be solved in order to maintain lower main stem salinity at or below 1972 levels while the basin States continue to develop their compact apportioned waters.

(iii) The goal of the plan shall be to achieve compliance with the adopted standards by July 1, 1983. The date of compliance with the adopted standards shall take into account the necessity for Federal salinity control actions set forth in the plan. Abatement measures within the control of the States shall be implemented as soon as practicable.

(iv) Salinity levels in the lower main stem may temporarily increase above the 1972 levels if control measures to offset the increases are included in the control plan. However, compliance with 1972 levels shall be a primary consideration.

(v) The feasibility of establishing an interstate institution for salinity management shall be evaluated.

(d) The States are required to submit to the respective Environmental Protection Agency Regional Administrator established procedures for achieving (c) (1) and (c) (2) above within 30 days of the effective date of these regulations and to submit progress reports quarterly thereafter. EPA will on a quarterly basis determine the progress being made in the development of salinity standards and the implementation plan.

§ 120.10 [Amended]

§ 120.10 is amended by adding to the paragraphs entitled "Arizona", "California", "Colorado", "Nevada", "New Mexico", "Utah", and "Wyoming" a salinity control policy and procedures and requirements for establishing water quality standards for salinity control in the Colorado River System.

(Sec. 303, Pub. L. 92-500, 86 Stat. 816 (33 U.S.C. 1313))

Effective date: December 18, 1974.

Dated: December 11, 1974.

A P P E N D I X B

Guidelines Adopted by States at Early Sessions of the Conference in the Matter of the Pollution of the Interstate Waters of the Colorado River and Its Tributaries

GUIDELINES FOR FORMULATING WATER QUALITY STANDARDS FOR THE INTERSTATE WATERS OF THE COLORADO RIVER SYSTEM*

January 13, 1967

General Considerations

Past and future economic growth of the States served by the Colorado River System** has been and will continue to be dependent upon the development and utilization of its water resources. Appropriate water quality standards will enhance this development by protecting the quality and productivity of the System's waters. Such standards will not be used to restrict reasonable use and development of each State's apportionment of water in the Colorado River System***. Nothing herein is intended to construe the Colorado River Compacts***.

The System's interstate waters are used for municipal and industrial supplies, irrigation, fish and wildlife, and recreation. Maximum effort must be directed toward maintaining the highest possible water quality for these uses consistent with reasonable beneficial future development and utilization of all resources within States served by the System.

In order to develop practicable and reasonable quality standards for interstate waters of the Colorado River System, full consideration must be given to the numerous factors and variables connected with the control, development, utilization, conservation, and protection of the System's water resources. It is evident that future development and utilization of the System's water resources for expansion of irrigated agriculture, increases in population, and industrial growth will be accompanied by progressive increases in consumptive losses of water and attendant increases in concentrations of dissolved solids.

In view of the anticipated increase in consumptive use of water, augmentation of the Colorado River is essential just to maintain the existing water quality. Enhancement, as contemplated by the Guidelines of the Federal Water Pollution Control Administration, of the present water quality of the Lower Colorado River is most practicable by a major water augmentation program. One objective of a major water augmentation program would be to approach the limits for total dissolved solids, chlorides, and sulfates recommended by the U. S. Public Health Service Drinking Water Standards of 1962.

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*Developed by the State Conferees in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries at a series of meetings during 1966 and 1967, in the interest of compatible State water quality standards. Several water resource interests of each State were involved in most meetings, particularly the last two, held in Scottsdale, Arizona on December 7, 1966 and January 13, 1967.

**The Colorado River and all those streams contributing water thereto.

***California and Nevada do not agree with these two sentences, but propose that there be further negotiations and discussions to resolve this issue.

Basic Principles

1. The States served by the Colorado River System recognize that answers to important questions regarding total dissolved solids, chlorides, sulfates and sodium are lacking or are based on factors that are not yet well defined. In respect of this recognition the States agree that pending the development of acceptable answers to enable the setting of criteria for total dissolved solids, chlorides, sulfates and sodium for the interstate waters of the Colorado River System, such criteria should be stated in qualitative terms. At the same time it is agreed that all identifiable sources of water pollution will be managed and controlled to the maximum degree practicable with available technology in order to provide water quality suitable for present and potential future uses of the System's interstate waters.

2. Reviews of all available technical knowledge* pertaining to the water quality problem and evaluation of new pollution potentials will be made at intervals of not greater than 3 years by representatives of the seven System States with the view and intent of improving, strengthening, or otherwise modifying the quality standards.

3. Monitoring of the quality of interstate waters will be carried out at designated points near State lines and other key locations for all constituents covered by the standards. In addition, measurements will be made at these locations for total dissolved solids, sulfates, chlorides, and sodium.

4. Any State may convene a meeting of all seven States to discuss remedies in those instances where the quality of water available to that State has been adversely affected or threatened by pollutants discharged into the Colorado River System.

Minimum Quality Criteria Applicable to Interstate Waters at Agreed State Line Sampling Points

1. Free from substances attributable to domestic or industrial waste or other controllable sources that will settle to form sludge or bottom deposits in amounts sufficient to be unsightly, putrescent or odorous, or in amounts sufficient to interfere with any beneficial use of the water.

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*During the periodic reviews of technical knowledge full consideration will be given to all new technological or other developments and research which may be utilized to upgrade the standards to provide for the protection and enhancement of water quality. This will include possibilities such as: (1) importation of water of better quality from outside the System; (2) control or management of natural sources of salinity; (3) reduction of total dissolved solids in irrigation return flows through reasonable and practicable means; and (4) other suitable measures.

2. Free from floating debris, oil, grease, scum, and other floating materials attributable to domestic or industrial waste or other controllable sources in amounts sufficient to be unsightly or in amounts sufficient to interfere with any beneficial use of the water.

3. Free from materials attributable to domestic or industrial waste or other controllable sources in amounts sufficient to produce taste or odor in the water or detectable off-flavor in the flesh of fish, or in amounts sufficient to change the existing color, turbidity or other conditions in the receiving stream to such degree as to create a public nuisance, or in amounts sufficient to interfere with any beneficial use of the water.

4. Free from high temperature, biocides, organisms pathogenic to human beings, toxic, corrosive, or other deleterious substances attributable to domestic or industrial waste or other controllable sources at levels or combinations sufficient to be toxic to human, animal, plant or aquatic life or in amounts sufficient to interfere with any beneficial use of the water.

5. Radioactive materials attributable to municipal, industrial or other controllable sources shall be minimum concentrations which are physically and economically feasible to achieve. In no case shall such materials exceed the limits established in the 1962 Public Health Service Drinking Water Standards or 1/10 of the 168-hr values for other radioactive substances specified in National Bureau of Standards Handbook 69.

6. No wastes from municipal or industrial or other controllable sources containing arsenic, barium, boron, cadmium, chromium, cyanide, fluoride, lead, selenium, silver, copper and zinc that are reasonably amenable to treatment or control will be discharged untreated or uncontrolled into the Colorado River System. At agreed points of sampling above Imperial Dam in the Colorado River System the limits for concentrations of these chemical constituents will be set at values that recognize their cumulative effects and which will provide River Water quality consistent with the mandatory requirements of the 1962 Public Health Service Drinking Water Standards.

7. The dissolved oxygen content and pH value of the waters of the Colorado River System shall be maintained at levels necessary to support the natural and developed fisheries.

A P P E N D I X C

Resolution of the State Conferees at the Seventh Session and the Conclusions and Recommendations of the Reconvened Seventh Session of the Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries

Resolution of the State Conferees at the Seventh Session of the Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries - Colorado, New Mexico, California, Nevada, Wyoming and Utah, held at Las Vegas, Nevada February 15-17, 1972

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NOW, THEREFORE, BE IT RESOLVED by the conferees of California, Arizona, Nevada, New Mexico, Colorado, Utah and Wyoming that:

1) a salinity policy be adopted for the Colorado River system that would have as its objective the maintenance of salinity concentrations at or below levels presently found in the lower main stem;

2) in implementing the salinity policy objective for the Colorado River system the salinity problem be treated as a basinwide problem that needs to be solved to maintain Lower Basin water salinity at or below present levels while the Upper Basin continues to develop its compact-apportioned water, recognizing that salinity levels may rise until control measures are made effective;

3) to guard against any rise in salinity the Congress and the Administration be urged to accelerate the entire salinity control program and, in particular, to augment the F.Y. 1973 budgeted amount of $1,005,000; and

4) the Bureau of Reclamation have the primary

responsibility for investigating, planning, and implementing the basinwide salinity control program in the Colorado River system;

5) the Environmental Protection Agency continue its support of the program by a) consulting with and advising the Bureau of Reclamation, b) accelerating its ongoing data collection and research efforts, and c) transferring funds to the Bureau of Reclamation;

6) the Office of Saline Water contribute to the program by assisting the Bureau of Reclamation as required to appraise the practicability of applying desalting techniques; and

7) the adoption of numerical criteria be deferred until the potential effectiveness of Colorado River salinity control measures is better known;

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Conclusions and Recommendations of the Conferees at the Reconvened Seventh Session of the Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries in the States of California, Colorado, Utah, Arizona, Nevada, New Mexico, and Wyoming, held in Denver, Colorado, April 26-27, 1972

I. It is recommended that:

A salinity policy be adopted for the Colorado River system that would have as its objective the maintenance of salinity concentrations at or below levels presently found in the lower main stem. In implementing the salinity policy objective for the Colorado River system, the salinity problem must be treated as a basinwide problem that needs to be solved to maintain Lower Basin water salinity at or below present levels while the Upper Basin continues to develop its compact-apportioned waters.

II. The salinity control program as described by the Department of the Interior in their report entitled "Colorado River Water Quality Improvement Program," dated February 1972, offers the best prospect for implementing the salinity control objective adopted herein. Therefore, it is recommended that:

1) to minimize salinity increases in the river, a salinity control program, generally as described in the Interior Department report, be implemented on an accelerated basis;

2) the Bureau of Reclamation have the primary responsibility for investigation, planning and implementing the basin-wide salinity control program in the Colorado River system;

3) to accelerate the salinity control program, the Bureau of Reclamation assign a high priority to LaVerkin Springs, Paradox Valley, and Grand Valley water quality improvement projects with the objective of achieving stabilization of salinity levels on the Lower Colorado River at the earliest possible date. The contemplated impact would be to initiate immediate action so as to achieve, by 1977, the removal of 80,000 tons of salt per year from LaVerkin Springs, 180,000 tons per year from Paradox Valley, and 140,000 tons per year from Grand Valley. This would provide a total reduction of 400,000 tons per year and would result in an estimated subsequent reduction of 33 mg/l at Imperial Dam.

4) the Office of Saline Water contribute to the program by assisting the Bureau of Reclamation as required to appraise the practicability of applying desalting techniques; and

5) the Environmental Protection Agency continue its support of the program by consulting with and advising the Bureau of Reclamation and accelerating its ongoing data collection and research efforts.

III. To achieve the salinity policy described herein, the long range program of the Bureau of Reclamation shall be directed toward achieving reduction of salinity concentrations that would otherwise exist at Imperial Dam to the extent of at least 120 mg/l in 1980, 355 mg/l in 1990 and 405 mg/l in the year 2000.

The conferees agree that the Bureau of Reclamation's program as submitted in its report "Colorado River Water Quality Improvement Program," dated February 1972, should be considered as an open-ended and flexible program. If alternatives not yet identified prove to be more feasible, they should be included as part of the program, and if ele-

ments now included prove not to be feasible, they should be dropped. In addition, it should be recognized that there may be other programs which could reduce the river's salinity. Since present levels are greater than desirable, an effort should be made to develop additional programs that will obtain lower salinity levels.

The February 1972 report states that the Bureau of Reclamation Mathematical Simulation Model for the Colorado River system will be used to evaluate the Water Quality Improvement Program. This will be an important tool to evaluate the program's progress. The results of this evaluation along with the general program progress should be reported annually to the conferees and other interested State agencies.

A P P E N D I X D

Statement of Position Adopted by Basin States on November 9, 1973

Statement of Position Adopted by Basin States on November 9, 1973. Contained in Letter of November 26, 1973, from Lynn M. Thatcher, Chairman, Colorado River Basin Salinity Control Forum, to Paul DeFalco, Jr., Regional Administrator, Region IX, Environmental Protection Agency

"The States agree that salinity criteria for the Colorado River Basin would be useful in the final formulation of a salinity control program such as would be undertaken by enactment of pending Congressional Bills, H.R. 7774, H.R. 7775, and S. 1807, and agree further that the States must cooperate with the Federal government and each other in support of such legislation which would implement the Conclusions and Recommendations published in the proceedings of the Reconvened Seventh Session of the Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries in the States of California, Colorado, Utah, Arizona, Nevada, New Mexico, and Wyoming, held in Denver, Colorado on April 26-27, 1972, under authority of section 10 of the Federal Water Pollution Control Act (33 U.S.C. 1160), and approved by the Administrator of the Environmental Protection Agency on June 9, 1972.

"The States have established a mechanism for interstate cooperation (Colorado River Basin Salinity Control Forum) and

for preparation of semi-annual reports on the development of numeric criteria and the adoption of such criteria by October 18, 1975.

"As was concluded by resolution of the Colorado River Basin States Conferees of the Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries held in Las Vegas, Nevada and the Reconvened Seventh Session held in Denver, implementation of the Colorado River Salinity Control Program generally as described in the report of the Secretary of the Interior entitled, 'Colorado River Water Quality Improvement Program, February 1972' would carry out the most appropriate plan of implementation for salinity control for the Colorado River system. The appropriate objective of the project is the maintenance of salinity at or below levels found in the lower main stem as of April 1972, while the Upper Basin States continue to develop their compact-apportioned waters.

"The seven States concur in the goal of compliance with the adopted criteria by July 1983, with the understanding that the levels of the criteria and the date of compliance are to be conditioned on the degree of effectuation of the Colorado River Salinity Control Program and other Federal, State, and local programs and the understanding that the criteria will not be used to delay or interfere with any State's development of its compact-apportionment of the waters of the Colorado River."

A P P E N D I X E

Identified Salt Sources in the Colorado River Basin

Table 1. Salt Load Contributions From Major Point Sources in Colorado River Basin

Source	EPA 1971 Salt Load (Tons/Day)	Revised* USBR 1974
Green River Subbasin		
Warm Kendall Spring	18	
Cold Kendall Spring	8	
Coal Mine Drainage near Oak Creek, Colorado	6	
Steamboat Springs Mineral Springs	24	
Jones Hole Creek-Whirlpool Canyon	21	
Split Mountain Warm Springs	51	
Test Hole near Jensen, Utah	1	
Stinking Spring	1	
Indian Creek Springs	3	
Meeker Oil Test Hole	160	
Piceance Creek Well	17	
Crystal Geyser	53	8
Total	363	
Upper Main Stem		
Hot Sulphur Springs	0	
Dotsero Spring	440	
Glenwood Springs Area	920	
Ouray Hot Springs	4	
Ridgeway Hot Springs	7	
Paradise Hot Spring	2	
Paradox Valley	688	550
Total	2,061	
San Juan Subbasin		
Pagosa Hot Springs	20	
Pinkerton Hot Spring	5	
Total	25	
Lower Colorado River Basin		
Blue Springs	1,500	
Miscellaneous small springs above Grand Canyon	10	
Vulcan or Lava Falls Spring	10	
Miscellaneous springs above Virgin River	21	
Havasu Spring	65	
LaVerkin Spring	286	300
Littlefield Salt Springs	81	46
Rogers Spring	17	
Total	1,990	

Source: "The Mineral Quality Problem in the Colorado River Basin, Appendix A, Natural and Man-Made Conditions Affecting Mineral Quality", by the Environmental Protection Agency, 1971.

* Revised by recent USBR studies.

Table 2. Salt Loads From Principal Industrial Sources, Colorado River Basin

Source	Salt Load (Tons/Day)
Green River Subbasin	
Flood Wash near Wellington, Utah	13
Iles Dome Oil Field water, Colorado	17
Ashley Valley Oil Field water, Utah	32
Total	62
Upper Main Stem	
New Jersey Zinc tailings decant, Gilman, Colorado	10
Union Carbide uranium mill effluent, Rifle, Colorado	40
Climax uranium mill effluent, Grand Junction, Colorado	35
American Gilsonite refinery effluent, Fruita, Colorado	9
Union Carbide uranium mill effluent, Uravan, Colorado	119
Atlas Mineral Corporation uranium mill effluent, Moab, Utah	36
Total	249
San Juan Subbasin	
Four Corners Power Plant, Shiprock, New Mexico	35
Foote Mineral Corporation uranium mill effluent Shiprock, New Mexico*	11
Total	46

Source: "The Mineral Quality Problem in the Colorado River Basin, Appendix A, Natural and Man-Made Conditions Affecting Mineral Quality", by the Environmental Protection Agency, 1971.

* Mill out of operation for several years.

A P P E N D I X F

Historical Streamflow and Quality of Water Data for the Colorado River Basin

Table 1
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Cisco, Utah
(Annual Summary)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1941	7,067	.80	588	5,653
1942	7,098	.77	568	5,483
1943	5,214	.86	634	4,498
1944	5,840	.74	546	4,336
1945	5,504	.76	562	4,210
1946	4,058	.91	667	3,680
1947	6,258	.73	539	4,587
1948	6,291	.74	542	4,636
1949	6,338	.75	555	4,783
1950	4,074	.94	690	3,823
1951	3,986	.94	693	3,758
1952	7,718	.66	482	5,063
1953	4,062	.97	714	3,944
1954	2,293	1.44	1,060	3,299
1955	3,185	1.07	789	3,420
1956	3,568	.96	706	3,428
1957	8,888	.63	463	5,602
1958	6,044	.72	529	4,348
1959	3,214	1.08	796	3,481
1960	4,002	.87	642	3,493
1961	3,395	1.05	770	3,556
1962	6,576	.68	501	4,484
1963	2,585	1.31	962	3,384
1964	3,433	1.06	779	3,639
1965	6,722	.73	535	4,892
1966	3,163	1.10	807	3,471
1967	3,146	1.14	842	3,602
1968	4,185	.92	680	3,869
1969	4,906	.77	565	3,777
1970	5,987	.67	495	4,032
1971	5,458	.70	512	3,801
1972	3,485	.96	708	3,358
1973	6,374	.71	522	4,531
Total	164,117			135,921
Average	4,973	.83	610	4,119

Table 2

Colorado River Basin
Historical Flow and Quality of Water Data
Green River at Green River, Utah
(Annual Summary)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg/l)	T.D.S. (Tons)
1941	4,608	.71	522	3,271
1942	4,622	.65	475	2,989
1943	4,294	.60	439	2,565
1944	4,417	.58	430	2,582
1945	4,260	.60	441	2,558
1946	3,519	.61	449	2,148
1947	5,523	.54	398	2,991
1948	3,928	.58	425	2,270
1949	5,129	.59	435	3,039
1950	5,476	.59	433	3,223
1951	4,738	.60	442	2,847
1952	6,712	.62	457	4,172
1953	3,334	.67	491	2,225
1954	2,638	.68	503	1,807
1955	2,791	.62	456	1,733
1956	4,021	.51	374	2,045
1957	5,808	.53	387	3,060
1958	4,212	.57	422	2,421
1959	2,884	.62	459	1,802
1960	2,864	.57	422	1,645
1961	2,265	.64	471	1,450
1962	5,601	.55	404	3,077
1963	1,576	.79	579	1,241
1964	3,242	.63	463	2,044
1965	5,211	.65	481	3,412
1966	2,966	.76	560	2,260
1967	4,227	.77	566	3,257
1968	4,589	.70	517	3,225
1969	5,022	.70	515	3,518
1970	3,984	.62	456	2,470
1971	4,319	.57	419	2,461
1972	4,185	.63	461	2,626
1973	5,193	.65	474	3,352
Total	138,158			85,786
Average	4,187	.62	456	2,600

Table 3
Colorado River Basin
Historical Flow and Quality of Water Data
San Rafael River near Green River, Utah
(Annual Summary)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1941	139	1.9	1,420	268
1942	137	2.1	1,530	286
1943	73	2.9	2,140	213
1944	149	1.8	1,300	263
1945	85	2.5	1,850	214
1946	69	3.1	2,310	217
1947	111	2.6	1,900	287
1948	62	2.7	1,960	165
1949	135	2.0	1,490	274
1950	53	3.2	2,370	171
1951	75	2.7	2,020	206
1952	314	1.5	1,090	466
1953	81	2.9	2,130	235
1954	36	3.8	2,800	137
1955	29	3.5	2,560	101
1956	33	2.6	1,940	87
1957	189	1.7	1,280	330
1958	172	1.5	1,080	252
1959	21	3.9	2,840	81
1960	46	2.6	1,890	118
1961	48	3.3	2,390	156
1962	112	1.8	1,300	198
1963	46	3.5	2,600	163
1964	57	2.7	2,020	157
1965	184	1.8	1,310	329
1966	33	4.0	2,960	133
1967	54	3.1	2,250	165
1968	72	3.0	2,240	219
1969	133	2.1	1,514	274
1970	98	2.3	1,679	224
1971	42	4.0	2,905	166
1972	32	4.2	3,078	134
1973	135	2.2	1,590	292
				6,981
Total	3,055			
Average	93	2.3	1,675	212

Table 4
Colorado River Basin
Historical Flow and Quality of Water Data
San Juan River near Bluff, Utah
(Annual Summary)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1941	4,899	.54	394	2,625
1942	2,247	.53	388	1,185
1943	1,494	.64	472	959
1944	2,291	.48	353	1,101
1945	1,588	.59	433	935
1946	887	.77	564	681
1947	1,677	.65	476	1,087
1948	2,140	.46	335	976
1949	2,487	.47	345	1,168
1950	854	.68	498	579
1951	691	.79	579	544
1952	2,554	.45	333	1,156
1953	967	.73	533	701
1954	1,011	.77	566	779
1955	910	.73	539	667
1956	838	.64	469	535
1957	2,909	.51	378	1,498
1958	2,298	.49	357	1,116
1959	712	.81	597	578
1960	1,607	.53	387	847
1961	1,264	.66	486	836
1962	1,480	.59	436	877
1963	579	1.10	806	635
1964	795	.98	722	781
1965	2,546	.54	398	1,379
1966	1,548	.64	473	996
1967	791	1.05	772	831
1968	1,060	.82	606	874
1969	1,938	.63	460	1,215
1970	1,524	.63	440	954
1971	1,182	.77	563	906
1972	1,260	.81	593	1,016
1973	2,897	.59	434	1,709
Total	53,925			32,226
Average	1,634	.61	446	992

TABLE 5

COLORADO RIVER BASIN
HISTORICAL FLOW AND QUALITY OF WATER DATA
COLORADO RIVER AT LEES FERRY, ARIZONA
(Annual Summary)
Units--1000

Calendar Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. Tons
1941	17,857	.70	514	12,481
1942	14,793	.63	466	9,381
1943	11,413	.73	539	8,375
1944	13,019	.65	481	8,525
1945	11,769	.72	531	8,501
1946	8,751	.84	617	7,346
1947	14,046	.68	498	9,513
1948	12,885	.66	487	8,531
1949	14,604	.68	501	9,954
1950	10,802	.75	551	8,098
1951	9,901	.79	581	7,833
1952	17,903	.64	468	11,396
1953	8,729	.86	630	7,485
1954	6,165	1.04	761	6,386
1955	6,966	.94	691	6,548
1956	8,658	.75	553	6,513
1957	18,700	.68	497	12,646
1958	13,139	.71	519	9,280
1959	7,061	.96	704	6,766
1960	8,790	.81	593	7,092
1961	7,314	.97	710	7,065
1962	14,439	.71	525	10,319
1963	1,384	1.27	934	1,758
1964	3,243	1.10	811	3,578
1965	11,585	.78	572	9,008
1966	7,739	.70	517	5,439
1967	7,560	.84	621	6,387
1968	8,782	.88	647	7,725
1969	9,078	.87	640	7,907
1970	8,149	.85	628	6,960
1971	9,259	.78	575	7,245
1972	9,345	.77	566	7,208
1973	9,019	.83	609	7,471
Total	342,847			260,720
Average	10,389	.76	559	7,901

TABLE 6

COLORADO RIVER BASIN
HISTORICAL FLOW AND QUALITY OF WATER DATA
COLORADO RIVER BELOW HOOVER DAM, ARIZONA, NEVADA
(Annual Summary)
Units--1000

Calendar Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. Tons
1941	14,889	1.00	735	14,897
1942	15,762	.98	717	15,381
1943	12,715	.90	665	11,502
1944	14,427	.94	693	13,607
1945	12,512	.92	676	11,512
1946	10,585	.91	668	9,626
1947	10,959	.94	690	10,283
1948	13,051	.90	660	11,713
1949	13,566	.83	610	11,250
1950	12,016	.84	614	10,046
1951	9,870	.91	671	9,005
1952	15,816	.85	623	13,401
1953	11,302	.89	656	10,093
1954	10,514	.94	693	9,913
1955	8,589	1.09	804	9,393
1956	7,812	1.14	839	8,918
1957	9,323	1.04	763	9,681
1958	11,877	.86	634	10,243
1959	9,282	.84	621	7,841
1960	8,997	.91	671	8,209
1961	8,586	.95	697	8,139
1962	8,615	.93	685	8,033
1963	8,533	.92	677	7,882
1964	8,163	.98	722	8,014
1965	7 792	1.10	809	8,574
1966	7,777	1.01	743	7,857
1967	7,932	.92	675	7,282
1968	7,839	.95	699	7,457
1969	7,892	1.01	744	7,990
1970	8,023	1.01	745	8,128
1971	8,164	1.02	747	8,297
1972	8,099	.98	723	7,962
1973	8,301	.96	706	7,967
Total	339,580			320,096
Average	10,290	.94	693	9,700

TABLE 7

COLORADO RIVER BASIN
HISTORICAL FLOW AND QUALITY OF WATER DATA
COLORADO RIVER BELOW PARKER DAM, ARIZONA - CALIFORNIA
(Annual Summary)
Units--1000

Calendar Year	Flow (A.F.)	Concentrations (T./A.F.)	Concentrations (Mg./l)	T.D.S. (Tons)
1941	14,749	1.05	772	15,486
1942	15,195	.99	730	15,088
1943	12,079	.92	676	11,113
1944	13,842	.93	687	12,941
1945	12,033	.92	678	11,089
1946	10,141	.93	682	9,404
1947	10,663	.94	688	9,980
1948	12,651	.90	664	11,431
1949	13,060	.84	619	10,998
1950	10,473	.86	633	9,013
1951	8,672	.90	660	7,781
1952	15,413	.86	629	13,182
1953	10,649	.86	632	9,160
1954	9,671	.91	669	8,801
1955	8,141	1.04	763	8,449
1956	6,869	1.12	824	7,697
1957	7,997	1.06	781	8,494
1958	10,892	.89	651	9,646
1959	8,186	.85	622	6,924
1960	7,794	.88	644	6,826
1961	6,975	.93	682	6,472
1962	7,159	.97	714	6,950
1963	7,251	.94	695	6,852
1964	6,651	.94	689	6,242
1965	6,356	1.07	784	6,786
1966	6,683	1.05	774	7,042
1967	6,322	.98	717	6,167
1968	6,643	.95	699	6,323
1969	6,438	1.01	745	6,529
1970	6,659	1.03	756	6,845
1971	6,911	1.03	761	7,149
1972	6,789	1.02	747	6,897
1973	6,846	.99	726	6,761
Total	306,851			290,514
Average	9,299	.95	696	8,803

TABLE 8

COLORADO RIVER BASIN
HISTORICAL FLOW AND QUALITY OF WATER DATA
COLORADO RIVER AT IMPERIAL DAM, ARIZONA - CALIFORNIA
(Annual Summary)
Units--1000

Calendar Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1941	14,024	1.07	785	14,980
1942	14,714	1.08	795	15,917
1943	11,345	.94	692	10,679
1944	13,205	.95	698	12,545
1945	11,390	.95	700	10,841
1946	9,486	.95	701	9,041
1947	10,041	.97	711	9,711
1948	12,036	.93	687	11,242
1949	12,567	.88	649	11,104
1950	9,906	.90	659	8,887
1951	8,053	.96	709	7,764
1952	14,815	.91	669	13,485
1953	10,045	.94	689	9,411
1954	9,030	1.00	735	9,024
1955	7,708	1.14	839	8,797
1956	6,266	1.25	918	7,828
1957	7,344	1.17	860	8,598
1958	10,500	1.01	744	10,626
1959	7,695	1.02	749	7,843
1960	7,107	1.06	777	7,511
1961	6,293	1.12	820	7,020
1962	6,458	1.11	818	7,189
1963	6,522	1.08	791	7,016
1964	5,900	1.12	824	6,616
1965	5,703	1.25	916	7,109
1966	5,849	1.22	896	7,133
1967	5,615	1.15	842	6,430
1968	5,741	1.15	846	6,611
1969	5,616	1.20	880	6,726
1970	5,705	1.21	886	6,877
1971	5,829	1.20	885	7,010
1972	5,797	1.20	879	6,929
1973	5,856	1.15	846	6,742
Total	284,161			295,242
Average	8,611	1.04	764	8,947

COLORADO RIVER BASIN

HISTORICAL FLOW AND QUALITY OF WATER DATA

COLORADO RIVER AT HOOVER DAM, NEVADA - ARIZONA

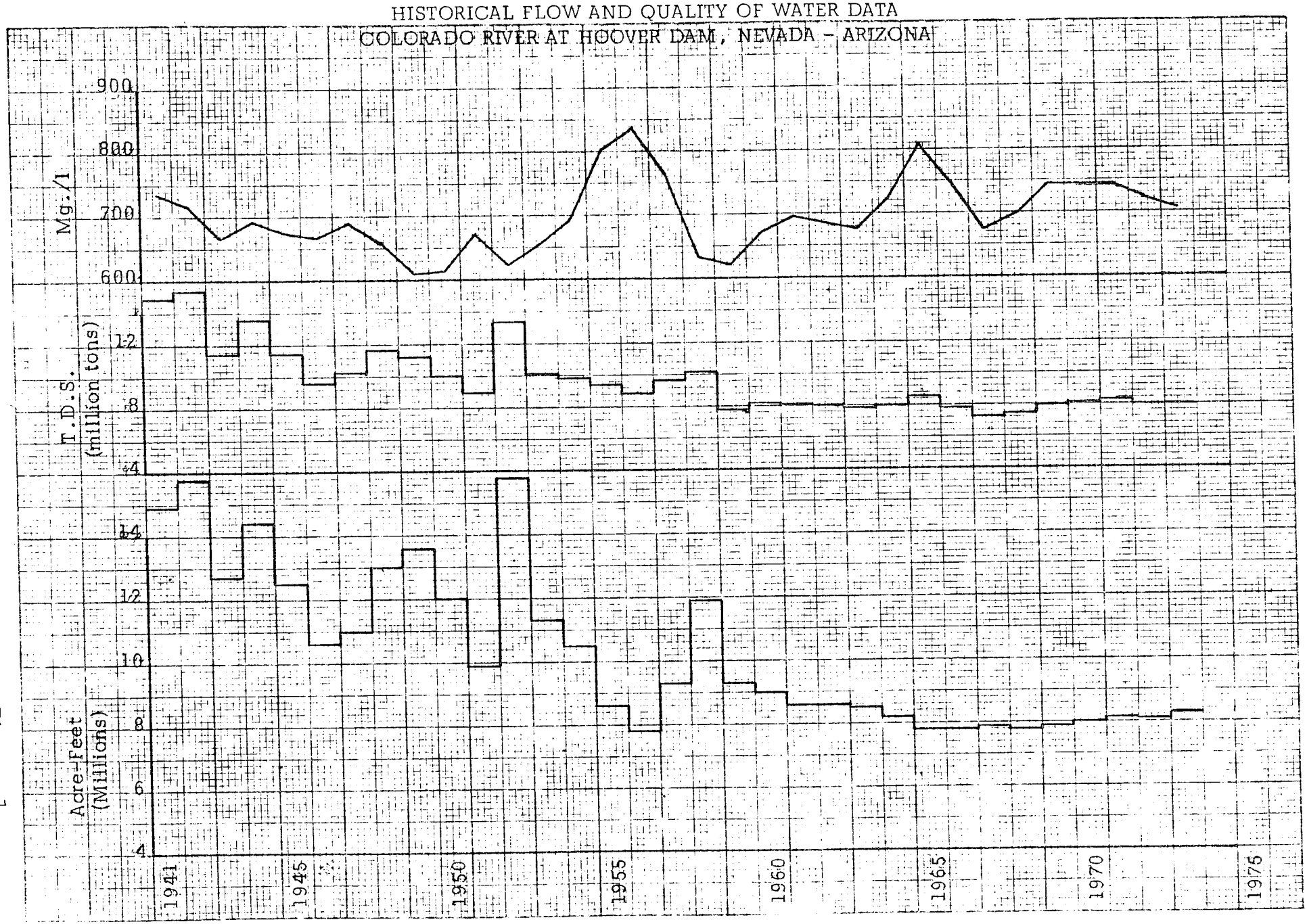


Fig. 1

Figure 1

COLORADO RIVER BASIN

HISTORICAL FLOW AND QUALITY OF WATER DATA

COLORADO RIVER BELOW PARKER DAM, ARIZONA - CALIFORNIA

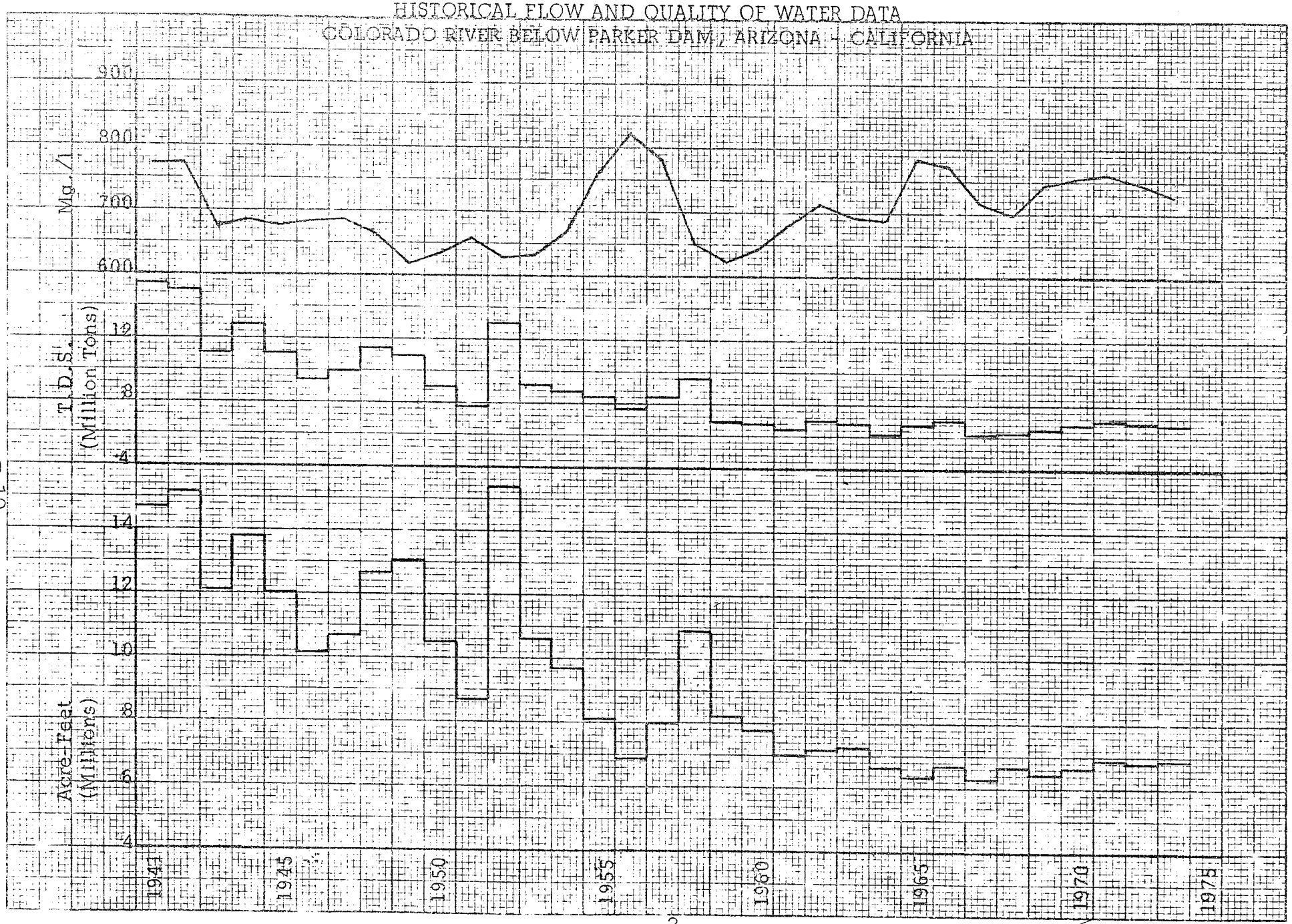


Fig. 2

Figure 2

COLORADO RIVER BASIN

HISTORICAL FLOW AND QUALITY OF WATER DATA

COLORADO RIVER AT IMPERIAL DAM, ARIZONA - CALIFORNIA

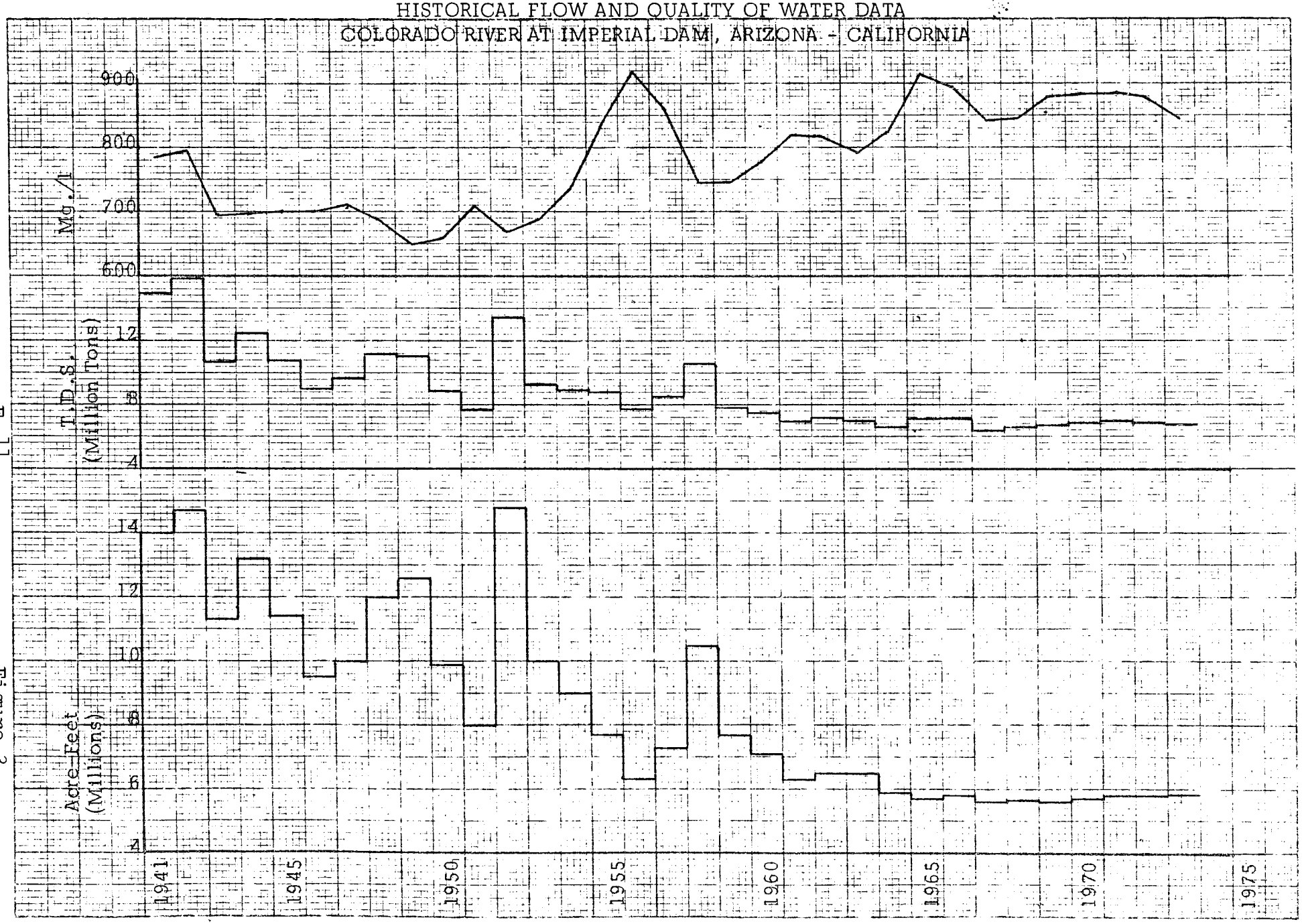


Fig. 3

Figure 3

TABLE 1

SUMMARY ESTIMATED TOTAL USE *
COLORADO RIVER BASIN

(Thousands of Acre Feet Per Year)

By State	YEAR 1973 Base Condition	YEAR 1980 Low	YEAR 1980 Moderate	YEAR 1980 High	YEAR 1985 Low	YEAR 1985 Moderate	YEAR 1985 High	YEAR 1990 Low	YEAR 1990 Moderate	YEAR 1990 High
UPPER COLORADO RIVER BASIN (Depletions)										
State										
Arizona	7	42	42	47	47	47	50	47	50	50
Colorado	1,764	1,924	1,989	2,069	1,999	2,134	2,244	2,234	2,344	2,639
New Mexico	201	346	376	486	441	586	656	511	641	791
Utah	684	754	789	934	829	949	1,059	909	1,049	1,189
Wyoming	320	360	380	485	370	460	580	410	510	795
Subtotal Depletions Upper Colorado River Basin*	2,976	3,426	3,576	4,021	3,686	4,176	4,589	4,111	4,594	5,464
LOWER COLORADO RIVER BASIN (Diversions less returns)										
State										
Arizona	962**	1,072	1,132	1,192	1,182	1,677	2,822	2,800	2,800	2,800
California	5,080	4,575	4,640	4,810	4,850	4,935	5,100	4,400	4,400	4,400
Nevada	101	166	181	201	206	226	246	261	276	300
Subtotal Mainstream Diversions Less Returns-Lower Colorado River Basin	6,143	5,813	5,953	6,203	6,238	6,838	8,168	7,461	7,476	7,500
TOTAL USE - Colorado River Basin	9,119	9,239	9,529	10,224	9,924	11,014	12,757	11,572	12,070	12,964

* Does not include estimated CRSP reservoir evaporation from the Upper Colorado River Basin.
** 1973 values for Arizona are diversions less returns including estimated unmeasured return flows.

TABLE 2

ESTIMATED INCREASE IN USE OVER 1973 BASE
COLORADO RIVER
BASIN
(Thousands of Acre Feet Per Year)

Category of Uses (by State)	YEAR 1973	YEAR 1980			YEAR 1985			YEAR 1990		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
UPPER COLORADO RIVER BASIN (Depletions)										
Out of Basin Exports										
Colorado	480	125	170	200	160	200	235	220	250	250
New Mexico	46	20	20	65	40	70	70	60	70	70
Utah	118	25	25	90	50	100	155	60	155	165
Wyoming	7	0	5	20	0	50	75	15	75	125
Subtotal	651	170	220	375	250	420	535	355	550	610
In Basin Agricultural Use										
Arizona	3	0	0	5	0	0	5	0	5	5
Colorado	1,245	0	0	5	20	50	100	90	120	250
New Mexico	117	70	95	120	110	200	235	160	250	285
Utah	536	20	30	55	30	50	75	50	70	90
Wyoming	274	10	10	65	10	15	85	10	20	205
Subtotal	2,175	100	135	250	170	315	500	310	465	835
In Basin Coal Development (Including electrical power generation)										
Arizona	0	35	35	35	35	35	35	35	35	35
Colorado	20	15	20	30	10	35	35	45	50	165
New Mexico	25	55	60	100	90	105	135	90	105	210
Utah	1	25	45	90	60	100	125	110	125	185
Wyoming	13	30	30	50	35	50	65	50	60	90
Subtotal	59	160	190	305	230	325	395	330	375	685
In Basin Oil Shale										
Colorado	0	15	20	45	25	50	60	95	110	140
New Mexico	0	0	0	0	0	0	0	0	0	0
Utah	0	0	0	10	0	10	10	0	10	60
Wyoming	0	0	0	10	0	5	10	10	10	25
Subtotal	0	15	20	65	25	65	80	105	130	225

TABLE 2 (contd)

Category of Uses (by State)	YEAR 1973	YEAR 1980			YEAR 1985			YEAR 1990		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Other In Basin Uses (Fish & Wildlife & Other M&I Uses)										
Arizona	4	0	0	0	5	5	5	5	5	5
Colorado	19	5	15	25	20	35	50	20	50	70
New Mexico	13	0	0	0	0	10	15	0	15	25
Utah	29	0	5	5	5	5	10	5	5	5
Wyoming	26	0	15	20	5	20	25	5	25	30
Subtotal	91	5	35	50	35	75	105	35	100	135
Total by States *										
Arizona	7	35	35	40	40	40	45	40	45	45
Colorado	1,764	160	225	305	235	370	480	470	580	875
New Mexico	201	145	175	285	240	385	455	310	440	590
Utah	684	70	105	250	145	265	375	225	365	505
Wyoming	320	40	60	165	50	140	260	90	190	475
Total Upper Colorado River Basin	2,976	450	600	1,045	710	1,200	1,615	1,135	1,620	2,490
LOWER COLORADO RIVER BASIN (Diversions less returns)										
Out of Basin Exports										
California	4,538	-500	-450	-300	-300	-240	-100	-810	-810	-810
Subtotal	4,538	-500	-450	-300	-300	-240	-100	-810	-810	-810
In Basin Agriculture Use										
Arizona	910	110	140	170	200	500	1,600	1,558	1,558	1,558
California	541	- 30	- 20	- 10	- 10	- 5	0	0	0	0
Nevada	10	0	5	10	5	5	10	10	10	15
Subtotal	1,461	80	125	170	195	500	1,610	1,570	1,570	1,575

TABLE 3b

PROJECTED SALT LOADS AND SALINITY LEVELS WITHOUT SALINITY CONTROL MEASURES
LOWER COLORADO RIVER BASIN

Year 1985

	At Lee Ferry				Below Hoover Dam				Below Parker Dam				At Imperial Dam			
	Salt Load (1,000 tons)	Min. Flow (1000 AF)1/	Add. Comp. Flows (1000 AF)2/	Conc. (Mg/l)	Salt Load (1000 tons)	Req. Flow (1000 AF)3/	Excess Flow (1000 AF)	Conc. (Mg/l)	Salt Load (1000 tons)	Req. Flow (1000 AF)3/	Excess Flow (1000 AF)	Conc. (Mg/l)	Salt Load (1000 tons)	Req. Flow (1000 AF)3/	Excess Flow (1000 AF)	Conc. (Mg/l)
Low Depletion																
Average Annual Flow*																
12 maf	7,416	8,232	0	662	8,520	7,776	0	810	7,572	6,672	0	834	7,656	5,520	0	1,020
13 maf	7,128	8,232	0	632	8,328	7,776	0	788	7,344	6,672	0	810	7,440	5,520	0	991
14 maf	7,920	8,232	1,380	606	9,648	7,776	1,656	752	8,736	6,672	1,656	771	8,784	5,520	1,644	902
15 maf	8,436	8,232	2,376	585	10,248	7,776	2,700	719	9,396	6,672	2,712	736	9,432	5,520	2,700	844
16 maf	8,952	8,232	3,372	567	10,848	7,776	3,756	692	10,044	6,672	3,756	708	10,080	5,520	3,744	800
Moderate Depletion																
Average Annual Flow*																
12 maf	7,836	8,232	0	700	9,776	8,676	0	829	7,920	6,792	0	857	8,016	5,580	0	1,056
13 maf	7,596	8,232	0	664	9,576	8,676	0	802	7,560	6,792	0	830	7,728	5,580	0	1,019
14 maf	7,896	8,232	924	634	9,624	8,676	504	771	7,884	6,792	504	794	8,004	5,580	504	967
15 maf	8,424	8,232	1,920	610	10,068	8,676	1,368	737	8,424	6,792	1,368	759	8,484	5,580	1,368	898
16 maf	8,940	8,232	2,916	590	10,704	8,676	2,412	710	9,132	6,792	2,424	729	9,168	5,580	2,412	844
High Depletion																
Average Annual Flow*																
12 maf	8,508	8,232	0	760	11,088	9,360	0	871	8,592	7,020	0	900	8,700	5,748	0	1,113
13 maf	8,256	8,232	0	714	10,632	9,360	0	835	8,232	7,020	0	862	8,340	5,748	0	1,067
14 maf	8,280	8,232	0	677	10,236	9,360	0	804	7,932	7,020	0	831	8,040	5,748	0	1,028
15 maf	8,592	8,232	1,512	648	10,260	9,360	420	771	8,040	7,020	420	794	8,124	5,748	420	969
16 maf	9,144	8,232	2,520	625	10,788	9,360	1,344	741	8,676	7,020	1,344	763	8,748	5,748	1,344	907

*Average virgin flow at Lee's Ferry

APPENDIX C

Baseline Values
Flow/Salinity Data
Based on 1972 Level
of Development at
Selected Stations

Figure C-1

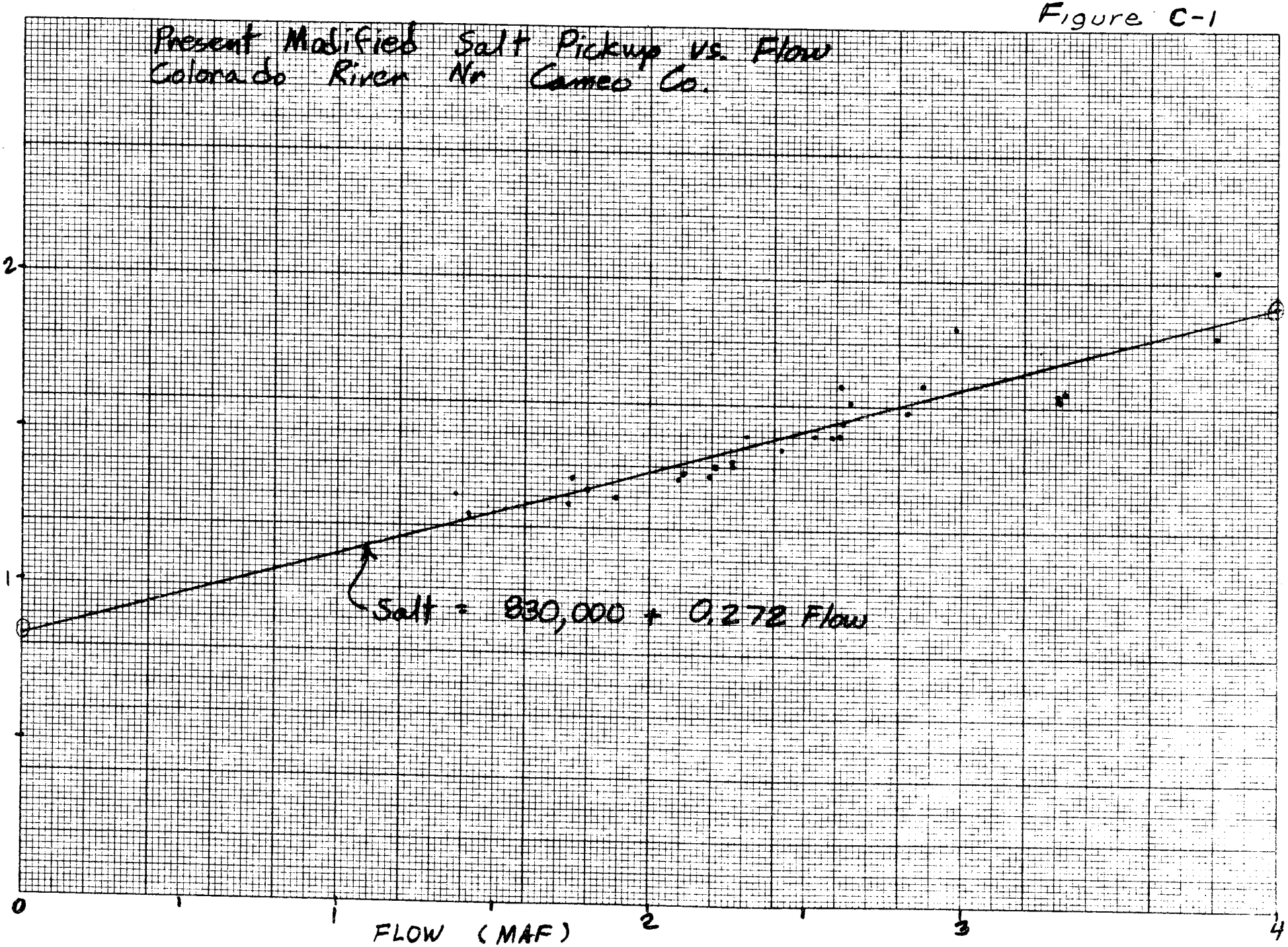


Figure C-2

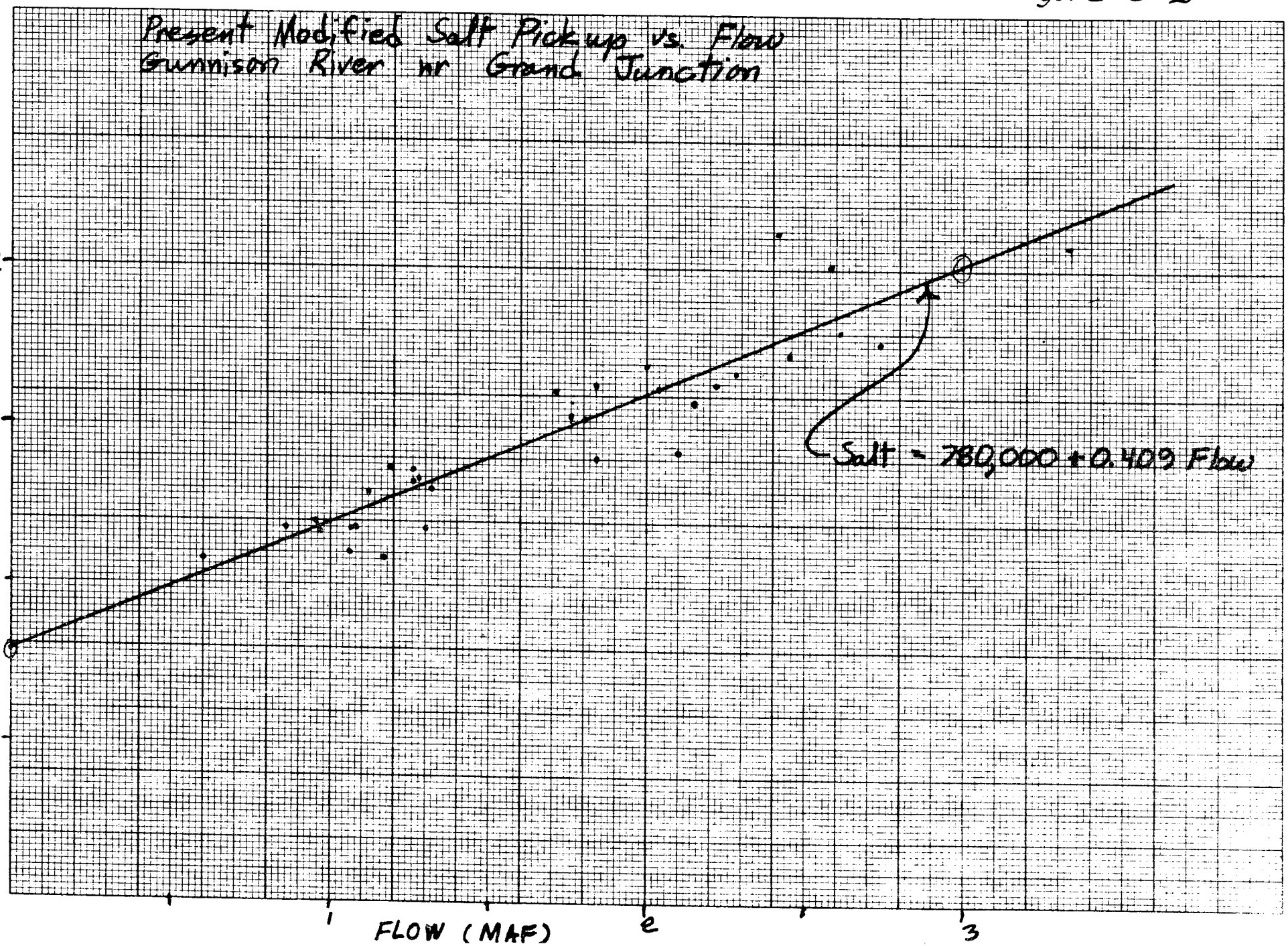


Figure C-3

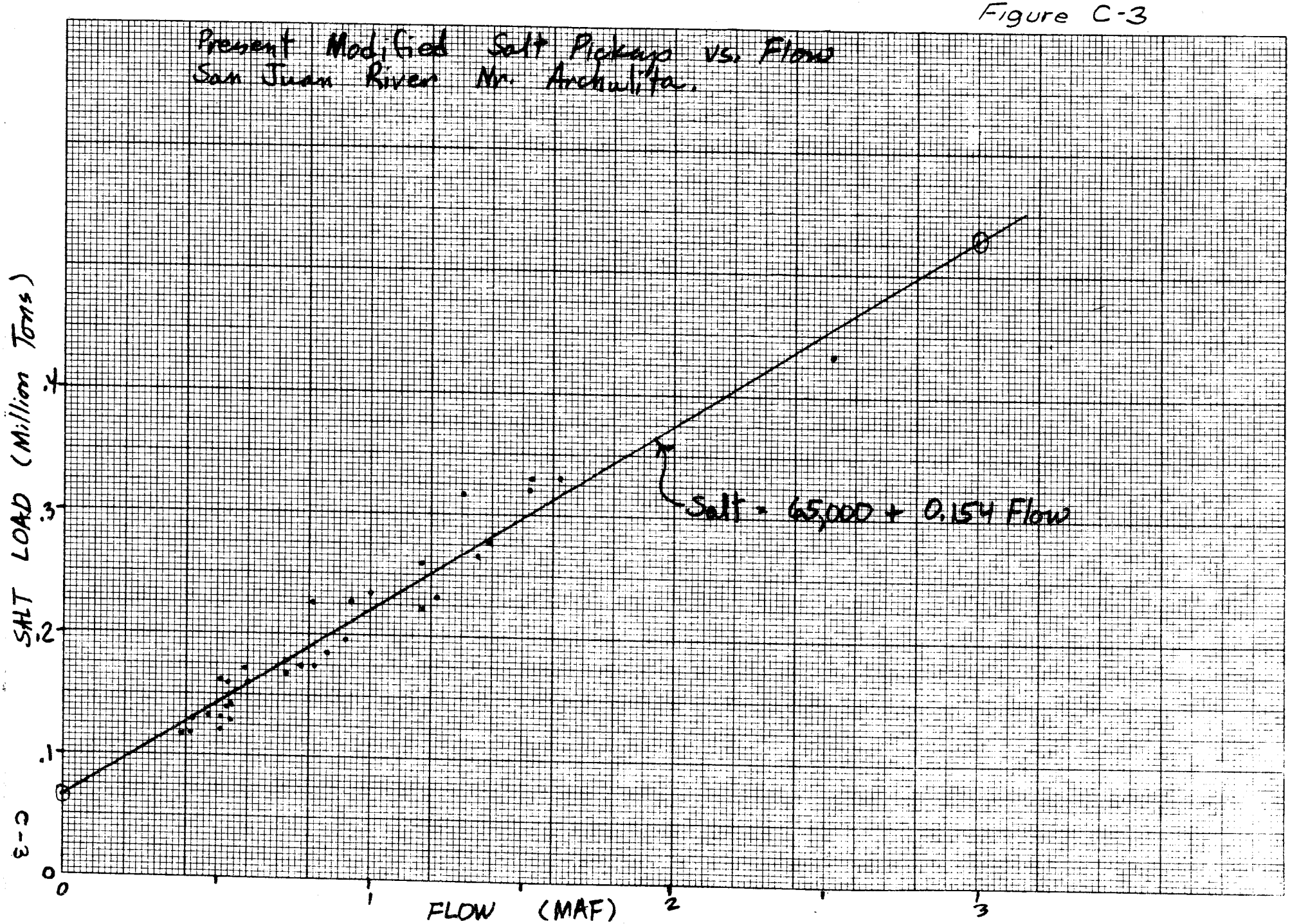


Figure C-4

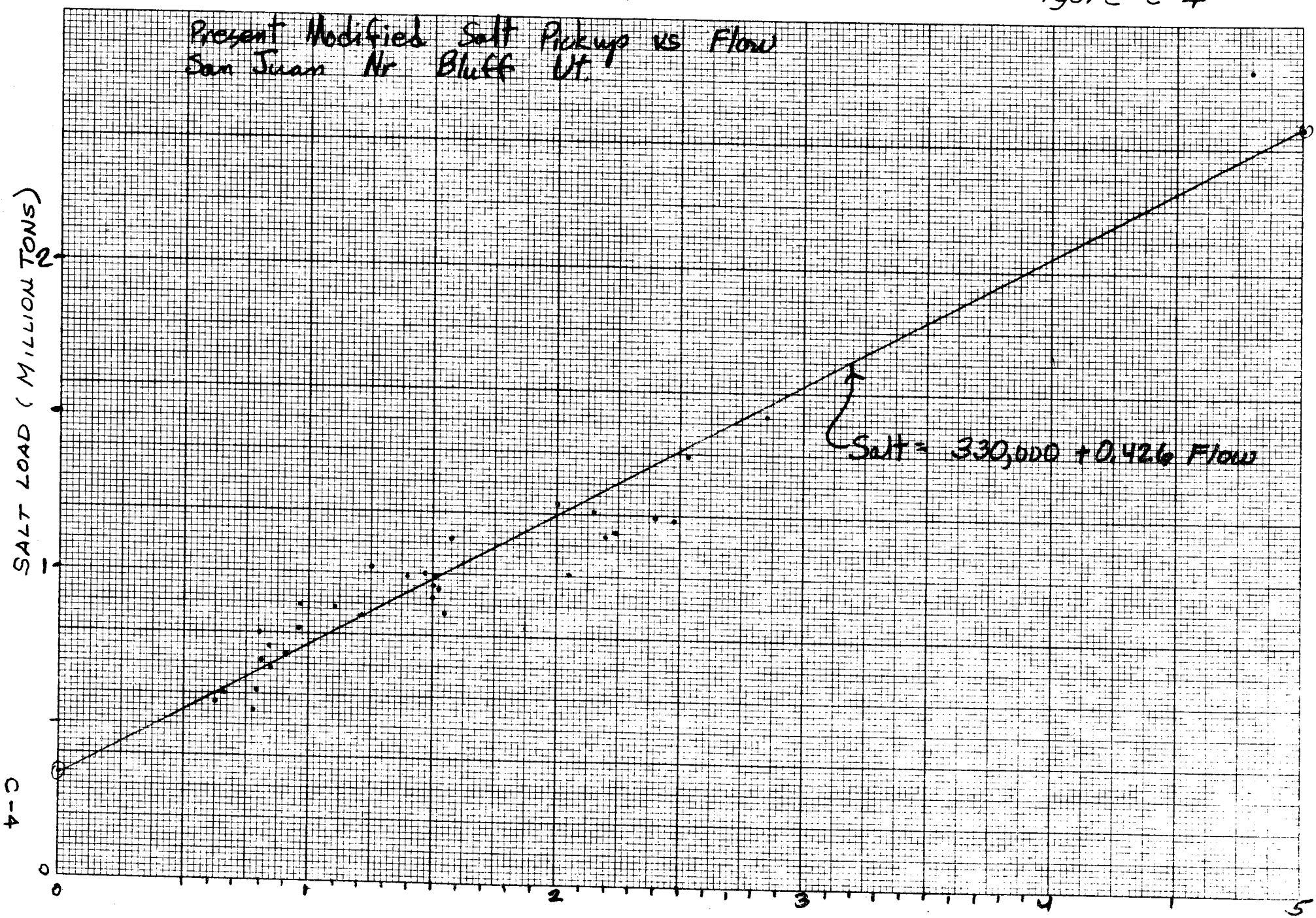


Figure C-5

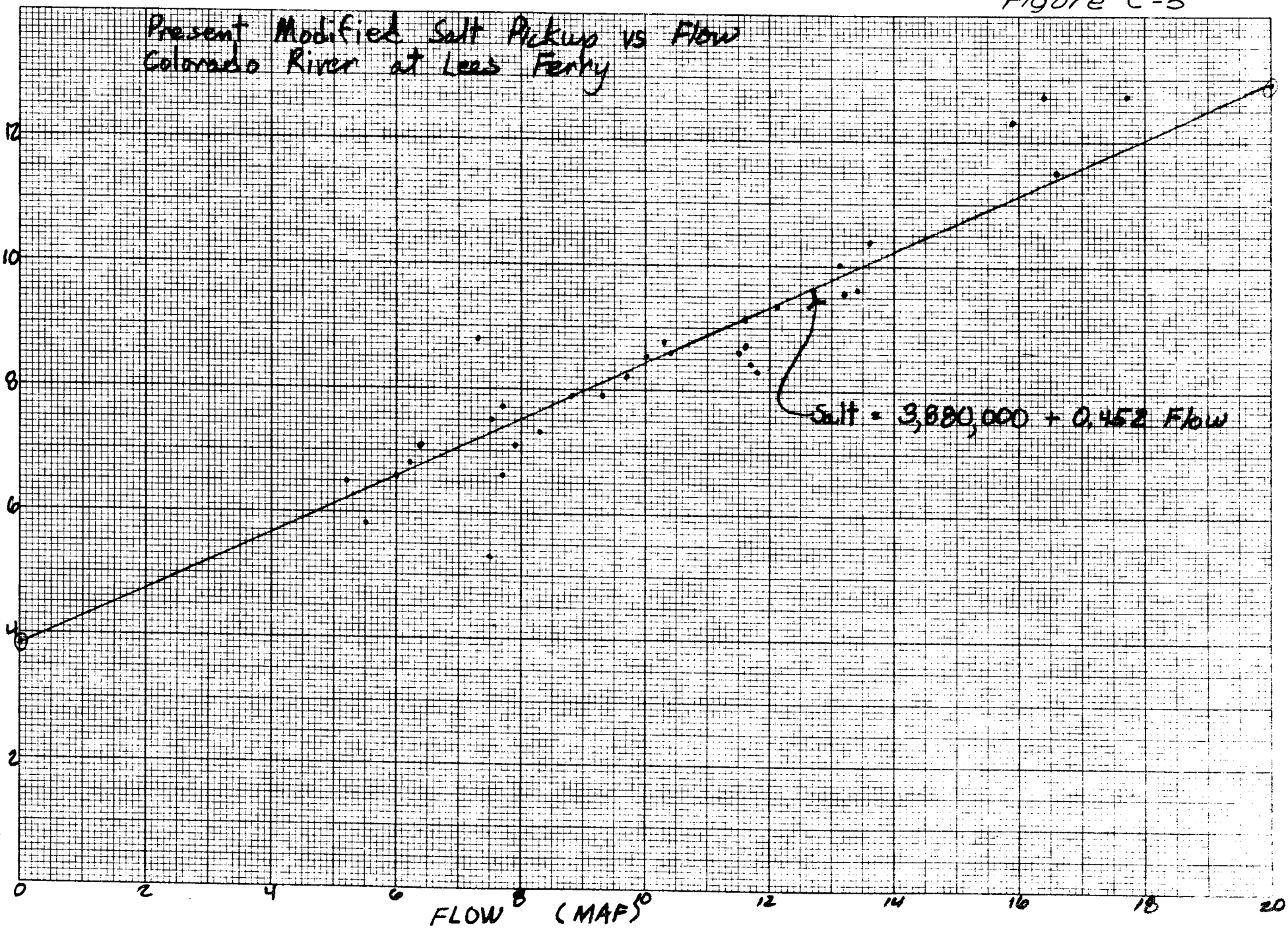


Figure C-6

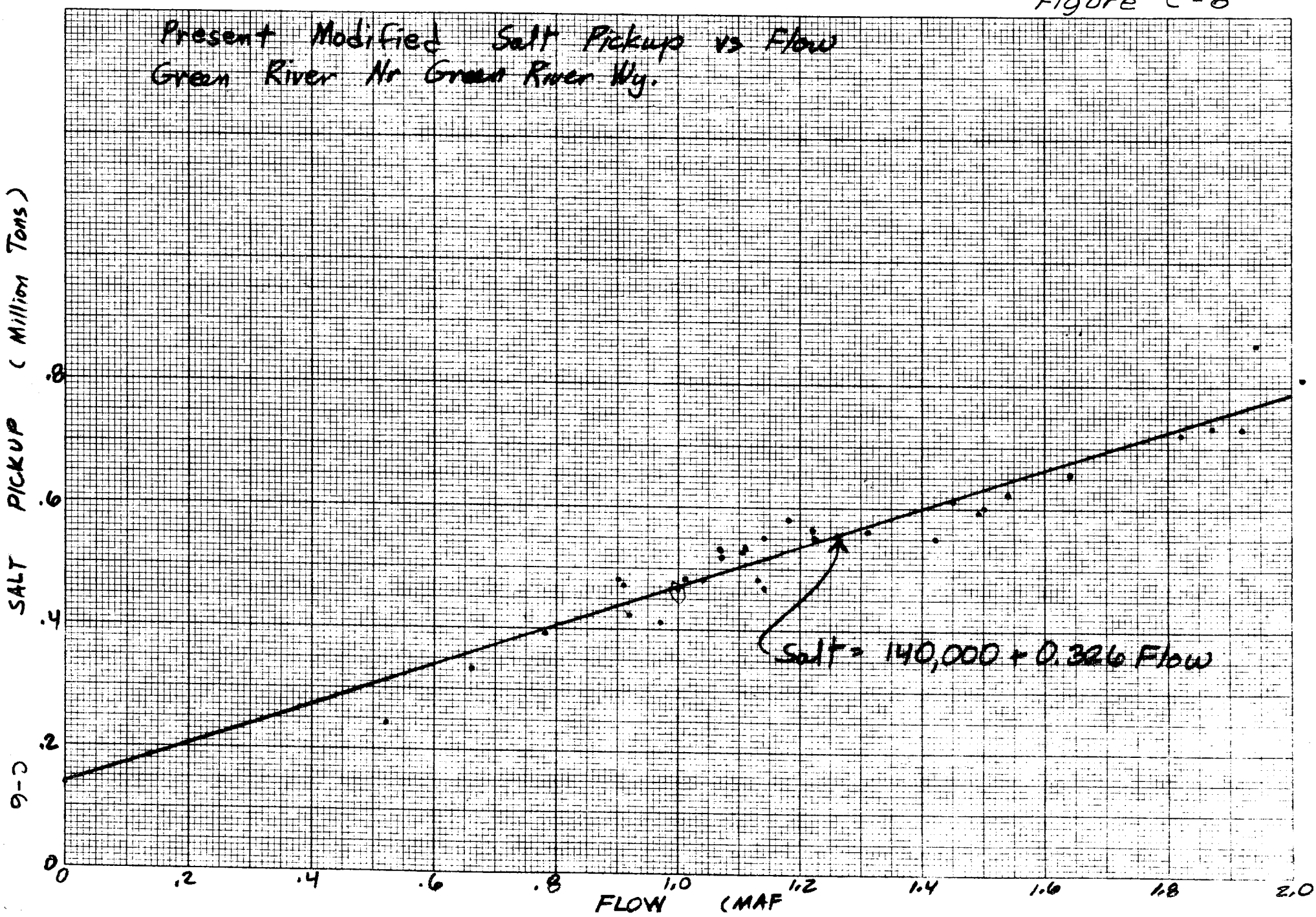


Figure C-7

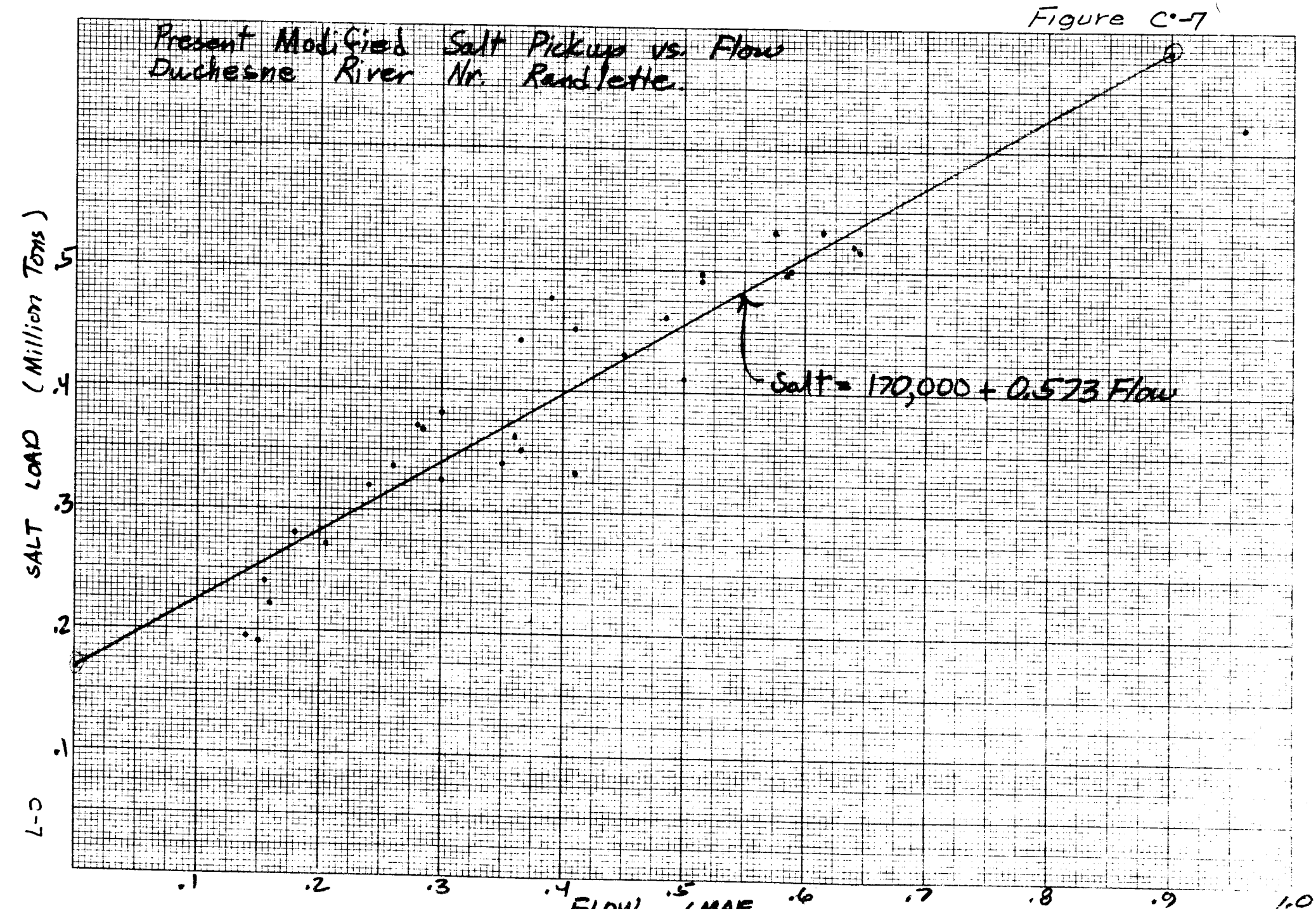


Figure C-8

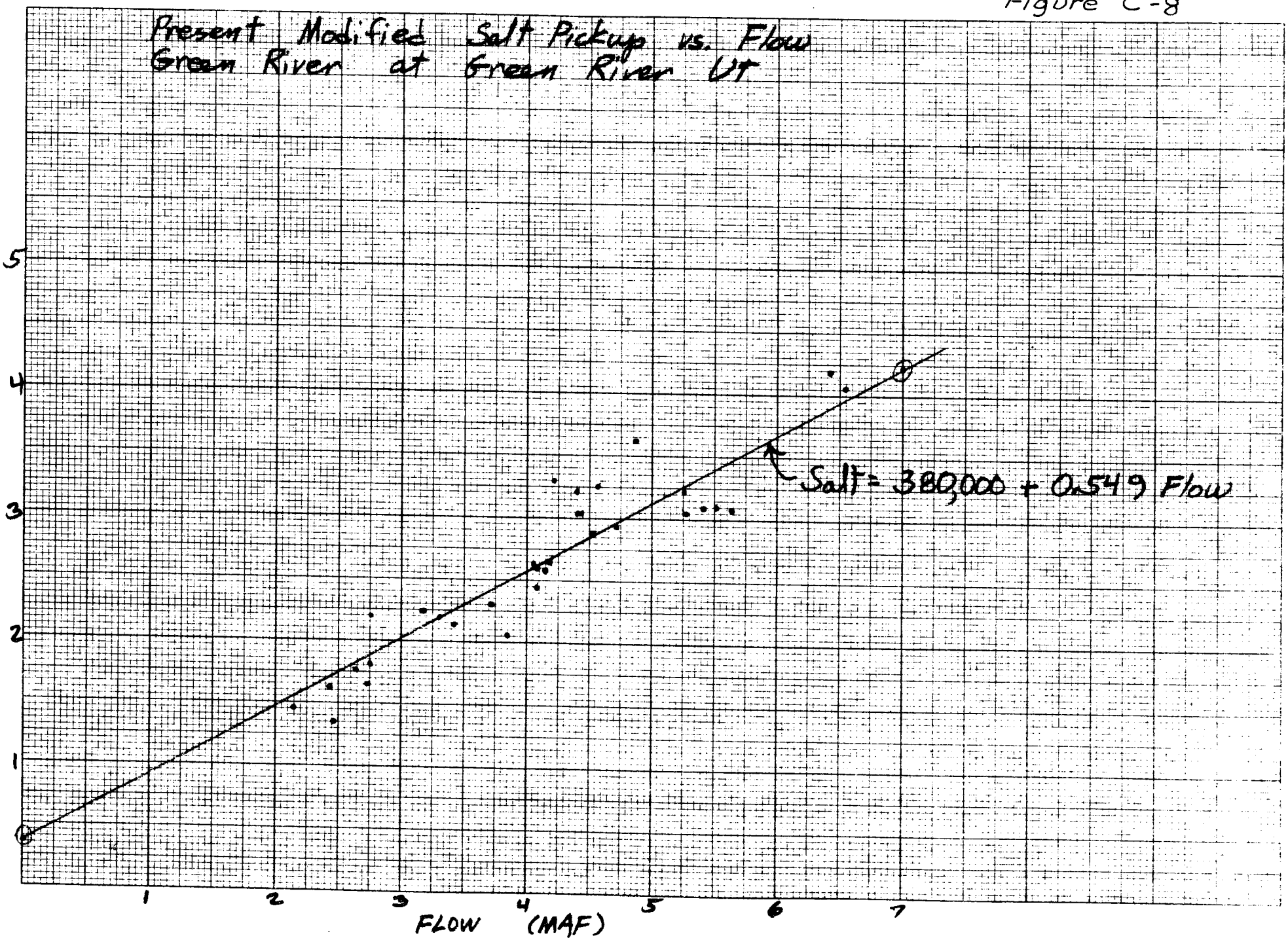
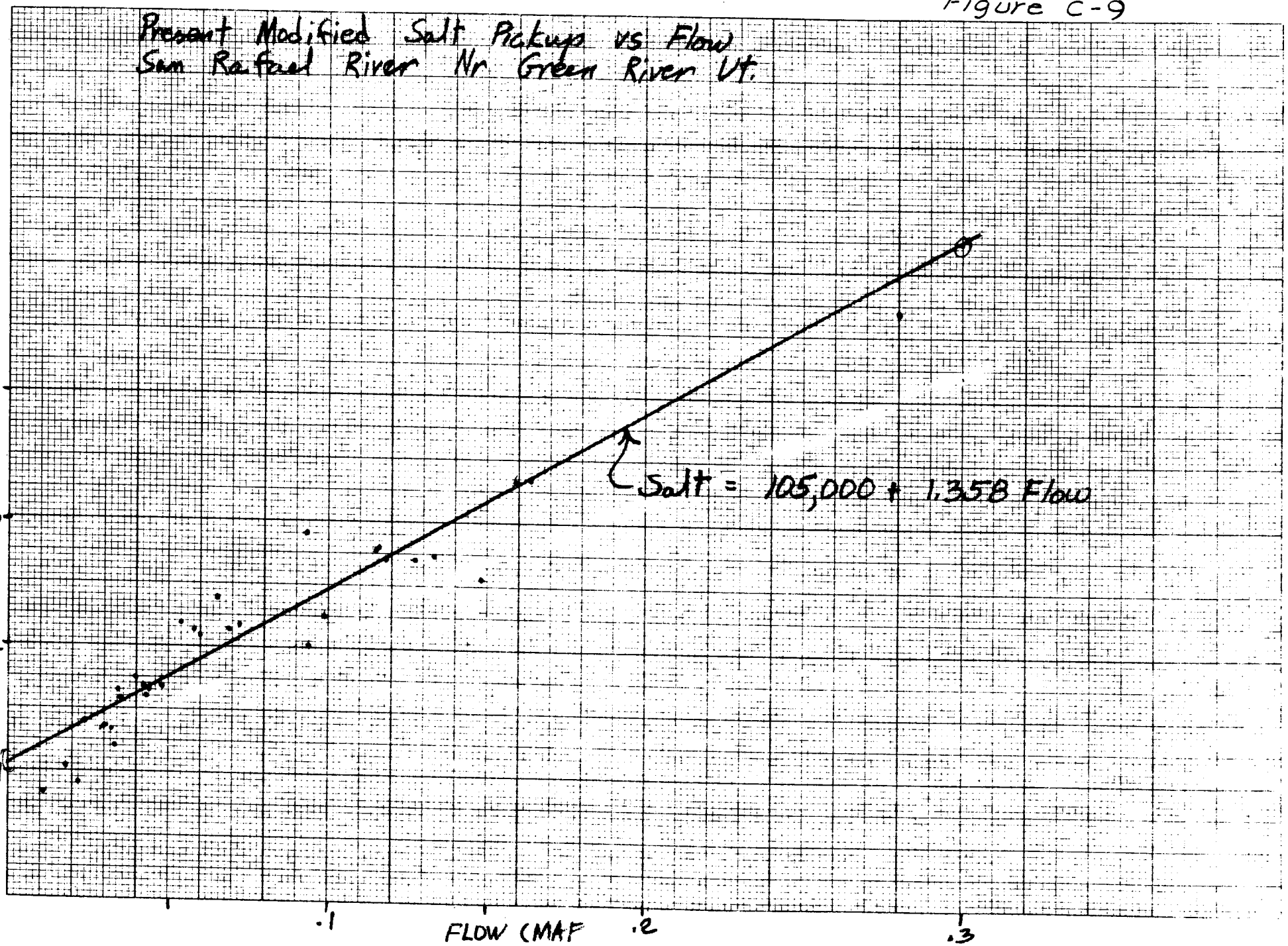


Figure C-9



SUPPLEMENT TO

1975 REVIEW

SUPPLEMENT INCLUDING MODIFICATIONS TO
"PROPOSED WATER QUALITY STANDARDS FOR SALINITY
INCLUDING NUMERIC CRITERIA AND PLAN OF IMPLEMENTATION
FOR SALINITY CONTROL, COLORADO RIVER SYSTEM, JUNE 1975"

August 26, 1975

August 26, 1975

SUPPLEMENT INCLUDING MODIFICATIONS TO "PROPOSED WATER QUALITY STANDARDS FOR SALINITY INCLUDING NUMERIC CRITERIA AND PLAN OF IMPLEMENTATION FOR SALINITY CONTROL, COLORADO RIVER SYSTEM, JUNE 1975"

This supplement to the subject report contains a summary and analysis of the comments on the report received at public meetings held in Las Vegas, Nevada, on August 4, 1975, and Grand Junction, Colorado, on August 7, 1975, and comments received by mail dated no later than August 8, 1975. The supplement also includes modifications to the Forum's June 1975 report based upon the comments received and to correct other minor errors. The states of the Colorado River Basin, acting through their Colorado River Basin Salinity Control Forum, prepared the report pursuant to an Environmental Protection Agency (EPA) regulation that had previously been subject to public notice and hearings by EPA.

Summary and Analysis

State of Utah

The State of Utah acknowledged its support of the standards as presented. No recommendations were made as to changes in the report.

Environmental Protection Agency

EPA suggested clarification in the second sentence of the section on "Effluent Limitations" on page 85 to remove the possible interpretation that the federal authority to regulate discharges could be delegated to a state in the absence of statutory state authority.

The Forum recognizes the possible problem and revises that sentence to read:

> "That authority takes different forms among the states having statutory authority; there is federal authority arising from Section 402 of PL 92-500 which can be exercised by EPA or delegated to the state."

EPA suggested clarifying language to indicate that it was not the intent in the discussion of "Effluent Limitations" on page 85 to preclude the application of sections of PL 92-500 other than specified subsections of Section 301.

The Forum revises the sentence to read: (insert underlined)

> "The plan of implementation contemplates, <u>without purporting to exclude any other applicable authority of PL 92-500,</u> that effluent limitations designed to fit local conditions will be established under Sections 301(b)(1)(A), 301(b)(1)(B) and 301(b)(2)(A), and will be applied equitably for salinity control throughout the Basin."

EPA recommended that discussion of "Industrial Discharges" on page 85 be revised to indicate that exceptions to a no-salt return policy be evaluated on a case-by-case basis considering "the availability of technology, the balance of basinwide benefits to costs and the distribution of benefits and costs".

The Forum does not believe that the proposed change strengthens the policy. The report indicates the objective is "a no-salt return policy wherever practicable". The term "wherever practicable" suggests that each discharge will need to be examined individually. Moreover, the term is to be viewed within the context of the general thrust of the report. The Forum believes that use of the term provides a proper degree of latitude to accommodate differing situations and assures a maximum effort toward salinity control.

EPA indicated need to clarify the Forum's proposal with respect to a previous recommendation that "benchmark" values be computed for points near statelines on the main stem and major tributaries.

The Forum's report states that appropriate salinity values will be developed for the monitoring points on the main stem and major tributaries. In the meantime the term "baseline" was thought to be more descriptive than "benchmark" and was used in discussing this phase of the future program on pages 58, 118, and 119. A definition of baseline was temporarily omitted until a better grasp of what is practicable is developed. As indicated on page 119, the Forum proposes to compute "baseline" values for the listed monitoring points where hydrologic and salinity data are available, and present them in the initial progress report in 1977.

However, after further consideration, the Forum revises the second paragraph on page 119 to read as follows:

> "As part of the process of identifying and evaluating progress in salinity control, salinity values will be computed for the monitoring points on the main stem and major tributaries identified on page 58. These values will be computed and included, along with the results of the program toward achieving the downstream salinity criteria, in at least preliminary form in the initial progress report in 1977."

Bureau of Reclamation

The Bureau spokesman stated the comments were coordinated with the two regional offices involved and the Commissioner's office in Washington, D. C. The comments outline the Bureau's salinity control program, responsibilities in the Colorado River Basin, and the working relationship with the Colorado River Salinity Control Forum. The Bureau agrees with the Forum that the entire Colorado River System needs to be considered as a single entity for salinity control. Their more sophisticated models support the conclusions of the simple model used in the Forum's salt routing studies. In conclusion, the Bureau stated that the "Proposed Water Quality Standards for Salinity Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System", as set forth in the Forum's June 1975 report "is an excellent and constructive proposal". No recommendations were made as to changes in the Forum's report.

Soil Conservation Service (USDA)

The SCS spokesman stated the comments had not been fully coordinated with all other interested services within USDA, such as the Forest Service. The comments primarily reflect the views of ARS and SCS. No comment was made regarding the numeric criteria themselves, but they support the maintenance of the salinity level in the lower main stem at or below the average value found during 1972. Mention was made regarding the progress on the Grand Valley program and coordination among agencies of the U. S. Departments of Agriculture and Interior, particularly the Soil Conservation Service and Bureau of Reclamation. No recommendations were made as to changes in the Forum's report.

Metropolitan Water District of Southern California

MWD gave its opinion that the Forum's report presents a pragmatic plan which recognizes the practical constraints that exist, and that it is a good first step toward the goal of meeting the salinity standards for the river.

MWD makes one specific suggestion which is accepted by the Forum. On pages 93 and 94, under the heading "Treating and Blending of Colorado River Water to Reduce Salinity", the entire section is deleted and replaced as follows:

> "Both individual water users and water distributing entities have adopted measures that reduce to some extent the harmful impacts of high salinity water. For many years, the Metropolitan Water District of Southern California operated a central softening plant. Operation of this plant was discontinued in May of 1975 when facilities for blending state project water with Colorado River water were completed as discussed below.
>
> "Beginning in 1972 with the completion of the initial phase of the California State Water Project, the District has had available to it increasing quantities of Northern California water which has less than one-third the salinity of Colorado River water. In order to reduce the salinity of the Colorado River water delivered to its service area, the District has constructed facilities for blending water from the two sources. The initial phases of this program have been completed and the District has begun the delivery of blended water to its service area."

In conclusion, MWD endorses the salinity standards and the plan of implementation and urges their early adoption by each of the concerned states.

Grand Valley Water Users Association

The Association summarized its interest in the Grand Valley Salinity Control Unit authorized in PL 93-320 for implementation by the Bureau of Reclamation. The Association generally supports the Forum's proposal, but made some suggestions regarding the Grand Valley Unit which the Forum believes are in the province of

the Bureau. Their conclusion is "We believe the Forum has done an admirable job with a complex problem". The Association made no recommendations as to changes in the Forum's report.

Grand Valley Canal Systems, Inc.

The Grand Valley Canal Systems, Inc., represents substantially all of the irrigated area in the Grand Valley. The company expressed its interest in the Grand Valley Salinity Control Unit. It also made suggestions concerning that salinity control unit which are in the province of the Bureau of Reclamation. The Forum is confident that good coordination among all parties involved in that program will be reexamined and strengthened if needed.

The Grand Valley Canal Systems, Inc., "commends the Forum for what we believe to be basically a workable and practical approach to the solution of the salinity problem, and we also commend the EPA for their willingness to consider development of standards by the Forum rather than setting them arbitrarily in Washington".

The company suggested one revision to the report. That was to add to the list of monitoring points on page 58 a station immediately below the mouth of Salt Creek. Its purpose would be to document the effectiveness of the salinity control program in the Grand Valley.

The Forum believes there is no need to make this specific addition, because page 58 of the report in the top paragraph explains that additional specific monitoring points will be established as an integral part of each control unit. The points will be selected in the definite plan report for the Grand Valley Unit. If early establishment is warranted, the Bureau of Reclamation would be expected to have the installation made.

Colorado River Water Conservation District

This District is described in the opening paragraph of their statement as "the primary western Colorado water policy body". The District presented its views that the report is oriented towards maintaining salinity levels to assure optimum use of Colorado River water resources by the Lower Basin, and attributes that orientation to "the language of the Environmental Protection Agency Notice in the December 18, 1974 Federal Register". The District then quotes and draws conclusions to support the above partly from the preamble contained in EPA's December 18, 1974, regulation.

The District called attention to what it considered to be a contradiction in EPA's December 18, 1974, regulation. Actually, the District misconstrues EPA's format. In the introductory portion of the regulation, EPA summarizes the comments received at public hearings on the regulation and gives its responses. Then, the subsequent part of the regulation contains the substance of the regulation; i.e., "120.5 Colorado River System Salinity Standards and Implementation Plan".

A careful reading of the entire regulation shows that EPA was following a carefully considered course of encouraging the states to develop standards rather than promulgating them at the federal level. The Forum does not feel its report needs any revision regarding this comment of the District.

The District states that salinity concentrations caused by exports from the Basin have not been dealt with adequately.

This is a matter of judgment. The Forum carefully based its work on the Basin States continuing to develop their

compact-apportioned waters in accordance with the goals of each state to do so. The basinwide approach was assiduously adhered to, and the control measures identified are based on the best implementable programs available -- in the combined judgment of the members of the Forum. Extra effort was taken not to make recommendations which could be construed as being in conflict with state water laws. The Forum is aware that exports of high quality water increase the concentrations in the Basin, but that the use of the same amount in-basin would also increase the concentration.

The Forum has carefully considered the District's comments, but believes no change in this report is warranted. Further examination will be made in the continuing update of this report which is to be done at not less than at 3-year intervals.

The District stated that it does not accept EPA's 1971 data purporting to show the salinity effects on the Colorado River at Lake Mead due to exports out of the Basin as presented in Table 1 (page 13) of the Forum's report. The District comments also indicated that the District was preparing an estimate of out-of-basin diversions and would like the opportunity to submit finalized calculations to the Forum and have the results published as part of the report.

The Forum will appreciate receiving the District's data, but the schedule contained in the December 18, 1974, regulation will preclude the consideration of these data in this report. As stated in the previous paragraph, the Forum will update its report periodically at not less than 3-year intervals. Consequently, new data from the District and other sources will be considered during the interim.

The District included an October 17, 1972 resolution and made several other specific suggestions as to revisions in the report.

The District proposed the deletion of "was" and the addition of "is estimated to have been" before "2,976,000 acre-feet" on page 25.

The Forum accepts this suggestion.

The District proposed a change to the first full paragraph on page 26 on the grounds that the language represents an interpretation of the Colorado River Compact.

The language was not so intended and to preclude any misunderstanding, the paragraph is modified to read:

> "The highest projected consumptive use[1/] from the mainstream in the Lower Basin by year 1990 was assumed to be 7,500,000 acre-feet. The low 1990 estimate is only slightly less -- 7,461,000 acre-feet. The projections of consumptive use used in this report are not based upon interpretations of the Colorado River Compact."

The District suggested some changes on pages 29 and 30 of the Forum report to the effect "that any reformulation must be carried out expeditiously and that in no event should reformulation delay the start of construction".

The Forum believes this would be an inappropriate revision to the report because it deals with federal matters outside the scope of this report.

The District suggested additions of 5 monitoring points to the list presented in the report.

The Forum believes that monitoring is properly handled on pages 58-60 of the report. Page 58 explains that appropriate monitoring points will be established as an integral part of

each of the authorized salinity control units. Hence, the suggestion concerning Salt Creek and the Grand Valley Salinity Control Unit is not needed. Irrigation return flows in the Parker to Imperial Dam reach, and on the Gila River (i.e., Wellton-Mohawk) are being measured and reported. However, they are not streamflow points whose measurement is the purpose of the list on page 58. As to the Paria and the Bill Williams Rivers, they were not included in the initial list of monitoring points because their flows are small. However, monitoring points at these locations will be considered during later studies described on page 60 as follows:

> "In addition, the states and federal agencies over the next few years will jointly evaluate a larger network to:
>
> > "1. More accurately determine natural salinity levels so that 'background' will not obscure changes in man-made salinity.
> >
> > "2. Isolate and evaluate changes in man-caused salinity including the distinction between salt loading and concentrating effects."

League of Women Voters, Las Vegas Valley

The statement was to the effect that the Forum's report and cooperative approach pleased the League. The League desires numeric standards because salinity is a major problem. The spokeswoman provided a few comments regarding the Las Vegas Wash salinity control project, and expressed concern over the alternative of total containment. She said:

> ". . . We would like very much to see whatever project is developed has a return credit in its outcome . . . ."

The spokeswoman also stated that a public education program is needed regarding salinity. No suggestions were made as to changes in the Forum's report.

Private Citizen, Las Vegas

The statement was to the effect that she was pleased with the report, liked the basinwide approach and emphasis on agriculture, wants basinwide management, and encourages continued effort to look to alternative preventive measures for salinity control. No suggestions were made as to changes in the Forum's report.

Quality Water Education Committee

The statement was from the viewpoint of dealers and manufacturers of point-of-use water conditioning equipment. It is stated:

> "After careful review of the salinity standard document, QWEC is in accord with the proposed standards and concurs with the major projects recommended for meeting the standards. . . ."

The statement of QWEC indicated that water conditioning brines in Las Vegas are being studied and that water conditioning brines account for only a small part of the salt loading.

The Forum has not examined the studies in Las Vegas Valley and will look forward to doing so. In the meantime, it cannot take the position suggested by QWEC that "To study further the sources of salt in municipal discharges other than Las Vegas is not warranted". No suggestions were made as to changes in the Forum's report.

Sierra Club, Southwest Office

The Office of the Sierra Club expressed concern as to the adequacy of the plan of implementation to prevent increases in salinity. Specifically, the Sierra Club expressed the view that the long-term virgin flow of the Colorado River may be much lower than the average recorded for the period 1896-1974 and that depletions in the Upper Basin may increase more rapidly than past history would suggest. It also

suggested that it may not be possible for technical, economic, political or environmental reasons to complete all 16 salinity control units identified in the report. It concluded there is a high probability that the salinity control program will not be adequate to maintain salinity at 1972 levels.

The Forum study of water supply included a range of 5 alternative estimates of water supplies and 3 alternative estimates of projected water uses in the Basin. Salinity routing studies of all combinations were made and the report summarizes the results on Table 6, page 34, and Figures 2-19, pages 35-52. Therefore, the lesser streamflows and the higher depletions in the Upper Basin were examined and reported by the Forum.

The Forum appreciates the possibilities that some of the 16 salinity control units will not be completed. That is the reason for adding "or their equivalent" to the text and to devoting a chapter to "Future Possible Salinity Control Programs", pages 121-132, and for extensive references to studies, research, means of coping with salinity, etc., throughout the report.

All of these points were major points of discussion and analysis during preparation of the report. In the final analysis they must be dealt with on a judgmental basis with the data which are available. It is emphasized that: (a) the Forum proposes an annual progress report, (b) a complete review of the analysis and the report at least each three years, and (c) the establishment of a permanent work group to keep current on changes in the Basin and

recommend changes in the report and program to the Forum. These measures should permit the states to assess the need for changes in a timely manner.

The Sierra Club believes there is a need for "definitive regulations and an agency or agencies with the authority and responsibility for enforcing them".

The Forum considered the desirability of establishing a formal interstate regulatory agency but concluded on the basis of experience elsewhere that the advantages do not justify a change at this time.

The Sierra Club believes that the many problems facing the salinity control program may make incompatible the Forum and EPA position of controlling salinity and allowing development of compact-apportioned water to proceed together. The Club indicates the states do not have an unfettered right to develop Colorado River water no matter what the cost. Therefore, some water developments may have to be foregone.

The Forum does not believe that regulations to forego water use can be an acceptable salinity control device in view of the continually increasing public demand for water to serve many purposes. The Forum believes that the objective of controlling salinity to the 1972 level in the lower main stem, while the states develop their compact-apportioned waters, has a reasonable probability of achievement.

The Sierra Club expressed concern that temporary increases in salinity are allowed without any balancing salinity control measures.

The Sierra Club is in error. The Forum's plan allows for temporary increases; however, such increases are to be offset by control measures included in the plan of implementation.

Sierra Club expresses concerns about the extent to which federal funds may be required for the salinity control program. It also expresses the view that those who contribute to salinity and/or those who benefit from the control measures should assume the cost.

The Forum's report recognizes the cost-sharing arrangements provided for in PL 93-320 on the initial 4 units. However, no cost-sharing arrangements are proposed for any of the other projects or measures. They will be established by Congress at the time the projects are authorized. Cost-sharing for other measures will be in accordance with then existing laws and regulations.

This office of the Sierra Club expresses concern that it was not advised of the Forum's report or of the public meetings.

It is most unfortunate that the particular office presenting the comments was overlooked. However, the meetings were publicized and notices of the report mailed to long lists of organizations. About 700 copies of the report were distributed throughout the seven states. The offices of the Sierra Club in other states received copies.

AUGUST 26, 1975

MODIFICATIONS TO THE WATER QUALITY STANDARDS FOR SALINITY INCLUDING NUMERIC CRITERIA AND PLAN OF IMPLEMENTATION FOR SALINITY CONTROL

COLORADO RIVER SYSTEM

Prepared by the
Colorado River Basin Salinity Control Forum

June 1975

On the bases of statements made at regional public meetings held in Las Vegas, Nevada, on August 4, 1975, and Grand Junction, Colorado, on August 7, 1975, and on written comments dated August 8, 1975, or before; and to correct other minor errors, the following changes, additions and deletions to the above identified report were approved by the Salinity Control Forum on August 26, 1975.

Forum Membership Listing

The listing is located on the backside of the cover page of the report. The corrections are:

(1) Arizona: Wesley E. Steimer should be changed to read Wesley E. Steiner.

(2) Utah: Lynn M. Thatcher's title should be changed to read Deputy Director of Health for Environmental Health Services, Utah State Division of Health.

(3) Wyoming: Arthur E. Williamsen should be changed to read Arthur E. Williamson and his titled changed to read Administrator, Division of Water Quality, Department of Environmental Quality.

Page 17

After the heading "Colorado River near Cameo, Colorado", "Stations" should be changed to read "Station".

Page 18, Figure 1

Line 17, "Colorado River at Lee's Ferry, Arizona" should be changed to read "Colorado River at Lees Ferry, Arizona".

Page 21

The heading "Colorado River at Lee's Ferry, Arizona" should be changed to read "Colorado River at Lees Ferry, Arizona".

Page 22

The last sentence in the last paragraph, "Lee's Ferry" should be changed to read "Lees Ferry".

Page 25

The first sentence under "Projections of Future Water Use" should be changed to read:

"The use of Colorado River water by the Upper Basin States in 1973 is estimated to have been 2,976,000 acre-feet".

Page 26

First full paragraph should be deleted and replaced as follows:

"The highest projected consumptive use[1/] from the mainstream in the Lower Basin by year 1990 was assumed to be 7,500,000 acre-feet. The low 1990 estimate is only slightly less -- 7,461,000 acre-feet. The projections of consumptive use used in this report are not based upon interpretations of the Colorado River Compact."

Page 26

The first sentence in the second full paragraph should be changed to read:

> "Estimates of both 1973 water use and projected future use through the year 1990 for each of the seven states were furnished by the respective Basin States."

Page 58

Under "Monitoring Points", No. 17 should be changed to read: "Lees Ferry, Arizona".

The last sentence of the last paragraph should be changed to read:

> "During the next three-year review period, analyses will be made of the monitoring program to determine the adequacy of the selected stations for the establishment of salinity values to provide an insight into the changes in salt concentration and salt load as discussed in Chapter VI."

Page 59, Figure 20

See attached revised Figure 20. (The location for the monitoring station on the Little Colorado River at Cameron, Arizona, No. 15, has been corrected. No. 17 "Lee Ferry" has been corrected to read "Lees Ferry".

Page 85

The second and third sentences under "Effluent Limitations" should be changed to read:

> "That authority takes different forms among the states having statutory authority; there is federal authority arising from Section 402 of PL 92-500 which can be exercised by EPA or delegated to the state. The plan of implementation contemplates, without purporting to exclude any applicable authority of PL 92-500, that effluent limitations designed to fit local conditions will be established under Sections 301(b)(1)(A), 301(b)(1)(B) and 301(b)(2)(A), and will be applied equitably for salinity control throughout the Basin."

Pages 93 and 94

The entire section entitled "Treating and Blending of Colorado River Water to Reduce Salinity" is deleted and replaced as follows:

> "Both individual water users and water distributing entities have adopted measures that reduce to some extent the harmful impacts of high salinity water. For many years, the Metropolitan Water District of Southern California operated a central softening plant. Operation of this plant was discontinued in May of 1975 when facilities for blending state project water with Colorado River water were completed as discussed below.

"Beginning in 1972 with the completion of the initial phase of the California State Water Project, the District has had available to it increasing quantities of Northern California water which has less than one-third the salinity of Colorado River water. In order to reduce the salinity of the Colorado River water delivered to its service area, the District has constructed facilities for blending water from the two sources. The initial phases of this program have been completed and the District has begun the delivery of blended water to its service area."

Page 118, Table 9

First paragraph under "Action to be Taken" should be changed to read:

"Analyze the monitoring program to determine the adequacy of the selected stations for the establishment of salinity values to evaluate salinity changes near statelines"

Second paragraph under "Action to be Taken" should be changed to read:

"Develop salinity values for the specified monitoring points as shown on page 58"

Page 119

Second paragraph, under "Identifying and Evaluating Progress in Program of Salinity Control" should be changed to read:

"As part of the process of identifying and evaluating progress in salinity control, salinity values will be computed for monitoring points on the main stem and major tributaries identified on page 58. These values will be computed and included, along with the results of the program toward achieving the downstream salinity criteria, in at least preliminary form in the initial progress report in 1977."

Page 122

The figure "100,00 in the third sentence of the last paragraph should be changed to read "100,000".

Page 124.

Last paragraph is deleted and replaced as follows:

"The implementation of the demonstration program may be affected by a number of external factors. Cloud seeding in wilderness and primitive areas has not been generally accepted by the Forest Service or the National Park Service. Either an administrative decision or separate legislation is required. On-going and future large-scale seeding operations such as those in Utah will require a high degree of coordination and cooperation. Claims for real or alleged detriment from persons in the project area and in the area receiving increased runoff must be recognized. A balanced policy and legal precedent will need to be formed and implemented."

Figure 20

MONITORING POINTS

1. Colorado River near Cameo, Colorado
2. Gunnison River near Grand Junction, Colorado
3. Dolores River near Cisco, Utah
4. Colorado River near Cisco, Utah
5. Animas River at Farmington, New Mexico
6. San Juan River near Bluff, Utah
7. Green River near Green River, Wyoming
8. Green River at Green River, Utah
9. Yampa River near Maybell, Colorado
10. Duchesne River near Randlett, Utah
11. White River near Watson, Utah
12. Price River at Woodside, Utah
13. San Rafael River near Green River, Utah
14. San Juan River at Shiprock, New Mexico
15. Little Colorado River at Cameron, Arizona
16. Virgin River at Littlefield, Arizona
17. Lees Ferry, Arizona
18. Below Hoover Dam, Arizona-Nevada
19. Below Parker Dam, Arizona-California
20. Imperial Dam, Arizona-California