QUALITY OF WATER

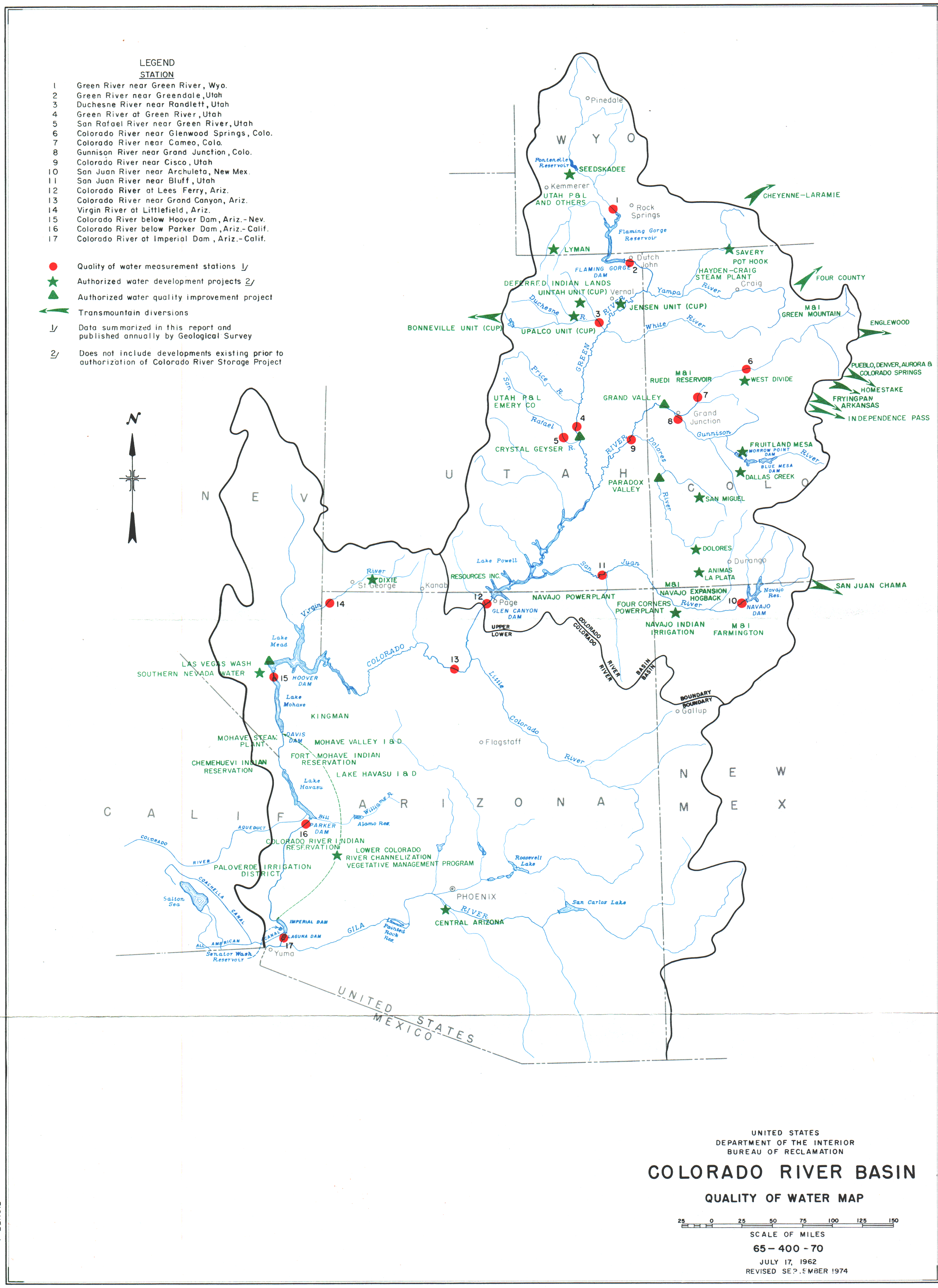
COLORADO RIVER BASIN

PROGRESS REPORT No. 7

JANUARY 1975

UNITED STATES
DEPARTMENT OF THE INTERIOR

Rogers C. B. Morton Secretary



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

COLORADO RIVER BASIN

QUALITY OF WATER MAP

65-400-70
JULY 17, 1962
REVISED SEPTEMBER 1974

FIGURE 1

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QUALITY OF WATER
COLORADO RIVER BASIN
PROGRESS REPORT

SUMMARY

This report presents the various important water quality aspects of the Colorado River. Although several water quality parameters are discussed, the major part of the report is allotted to salinity (total dissolved solids) because it is presently the most serious quality problem on the river system. The historical, present modified, and future salinity conditions of water of the Colorado River down to Imperial Dam are presented in this report. The historical is represented by a tabulation of the recorded or estimated past condition at 17 quality of water stations for the 1941-72 period. The present modified condition includes adjustments of the historic condition based on the assumption that developments completed during the 1941-72 period were in operation for the full period. The future is depicted by condition of 1980, 1990 and year 2000 and is an estimated projection after the presently authorized developments, projects proposed for authorization and other future anticipated projects are placed in operation.

Under historic conditions the average concentration of dissolved solids of the Colorado River at Lees Ferry was about 0.76 ton per acre-foot, below Hoover Dam about 0.94 ton per acre-foot, and at Imperial Dam about 1.04 tons per acre-foot for the 1941-72 period.

Under present modified conditions (that is assuming the projects that started operating sometime during the 1941-72 period were in operation throughout the entire period) the concentrations would have been about 0.83; 1.02, and 1.15 tons per acre-foot, respectively, at the three stations.

It has been assumed for purposes of this study that the average rate of pickup of dissolved solids from new irrigated lands would be in the range of zero to 2 tons per acre. The effect of salt contributed from new lands is thus evaluated by computations of salinity concentrations using zero tons per acre pickup and 2 tons per acre pickup. It was also assumed no additional pickup of dissolved solids would occur for lands already under irrigation.

Under future flow depletions projected for 1980, 1990 and 2000 conditions, assuming negligible salinity control measures, and using the assumed zero to 2 tons per acre pickup on the new irrigated lands, the concentrations are estimated as follows:

SUMMARY (Continued)

	1980		1990		2000	
	ZeroT/A	2T/A	ZeroT/A	2T/A	ZeroT/A	2T/A
Lees Ferry	0.87	0.88	0.97	1.03	1.01	1.09
Hoover Dam	1.09	1.10	1.24	1.31	1.30	1.39
Imperial Dam	1.28	1.31	1.50	1.61	1.57	1.70

Since the above figures (taken from Table 18) were computed by using average 1941-1972 values, they show only average conditions. Under actual operation of the river system, it should be realized there will be years of higher flow, producing better quality water or years of lower flow, producing poorer quality water.

The depletions used in this report for the projects, both authorized and proposed for authorization together with present developments and other proposals are the depletions for the developments as presently conceived. The study also shows that by about 1990 storage releases and/or augmentation from other sources will be required to supply all the demands.

This report also includes discussion of the effect of salinity on water uses and the potential for salinity control measures. Investigations of the potential for water quality improvement on the Colorado River were initiated by the Bureau of Reclamation in FY 1972. A report entitled "Colorado River Water Quality Improvement Program" dated February 1972 describes potential projects for controlling the salinity of the Colorado River. A second report titled "Colorado River Water Quality Improvement Program, Status Report," was published by the Bureau of Reclamation in January 1974. This report, with appropriate updating, is the basis of discussion of the status of the Colorado River Salinity Control program presented in part IX of this report. This evaluation of the program is made in accordance with requirements of the Colorado River Salinity Control Act, Public Law 93-320.

Other water quality aspects including sources of pollution, and parameters such as dissolved oxygen, temperature, pH, heavy metals, toxic materials, nutrients, bacteria, radioactivity, mercury, and sediment are discussed.

PART I. INTRODUCTION

A. Authorization for Report

This is the seventh progress report on Quality of Water in the Colorado River Basin. The directive for preparing this and the six previous reports is contained in three separate public laws. Section 15 of the authorizing legislation for the Colorado River Storage Project and participating projects, Public Law 485, 84th Congress, Second Session, April 11, 1956, states, "The Secretary of the Interior is directed to continue studies and make a report to the Congress and to the States of the Colorado River Basin on the quality of water of the Colorado River."

A progress report to comply with Public Law 84-485 was in preparation when the authorizing legislation for the San Juan-Chama Project and the Navajo Indian Irrigation Project (Public Law 87-483) became effective on June 13, 1962. Section 15 of this act states, "The Secretary of the Interior is directed to continue his studies of the quality of water of the Colorado River system, to appraise its suitability for municipal, domestic, and industrial use and for irrigation in the various areas in the United States in which it is used or proposed to be used, to estimate the effect of additional developments involving its storage and use (whether heretofore authorized or contemplated for authorization) on the remaining water available for use in the United States, to study all possible means of improving the quality of such water and of alleviating the ill effects of water of poor quality, and to report the results of his studies and estimates to the Eighty-Seventh Congress and every 2 years thereafter."

A few weeks later Public Law 590, 87th Congress, Second Session, which authorized the Fryingpan-Arkansas Project, was passed with a similar section pertaining to quality of water reports. This public law, however, stipulated that January 3, 1963, would be the submission date for the initial report and that the reports should be submitted every 2 years thereafter.

B. Previous Reports

A series of six reports starting with the 1963 edition have been prepared prior to this report. Each succeeding report updated the previous report and added changes which occurred within the 2-year interval.

In addition to including 2 more years of record, the major changes in this report from the January 1973 report are as follows: (1) transferring that part of the future estimated depletions that actually occurred during the 2 years to present depletions; (2) revising and updating Part IX "Colorado River Salinity Control Program" in order to report on the progress of investigations, planning, and construction of salinity control units as required under Title II Section 206 of the Colorado River Basin Salinity Control Act, Public Law 93-320; (3) changing average present estimated evaporation of the Upper Basin Storage and Navajo and Fontenelle Reservoirs from 541,000 acre-feet a year to 568,000 acre-feet (this is latest evaporation estimate, pending results from new investigations presently being conducted); (4) assuming no salt or water return from future large energy related uses; (5) expanding table 18 to show conditions of 1980, 1990 and 2000 rather than just a single future condition. The future conditions in this study were based on a revised depletion schedule.

C. Scope

This report presents data concerning (1) the historical quantity and quality of the flows of the Colorado River and its principal tributaries for the 1941-72 period; (2) an evaluation of historical conditions modified to reflect present development; and (3) a projection of the range of salinity conditions resulting from future development at 17 selected stations in the basin. The potential for salinity control and the current status of salinity control activities are also discussed. A section of the report is also devoted to water quality parameters other than salinity. Park IX of this report is a report on the status of the Colorado River Salinity Control program in accordance with requirements of section 206 of Title II of the Colorado River Basin Salinity Control Act (PL. 93-320).

D. Cooperation

This report was prepared chiefly by the Bureau of Reclamation. The Geological Survey provided most of the basic data and prepared a technical study on salinity in the Flaming Gorge Reservoir. A continuing cooperative program between the Bureau of Reclamation and the Survey for the collection of streamflow quality data and the exchange of information has been in effect for a number of years. This cooperation provides for the collection of data at stations other than basic data stations maintained by the Geological Survey in order to obtain additional data at key points in the basin.

In the Upper Basin, data are obtained at various points along the river and in drains cooperatively with the Geological Survey and other agencies. Along the main stem below Lees Ferry, data are obtained on a regular basis at a network of stations that includes essentially all significant diversions, surface return flows, and major river stations. This network is being used in an intensive measurement program which began in February 1970 with the objective of determining the source of the salt load arriving at Imperial Dam. The Bureau of Reclamation is the lead agency of an ongoing task force for coordinating the collection of other quality data in the Lower Basin. This task force is composed of representatives from the Geological Survey, International Boundary and Water Commission, and Environmental Protection Agency.

E. Water Quality Legislation

Various water quality legislative acts have been passed by the Congress of the United States. Discussion of three acts that are of special significance to the Colorado River Basin follows:

1. Water Quality Act of 1965 and Related Developments.

The Water Quality Act of 1965, Public Law 89-234, is an Act to amend the Federal Water Pollution Control Act and establish a Federal Water Pollution Control Administration, to provide grants for research and development, to increase grants for construction of sewage treatment works, to require establishment of water quality criteria, and for other purposes. Section 5 of this Act requires States to adopt water quality criteria applicable to interstate waters or portions thereof within their boundaries by June 30, 1967.

Each of the seven Basin States proceeded with actions directed toward establishment of water quality standards for interstate streams. Early in the standards setting process, it became apparent to the States that because of legal and institutional constraints combined with lack of technical knowledge of salinity control and management, it would be very difficult to establish numerical salinity standards on the Colorado River which would be workable, equitable, and enforceable. The seven Basin States subsequently developed water quality standards which did not include salinity standards.

The "Seventh Enforcement Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries" was held in Las Vegas (February 15-17, 1972) and Denver (April 26-27, 1972).

The conferees, official representatives of the seven Basin States and the Environmental Protection Agency, unanimously adopted conclusions and recommendations pertaining to the salinity problems of the Colorado River. The conclusions and recommendations were approved by Mr. William D. Ruckelshaus, Administrator of the Environmental Protection Agency in June 1972. The more significant conclusion being as follows:

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"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."

The conferees further suggested that the Bureau of Reclamation should have the primary responsibility for investigation, planning, and implementing the Colorado River Basin Salinity Control Program with the assistance of the Office of Saline Water and the Environmental Protection Agency at the Federal level.

2. The Federal Water Pollution Control Act Amendments of 1972

The object of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) is to restore and maintain the chemical, physical, and biological integrity of the Nations waters. It declares that the national goals are to eliminate discharge of pollutants into navigable waters by 1985 with an interim goal of attaining by July 1983, water quality which provides for the protection and propogation of fish, shellfish and wildlife and for recreation in and on the Nation's water.

The Act authorizes the Environmental Protection Agency after cooperation with other Federal agencies, State water pollution control agencies, interstate agencies and municipalities and industries involved, to prepare or develop comprehensive programs for preventing, reducing or eliminating the pollution of the navigable waters and ground waters and improving the sanitary condition of surface and underground waters.

Some of the more important aspects of the Act briefly explained are as follows. The Act authorizes the Environmental Protection Agency to provide grants for research or demonstration projects and construction of treatment works to Federal Agencies, States, or private organizations. It also authorizes Environmental Protection Agency to publish and revise from time to time water quality criteria and to revise standards to include intrastate as well as interstate streams. The law also provides that by July 1, 1977, the best practical water pollution control technology must be applied followed by the best available technology economically achievable by July 1, 1983. Section 402 of the Act provides for the Governmental regulation of pollutant discharges through a mandatory permit program, monitoring, inspection, and periodic reporting.

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Enactment of PL. 92-500 introduced a new factor into the salinity problem. The legislation has been interpreted by EPA to require that numerical standards for salinity on the Colorado River be set. Consequently in November the EPA submitted to several of the Colorado River Basin states proposed requirements and procedures for Salinity Control of the Colorado River System and proposed the establishment of an interstate organization to develop a salinity control plan.

The basin states in response to EPA's submittal of the proposed requirements, and to discuss 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 for use in discussing the proposed requirements and procedures for salinity control was adopted on November 9, 1973 and 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."

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

> ". . . The Final statement on proposed water quality standards and standards and plan of implementation for salinity control should be consistent for all seven States of the Colorado River Basin; and 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. . . . ."

Following the formulation of the Colorado River Basin Salinity Control Forum, meetings were held with representatives of the EPA in January, March and April 1974 to discuss the proposed regulation on Colorado River Salinity.

The Environmental Protection Agency published a notice of proposed amendements to (40 CFR Part 120) COLORADO RIVER WATER SYSTEM, Salinity Control Policy and Standard Procedures in FR DOC 74-13683 dated 6/12/74. The notice proposes in part that 40 CFR Part 140 be amended by adding Section 120.5 Colorado River System Implementation Plan, which reads as follows:

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

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"(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) of this section, 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 provided 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 basin-wide 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."

3. Colorado River Basin Salinity Control Act

On June 24, 1974, Public Law 93-320 of the 93rd Congress was signed into Law by the President. This Act is cited as the "Colorado River Basin Salinity Control Act." The Secretary of the Interior is authorized to construct several projects for the improvement and enhancement and protection of the quality of water available in the Colorado River for use in the United States and the Republic of Mexico, and to enable the United States to comply with its obligations to Mexico under Minute No. 242 of the International Boundary and Water Commission, United States and Mexico. The agreement with Mexico is further discussed in Part III under "Mexican Treaty."

PART II. DESCRIPTION OF BASIN

A. Geology

Rocks of all ages from those of the Archean age (the oldest known geological period) to the recent alluvial deposits, including igneous, sedimentary, and metamorphic types, are found in the Colorado River Basin. The high Rocky Mountains which dominate the topography of the upper regions are composed of granites, schists, gneisses, lava, and sharply folded sedimentary rocks of limestone, sandstone, and shale. Many periods of deposition, erosion, and upheaval have played a part in the present structure of these mountains.

In contrast to the folded rocks of the mountains which fringe the basin, the plateau country of southwestern Wyoming, eastern Utah, and northern Arizona is composed principally of horizontal strata of sedimentary rocks. Slow but constant elevation of the land area has allowed the Colorado River and its tributaries to cut narrow, deep canyons into the flat-topped mesas. This type of erosion reaches its culmination in the Grand Canyon where the Colorado River has cut through all of the sedimentary rocks down to the oldest Archean granites.

The Lower Basin is characterized by broad, flat valleys separated by low mountain ranges. These valleys are filled by large accumulations of alluvial deposits.

Sediment removed by constant erosion of the upper areas was deposited in Arizona, California, and Mexico and now forms the great delta of the Colorado River.

Reservoirs constructed above Lee Ferry (Lake Powell, Flaming Gorge, Fontenelle, Navajo, Morrow Point, and Blue Mesa), together with Lake Mead downstream, have caused some major changes in stream regimen: (1) The stream channels inundated by these reservoirs are no longer subject to natural stream erosion; (2) the accumulation of sediment and water within the reservoirs slows the growth and flooding of the Colorado River delta; (3) flooding has diminished in many areas; and (4) sections of sediment-laden streams have given way to clear water streams and lakes.

The salt concentration in runoff increases from the headwater areas downstream and occurs in relation to the geologic character of the terrain across which the Colorado River and its tributaries flow. The geologic formations that largely contribute to the salinity concentrations in natural runoff are evaporites of Paleozoic age, shale of Cretaceous age, and salt and gypsum of Tertiary age.

B. Soils

The soils of the Colorado River Basin closely resemble the geologic formations of their origin. Only in limited areas at the higher elevations has the precipitation leached the soil mass of its soluble constituents. Over most of the area both residual and transported soils are basic in reaction and well supplied with carbonates with normal or mature soils exhibiting a distinct horizon of carbonate accumulation. The impress of soil-forming factors has resulted in a wide range of soil development. Soils formed in areas with low precipitation are classified in the orders Entisols and Aridisols. Those formed in areas with high precipitation are classified in orders Mollisole and Alfisols. Saline and alkali (sodic) soils occur in many parts of the basin.

The residual soils comprise the larger area and are usually shallow in depth over shale and sandstone of various ages. Many of the shales are saline but contain much gypsum as well as other chloride and sulphate salts. Some formations are high in sodium chloride and some have sodium carbonate or bicarbonate strata. Very few residual soil areas are suitable for irrigation development. A large part of the salt pickup occurs in areas where the natural runoff contacts the saline shales before entering the streams.

The alluvial materials are extremely variable and range from alluvial fans and terraces, outwash plains, to lacustrine sediments. Some areas have soils from material transported only short distances and resemble the original materials. Other areas have soils which have been transported and mixed extremely well. Most of the agricultural areas are on these well-mixed alluviums and, therefore, the soils are quite variable.

Extensive areas of Eolian deposits occur in parts of the basin, principally in southwestern Colorado. The uniformly textured soils are reddish brown in color and have no resemblance to either the underlying formations or adjacent areas. These are excellent agricultural soils, but in many areas topography makes agriculture difficult.

C. Climate

The Colorado River Basin has climatic extremes, ranging between year-round snow cover and heavy precipitation on the high peaks of the Rocky Mountains to desert conditions with very little rain in the southern part of the basin. This wide range of climate is caused by differences in altitude, latitude, and by the configuration of the high mountain ranges. The encircling mountain ranges obstruct and deflect the air masses to such an extent that storm patterns are more erratic than in most other parts of the United States. Most of the moisture for precipitation on the Upper Basin is derived from the Pacific Ocean and the Gulf of Mexico. The Pacific source predominates generally from October through April and the Gulf source during the late spring and early summer.

In the northern part of the basin most precipitation falls in the form of winter snows and spring rains. Summer storms are infrequent but are sometimes of cloudburst intensity in localized areas. In the more arid southern portion the principal rainy season is in the winter months with occasional localized cloudbursts in the summer and fall.

Extremes of temperature in the basin range from 50° F. below zero to 130° F. above zero. The northern portion of the basin is characterized by short, warm summers and long, cold winters, and many mountain areas are blanketed by deep snow all winter. The southern portion of the basin has long, hot summers, practically continuous sunshine, and almost complete absence of freezing temperatures.

Nevertheless, the entire basin is arid except in the extremely high altitudes of the headwaters areas. Rainfall averages as low as 2.5 inches in the southern end of the basin while total precipitation in the high mountains may range from 40 to 60 inches annually.

D. Vegetation

Areas of higher elevation are covered with forests of pine, fir, spruce, and silver-stemmed aspens, broken by small glades and mountain meadows. Pinon and juniper trees, interspersed with scrub oak, mountain mahogany, rabbit brush, bunch grasses, and similar plants grow in the intermediate elevations of the mesa and plateau regions. Large areas in the Upper Basin are dominated by big sagebrush and related vegetation. Many of the streams are bordered by cottonwoods, willows, and salt cedar. Scattered cottonwoods and chokecherries grow in the canyons with the cliff rose, the redbud, and blue columbine. A profusion of wildflowers carpets many mountain parks. At lower elevations large areas are almost completely devoid of plant life while other sections are sprinkled with desert shrubs, Joshua trees, other Yucca plants, and saguaro cacti, some of the latter giant plants reaching 40 feet in height. Occasionally, cottonwoods or desert willows are found along desert streams with mesquite and creosote bush or catclaw and paloverde. In recent years many river channels have been overrun with tamarisk or salt cedar to the extent that a large volume of water is being consumed by such vegetation.

E. Hydrology

The Colorado River begins where peaks rise more than 14,000 feet high in the northwest portion of Colorado's Rocky Mountain National Park, 70 miles northwest of Denver. It meanders southwest for 640 miles through the Upper Basin to Lee Ferry. The Green River, its major tributary, rises in western Wyoming and discharges into the Colorado River in southeastern Utah--730 river miles south of its origin and 220 miles above Lee Ferry. The Green River drains 70 percent more area than the Colorado River above their junction but produces only about three-fourths as much water. The Gunnison and the San Juan are the other principal tributaries of the Upper Colorado River.

The flows of the San Juan River are now controlled by the Navajo Dam, the Green River by Fontenelle and Flaming Gorge Dams, and the Gunnison River by the Curecanti Unit Dams. Glen Canyon Dam is the only major dam on the main stem of the Colorado above Lee Ferry, but it will permit control of almost all flows leaving the Upper Basin.

The flow at various points in streams in the Colorado River Basin for the 1941-72 period is given in Tables 1 through 17. The records of flow depict the characteristic wide fluctuations from month-to-month and the considerable variation from year-to-year. The storage reservoirs now level out some of the fluctuations in the reaches below the dam.

The natural drainage area of the lower Colorado River below Lee Ferry and above Imperial Dam is about 75,100 square miles. This section of the river is now largely controlled by a series of storage and diversion dams starting with Hoover Dam and ending at Imperial Dam.

At the present time there is no significant storage on the main river or on the tributaries between Glen Canyon Dam and Lake Mead. The intervening tributary inflow is erratic but amounts to almost enough to offset the evaporation from Lake Mead.

Lake Mead provides most of the storage and regulation in the Lower Colorado River Basin with the water being stored for irrigation and municipal and industrial uses, generation of electrical power, and other beneficial uses.

Lake Mohave, the reservoir formed by Davis Dam, backs water at high stages about 67 miles upstream to the tailrace of Hoover Powerplant. Storage in Lake Mohave is used for some reregulation of releases from Hoover Dam, for meeting treaty requirements with Mexico, and for developing power head for the production of electrical energy at Davis Powerplant.

DESCRIPTION OF BASIN

The river flows through a natural channel for about 10 miles below Davis Dam at which point the river enters the broad Mohave Valley 33 miles above the upper end of Lake Havasu.

Lake Havasu backs up behind Parker Dam for about 45 miles and covers about 25,000 acres. Lake Havasu serves as a forebay from which the Metropolitan Water District of Southern California pumps water into the Colorado River Aqueduct. Havasu Lake will also serve as forebay for the Central Arizona Project pumping plants and aqueducts. Lake Havasu and Alamo Dam and Reservoir are used to control floods originating below Davis Dam and above Parker Dam.

Headgate Rock Dam, Palo Verde Diversion Dam, and Imperial Dam all serve as diversion structures with practically no storage. Imperial Dam, located some 150 miles downstream from Parker Dam, is the major diversion structure to irrigation projects in the Imperial Valley and Yuma areas. It diverts water on the right bank to the All-American Canal which delivers water to the Yuma project in Arizona and California and Imperial and Coachella Valleys in California. It diverts on the left bank to the Gila Gravity Main Canal.

The Senator Wash Dam also affords regulation in the vicinity of Imperial Dam and assists in the delivery of water to Mexico.

PART III. HISTORY OF WATER RESOURCE DEVELOPMENT

A. Irrigation Development

Irrigation development in the Upper Basin took place gradually from the beginning of settlement about 1860 but was hastened by the purchase of land from the Indians in 1873. About 800,000 acres were irrigated by 1905. Between 1905 and 1920 the development of irrigated land continued at a rapid pace, and by 1920 nearly 1,400,000 acres were irrigated. The development then leveled off and increase since that time has been slow. In 1965, 1,600,000 acres were under irrigation in the Upper Basin. Since 1965, there has been very little change.

The slow growth in irrigated acreage in the Upper Basin in the last 50 years is ascribed to both physical and economic limitations on the availability of water. By 1920 most of the lower cost and more easily constructed developments were in operation, and, although some new developments have taken place since that time, they have been partially offset by other acreages going out of production.

Irrigation development began in the Lower Basin about the same time as in the Upper Basin. Development was slow because of difficult diversions from the Colorado River with its widely fluctuating flows. Development of the Gila area began in 1875 and the Palo Verde area in 1879. Construction of the Boulder Canyon Project in the 1930's and other downstream projects since that time has provided the means for a continued expansion of the irrigated area. In 1972, there were nearly 810,000 acres irrigated from Colorado River diversions below Hoover Dam. About 25,500 acres of Lower Basin lands in Utah and 12,000 in Nevada are also now under irrigation. An additional unknown acreage is irrigated by private pumping from wells in the river aquifers in the Lower Colorado River Basin.

B. Streamflow Depletions

Development and utilization of the basin's water resources result in depletions of streamflows. Consumptive use of water by irrigated crops and exports to other basins produce the greatest flow depletions. Reservoir evaporation and consumptive use of water for municipal and industrial purposes also produce significant depletions.

The 1973 estimated consumptive use of water by irrigated crops and municipal and industrial in the Upper Basin was more than 2,200,000 acre-feet. Depletions related to irrigation such as evaporation from irrigation reservoirs (not Colorado River Storage Project Reservoirs) was estimated to be about 150,000 acre-feet per year.

Water exported from the Upper Basin during the period 1941-70 averaged about 360,000 acre-feet per year. With completion and diversions by the large projects such as the Colorado-Big Thompson, Duchesne Tunnel, Roberts Tunnel, and the more recent projects such as the San Juan-Chama Fryingpan-Arkansas, and Homestake. The transmountain diversion from the Upper Basin increased to about 690,000 acre-feet in 1973.

Reservoir evaporation varies from year-to-year but the variations have little effect on average streamflow depletions. For the period of record considered, average reservoir evaporation in the Upper Basin was not large until about 1963 when the Colorado River Storage Project Reservoir started to store water. In 1973 about 550,000 acre-feet were evaporated from the reservoirs. Under normal operating conditions, evaporation from the Colorado River Storage Project reservoirs is expected to average about 568,000 acre-feet annually.

In the Lower Basin above Imperial Dam, water is exported to the Southern California coastal areas through the Colorado River Aqueduct and to the Imperial and Coachella Valleys through the All-American Canal. Along the river, the main water diversions are to the Southern Nevada Water Project, Colorado River Indian Reservation, Palo Verde Irrigation District, Gila Project, and the Yuma Project. Below the Imperial Dam, water is delivered to Mexico as required by the treaty with Mexico. There is essentially no flow below Morellos Diversion Dam except for the bypassed saline flows from the Wellton-Mohawk Drain Extension.

C. Legal Aspects

1. Colorado River Compact

Water of the Colorado River was divided between the Upper and Lower Colorado River Basins by the Colorado River Compact which was signed in 1922 by a commissioner of each of the seven States of the river basin and by a representative of the United States. All States but Arizona ratified the compact prior to its effective date in 1929. The dividing point on the river between the Upper and Lower Basins is at Lee Ferry which is defined as a point 1 mile below the mouth of the Paria River. (Not to be confused with Lees Ferry which is the site of the gaging station just above the Paria River.) The compact apportions from the Colorado River system to each of the Upper and Lower Basins in perpetuity for exclusive beneficial consumptive use a total of 7,500,000 acre-feet annually. In addition to the apportionment of 7,500,000 acre-feet, the Lower Basin is given the right to increase its beneficial consumptive use of water from the Colorado River system by 1 million acre-feet annually. The compact further provides that the States of the upper division will not cause the flow of the river at Lee Ferry to be depleted below an aggregate of 75 million acre-feet for any period of 10 consecutive years.

One provision in the compact permits exportation of the water out of the basin as long as it is used beneficially in the seven Basin States, and another provision recognizes the obligations of the United States to the Indian Tribes. The compact prescribes the manner in which the waters of the Colorado River system may be made available to Mexico under any water rights recognized by the United States.

The compact, in effect, cleared the way for legislation authorizing the construction of major projects such as Boulder Canyon Project, and it also cleared the way for compacts or agreements within the Upper and Lower Basins to further divide the water among the States.

2. Mexican Treaty

The treaty with Mexico, signed in 1944, provides for the annual delivery by the United States of 1,500,000 acre-feet of Colorado River water to Mexico. In recent years, the quality of these waters has been of much concern to both countries.

The average annual salinity of the water delivered to Mexico at the Northerly International Boundary increased in 1961 from about 800 mg/l to nearly 1,400 mg/l, and in 1962 to nearly 1,500 mg/l. Although the return flow from the Wellton-Mohawk Irrigation and Drainage District was the primary cause of the increase in salinity, another factor had a significant impact. Beginning in 1961, releases of Colorado River water to Mexico were reduced to the Treaty minimum in order to build up storage in Lake Powell behind Glen Canyon Dam.

The increase in salinity resulted in negotiations between the United States and Mexico. In March 1965, Minute No. 218 was signed and approved by the two Governments. Beginning on November 16, 1965, Wellton-Mohawk drainage flows were bypassed around Morelos Dam during periods of low flow which amounted to about 55,000 acre-feet per year. This agreement was in effect until June 30, 1972, and reduced the average annual salinity of waters delivered to Mexico to about 1,245 mg/l.

On July 14, 1972, another agreement, Minute No. 241, was entered into. This Minute provided that the United States would increase the bypass of Wellton-Mohawk drainage, without charge against scheduled Treaty deliveries to Mexico, to the annual rate of 118,000 acre-feet and substitute equal volumes of other waters of better quality to be discharged to the Colorado River above Morelos Dam. This would reduce the salinity of waters delivered to Mexico by an estimated 100 mg/l. Minute 241, with three extensions, was in effect from July 1, 1972, through December 31, 1972.

Minute No. 242

In keeping with President Nixon's objective to find a permanent, definitive, and just solution to the salinity problem with Mexico, accord was reached on August 30, 1973, with the execution of Minute 242 of the International Boundary and Water Commission. The Minute was developed following an intensive study of the problem by former Attorney General Herbert Brownell and a federal Task Force appointed to assist him. Participation of the Basin States was sought by Mr. Brownell and representatives of the Governors (identified as the Committee of Fourteen), assisted in defining the solution. The key elements of the agreement were:

"1. Referring to the annual volume of the Colorado River waters guaranteed to Mexico under the Treaty of 1944, of 1,500,000 acre-feet (1,850,234,000 cubic meters):

a. The United States shall adopt measures to assure that not earlier than January 1, 1974, and no later than July 1, 1974, the approximately 1,360,000 acre-feet (1,677,545,000 cubic meters) delivered to Mexico up stream of Morelos Dam, have an annual average salinity of no more than 115 ppm ± 30 ppm United States count (121 ppm ± 30 ppm Mexican count) over the annual average salinity of Colorado River waters which arrive at Imperial Dam, with the understanding that any waters that may be delivered to Mexico under the Treaty of 1944 by means of the All American Canal shall be considered as having been delivered upstream of Morelos Dam for the purpose of computing this salinity.

b. The United States will continue to deliver to Mexico on the land boundary at San Luis and in the limitrophe section of the Colorado River downstream from Morelos Dam approximately 140,000 acre-feet (172,689,000 cubic meters) annually with a salinity substantially the same as that of the waters customarily delivered there.

c. Any decrease in deliveries under point 1(b) will be made up by an equal increase in deliveries under point 1(a).

d. Any other substantial changes in the aforementioned volumes of water at the stated locations must be agreed to by the Commission.

e. Implementation of the measures referred to in point 1(a) above is subject to the requirement in point 10 of the authorization of the necessary works.

"2. The life of Minute 241 shall be terminated upon approval of the present Minute. From September 1, 1973, until the provisions of point 1(a) become effective, the United States shall discharge to the Colorado River downstream from Morelos Dam volumes of drainage waters from the Wellton-Mohawk District at the annual rate of 118,000 acre-feet (145,551,000 cubic meters) and substitute therefor an equal volume of other waters to be discharged to the Colorado River above Morelos Dam; and, pursuant to the decision of President Echeverria expressed in the Joint Communique of June 17, 1972, the United States shall discharge to the Colorado River downstream from Morelos Dam the drainage waters of the Wellton-Mohawk District that do not form a part of the volumes of drainage waters referred to above, with the understanding that this remaining volume will not be replaced by substitution waters. The Commission shall continue to account for the drainage waters discharged below Morelos Dam as part of Article 10 of the Water Treaty of February 3, 1944.

"3. As a part of the measures referred to in point 1(a), the United States shall extend in its territory the concrete-lined Wellton-Mohawk bypass drain from Morelos Dam to the Arizona-Sonora international boundary, and operate and maintain the portions of the Wellton-Mohawk bypass drain located in the United States.

"4. To complete the drain referred to in point 3, Mexico, through the Commission and at the expense of the United States, shall construct, operate and maintain an extension of the concrete-lined bypass drain from the Arizona-Sonora international Boundary to the Santa Clara Slough of a capacity of 353 cubic feet (10 cubic meters) per second. Mexico shall permit the United States to discharge through this drain to the Santa Clara Slough all or a portion of the Wellton-Mohawk drainage waters, the volumes of brine from such desalting operations in the United States as are carried out to implement the Resolution of this Minute, and any other volumes of brine which Mexico may agree to accept. It is understood that no radioactive material or nuclear wastes shall be discharged through this drain, and that the United States shall acquire no right to navigation, servitude or easement by reason of the existence of the drain, nor other legal rights, except as expressly provided in this point.

"5. Pending the conclusion by the Governments of the United States and Mexico of a comprehensive agreement on ground water in the border areas, each country shall limit pumping of ground waters in its territory within five miles (eight kilometers) of the Arizona-Sonora boundary near San Luis to 160,000 acre-feet (197,358,000 cubic meters) annually.

"6. With the objective of avoiding future problems, the United States and Mexico shall consult with each other prior to undertaking any new development of either the surface or the ground water resources, or undertaking substantial modifications of present developments, in its own territory in the border area that might adversely affect the other country.

"7. The United States will support efforts by Mexico to obtain appropriate financing on favorable terms for the improvement and rehabilitation of Mexicali Valley. The United States will also provide nonreimbursable assistance on a basis mutually acceptable to both countries exclusively for those aspects of the Mexican rehabilitation program of the Mexicali Valley relating to the salinity problem, including tile drainage. In order to comply with the above-mentioned purposes, both countries will undertake negotiations as soon as possible.

"8. The United States and Mexico shall recognize the undertakings and understandings contained in this Resolution as constituting the permanent and definitive solution of the salinity problem referred to in the Joint Communique of President Richard Nixon and President Luis Echeverria dated June 17, 1972.

"9. The measures required to implement this Resolution shall be undertaken and completed at the earliest practical date.

"10. This Minute is subject to the express approval of both Governments by exchange of Notes. It shall enter into force upon such approval; provided, however, that the provisions which are dependent for their implementation on the construction of works or on other measures which require expenditure of funds by the United States, shall become effective upon the notification by the United States to Mexico of the authorization by the United States Congress of said funds, which will be sought promptly."

The passage of the Colorado River Basin Salinity Control Act Public Law 93-320 on June 24, 1974, authorized construction of a desalting plant and other works necessary for the United States to comply with the provisions of Minute 242.

3. Upper Colorado River Basin Compact

With the water allocated to the Upper Basin by the Colorado River Compact and with the 1944 Mexican Treaty signed, the Upper Basin States began negotiations which resulted in the signing of the Upper Colorado River Basin Compact in 1948. Under the terms of the compact, Arizona is permitted to use 50,000 acre-feet of water annually from the Upper Colorado River system, and the remaining water is apportioned to the other Upper Basin States in the following percentages.

State of Colorado	51.75 percent
State of New Mexico	11.25 percent
State of Utah	23.00 percent
State of Wyoming	14.00 percent

Congress had previously been unwilling to approve projects without assurance that a water supply would be available, so this division of water among the States permitted development to proceed and resulted primarily in the authorization of most of the Federal projects above Lee Ferry that are mentioned in this report.

Neither of the compacts specifically mentions water quality, but it has been recognized as a factor to be considered in developing projects, and water quality studies have been required by recent legislation authorizing the construction of projects in the Upper Basin.

4. Arizona vs. California Suit in the Supreme Court

The States of the Lower Basin have never agreed to a compact for the division of use of the waters of the Lower Colorado River Basin. The State of Arizona filed suit in the Supreme Court of the United States in October 1952 against the State of California and others for the determination of the rights to use the waters of the Lower Colorado River system. The Supreme Court gave its decision on June 3, 1963, and issued a decree on March 9, 1964, providing for the apportionment of the use of the waters of the main stream of the Colorado River below Lee Ferry among the States of Arizona, California, and Nevada. The States of Arizona and New Mexico were granted the exclusive use of the waters of the Gila River system in the United States. The decree did not affect the rights or priorities to the use of water in any of the other Lower Basin tributaries of the Colorado River.

The decree permitted the States of the Lower Basin to proceed with developments to use their apportionments of Colorado River water. Major new developments include the Southern Nevada Water Project in Nevada, the Dixie Project in Utah, and the Central Arizona Project in Arizona. Development of the Indian lands is expected to use all of the water allocated to them by the decree. These lands include the Colorado River Indian Reservation, Arizona-California; the Fort Mohave Indian Reservation, Arizona-California-Nevada; and the Chemehuevi Indian Reservation, California.

5. Colorado River Basin Project Act (Public Law 90-537, 90th Congress, September 30, 1968)

The major items provided in the law include the following:

Construction of the Central Arizona Project consisting of a system of main conduits and canals including a main canal and pumping plants (Granite Reef aqueduct and pumping plants) for diverting and carrying water from Lake Havasu to Orme Dam or suitable alternative.

Construction of five multiple-purpose projects in Colorado; the Animas-La Plata, Dolores, Dallas Creek, West Divide, and San Miguel; and one in Utah, the Uintah Unit of the Central Utah Project, upon completion and approval of a feasibility report to Congress.

Establishment of a Lower Colorado River Development Fund.

Development of criteria for the coordinated long-range operation of the Federal reservoirs, equalizing the storage in Lake Mead and Lake Powell.

Directed that the Secretary of the Interior shall conduct full and complete reconnaissance investigations for the purpose of developing a general plan to meet the future water needs of the Western United States, except that for a period of 10 years from the date of the act, studies shall not be undertaken of any plan for the importation of water into the Colorado River Basin from any other natural river drainage basin lying outside the States of Arizona, California, Colorado, New Mexico, and those portions of Nevada, Utah, and Wyoming which are in the natural drainage basin of the Colorado River.

Directed the Secretary to make annual reports of annual consumptive use and losses of water from the Colorado River system after each successive five-year period beginning with the five-year period starting on October 1, 1970.

D. Economic Conditions

The prosperity of agriculture in the Upper Colorado River drainage basin generally parallels the prosperity of the livestock industry. With vast areas of fine rangeland available for summer grazing, livestock production is limited by the production of hay for winter feed.

Intensified development of mineral resources in recent years has created new employment opportunities, including off-the-farm work for many farmers. The most extensive and commercially important mineral resources of the Upper Basin are coal, oil, and natural gas. The Upper Basin is also the leading domestic source of vanadium, uranium, radium ore, and molybdenum. Copper, zinc, lead, silver, and gold are also commercially important. In recent years mining of trona has become extensive in the State of Wyoming.

The recent energy shortage has resulted in an intense search for new sources of providing for this need. As a result, investigations are underway for the commercial development of shale oil in Colorado, Utah and Wyoming. Fossil fuel powerplants are either being constructed or are in the planning stage for construction throughout the Upper Basin States. Coal gasification is an emerging industry in northwestern New Mexico where several billion tons of strippable coal is available. These developments have already and will continue to provide job opportunities throughout the area. The increase in population resulting from new job opportunities has created new markets for locally produced and imported products, has taxed municipal facilities and water supplies in several areas, and has increased demands for electricity. Raw materials are also stimulating industrial activities in areas adjoining the upper drainage basin, particularly areas near Denver, Pueblo, Provo, and Salt Lake City. These adjoining areas all import water from the Colorado River Basin and without the imported water their economic growth would be limited.

Tourism as an industry has increased significantly in recent years because of the recreational developments and the many natural attractions. Manufacturing as a basic industry is of relatively minor importance in the Upper Basin.

Irrigated areas in the Lower Colorado River Basin and in adjoining basins using Colorado River main stream water are highly productive and the agricultural operations very intensified. Gross crop values per acre probably are greater than any other area of comparable size in the world with a 1972 average gross crop income of about $400 per acre.

HISTORY OF WATER RESOURCE DEVELOPMENT

The Pacific Southwest is one of the most rapidly developing areas in the Nation, both industrially and populationwise. Colorado River water for municipal and industrial purposes is supplied to approximately 130 incorporated towns and other communities in this area with a population of about 10 million people. This water supply, which has been about 1,200,000 acre-feet annually in recent years, is delivered through the facilities of the Metropolitan Water District. The Colorado River supplies about 36 percent of all of the developed water in the 4,800-square-mile service area. This water ranges from a minor supply for some entities to a complete supply for others.

PART IV. SPECIAL STUDIES

A. Impoundments

1. Flaming Gorge Reservoir

Salinity samples have been obtained approximately twice a year in the spring and fall by the Bureau of Reclamation since 1967 at two locations in the Flaming Gorge Reservoir. Samples are obtained at 50-foot depths from the surface to the bottom of the reservoir. These two sites are at the mouth of Henry's Fork and about 1 mile above the dam. Parameters analyzed are specific conductance, dissolved solids, pH, and common ions. The Geological Survey conducted a water quality reconnaissance of Flaming Gorge Reservoir during 1966-68 and the results are published in Water Supply Paper 2009-C. A more comprehensive project was conducted from 1970-74 and those results are in preparation and will be published as Water Supply Paper 2039-A. Studies by the Geological Survey on Flaming Gorge Reservoir have been continuing and the latest observations are presented as "Effects of Flaming Gorge Reservoir on the Colorado River" under G. of this Special Studies section.

2. Lake Powell

A network of six sampling stations was established in Lake Powell in 1965 and sampling at these sites had continued on a quarterly basis until the fall of 1971. In addition, samples were taken at the mouth of Wahweap Creek and below the Glen Canyon Dam on a monthly basis. The purpose of this program was to observe chemical changes in the reservoir with time. In the fall of 1971 the quarterly sampling program was increased to a monthly program to obtain sufficient data for a mathematical model of the Colorado River system. The seven sites in the reservoir are: (1) Wahweap, (2) Crossing of the Fathers, (3) Oak Creek, (4) Cha Canyon, (5) Escalante River, (6) Bullfrog, and (7) Hite Basin. The samples are taken at 50-foot intervals to the bottom of the lake and analyzed for dissolved solids, common ions, specific conductance, pH, temperature, and dissolved oxygen.

In addition to the model being developed by the Bureau of Reclamation, other organizations have requested the available basic data on Lake Powell to make special studies. For example, a research project is now being conducted titled the "Lake Powell Research Project." The organization making the study consists of universities, colleges and other participants and collaborates in assessing man's activities in the Lake Powell region. The organization seeks to establish the natural framework of the region, evaluate recent changes that man has brought about, and determine how these changes in turn affected man.

3. <u>Lake Mead</u>

The Bureau of Reclamation conducted an extensive sampling program of Lake Mead from 1964 through 1968. The data collected from the sampling program were published by the Bureau of Reclamation in Report No. CHE-70, Water Quality Study of Lake Mead, 1970.

A more recent report funded by the Bureau of Reclamation entitled "A Mathematical Model of Primary Productivity and Limological Patterns in Lake Mead, Technical Report No. 13." September 1972, analyzes the biological and chemical properties of Lake Mead based on eight sampling stations. This report indicates the sources of water pollution and the time of highest pollution potential. It also presents a method of quantifying eutrophication trends in Lake Mead.

Another report entitled "Final Report on Interrelationships between Chemical, Physical and Biological Conditions of the Waters at Las Vegas Bay of Lake Mead" by Dr. James Deacon, University of Nevada, Las Vegas, May 1973 describes the effects of Las Vegas Wash, an enriched stream, on Lake Mead.

The Biology Department of the University of Nevada, Las Vegas is conducting a special study called the "Lake Mead Water Quality Monitoring Program." A report on this program is scheduled to be issued in April 1975.

Complete chemical and nutrient analyses are made for water samples taken by the Bureau of Reclamation quarterly at three stations in Lake Mead: Hoover Dam Intake Towers, Saddle Island Station, and Station 10.

B. <u>Upper Colorado River Salinity Investigations</u>

Water quality samples are being collected daily, monthly, or quarterly from approximately 100 sites on the rivers, canals, drains, and sloughs by the Bureau of Reclamation and by the Geological Survey for the Bureau of Reclamation in the Upper Colorado River Basin. This program is in addition to the regular Geological Survey network. Samples are collected at various locations for the purpose of evaluating effects of future water resource projects on the river system, identifying sources of salinity for water quality improvement projects, obtaining basic data for research projects, and acquiring long-term records to determine trends and observe overall changes in the salinity of the river system. This monitoring system will be especially valuable in providing data for the "Colorado River Water Quality Improvement Program" in the basin.

C. Lower Colorado River Salinity Investigations

In February of 1970, the Bureau of Reclamation began a trial program to analyze the source and makeup of the salt load arriving at Imperial Dam on a daily basis. Conductivity measurements were made each day at 10 stations between Parker Dam and Imperial Dam. The network included essentially all significant diversions, surface return flows, and major river stations.

An intensive program was carried on for one year. After one year of operation, the frequency of sampling was reduced. During the fall of 1971, an experimental program of automatic salinity monitoring was started. Conductivity probes were installed at nine stations on the lower river and the data transmitted by telemetry to the Boulder City and Imperial Dam offices. The nine stations are as follows:

1. Colorado River below Hoover Dam.
2. CRIR Main Canal near Parker.
3. Poston Wasteway near Poston.
4. Palo Verde canal near Blythe.
5. Colorado River at Taylor Ferry near Cibola.
6. Colorado River below Cibola Valley.
7. Yuma Mesa Drain near Yuma.
8. Main Outlet Drain Extension Bifurcation for MODES 2 and 3.
9. Colorado River at the Northerly International Boundary above Morelos Dam.

Samples are collected from 10 stations, five of which are telemetered stations. Individual samples are analyzed for conductivity. The U.S. Geological Survey Laboratory makes weekly analyses for total dissolved solids (residue at 180° C.) and monthly analyses of the chemical constituents of composite samples.

Sampling frequencies for these stations were selected from an analysis of past records so that samples would represent the actual salt load with an error of less than 5 percent, 95 percent of the time. These stations and the selected frequencies are shown in the following tabulation:

	Samples/Week
Colorado River below Parker Dam	1
CRIR Main Canal near Parker	1
Poston Wasteway near Poston	1
Palo Verde Canal near Blythe	1
CRIR Levee Drain near Parker	1
CRIR Lower Main Drain near Parker	1
Colorado River at Taylor Ferry near Cibola	1
Palo Verde Outfall Drain near Palo Verde	1
Colorado River below Cibola Valley	1
Colorado River at Imperial Dam	7

This data collection program is being continued. In addition, the latest salinity monitoring equipment is being tested on a trial basis to determine its application to conditions along the Lower Colorado River. Data from the program are being used to develop a prediction model of salinity movement in the river. Such a model will be valuable in helping to improve operational procedures for better salinity control.

The U.S. Geological Survey made a salinity study of the Lower Colorado River Basin and presented it in professional paper 486-E, "Salinity of Surface Water in the Lower Colorado River - Salton Sea Area," by Burdge Irelan, dated 1971. The report shows that during the period 1926-62 the chemical regimen of the Colorado River at Grand Canyon and upstream, although probably somewhat different from the virgin regimen, was relatively stable. There may have been small increases in average mineral concentrations, particularly toward the end of the period, caused by construction of reservoirs, increased irrigation and out-of-basin diversions. The research also found that most of the mineral burden of the Colorado River originates in the upper Basin. The largest individual increment to the mineral burden of the Colorado River below the compact point and above Imperial Dam was found to be Blue Springs near the mouth of the Little Colorado River. The report also shows that cultivated lands in Parker and Palo Verde Valleys and increasing out-of-basin diversions contribute to increasing salinity in the lower reaches of the river.

D. Irrigated Areas

Studies have been made in several areas to determine irrigation effects on water quality. Two of these worthy of mention are the Vernal, and Florida Project areas and are described in the following paragraphs:

1. Vernal Area

A cooperative study initiated in 1969 entitled "Water Quality Prediction Investigations" was conducted by the Bureau of Reclamation and Environmental Protection Agency to develop a technique for predicting more precisely, the mineral quality of irrigation return flow. The means for accomplishing this is through the use of mathematical models and highspeed computers. The mathematical model is primarily a mathematical formula or expression attempting to duplicate conditions encountered on an irrigation project. The study utilizes data from existing irrigation projects in order to verify the technique.

The objective of the study was to use a model in predicting changes in capacity and the associated water quality distribution of the aquifer and also the quality distribution of the water as surface effluents from the system. The prediction of the system responses was compared with the historical data, both quantity and quality distributions as a measure of the reliability of the model. Data from the Vernal Unit of the Central Utah Project have been used for designing and testing the model. Further tests will be made using data from the Grand Valley area in Colorado and the Cedar Bluff Unit in Kansas. A final report of this project is now being prepared by the Environmental Protection Agency.

Although model testing and development of all the mathematical submodels is not complete, it appears that a satisfactory model has been designed to predict the mineral quality of return flow from irrigation projects. Completion of the submodels will extend capability to impact analysis, and best plan selection.

The implication for water resource projects is that farm operation could be designed to use the least amount of water and return the smallest amount of salt to the river while permitting the farmer to obtain the greatest possible return from his farm. Using this model, the salt load reductions expected from irrigation scheduling and management could be verified on the Vernal Unit in the Uintah Basin.

2. <u>Florida Project</u>

Flow and quality data were collected at several points in the Florida Project area beginning in 1958 before the project was constructed. A study of these data for the period 1958-63show the effect of irrigation of these lands on the quality of return flows leaving the area.

Results show that there has been a very small amount of pickup measured in the river downstream from the irrigated area. The concentration of total dissolved solids in the inflowing water ranges from 0.14 to 0.17 ton per acre-foot, and that of the outflowing water ranges from 0.17 to 0.30. About 13,720 acres were irrigated at the time the measurements were made.

Other areas in the Colorado River Basin with similar type soils under irrigation would yield only minor amounts of salt.

3. <u>Other Studies</u>

Considerable variation in the effects of irrigation return flow on water quality is to be expected. Differences arise due to the size of the irrigated areas, the number of times the return flow is reused, properties of the soils and drainage area, number of years land has been irrigated, nature of aquifers, rainfall, dilution, temperature, irrigation methods, storage reservoirs, vegetation, and type of return flow channels.

Consumptive use, return flow, and salinity studies are now being conducted by Federal agencies in cooperation with State and local agencies. Some of the study areas are purposely being held small to achieve better control, but they will be as representative as possible of existing projects. The results pertaining to the quantity of return flow will be very helpful in estimating effects on water quality of return flows from larger areas where measurement of inflow and outflow is not always possible or practical.

Special studies in areas of the basin will continue to be made from time to time to determine water quality conditions, and studies of projects, such as Florida and Vernal Area should be repeated or continued in order to evaluate changes with time.

E. Environmental Protection Agency Report

A special 1971 report by the Environmental Protection Agency entitled "The Mineral Quality Problem in the Colorado River Basin" presents results and recommendations obtained from a comprehensive salinity control study. This report includes a presentation of natural and manmade conditions affecting mineral quality, the physical and economic impacts, and salinity control and management aspects.

F. Model Studies

1. Colorado River Storage Project Model

This mathematical model was developed by the Bureau of Reclamation for the Colorado River Reservoir Long Range operating criteria (PL. 90-537) and includes monthly water supply data for the period 1906-72. Conditions were adjusted to the 1968 level of depletions. In 1974 a study was conducted in relation to the sizing of the Welton-Mohawk desalting plant in which salt loadings were assigned to the flows. This part of the study covered the reach from Lake Powell to Parker Dam and a supplemental quality study carried the operation on down to Imperial Dam. Since quality records are not available for the years prior to about 1941, those back to 1906 had to be obtained by correlation. This study is expected to be updated by use of a revised depletion schedule, which was recently developed and used in computing Table 18 of this report.

2. Interim Water Quality Simulation Model for the Colorado River

This model was developed by the Bureau of Reclamation in 1973, and nominally duplicated the hand computed model shown in Table 18 of the January 1973 "Quality of Water Colorado River Basin Progress Report"

No. 6, as it included the 1941-70 period of record. The model ("Application of a River Network Model to Water Quality Investigations for the Colorado River," September 1973 by R. W. Ribbens and R. F. Wilson) however, was different in that it simulated reservoir operations, was computed on a monthly, year by year instead of an average annual basis and was developed for the reach from Lake Powell to Imperial Dam instead of including all the Upper Basin stations as well as the Lower Basin stations. Results were comparable to the Biennial Report study, but updating will have to be made using the revised depletion schedule.

3. Colorado River Model

This comprehensive mathematical model of the Colorado River was developed by the Bureau of Reclamation during the years 1972 to 1974. It was developed so it could be adapted to other basins as well as the Colorado River Basin, simulating both water quality and quantity. It also includes the interaction of ground water with the surface water. At the present time the model uses a stochastic hydrologic data base. This base was used in the model applied to the West Wide studies. An updated data base is being developed for use in the simulation model.

4. Utah State University Study

In 1970 the Utah State University issued a report entitled "Computer Simulations of the Hydrologic-Salinity Flow System Within the Upper Colorado River Basin." This report was based on a study which employed an electronic analog computer in developing a simulation model of the hydrologic and salinity flow systems of the Upper Colorado River Basin. The period of record used in the study was from 1931-60 and reflected conditions of 1960 in cropping and river regulations. The estimated salt load at Lees Ferry was 8.6 million tons consisting of about 4.3 million tons (50 percent) from natural sources, 1.5 million tons (17 percent) from agriculture and 2.8 million tons (33 percent) from other unidentified sources. The model was designed to predict the effects of various possible water resources management alternatives.

G. Effects of Flaming Gorge Reservoir on the Colorado River

1. Water Quality in and Below Flaming Gorge Reservoir

The effect of Flaming Gorge Reservoir on the Green River, a tributary to the Colorado River, has been to deplete the flow of the river, to leach minerals from the rocks and soils inundated by the reservoir, to increase the dissolved-solids concentration in the river below the reservoir, and to alter the temperature regime in the river below the reservoir. Depletion of dissolved oxygen occurs in parts of the reservoir during certain periods of the year.

Depletion of Flow.--Depletion of flow in the Green River is due to storage in Flaming Gorge Reservoir, storage in the rocks and soils inundated by the reservoir, and to evaporation. Water was first impounded by Flaming Gorge Dam in November 1962. From then until the end of the 1973 water year (September 30, 1973), the depletion of flow in the Green River was about 4.1 million acre-feet, of which approximately 3.2 million acre-feet of water was stored in the reservoir. Evaporation and bank storage during this period was about 0.9 million acre-feet.

Effects of Leaching.--To estimate dissolved-solids load changes in the river system and to evaluate the effects of leaching, data were obtained from several depths at selected sampling sites in the reservoir as well as at sites on the major inflowing and outflowing tributaries.

From closure of Flaming Gorge Dam until the end of the 1973 water year, the net gain of dissolved-solids load to the river system resulting from the effects of leaching was about 1.95 million tons.

Net gains of dissolved-solids loads and rates of leaching for various periods are shown in the following table.

Time period (water year)	Load gain (thousands of tons)	Rate per year (thousands of tons, rounded)
1963-66	800	200
1967-70	630	160
1971-73	520	170

The highest rate of leaching occurred during the 4-year period 1963-66, when the reservoir was initially filling. During the next 4-year period (1967-70) the reservoir level was relatively stable and the leaching rates declined, probably because few additonal soils and rocks were inundated during this period. During the period 1971-73, reservoir levels exceeded previous highs and fluctuations in reservoir level were greater than during the previous period. During 1972, the reservoir level was raised to within about 5 feet of maximum pool level. Thus, the increase in the leaching rate for the latter period was due to inundation of rocks and soils not previously inundated by reservoir waters.

Dissolved-solids Concentration Below the Reservoir.--Since the closure of Flaming Gorge Dam, the weighted-average dissolved-solids concentration of the water in the river below the reservoir has increased (fig. 2). The highest concentration was in 1963 when a minimum of water was being released as the reservoir filled. During the next 10 years (1964-73) the concentrations were less than in 1963 but greater than during the

5 years preceding closure. The increase in concentration after closure was due to leaching and evaporation in the reservoir. Although the weighted-average concentration has increased since closure of the reservoir, the annual variation of the maximum and minimum has been considerably attenuated.

Variations of temperature below the reservoir.--The range of average monthly temperatures of the Green River below the reservoir has been reduced considerably since closure of the dam (fig. 3). Prior to closure, the average monthly temperatures ranged from 0°C to 19.5°C, and after closure the range has been 3.5°C to 9.5°C. The reservoir not only reduced the magnitude of variation in temperature but also changed the time period of the high and low temperatures. Prior to closure, the lowest temperature was in the period December to February and the highest in July, whereas after closure the low and high have been in March and November.

Depletion of Dissolved Oxygen.--Anaerobic or near-anaerobic conditions were observed in parts of Flaming Gorge Reservoir during the period from October 1970 through September 1973. These conditions occurred throughout this period in the deepest part of the reservoir near the dam where circulation with overlying water was nil. Near the confluence of Blacks Fork and the Green River, near-anaerobic conditions were observed in the bottom waters during the summer months. Also, unusually low concentrations of dissolved oxygen were observed in the metalimnetic zone of the reservoir during the summer months. These two summer conditions are probably related in that the depletion of oxygen may be due to the decomposition of naturally occurring organic matter or to pollutants brought in by either or both Blacks Fork and the Green River.

ANNUAL MAXIMUM, MINIMUM, AND WEIGHTED-AVERAGE CONCENTRATION OF DISSOLVED SOLIDS OF GREEN RIVER NEAR GREENDALE, 1958 - 73

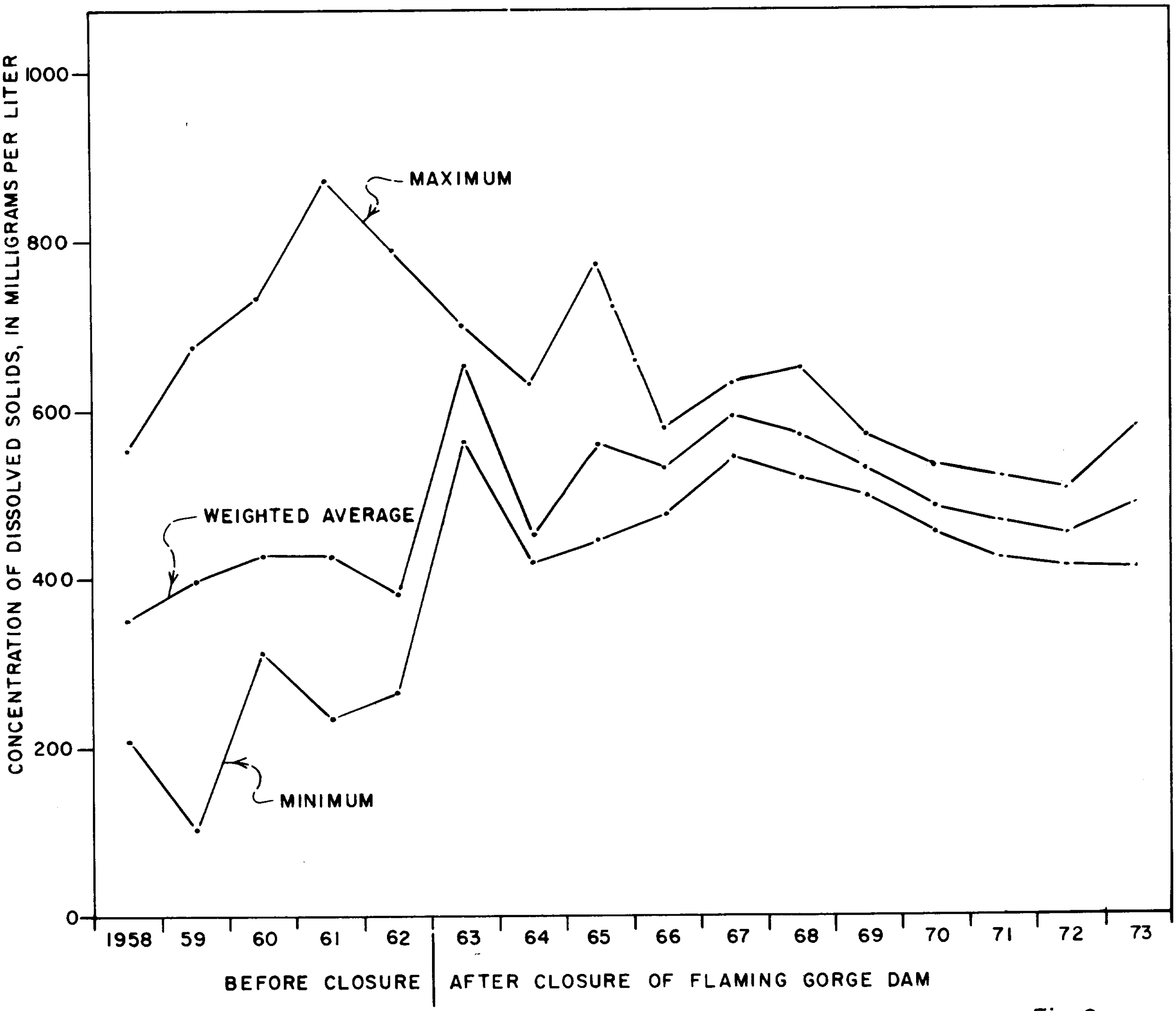


Fig. 2

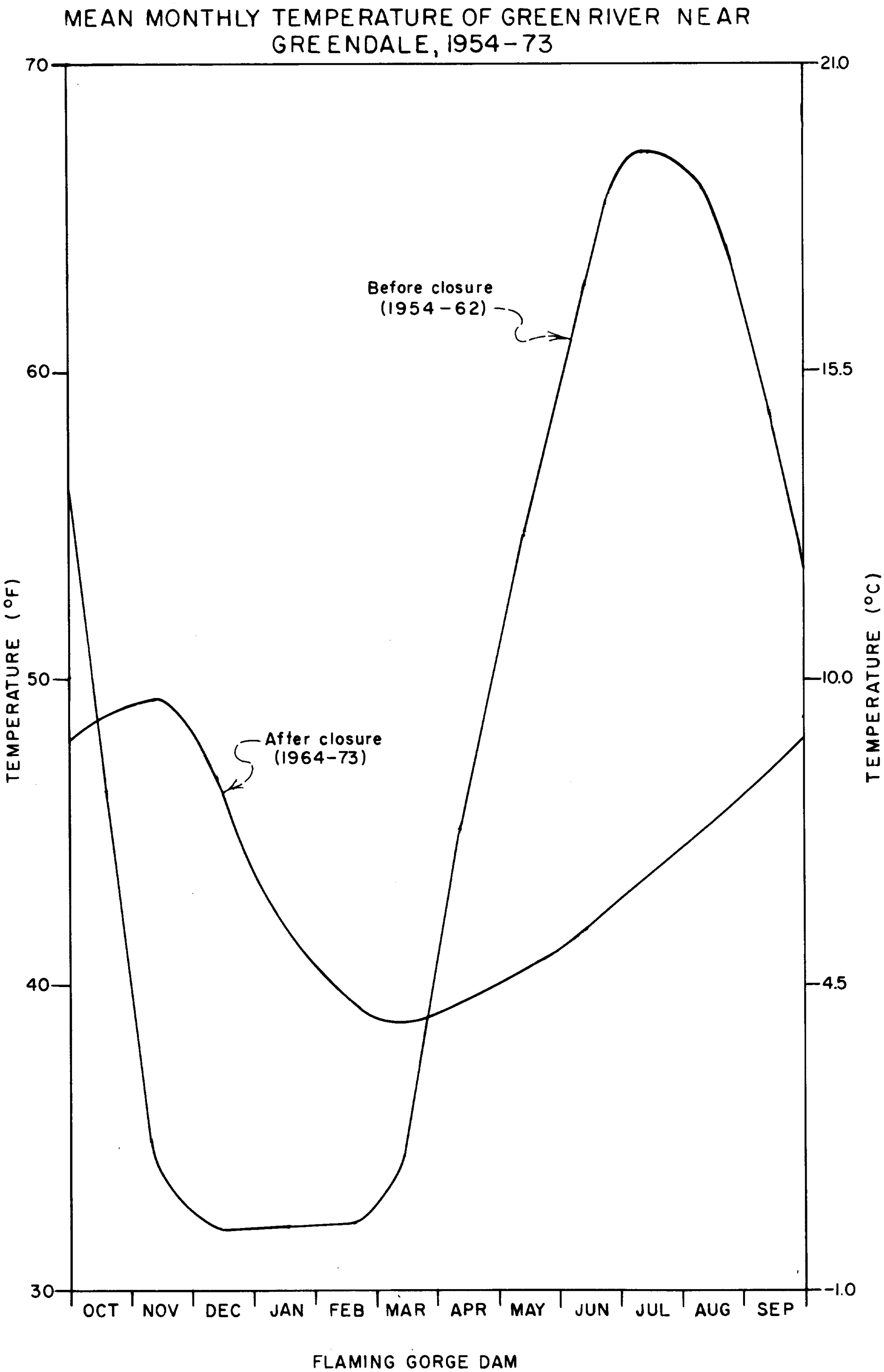

MEAN MONTHLY TEMPERATURE OF GREEN RIVER NEAR GREENDALE, 1954-73
70
60
50
40
30
21.0
15.5
10.0
4.5
-1.0
TEMPERATURE (°F)
TEMPERATURE (°C)
Before closure (1954-62)
After closure (1964-73)
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FLAMING GORGE DAM

Fig. 3

PART V. CAUSES OF SALINITY

A. Increased Concentration from Salt Additions

1. Natural Sources of Salinity

Inspection of the flow and quality records reveals that along certain reaches of the Colorado River there are large increases in the dissolved-solids load that cannot be attributed to irrigation or other man-related activity. This increase is mainly due to natural diffused sources and saline springs.

Natural diffused sources are those sources of salt contribution which occur gradually over long reaches of the river system. Salt pickup occurs over large areas of surface and underlying soils, from stream channels and banks, and is difficult to identify, measure, or control. This source contributes the largest overall share of the salts to the Colorado River. Natural point sources are mainly saline springs where the contribution of salt and water is easily identified, issuing from single or concentrated sources.

Very little information was obtained prior to irrigation and therefore more studies are needed to identify the magnitude of specific natural sources of salinity in the Colorado River Basin.

Upper Basin.--Past records indicate a substantial increase in salt load in the Lake Powell area above Lees Ferry and below the Green River, Cisco, and Bluff stations. Iorns and others (1965, p. 20) presented estimates of dissolved-solids loads in this river reach based on the period 1914-57 adjusted to 1957 conditions of development. Unaccounted inflow of dissolved solids in this reach amounted to about 5 percent of the load at Lees Ferry. Most of this resulted from natural diffused sources with the San Rafael and Dirty Devil areas fairly heavy contributors.

Other areas in the Upper Basin with large amounts of natural diffused sources of salt are the Grand Valley, Uncompahgre, lower Gunnison, and McElmo Creek areas in Colorado; Price, and Uintah Basin in Utah; and Big Sandy River area in Wyoming. Although a large amount of salt pickup in these areas is due to natural runoff, some can be attributed to irrigation.

Table A summarizes information about the contribution of water and dissolved salts by springs and wells to the Upper Colorado River system. Although wells are man-made and not a natural source, abondoned saline

Table A
Saline Springs and Wells
Upper Colorado River Basin 1/

Spring and location	Flow (c.f.s.)	Total dissolved-solids concentration (mg./l.)	Total dissolved-solids concentration (tons/ ac.-ft.)	Total dissolved-solids load (tons/ day)	Total dissolved-solids load (tons/ year)	Flow (ac.-ft./ year)
Castle Creek Spring near Moab, Utah	0.245	4,390	6.0	2.9	1,060	177
Onion Creek Spring near Moab, Utah	0.122	9,120	12.4	3.0	1,100	88
Cold Kendall Spring near Kendall Ranger Sta., Wyo.	1.400	2,100	2.8	7.9	2,880	1,014
Ragen Spring on Muddy Cr. west of Ft. Bridger, Wyo.	0.089	9,210	12.6	2.2	800	64
Dotsero Springs 1.5 mi. west of Dotsero, Colo.	17.000	10,700	14.5	500.0	182,600	12,308
Glenwood Springs area, Glenwood Springs, Colo.	18.000	18,900	25.5	919.0	335,000	13,032
Steamboat Springs at Steamboat Springs, Colo.	1.400	6,140	8.4	23.4	8,500	1,014
Lithia Spring, Steamboat Springs, Colo.	0.022	5,770	7.8	0.3	110	16
Piceance Creek Spring, Meeker, Colo.	0.022	4,650	6.5	0.2	72	16
Trimble Hot Spring, Durango, Colo.	0.066	3,250	4.4	0.1	36	48
Pagosa Hot Spring, Pagosa, Colo.	2.300	3,240	4.4	20.0	7,300	1,665
Pinkerton Hot Spring, Durango, Colo.	0.500	3,670	5.0	5.0	1,820	362
Yellow Creek Spring, Rangely, Colo.	0.089	9,370	12.7	2.3	840	64
Ridgway Hot Spring, Ridgway, Colo.	1.000	2,850	3.9	7.0	2,550	724
Paradise Hot Spring, Dunton, Colo.	0.111	5,490	7.5	1.7	620	80
Big Sulphur Spring, Meredith, Colo.	0.333	2,250	3.1	2.0	730	241
Arsenic Spring, Crystal Mining Camp	2.000	2,030	2.8	11.0	4,000	1,448
Coal Mine Drainage, Oak Creek, Colo.	0.666	3,430	4.7	6.2	2,260	482
South Drain Ashley Cr. Oil Field, Vernal, Utah	2.200	2,670	3.6	15.9	5,800	1,593
Crystal Geyser, Green River, Utah	0.207	14,000	19.0	8.0	3,000	150
Flowing Well near Aneth, Utah	0.133	4,560	6.2	1.6	580	96
Drainage, Iles Dome Oil Field near Loyd, Colo.	2.900	2,180	2.9	17.0	6,200	2,100

1/ List of springs and wells limited to those with T.D.S. concentrations in excess of 2,000 mg./l.

flowing wells are shown with the natural springs. The largest contributors in the Upper Basin are the Dotsero and Glenwood Springs which supply the major part of the salts from point sources.

Lower Basin.--During 3 consecutive years (1949-51) when there was very little increase in water discharge between Lees Ferry and Grand Canyon, the dissolved-solids load increased about 1.3 million tons each year. During 1941 the discharge increased by about 1 million acre-feet, but the load increased by only 2 million tons. In 1952 the discharge increased by 0.2 million acre-feet and the load by 2.2 million tons. With the exception of these 2 years the annual increase in dissolved-solids load during the 30-year period has ranged from 0.5 million tons to 1.8 million tons.

In 1962 runoff of 14.4 million acre-feet at Lees Ferry increased by 400,000 acre-feet at Grand Canyon and the dissolved-solids load increased by half a million tons. By contrast, during the filling of Lake Powell the following year, only 1,384,000 acre-feet was recorded at Lees Ferry and the increase in flow at Grand Canyon amounted to 246,000 acre-feet, but the dissolved-solids load still increased by more than a half million tons. Likewise, with a small flow in 1964 the dissolved-solids load increased by nearly 900,000 tons. The fairly consistent salt inflow is the result of the salt load from the saline springs which contribute the major part of the dissolved solids within this reach.

Large amounts of dissolved solids are also added to the Colorado River between Grand Canyon and Hoover Dam. Some of this results from the solution of material in the bed of Lake Mead, but like the reach above Grand Canyon, most is contributed by springs and tributary inflows. Recent studies in the Lower Basin by the Geological Survey and the Bureau of Reclamation have provided information about the contribution of springs to the Colorado River between Glen Canyon Dam and Lake Mead and to the Virgin River which drains into Lake Mead.

Major springs and spring-fed tributaries annually contribute about 760,000 tons of dissolved solids to the Colorado River between Glen Canyon Dam and Lake Mead. Storm runoff in small tributaries in this reach of the Colorado River contributes an unknown, but probably much smaller, load to the river. The contribution of dissolved solids by major sources of inflow between Glen Canyon and Lake Mead equals about 10 percent of the average dissolved-solids load of the Colorado River at Lees Ferry. Springs in the lower portion of the Little Colorado River contribute about half of the measured increase in dissolved-solids discharge in the Colorado River between Lees Ferry and Grand Canyon.

The annual dissolved-solids contributions of major springs, streams, and spring-fed tributaries to the Colorado River between Glen Canyon Dam and Lake Mead and to the Virgin River are summarized in Table B.

Table B
Contribution from major springs and tributaries between Glen Canyon and Hoover Dams

Source	Dissolved-solids discharge in thousands of tons per year
Paria River	30
Little Colorado River above Blue Spring	130
Springs in Lower Little Colorado River	550
Bright Angel Creek	7
Tapeats Creek	12
Kanab Creek (base flow)	4
Havasu Creek (base flow)	24
Total inflow in Colorado River (Glen Canyon Dam to Lake Mead)	757
LaVerkin Springs (inflow to Virgin River)	98
Littlefield Springs (inflow to Virgin River)	30
Total inflow to Colorado and Virgin Rivers	885

The minimum annual inflow of 885,000 tons from these sources results in an increase of about 62 milligrams per liter (0.08 ton per acre-foot) in the Colorado River on the basis of an average annual flow of 10.5 million acre-feet at Hoover Dam.

2. Agricultural Sources of Salinity

It is anticipated that development of new irrigation projects may increase the total dissolved solids in the Colorado River. Return flows from the irrigated lands pick up salts from the soils and underlying shales and transport them to the river system.

Studies prior to irrigation would be helpful, but they have not been made in most areas, so comparisons must be made when new land is added or new storage is made available.

Salt balance conditions exist when the amount of dissolved solids carried off the land is equal to that amount added. Pickup of salt as used in this report represents an unbalanced condition shown by the increase of total dissolved-solids load in the runoff over the total load in the applied water. This pickup from an area could result from natural sources, such as precipitation runoff, and/or irrigation return flows. Salt pickup chargeable to irrigation would be only that additional which occurs as a result of irrigation and should not include the amount of prior pickup off the land resulting from natural sources.

The small amount of data presently available gives indications of much variation in the amount of pickup from land due to irrigation. The estimated salt pickup in this report is based on values of zero and 2 tons per acre from newly irrigated land. Zero or minimum conditions occur generally after initial leaching in areas where soils are loose and contain very little salt. The 2-ton-per-acre value was selected as the higher end of the range for the average pickup over a project area. It was also assumed in this report no additional pickup would result from supplemental water applied to presently irrigated lands.

3. Municipal and Industrial Sources of Salinity

Salt loads contributed to the Colorado River system by municipal and industrial sources in general are minor, totaling about 1 percent of the basin salt load. Future increases in salt loads from these sources are expected to be small relative to the total basin salt burden and will have only a minor effect on salinity levels.

With the exception of concentrated return flows from the Las Vegas area, most municipal and minor industrial wastes are relatively low in total salt load in comparison with natural and agricultural sources, and complete elimination of such waste discharges would have little effect on salinity concentrations in the main river system. Since these wastes are point sources of salinity, control of a source could be achieved if salinity levels in the waste being discharged (i.e., industrial brines) warrant such control.

The recent energy shortage has caused an increase of activities for construction of large energy producing industries within the Colorado River Basin. With emphasis placed on improving the water quality in the basin, these industries are striving to prevent the return of salts to the river by consuming all water diverted for use.

B. Increased Concentration from Water Depletions

Addition of salts to the river system is not the only cause of increased salinity concentrations. The depletion of water of higher quality than in downstream reaches produces a concentration effect on the waters of the downstream reaches. This concentration effect occurs to a greater degree when the diverted salts return to the river than when they are depleted along with the water.

CAUSES OF SALINITY

1. In-basin Depletions

Consumptive use of water for irrigation within the basin is responsible for the largest depletions while consumptive use for municipal and industrial purposes accounts for a lesser depletion. Evaporation from reservoir and stream surfaces also produces large depletions. Phreatophytes, cause significant water losses by evapotranspiration, especially in the Lower Basin below Hoover Dam. In most cases where in-basin depletions occur, salts return to the river system, adding significantly to the increase in concentration.

2. Transbasin Depletions

The major part of the transbasin depletions are made at higher elevations where the salinity concentrations are very low. This removal of high quality water results in the remaining flows downstream to become more saline even though salts are also carried by the water to another basin. Many transbasin diversions have been made for several years, however, an additional number are just starting to divert water or will divert in the future. The largest ones are the Bonneville Unit of the Central Utah Project, the Denver-Englewood and Homestake diversions, the San Juan-Chama Project, and the Fryingpan-Arkansas Project all of which are now diverting water.

PART VI. EVALUATIONS OF EXISTING SALINITY CONDITIONS

A. Quality of Water Stations

A primary purpose of this report is to summarize water quality conditions for the Colorado River Basin. This part summarizes chemical quality under both historical and present conditions of water resource development and utilization. Anticipated changes in future chemical quality are discussed in Part VII. Other water quality parameters are discussed in Part X.

Evaluations of the salinity of the water in the basin are based on quality of water and streamflow records at 17 selected stations. Each station is considered to reflect flow and water quality conditions at its location. Records were generally available at each station for the time period considered by this report, 1941 to 1972. Where records were not available, missing data were estimated by correlation with other stations.

Basic data summarized in this report were primarily obtained from records of the Geological Survey developed by a continuing program for collection of water data which is supported in part by a transfer of funds from the Bureau of Reclamation.

Locations of the 17 key stations are shown on Figure 1. Available flow and quality records for each station are shown on Figure 4. The source and method of derivation of basic data for each of the stations are briefly discussed in the following sections.

1. Key Stations with Complete Records

Records of flow and water quality are available for all of the 1941-72 period for the Green River at Green River, Utah (Station No. 4); Colorado River near Cameo, Colorado (Station No. 7); Gunnison River near Grand Junction, Colorado (Station No. 8); Colorado River near Cisco, Utah (Station No. 9); and San Juan River near Bluff, Utah (Station No. 11). Minor extensions only were needed to fill in short periods of record for a few of these stations. The Colorado River near Glenwood Springs gage was moved from above to below the Roaring Fork at the end of the water year 1966. Subsequent records for this station were adjusted by subtracting the Roaring Fork flows. All records were obtained from the Geological Survey publications. Current Geological Survey data may be obtained from the respective U.S. Geological Survey, Water Resource Division computer data storage banks in Reston, Virginia, or from the Environmental Protection Agency's STORET system.

Colorado River Basin
Flow and Quality of Water Records
1941 – 1972

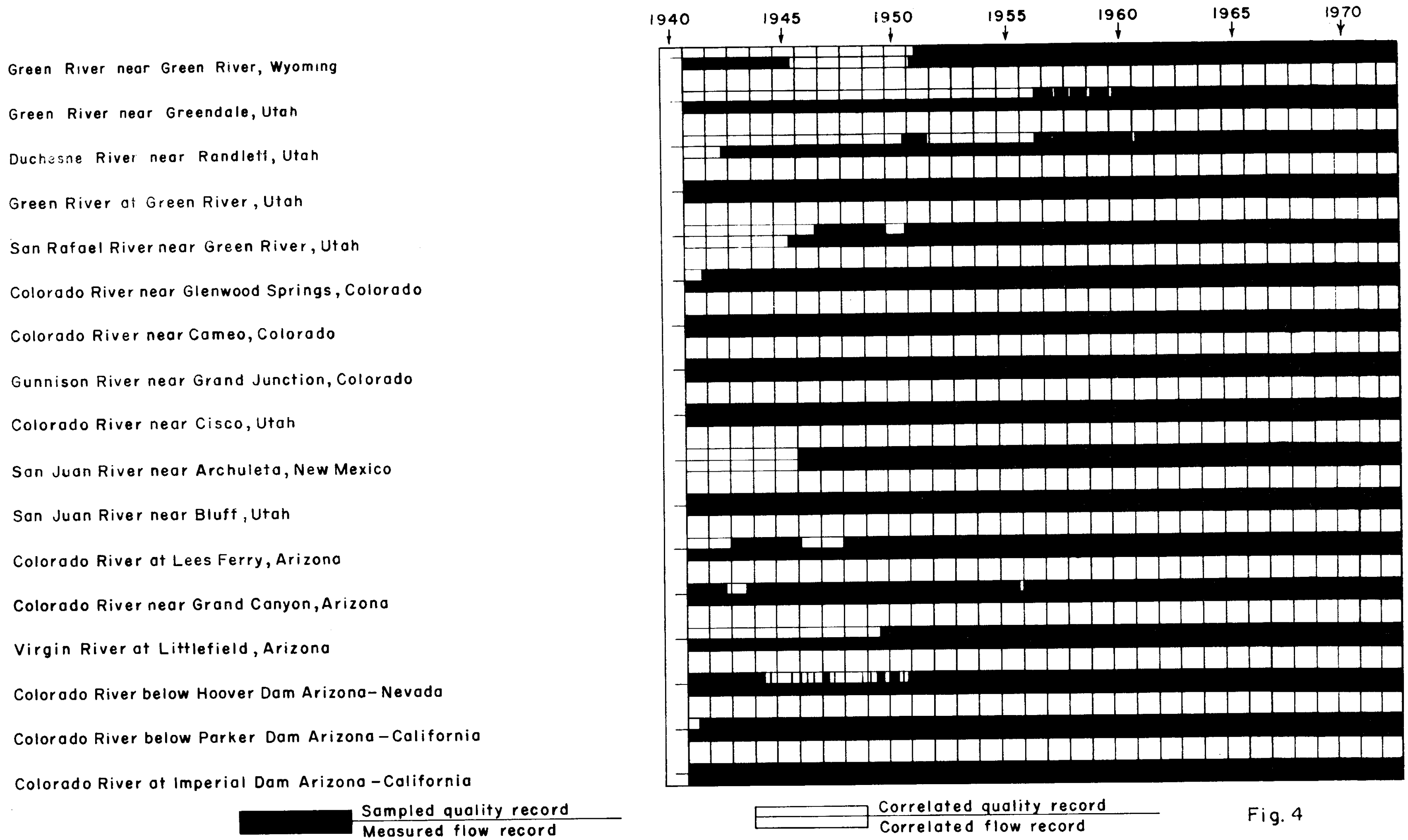


Fig. 4

2. Key Stations with Partial Records

Green River near Green River, Wyoming (Station No. 1).--Flow records are available at this station from April 1951 and quality records from May 1951. The records have been extended back to 1941 by correlation with nearby stations.

Green River near Greendale, Utah (Station No. 2).--Flow measurements or comparable data are available for this station for the report period, but chemical quality data are available only for the years 1957 through 1972, inclusive. Extensive correlations with other available records on the Green River system were employed to develop estimates for dissolved solids.

Duchesne River near Randlett, Utah (Station No. 3).--Flow records have been obtained continuously since 1943 and quality data are available for 1951 and 1957 through 1972. Correlations with other stations in the Duchesne River system were employed to estimate the data for the missing period.

San Rafael River near Green River, Utah (Station No. 5).--Correlations were used to estimate flow at this gage from 1941 to 1945 after which measurements of flow were available. Quality sampling started in 1946 and is complete for the remainder of the study period except for 1950. Extensions of available data provided satisfactory estimates of quality for the missing years.

Colorado River near Glenwood Springs, Colorado (Station No. 6).--Correlations were used to estimate the quality data for the 1941 year prior to October 1. Quality records are available after October 1, 1941. Flow records are available for the entire period of study.

San Juan River near Archuleta, New Mexico (Station No. 10).--For the period 1954 to 1972 flow and quality data presented are a combination of measurements obtained near Archuleta and at Blanco, New Mexico, with a few adjustments and correlations. Correlations were employed to estimate the data for 1941-54. Quality data for 1969 through 1972 were estimated from once-a-month sampling at the Archuleta gaging station. In 1974 electrical conductivity measurements were started on a 3 time per week basis along with occasional chemical analyses. These measurements indicate the quality to be very uniform since the station is close to the outlet works of the Navajo Dam.

Colorado River at Lees Ferry, Arizona (Station No. 12).--This station has complete flow records available for the study period but lacks quality of water measurements for 1941, 1942, 1946, and 1947. Quality 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, Utah; and the San Juan River near Bluff, Utah. Water samples are collected monthly by the Geological Survey for a chemical analysis of major constituents and nutrients analysis. Samples for minor element analyses are collected quarterly. Specific conductance and field water temperature measurements are made daily.

Colorado River near Grand Canyon, Arizona (Station No. 13).--Flow records are available for the report period and chemical quality records are also available except for the period December 1942 to August 1943. Quality data for the period of missing records were estimated from records at upstream stations. Water samples are collected and chemical analyses are made monthly by the Geological Survey with records dating back to 1925.

Virgin River at Littlefield, Arizona (Station No. 14).--"Flow records are available for the report period, but quality data are available only from July 1949 to the present. Detailed correlations were employed to estimate the data for the missing period. Determinations are made daily by the Geological Survey for specific conductance, and water temperature chemical analyses are made monthly unless significant changes in conductivity occur."

Colorado River below Hoover Dam, Arizona-Nevada (Station No. 15).--Discharge and quality records are available from October 1939 until the present, except for water quality records during the period November 1944 to September 1950. The water quality for this time period is based on specific conductance records and intermittent chemical analyses. The samples used for the chemical analyses are collected monthly by the Geological Survey stream gaging station below the dam.

Colorado River below Parker Dam, Arizona-California (Station No. 16).--Flow records at this station are available from October 1934 and have been published or are available from the Geological Survey. The water quality data for the period January 1964 through December 1970 were taken at the Geological Survey station, Colorado River below Parker Dam. The water quality data for the period January 1941 through December 1963 used in the "Quality of Water Colorado River Basin Progress Report No. 5" were based on chemical analyses of Colorado River Aqueduct flows made by the Metropolitan Water District. These data have been adjusted based on a correlation of concurrent Metropolitan Water District records with records made by the Geological Survey below Parker Dam for the year 1964-70.

Colorado River at Imperial Dam, Arizona-California (Station No. 17).--Although Figure 4 indicates flow records are available for the report period, no single station was used to obtain the record. It was obtained from a combination of several stations. Records from January 1941 through September 1942 are from the station, Colorado River near Picacho, California. Records from October 1942 through September 1960 are based on the combined records of discharge obtained at gaging stations on 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 that of Gila River near Dome, Arizona. Records after September 1960 are based on the combined daily discharge of Colorado River passing Imperial Dam and at gaging stations on All-American Canal near Imperial Dam and Gila Gravity Main Canal at Imperial Dam and the diversion to Mittre Lake.

Quality data from 1943 through October 1970 were obtained from Geological Survey records and are based on data for the Yuma Main Canal below the Colorado River Siphon. The water quality data for November and December 1970 and for calendar years 1971 and 1972 were obtained from the Geological Survey records for the water quality station at Imperial Dam. The samples are presently being collected by the Geological Survey and the Bureau of Reclamation above the trash racks at the diversion to the All-American Canal. Salinity analyses are made by the Geological Survey in cooperation with the Bureau of Reclamation. Field analyses and bacteria determinations are made by the Geological Survey in cooperation with Environmental Protection Agency.

3. Other Quality of Water Stations

In addition to the key stations discussed above, there are many more points at which water quality data are obtained. Most of these sampling stations are operated by the Geological Survey; however, some are operated by other Federal, State, and private agencies.

The type of data obtained and the purpose of the sampling vary with each station. Many of the stations provide data for the special studies described in Part IV.

B. Methods of Chemical Analyses

Published quality of water records consist of a combination of stream discharges with chemical analyses of stream water samples collected at more or less regular intervals. The reliability of the records depend on the accuracy of the streamflow records, the frequency of collection and representativeness of the samples, the stability of the samples during the storage periods prior to making of the analyses, the completeness and accuracy of the individual analyses, and the manner in which the individual samples are combined before analysis to represent increments of stream discharge.

Most of the chemical analyses of water samples which provided the water quality data were made in the laboratories of the Geological Survey at Washington, D.C., Albuquerque, New Mexico, and Salt Lake City, Utah, using standard procedures by chemists specifically trained in water analysis. During the 32-year period considered there were numerous changes in laboratory techniques and procedures mostly due to introduction of new instrumental methods. New procedures were adopted only after careful investigation to insure results consistent with those obtained previously. Some of the quality of water records are based on analysis of samples by Bureau of Reclamation laboratories. Bureau of Reclamation results and methods have been checked by the Geological Survey to insure comparable records. It is probable that errors in the load computations due to errors in chemical analyses are less than those due to changes in the samples upon storage, inaccuracies in sampling, or inaccuracies in the determination of stream discharges.

Prior to about 1970 the U.S. Geological Survey analyzed water quality on a composite sample basis and also determined and published the annual total dissolved solids loads. Since that time the results of the analysis in the Colorado River Basin have been those of individual samples rather than composites and no totals for the year have been computed. At present individual samples are taken and analyzed about once a month together with daily conductivities. The annual total dissolved solids loads since this change, have been determined from daily conductivities applied to a curve or conversion factors relating conductivities and total dissolved solids concentrations.

C. Historic Conditions

1. Total Dissolved-Solids Concentrations

Historic streamflow, total dissolved-solids (salinity concentrations, and salt-load data for the 17 key stations for the 1941-72 period of record are presented in Table 1 to 17 with each table number corresponding to a station number. The concentrations as shown were determined on a flow weighted basis.

To simplify tabulation, monthly values of flow and total dissolved-solids loads were rounded to the nearest 1,000. This resulted in some differences between the recorded and the computed monthly concentrations when the flows were low, for example, below 1,000 acre-feet in the San Rafael and Duchesne Rivers. Similarly, minor differences from published data in monthly concentrations occur in isolated instances in the flow and quality tables for the other stations.

The addition of quality of water data for 1971 and 1972 produced little change in long-term averages in comparison to the 1941-70 period. Ten of the stations show no change; at one the concentration decreased by 0.01 ton per acre-foot, at four it increased by 0.01, and at one it increased 0.02 ton per acre-foot. The average concentration for the San Rafael River station concentration was increased from 2.24 to 2.30 tons per acre-foot.

The water quality at the Lees Ferry and the four other key stations on the Lower Colorado River has been affected by abnormal conditions during the 1959-72 period because of low runoff in 1959, 1960, and 1961 and the filling of Lake Powell in 1963 to 1972. Figure 5 shows the historical flow weighted average salinity concentration for these five stations.

During the first year of storage in Lake Powell in 1963, the flow at Lees Ferry was reduced to 1,384,000 acre-feet with a salinity concentration of 1.27 tons per acre-foot. The average concentration for the 1941-72 period was 0.76 ton per acre-foot.

The 1963 flow at the Grand Canyon station was 1,630,000 acre-feet with a salinity concentration of 1.41 tons per acre-foot. The previous low flow was 4,186,000 acre-feet in 1934 with a salinity concentration of 1.32 tons per acre-foot. It is interesting to note that the 1963 concentration was only 0.09 tons per acre-foot higher than the 1934 concentration.

The Grand Canyon station has the longest water quality record on the Colorado River, 1926 to 1972. It is also of interest that the average salinity concentration for the period 1941-72 is only slightly higher than the average salinity concentration for the period 1926-40, 0.84 to 0.81 tons per acre-foot, respectively.

Generally the salinity concentration increases at each succeeding downstream station as a result of depletions by diversions, reservoir and stream evaporation, and consumptive use by irrigated crops and phreatophytes, and by salt loading by inflowing springs, streams, solution of salt from the streambeds and reservoir basins, and by irrigation return flows. The flows of the Bill Williams River often dilute the flow of the Colorado River in Lake Havasu which sometimes results in a decrease in the salinity concentration from the Below Hoover Dam station to the Below Parker Dam station. Figure 5 shows the concentration changes between the five lower stations on the Colorado River. Note also that Lake Mead has a dampening and delaying effect, about 2 years, on the salinity concentrations at the downstream stations. This is especially noticeable for the high salinity concentrations of 1963 at the Lees Ferry and Grand Canyon stations.

WEIGHTED AVERAGE DISSOLVED SOLIDS CONCENTRATIONS, COLORADO RIVER BELOW LEES FERRY, ARIZONA

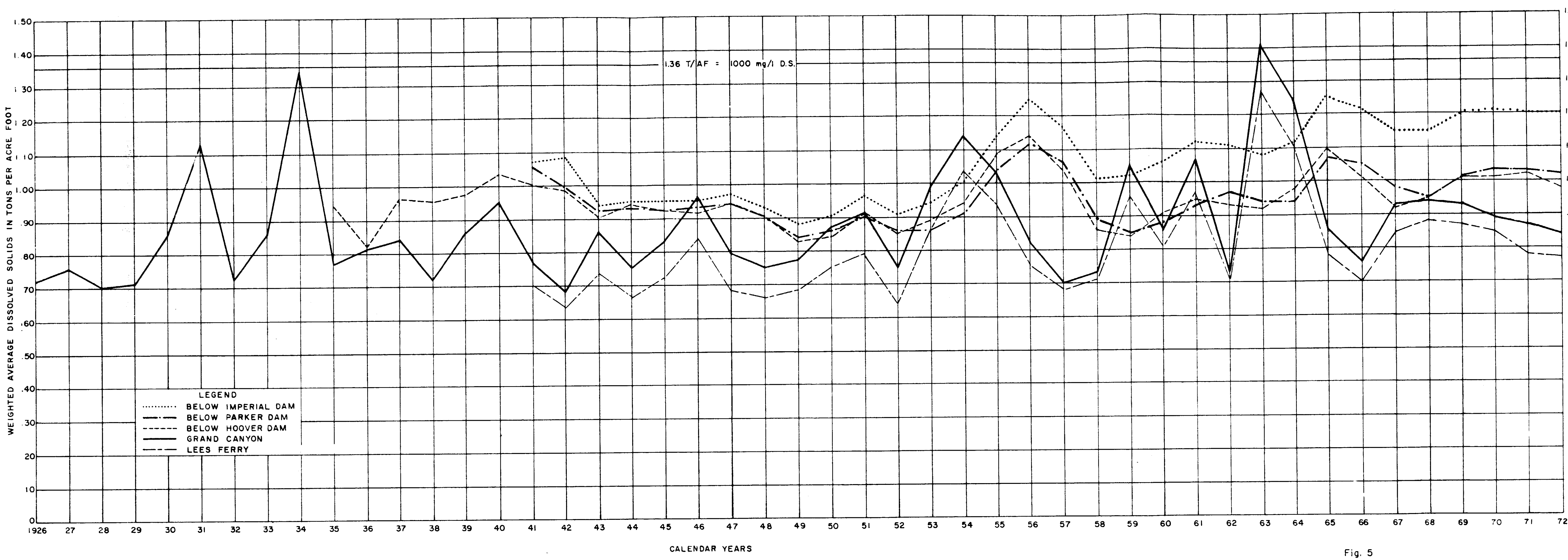


Fig. 5

D. Present Modified Conditions

The 1941-72 period average present modified flow and quality at any station, as defined in this report, is the average of the flows and quality that would have resulted if the present (1972) level of depletions instead of actual depletions had occurred each year of this period. This average present modified flow and quality, therefore, represent an average condition based on the 1941-72 water supply period occurring at the present (1972) time. This is shown for each station on Table 18. Adjustments to the historic flow that were made to develop the present modified flow included: (1) adjustments for the increase in depletion in 1972 over that for years prior to 1972; (2) adjustment of records below large reservoirs to present unregulated flows by these reservoirs at each station; (This required modifying flows at downstream points for gains or losses resulting from reservoir operation. In the Upper Basin depletions resulting from filling reservoirs the first time was a major factor.) and (3) adjustments for historic evaporation as compared to average present evaporation. Adjustment for operation of the Colorado River Storage Project and Fontenelle Reservoir in the Upper Basin and for operation of Lake Mead, Lake Mohave, and Lake Havasu in the Lower Basin was made in developing the present modified flow.

Present evaporation from the Colorado River Storage Project Reservoir plus Navajo and Fontenelle Reservoirs was estimated to be 568,000 acre-feet per year. (Note: this is the latest evaporation estimate pending results from additional investigations being conducted.) This would include evaporation from Lake Powell of 460,000 acre-feet; Flaming Gorge, 50,000 acre-feet; Curecanti Unit Reservoirs, 10,000 acre-feet; Navajo, 26,000 acre-feet; and Fontenelle Reservoir, 22,000 acre-feet. These are average figures which were chosen to represent present conditions rather than using the 1972 historical evaporation since a single year record could show an above-or-below normal condition. Present evaporation of the Lower Basin Reservoirs was assumed the same as historical since these reservoirs have been operating for a number of years.

Historical flows since 1941 have been affected by the transmountain diversions of the Colorado-Big Thompson Project, Duchesne Tunnel of Provo River Project, Roberts Tunnel of the City of Denver, and a number of small in-basin developments in the Upper Basin. More recently the Independence Pass expansion, Collbran, Paonia, Smith Fork, Silt, Florida, Hammond, Bostwick Park, and Emery County Projects and Vernal Unit of Central Utah Project have come into operation. Also, evaporation from the Glen Canyon, Flaming Gorge, Navajo, Curecanti, Unit and Fontenelle Reservoirs is now in effect along with the Hayden Steamplant, Four Corners

Steamplant, expansion of Hogback Indian lands, and the municipal and industrial uses in Wyoming. In the Lower Basin, corrections have been made for the Southern Nevada Water Project, the Metropolitan Water District diversion at Lake Havasu, the Colorado River Indian Reservation, and the Palo Verde Irrigation District. The depletions from all of the above projects have been extended back to 1941, from the time they became operational, so that when increased depletions on existing projects or new depletions on new projects occur they can be imposed directly on the present modified condition to show the anticipated effect of all development on the river. In the near future several projects now under construction will become operational. The addition of these new depletions will result in slight increases in dissolved-solids concentrations under present modified conditions.

Quality data for present modified conditions were computed by taking into consideration the flow weighted average of the concentrations of total dissolved solids for the various transmountain diversions. The change in dissolved solids resulting from the in-basin developments were computed on the basis of an assumed pickup of 2.0 tons of dissolved solids per acre of irrigated land and a depletion of 1.5 acre-feet of water per irrigated acre. In the Lower Basin a consumptive use of 4 acre-feet per acre was used for irrigation of the Palo Verde Irrigation District, the Fort Mohave, Chemehuevi, and Colorado River Indian lands. This value is the rate presented in the Colorado River Basin Project hearings before the Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs, House of Representatives. The average salt pickup resulting from the in-basin developments of 2.0 tons of dissolved solids per acre of irrigated land was used in the Lower Basin.

The present modified conditions are shown on Table 18 and are used as a base value for developing the anticipated effect of new depletions from new projects and the full development of present partially developed projects in the river basin.

Following is a description of the storage units, now constructed, for which the evaporation losses were considered as depletions in the computation of present modified flows.

1. <u>Glen Canyon Unit</u>

The Glen Canyon Dam is located on the Colorado River in Arizona, 4 miles south of the Utah-Arizona boundary and 16 miles upstream from Lees Ferry. The bulk of the reservoir lies in Utah. At a normal water surface elevation of 3,700 feet m.s.l., Lake Powell would extend 186 river miles up the Colorado River and 71 miles up from the mouth of the San Juan River. River mile 71 on the San Juan River is 133 river miles from Glen Canyon Dam. This 27,000,000-acre-foot (20,876,000 active) reservoir will regulate the flow of the river for compact delivery purposes and for power generation and thus permit exchanges for upstream consumptive use of the water. Fish and wildlife conservation and recreation will also be of major significance. Storage commenced March 31, 1963, in Lake Powell.

2. Flaming Gorge Unit

This storage unit is located on the Green River in northeastern Utah and southwestern Wyoming. The primary purposes of the Flaming Gorge Unit are the regulation and storage of flood flows of the Green River and the generation of hydroelectric power. The reservoir has a storage capacity of 3,789,000 acre-feet (3,516,000 active). The stored water assists in complying with the terms of the Colorado River Compact and will, by exchange, furnish an irrigation supply for the participating projects in the Upper Basin States. In addition there will be benefits from fish and wildlife conservation and recreational facilities. Storage commenced November 1, 1962, at Flaming Gorge Reservoir, and from the records taken immediately below the dam it shows that the reservoir releases are more uniform in quality than uncontrolled streamflow prior to reservoir construction.

3. Curecanti Unit

Facilities of the Curecanti Unit, located in west-central Colorado, include the Blue Mesa, Morrow Point, and Crystal Dams, Reservoirs, and Powerplants. The primary purposes are regulation and storage of flood flows of the Gunnison River and generation of hydroelectric power. In addition benefits will be provided to recreation, fish and wildlife conservation, and irrigation. The reservoirs of the Curecanti Unit will help regulate the flows of the Colorado River at Lees Ferry. The storage capacity provided is 941,000 acre-feet (749,000 active) at Blue Mesa, 117,000 acre-feet (42,000 active) at Morrow Point, and 27,000 acre-feet (13,000 active) at Crystal Reservoir with total reservoir evaporation losses estimated to average 10,000 acre-feet annually for all three units. Storage was initiated late in 1965 at the Blue Mesa Reservoir and on January 24, 1968, at the Morrow Point Reservoir. Construction has been initiated on Crystal Dam, and it possibly could have been considered as a future development, but since the annual evaporation will amount to only about 300 acre-feet, its effect is insignificant.

It is expected that operation of the Curecanti Unit on the Gunnison River will improve the quality of the Colorado River below Grand Junction during the late summer months.

4. Navajo Unit

The Navajo Dam and Reservoir are located on the San Juan River in northwestern New Mexico and southwestern Colorado. Total storage capacity of the reservoir is 1,709,000 acre-feet (1,036,000 active). This reservoir regulates the flow of the river for irrigation of the Hammond Project, the Navajo Indian Irrigation Project, and for other uses including by exchange potential uses above the reservoir and transmountain diversions to the San Juan-Chama Project. It also helps regulate the flows of the Colorado River at Lees Ferry. Other purposes include recreation, sediment control, fish and wildlife propagation, and flood control. Storage began July 1, 1962, and the effect on quality is recorded at the Archuleta station below Navajo Dam.

5. Fontenelle Reservoir

Fontenelle Reservoir, located on the Green River above Green River, Wyoming, has a storage capacity of 345,000 acre-feet (150,000 active) and regulates the flow in the Green River above Flaming Gorge Reservoir. It will be used to supply water to the Seedskadee Project including municipal and industrial uses, and for wildlife refuge purposes.

PART VII. ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

In order to estimate the probable effect of the authorized or contemplated developments on the quality of water at certain points along the Colorado River, the developments have been generally listed in downstream order. By following the flow and salts down the river the estimated effects of the development can be shown at the pertinent stations for the future years of 1980, 1990, and 2000. These results are tabulated in Table 18 for the new period of record used in this report. The table was computed on the basis of the 1941-72 average annual flow and total dissolved solids. An additional station, "Colorado River above Parker Dam," was included in the table only for purposes of clarification and maintaining continuity in computations. It should be noted that future concentrations were estimated without consideration to possible future control measures. Salinity control measures are discussed separately in Part IX.

The anticipated future conditions evaluated in Table 18 would result from the construction of the Colorado River Basin Projects and non-Federal developments. Pickup of dissolved solids from newly irrigated lands has been computed for two assumed conditions, zero and 2 tons per acre. The future increase in evaporation over average present evaporation, by the Colorado River Storage Reservoirs, was considered negligible and therefore not included in future depletions. Present evaporations are reflected in present modified conditions.

Following is a discussion of the various projects including a brief description of the physical conditions for each development authorized or contemplated for authorization. It should be recognized that the acreages and depletions as listed could change with change of plans on some of the contemplated projects. The figures presented below and in Table 19 are those which were current at the time of writing this report. (Some ultimate depletions as presented in the following discussion are not expected to occur until after year 2,000 and therefore may not correspond to figures presented in Table 19.) In addition to the developments listed, a number of smaller private industrial developments either under construction or contemplated will result in certain depletions and will have some effect on water quality.

The effects of all upstream developments are carried on down to and including Imperial Dam.

A. Description of Projects

1. Above Green River near Green River, Wyoming

Seedskadee Project.--This multipurpose project is located adjacent to the Green River in southwestern Wyoming.

ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

Water uses of the Seedskadee Project are not yet definite but it now appears that most of the water will be used for industrial purposes. A total of 278,000 acre-feet depletion exclusive of Fontenelle evaporation is anticipated. Of this, an estimated 20,000 acre-feet is planned for wildlife purposes while the remaining 258,000 acre-feet of depletions was assumed to be for industrial purposes. Irrigation, however, may not yet be completely out of the picture. Industrial users include Pacific Power & Light Co., Sun Oil, and other possible industries. It was assumed the 20,000 acre-feet of water for refuge purposes would neither pick up nor lose salts but the remaining water for industrial purposes would deplete the salts as well as the water. The salinity concentration of the water in the future at the Green River, Wyoming, gage would remain almost the same as present because diversions to industries are anticipated to be about the same location as the present gage.

Non-Federal Energy Related Industry.--With the recent energy crises a great demand was created for new sources of energy. This demand is not only for the Upper Colorado River Basin but is a national demand. Extensive activities have been undertaken to develop the fossil-type energy resources in the Upper Basin.

Locations of coal and oil shale have been generally determined within the Upper Colorado River Basin. Some thermal generating plants have already been constructed, others are in the process of being constructed and future energy developments are being planned. Specific sources of water however, to supply each future development have not yet been established but various potential sources for the developments have, been considered. Because of the uncertainty of exact sources of water for these industries, only estimates could be made in determining water and salt depletions for the various reaches of the Upper Basin.

It was assumed where future energy related industrial developments are involved that all the water diverted and used for this purpose and all of the total dissolved solids would be depleted from the river system.

2. Between Green River near Green River, Wyoming, and Green River near Greendale, Utah

Lyman Project.--This is a multipurpose project located in southwestern Wyoming. Project facilities consist of two dams and reservoirs. One is located at the Meeks Cabin site on the Blacks Fork in Wyoming and provides 33,000 acre-feet of storage capacity. The other will be located at the China Meadows site of the East Fork of Smith Fork in Utah or an alternate site and will provide 13,000 acre-feet of storage capacity. The project will have the primary purpose of providing supplemental water to 42,674 acres of existing farmland along with fish and wildlife and recreation benefits. Construction of Meeks Cabin Dam has been completed.

This project will give an opportunity to study the effect on quality of adding supplemental water to lands already irrigated. The resulting new depletion will be 10,000 acre-feet.

Utah Power & Light Co.--This steam powerplant is located at Kemmerer, with present depletions of about 8,000 acre-feet. Total present and future depletions of this plant and other industrial developments will amount to about 65,000 acre-feet/year. No salt return is anticipated.

3. Above Duchesne River near Randlett

Central Utah Project (Bonneville Unit).--The Bonneville Unit will include a transmountain diversion of water from the headwaters of the Duchesne River in the Uinta Basin portion of the Colorado River Basin to the Bonneville Basin. Related developments of local water sources will be made in both basins. The project will develop water for irrigation, municipal and industrial use, and power production. It will also provide benefits to recreation, fish and wildlife, flood control, water quality control, and area redevelopment.

The net depletion to the Green River will be 166,000 acre-feet.

Central Utah Project (Upalco Unit).--The Upalco Unit will be located in Duchesne County near Roosevelt, Utah. The plan of development is primarily to provide supplemental irrigation water for Indian and non-Indian lands along Lake Fork River and to enhance recreation, fish and wildlife, while maintaining flood control. The mean annual stream depletion is estimated to be about 10,000 acre-feet.

Central Utah Project (Uintah Unit).--The Uintah Unit of Central Utah Project will provide a full supply to irrigate 7,800 acres of new lands and supplemental water to other lands on the south slope of the Uinta Mountains in the Uinta and Whiterocks Rivers drainage areas. The new annual depletion will be about 30,000 acre-feet.

Deferred Indian Lands.--It is estimated that depletion of 50,000 acre-feet of water for these lands will begin between year 1990 and year 2000. Approximately 29,100 acres of new land including the 7,800 acres in the Uintah Unit will receive irrigation. This will result in a net 21,300 acres exclusive of the Uintah Unit.

4. Between Green River near Greendale, Duchesne River near Randlett, and Green River at Green River, Utah

Four County, Colorado.--This non-Federal development, as proposed, would divert 40,000 acre-feet of water through the Continental Divide for use in Colorado. The water would be transported from the headwaters of the Yampa River through Rabbit Ears Pass to the North Platte Basin, from which basin an equivalent amount of water would be directed by exchange over Willow Creek Pass into the Colorado River drainage, thence by transbasin diversion to Lafayette, Erie, Bloomfield, Brighton, Thornton, and Ft. Lupton.

Hayden-Craig Steamplant.--The addition of new units will require estimated increases of 12,000 acre-feet of water between 1972 and 1980 and 8,000 acre-feet from 1980 to 1990. It was assumed that the first 12,000 acre-feet would return all the salts and the remaining 8,000 acre-feet would return no salt.

Cheyenne-Laramie, Wyoming.--The city of Cheyenne diverts water from the Little Snake River to a tributary of the North Platte in exchange for water diverted from Douglas Creek for municipal use by the city of Cheyenne. This transmountain diversion is now using about 7,000 acre-feet and it is estimated that this city and the Laramie area will ultimately deplete the Colorado River by an additional 24,000 acre-feet.

Savery-Pot Hook Project, Colorado-Wyoming.--This project is located in the Little Snake River Basin in southern Wyoming and northwestern Colorado. The authorized project plan calls for construction of an 18,600-acre-foot-capacity reservoir on Savery Creek and a 65,000-acre-foot-capacity reservoir on Slater Creek. This storage will make possible the irrigation of 17,920 acres of new land and will provide supplemental water for land presently irrigated. Depletion of the Little Snake River by the Savery-Pot Hook Project would amount to 27,000 acre-feet annually.

Central Utah Project (Jensen Unit).--This unit will be located along the Green River east of Vernal in Uintah County in Uinta Basin, Utah. Storage of water in Tyzack Reservoir on Brush Creek together with pumping from the Green River will supply 440 acres of new land and 3,640 acres of presently irrigated lands. Approximately 15,000 acre-feet of water is anticipated to be depleted by this project.

Non-Federal Energy Related Industry--See discussion of same topic under the "Above Green River near Green River, Wyoming."

5. Above San Rafael River near Green River, Utah.

The anticipated future effects on the San Rafael River would be steam-electric plants depleting about 21,000 acre-feet of water and replacing an estimated 5,000 acres of presently irrigated lands with industries. The salt was also assumed to be depleted with the water.

6. Above Colorado River near Glenwood Springs

Denver, Englewood, Colorado Springs, and Pueblo, Colorado.--Expansion of municipal supplies for these four cities will eventually deplete the Colorado River by 235,000 acre-feet above present uses. These are transmountain diversions from the Blue, Fraser, and Eagle Rivers in the headwaters of the Colorado River. The diversions would vary according to runoff each year.

M&I--Green Mountain.--Most of the water stored in Green Mountain Reservoir will probably be released for industrial use in the vicinity of Rifle, in Garfield County, Colorado. This depletion will utimately be about 45,000 acre-feet.

Homestake Project, Colorado.--The Homestake Project in Colorado, constructed by the cities of Aurora and Colorado Springs, will ultimately divert an average of 49,000 acre-feet additional annually to the eastern slope from the headwaters of the Colorado River although the diversions will vary from year to year. Present diversions amount to about 25,000 acre-feet.

7. Between Colorado River near Glenwood Springs and Colorado River near Cameo

Independence Pass.--This water is diverted from the upper Roaring Fork to the east slopes of the Rocky Mountains. The present depletions will ultimately be increased an additional amount of about 14,000 acre-feet.

Fryingpan-Arkansas Project.--This transmountain diversion project transfers water from the headwaters of the Colorado to the Arkansas River. It is a multipurpose development to supply supplemental irrigation water, municipal water, and water for power production. In addition the project will also control floods originating above Pueblo, retain sediment, preserve fish and wildlife, and provide recreation opportunities. Some diversions were made in 1973 and 1974. Additional diversions beyond 1974 of 33,000 acre-feet are anticipated making a total of about 69,000 acre-feet. A depletion of about 1,000 acre-feet by evaporation from Ruedi Reservoir is also occurring at present.

M&I--Ruedi Reservoir, Colorado.--It was assumed the use of 24,000 acre-feet would be for oil shale or other industrial development along the Colorado River in Colorado. The water would be stored in Ruedi Reservoir on the Fryingpan River and then released through natural channels to the points of use in the oil shale areas. The remaining 9,000 acre-feet of future depletions was assumed will be used by the Basalt Project.

West Divide Project, Colorado.--The West Divide Project will provide 115,600 acre-feet of water for irrigation and 77,500 acre-feet for municipal and industrial uses. The irrigation water will supply nearly 19,000 acres of new land and a supplemental supply to 21,000 acres of land presently irrigated. The new depletion of Colorado River water will be 76,000 acre-feet annually.

The first 30,000 acre-feet depletion was assumed to be used for industrial and municipal purposes. Project water will be obtained from a series of Colorado River tributaries south of the river in west-central Colorado with most of the storage planned for the 105,000-acre-foot Placita Reservoir. The above uses which were based on the authorizing report could be altered in the definite plan report due to increased demands for shale oil and energy from other sources.

Non-Federal Energy Related Industry.--See discussion of same topic under the "Above Green River near Green River, Wyoming."

8. Above Gunnison River near Grand Junction

Fruitland Mesa Project, Colorado.--This project is located in western Colorado in Gunnison River Basin. A 48,235-acre-foot storage reservoir on Soap Creek and diversion from Crystal and Curecanti Creeks would provide water needed for 12,900 acres of newly irrigated land and 6,300 acres of land now irrigated. Project uses will increase Colorado River depletions by about 26,000 acre-feet per year.

The project water for irrigation use has been determined by laboratory analysis to be of excellent quality. Likewise, most of the return flow considered as part of the project water supply will be diluted with higher quality direct flow.

Dallas Creek Project, Colorado.--The Dallas Creek Project as now planned will develop water of the Uncompahgre River and tributaries for irrigation and municipal and industrial use. The project will provide water for 3,900 acres of new land and supplemental water for 3,500 acres of land presently irrigated. Depletion of the Colorado River will amount to 46,000 acre-feet annually. Salt loading effects were based on a detailed study especially made for this project.

Non-Federal Energy Related Industry.--See discussion of same topic under the "Above Green River near Green River, Wyoming."

9. Between Colorado River near Cameo, Gunnison River near Grand Junction, and Colorado River near Cisco, Utah

Dolores Project, Colorado.--The Dolores Project will divert water from the Dolores River Basin to the San Juan drainage for the irrigation of 61,000 acres. Some 32,000 acres will be new land; the remaining 29,000 acres of land are now receiving a partial supply. This project will divert 140,000 acre-feet of water from the Dolores River of which 87,000 acre-feet will be depleted and the balance returned to the San Juan River.

Return flows from lands in the Montezuma Valley are presently used for irrigation of land in McElmo Canyon outside the project area. Analyses show these flows have relatively high concentrations of soluble salts. They are successfully used for irrigation, however, because of internal drainage characteristics of the soils.

San Miguel Project, Colorado.--The San Miguel Project will regulate flows of the San Miguel River for irrigation, municipal and industrial use, recreation, flood control, and fish and wildlife conservation. The project will supply water to 26,000 acres of new land and 12,500 acres of land now receiving a partial supply. Depletion of the Colorado River will be about 85,000 acre-feet.

Non-Federal Energy Related Industry.--See discussion of same topic under the "Above Green River near Green River, Wyoming."

10. Above San Juan River Near Archuleta

San Juan-Chama Project.--Construction is now completed on this transmountain diversion project with delivery of water to the Rio Grande Basin initiated in 1971. The project will eventually divert an average of 110,000 acre-feet annually from the headwaters of the San Juan River across the Continental Divide to the Rio Grande Basin. The effect of this depletion on the Colorado River will be that some dissolved solids will be transported out of the basin and less high quality water will be available downstream for dilution of lower quality water.

The water will be used in New Mexico for municipal and industrial developments and for irrigation.

Navajo Indian Irrigation Project.--Construction activities are underway on this project, but completion of construction and delivery of water are several years away. The direct diversion of 508,000 acre-feet of water annually from the Navajo Reservoir to 110,000 acres of lands south of the San Juan River is contemplated. None of these lands are presently irrigated and the effect of irrigation on the quality and quantity of return flow is difficult to predict.

There will be times under ultimate basin development when the San Juan Valley lands below Farmington, New Mexico, will be dependent largely upon return flows for their supply of irrigation water. There are very little data upon which to base estimates of the quality of the return flow. Miscellaneous records from the San Juan, Animas, and LaPlata Rivers indicate some periods of low flow water of questionable quality, especially from La Plata River system where some of the lands are known to be of marine origin. Practically all of the lands in the Navajo Indian Irrigation Project which would contribute return flow at the Hogback, however, are of fresh water origin with low salinity and alkalinity as determined by soil borings. The estimated depletion is 254,000 acre-feet annually with a return flow of 254,000 acre-feet.

The effect of the San Juan-Chama and Navajo Indian Irrigation projects in the quality of water at the Archuleta station would be small since the water is presently of very good quality and the station is located only a short distance below the Navajo Dam where there would be no return flows.

11. Between San Juan River near Archuleta and San Juan River near Bluff

Farmington Municipal and Industrial.--This future depletion is to Farmington, New Mexico for 5,000 acre-feet out of the San Juan River. It was estimated that this would begin by year 1990.

Animas-La Plata Project, Colorado-New Mexico.--The Animas-La Plata Project will develop flows of the Animas and La Plata River systems for irrigation, municipal and industrial use, recreation, and fish and wildlife conservation. The project will supply water to 46,500 acres of new land and 25,600 acres of presently irrigated land. The new land will include 17,200 acres of Indian land. The total new depletion will amount to nearly 146,000 acre-feet. Project features include four storage dams, lengthy canals, and several diversion dams.

Preliminary water quality studies indicate that irrigation will not present any particular quality problem, and the additional return flow at the state line may be somewhat improved over the present.

Expansion Hogback.--This direct diversion to Indian lands adjacent to the San Juan River will result in a new depletion of about 10,000 acre-feet annually. These lands, in the vicinity of Shiprock, New Mexico, have been developed in small blocks by the Bureau of Indian Affairs over a period of years with further expansion planned for the future. The seepage and return flows return direct to the San Juan River, but the quality of these flows has not been determined.

Four Corners Powerplant.--In northwestern New Mexico, a large steam-electric powerplant, which has been partially completed by Utah International Inc. for the Navajo Indian Tribe and the Arizona Power Authority, is now using about 25,000 acre-feet out of an estimated 39,000 acre-feet when the plant is complete. No salt is expected to return with future diversions.

ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

Navajo M&I Contracts--Several energy related industries and possibly municipalities near the four corners area of New Mexico have either purchased or considering the purchase of Navajo Reservoir water on a temporary basis. The annual delivery of water under these contracts will not exceed 100,000 acre-feet. It was estimated that by year 2030 the contracts will be terminated and the water will be returned to the river system. These users include the San Juan Powerplant, Utah International (coal gasification) El Paso (coal gasification) and others including possibly the City of Gallup.

Return Flow Dolores and Navajo Indian Irrigation Project--The return flows from the Dolores Project and the Navajo Indian Irrigation project were identified separately because they do not return back to the system above the "Colorado River near Cisco" and "San Juan River near Archuleta" gages respectively. They do return above the "San Juan River near Bluff" gage and must be accounted for at this gage. The additional salts brought in with these return flows would be those picked up from the new lands that are irrigated plus the salts originally in the water diverted.

Non Federal Energy Related Industry--See discussion of same topic under the "Above Green River near Green River, Wyoming."

12. Between Green River at Green River, Utah, San Rafael River near Green River, Utah, Colorado River near Cisco, San Juan River near Bluff, and Colorado River at Lees Ferry

Resources, Incorporated, Utah.--Resources, Incorporated, proposed to construct a large powerplant in Utah near Lake Powell using coal from the Kaiparowits Plateau for fuel and water from Lake Powell for plant operation. The expected annual depletion to the Colorado River would be 102,000 acre-feet, based on the company's application to the State of Utah for that much water. The exact date of this depletion is not known at present. It is expected that the salt will be depleted with the water.

Navajo Powerplant--About 34,000 acre-feet will be used in that portion of Arizona within the upper Basin and would be diverted above Lees Ferry with most of it being used by the Navajo Powerplant at Lake Powell. It is expect that the salt will be depleted with the water.

Other M&I in Arizona--Of the Upper Colorado River Compacts allocated 50,000 acre-feet to Arizona from the Upper Colorado River system about 13,000 acre-feet is presently being used, and 3,000 acre-feet will be for municipal and industrial use besides the 34,000 acre-feet to the Navajo Powerplant.

13. Above the Virgin River at Littlefield, Arizona

Dixie Project, Utah,--The Dixie Project would, through the construction of an offstream multipurpose dam and reservoir near the town of Hurricane, Utah, provide a full water supply to 4,625 acres of new land and a supplemental supply to 9,650 acres of existing irrigated land. Approximately 16,000 acre-feet of municipal and industrial water would be provided to the City of St. George, Utah, Cedar City, Utah, could also exercise the existing agreement to divert up to 8,000 acre-feet annually out of the basin from tributaries.

It is estimated that the Dixie Project with the offstream reservoir would cause a depletion of 39,000 acre-feet by 1980.

A principal concern of the downstream users in Arizona and Nevada would be in regard to the effect of the project operation on water quality and water supply. The effect of the LaVerkin Springs, which enters the Virgin River below the proposed diversion of the offstream dam, is of considerable importance. The average annual historic flow of the Virgin River at Littlefield, for the January 1941 through December 1972 period of record is 154,000 acre-feet. Development of the Dixie Project would increase the average concentrations at Littlefield from the present 2.26 (1,640 mg/l) tons per acre-foot to 3.01 (2,212 mg/l) and 3.09 (2,270 mg/l) tons per acre-foot under zero and two tons pickup, respectively.

14. Between the Colorado River at Lees Ferry, Virgin River at Littlefield, and Colorado River below Hoover Dam

Southern Nevada Water Project, Nevada.--The first stage of the Southern Nevada Water Project was completed by the Bureau of Reclamation and was accepted by the Colorado River Commission on November 1, 1971. The project is operated by the Las Vegas Valley Water District to provide supplemental municipal and industrial water to the cities of Las Vegas, North Las Vegas, Henderson, and Boulder City, and to Nellis Air Force Base. It will also provide water to the potential Eldorado Valley development.

The total annual diversions for the project and the other existing systems in southern Nevada will total 380,000 acre-feet which would give an estimated net annual depletion of 262,000 acre-feet which would give an allowance of 118,000 acre-feet for creditable return flows. The diversions in 1972 from Lake Mead were about 66,500 acre-feet by Basic Management, Inc., and the Las Vegas Valley Water District, and 3,400 acre-feet for Boulder City and the National Park Service for the Lake Mead National Recreation Area for a total of 69,900 acre-feet. No creditable return flow from these diversions was listed in the "Compilation of Records in Accordance with Article V of the Decree of the Supreme Court of the United States in the Arizona v. California dated March 9, 1964," for calendar year 1972. If it is assumed for purposes of computations in this report that the unidentified return flows from the 69,900 acre-feet diverted in 1972 would be in about the same proportion to diversion as was assumed in the determination of depletion for the Southern Nevada Water Project, there would be a return flow of about 23,700 acre-feet. This would give a depletion for 1972 of about 46,200 acre-feet.

The expected depletions for the Southern Nevada Water Project would be an additional depletion of 45,000 acre-feet by 1980. The projected depletion for the 1980-1990 time period would be an additional 62,000 acre-feet. The projected annual depletion for the period 1990-2000 would be 54,000 acre-feet for a total of 207,000 acre-feet by the year 2000.

It has been assumed for projections in this report that the return flows from the Southern Nevada Water Project would carry as much salt as would be pumped from the river. In addition, the sewage treatment plants would contribute an added load of 0.2 ton per acre-foot of depletion under zero pickup and 0.4 ton per acre-foot of depletion for the 2 ton per acre pickup condition.

Other Nevada Projects.—The Southern Nevada Water Project's estimated net annual depletion would be 262,000 acre-feet of the 300,000 acre-feet depletion allotted to Nevada from the Colorado River. Of the 38,000 acre-feet of uncommitted allotment, it is expected that 7,000 acre-feet will be used by the Fort Mohave Indian Reservation while the remaining 31,000 acre-feet has not been allocated. The remaining 31,000 acre-feet of water has not been assigned to any particular project in Nevada. It was projected for this report that this water would probably be utilized at the rate of 5,000 acre-feet by 1980, an additional 5,000 acre-feet by 1990, an additional 11,000 acre-feet by the year 2000. These other projects could include such items as fish and wildlife uses, irrigation projects, additional energy requirements and municipal and industrial projects.

Mohave Steamplant.--A portion of the Southern Nevada Water Project allotment of 262,000 acre-feet will be used by the Southern California Edison Company by diverting 30,000 acre-feet annually from the Colorado River for thermal power production purposes at a site about 3 miles downstream from Davis Dam. Use of this water until July 1, 2006, by the Southern California Edison Company is in accordance with two contracts--one with the State of Nevada and the Southern California Edison Company and one with the Bureau of Reclamation and the State of Nevada.

The depletions for the Mohave steamplant in 1972 was 11,000 acre-feet. The anticipated total depletion for the years 1980, 1990, and 2000 would be 20,000; 30,000; and 30,000 acre-feet respectively.

15. Between Colorado River below Hoover Dam and Colorado River at Imperial Dam

The Southern Nevada Water Project and the other Nevada projects, plus all the developments above Lees Ferry and on the Virgin River, not including the salinity control programs would affect the salinity at the Colorado River below Hoover Dam Station. Salinity concentrations would increase from 1.02 tons per acre-foot (749 mg/l) under present modified conditions to 1.30 (953 mg/l) and 1.39 (1019 mg/l) tons per acre-foot for estimated conditions for the year 2000 under zero and 2 tons per acre pickup.

Fort Mohave Indian Reservation.--The Fort Mohave Indian Reservation, located below Davis Dam, is allocated water by the Supreme Court Decree to irrigate 18,974 acres of land--14,916 acres in Arizona, 2,119 acres in California, and 1,939 acres in Nevada with a maximum annual diversion from the Colorado River of 122,648 acre-feet. The consumptive use required for irrigation of these lands is estimated to be 4 acre-feet per acre, which would result in main-stream depletion of about 76,000 acre-feet annually. The Bureau of Indian Affairs reports that a major portion of this reservation is under development contract.

Studies made for a Bureau of Reclamation Small Projects Loan proposes the irrigation development of approximately 7,000 acres by 1980 utilizing 28,000 acre-feet of new depletions. An arbitrary uniform land development rate was used for the remaining available land in the Fort Mohave Indian Reservation. An additional 5,000 acres would be developed by 1990 utilizing an additional 20,000 acre-feet of new depletions for a total of 48,000 acre-feet. Between 1990 and the year 2000, an additional 4,000 acres of land would be developed requiring 16,000 acre-feet of new depletions. The remaining 3,500 acres of land would be developed after the year 2000, using the remaining 12,000 acre-feet of available water.

The consumptive use of 4 acre-feet per acre for irrigation of the Fort Mohave, Chemehuevi, and Colorado River Indian lands is based on the rate presented in Colorado River Basin Project hearings before the Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs, House of Representatives. This value is under study and may be subject to change in future reports.

Chemehuevi Indian Reservation.--The Chemehuevi Indian Reservation, located above Parker Dam, is allocated water by the Supreme Court Decree to irrigate 1,900 acres of land in California with a maximum annual diversion from the main stream of the Colorado River of 11,340 acre-feet. The consumptive use required for irrigation of these lands is estimated to be 4 acre-feet per acre, which would result in a main-stream depletion of about 7,000 acre-feet annually. Full development of this reservation is expected by 1990.

Central Arizona Project.--The Colorado River Basin Project Act authorizes the Central Arizona Project for the purposes of furnishing irrigation and municipal water supplies to the water-deficient areas of Arizona and western New Mexico through direct diversion or exchange of water. This project will provide a supplemental water supply to lands now being irrigated. Water will be made available only to lands having a recent irrigation history. The Central Arizona Project must stand shortages up to its full allocation if there is insufficient main-stream water to satisfy an annual consumptive use of 7,500,000 acre-feet allocated under the Supreme Court Decree of March 1964 to the States of Nevada, Arizona, and California. When shortages occur, diversions to the Central Arizona Project will be limited to assure California water users 4,400,000 acre-feet of main-stream water. A maximum of 2,172,000 acre-feet of Colorado River water is all that could be diverted with a canal capacity of 3,000 c.f.s. California diversions in the future would eventually be reduced to 4,400,000 acre-feet.

Contracts—Boulder Canyon Project.--Separate contracts have been signed with the City of Kingman, Arizona, the Lake Havasu Irrigation and Drainage District, and the Mohave Valley Irrigation and Drainage District for diversion, respectively, of 18,500 acre-feet, 14,500 acre-feet, and 51,000 acre-feet annually. Although some new lands may be developed for irrigation in the Mohave Valley Irrigation and Drainage District, other lands now irrigated will be taken out of production due to future municipal and industrial development. As a result, it is probable that the diversion under the contract with the Mohave Valley Irrigation and Drainage District would cause no appreciable increase over the present depletions from existing irrigation in the District and municipal and industrial development would result in an increased depletion of about 6,000 acre-feet per year.

The Mohave Valley Irrigation and Drainage District would develop at the assumed rate that would cause annual depletion rate of 3,000 acre-feet by 1980, an additional 2,000 acre-feet by 1990, and the remaining 1,000 acre-feet depletion by the year 2000,

All of the diversions to the City of Kingman would be a depletion because of the distance of the City from the Colorado River. It has been assumed for this report that the depletions for Kingman, Arizona, would be 6,000 acre-feet by 1980, by 1990 an additional 8,000 acre-feet depletion would occur, and the remaining 4,000 acre-feet of depletion would occur by the year 2000.

ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

Diversion to Lake Havasu Irrigation and Drainage District would cause an increased depletion of about half of the diversion.

The depletions for the Lake Havasu Irrigation and Drainage District would occur at the rate of 3,000 acre-feet by 1980 with an additional 3,000 acre-feet by 1990 and the remaining 1,000 acre-feet by the year 2000.

Lower Colorado River Indian Reservation.--The Lower Colorado River Indian Reservation is located along the Colorado River just below Parker Dam, Arizona, with most of the land in Arizona and the remainder in California. The Supreme Court Decree allocated 717,148 acre-feet of diversions to the Colorado River Indian Reservation for irrigation of the 107,588 acres of land. The consumptive use required for irrigation of these lands is estimated to be 4 acre-feet per acre which would result in an annual main-stream depletion of 430,352 acre-feet. The consumptive use in 1972 from irrigation of 60,296 acres is estimated to be 241,184 acre-feet. This leaves an additional depletion of about 189,000 acre-feet per year for future developments.

The Bureau of Indian Affairs for the Colorado River Indian Reservation has predicted that the rate of development on the reservation should average 5,000 acres per year until full development is achieved. Therefore by 1980 there should be 100,000 acres under irrigation development with the remaining acres to be developed by 1990. There are 99,375 acres of land in Arizona, of which 60,300 acres have been developed and 8,213 acres of land in California to be developed.

Lower Colorado River Channelization Project, Arizona-California.--Between Davis Dam and Parker Dam, the channelization work in the Mohave Valley Division was completed in 1960 to salvage an estimated 109,000 acre-feet of water per year. However, the permanence of 44,000 acre-feet of that salvage is dependent on future maintenance in the Topock Gorge Division. The work in the Topock Gorge Division would also salvage an additional 28,000 acre-feet per year.

Between Parker Dam and Imperial Dam, work in the Palo Verde Division to salvage 10,000 acre-feet of water per year, and work in the Cibola Division to salvage 36,000 acre-feet per year has been completed. Work in the Parker and Imperial Divisions to salvage 39,000 acre-feet per year has not yet been started.

In summary, at the end of 1970 channelization work to salvage 155,000 acre-feet of water per year was complete, and additional work to salvage 67,000 acre-feet per year is planned.

It is estimated that an additional 100,000 acre-feet of water per year could be salvaged by phreatophyte eradication and control. A vegetative management research project is being undertaken to more clearly define the potential salvage from this source. Pending further studies, the location and estimates of potential salvage developed for the Pacific Southwest Water Plan have been used in this study. This plan indicates that 88,000 acre-feet could be salvaged above Imperial Dam. Of this amount, 59,000 acre-feet would be above Parker Dam and 29,000 acre-feet between Parker and Imperial Dams. The potential salvage from the combined channelization and phreatophyte eradication and control programs is estimated to be 87,000 acre-feet per year above Parker Dam.

It was assumed for this report that the estimated salvage for the lower Basin above Parker Dam would be accomplished in the following manner: 22,000 acre-feet per year by 1980, an additional 22,000 acre-feet for a total of 44,000 acre-feet annually by 1990, an additional 22,000 acre-feet by the year 2000 for a total of 66,000 acre-feet. The remaining salvage of 21,000 acre-feet above Parker Dam would be accomplished after the year 2000.

It was also estimated that the salvage for the reach of the river between Parker Dam and Imperial Dam would be accomplished in the following manner: 22,000 acre-feet annually by the year 1990 and an additional 23,000 acre-feet per year by the year 2000 for a total annual salvage of 45,000 acre-feet, the remaining potential salvage would be accomplished after the year 2000. The total potential salvage above Imperial Dam is then 155,000 acre-feet per year.

Summary below Hoover Dam.--The development of Indian lands on the Fort Mohave, Chemehuevi, and Colorado River Indian Reservations, separate contracts to various water users, and increases to the water supply resulting from salvage by channelization and vegetative management of the Lower Colorado River will all contribute to changes in the salinity concentration at Imperial Dam.

The Fort Mohave Indian Reservation has plans for the development of 7,000 acres by 1980. It has been estimated that an additional 5,000 acres of land would be developed by 1990 and 4,000 more acres of land would be developed by the year 2000.

It has been estimated that the Chemehuevi Indian Reservation would develop their 1,900 acres of land by 1990.

Salinity concentrations for the station Colorado River below Parker Dam would increase from the present modified value of 1.02 tons per acre-foot (749 mg/1) to 1.31 (966 mg/1) and 1.41 (1040 mg/1) tons per acre-foot for the zero and 2 tons per acre pickup conditions by the year 2000.

ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

16. Augmentation

Public Law 90-537 (dated September 30, 1968) states that augmentation of the Colorado River will be a national obligation to supply the Mexican Treaty requirements. Although temporary periods of subnormal water supply can be satisfied from storage releases, permanent deficiencies caused by full utilization of the waters allocated to the states would require augmentation. It has been estimated that a flow augmentation program will be needed by about 1990 to supply the Mexican Treaty obligation, assuming water requirements occur as projected.

PART VIII. EFFECTS OF SALINITY ON WATER USE

Water quality can be a factor in limiting the use of a water supply. Different water uses require different water qualities, and a supply may thus be acceptable for some uses but unsuitable for others. Most water uses have a range of quality within which a supply may be acceptable for that use. Use of water at the low quality end of this range may impose an economic, a social, and/or a political penalty on the water user in comparison to use of the water at a higher quality. The suitability of the quality of a water supply for use is thus a relative matter and must be evaluated with regard to specific uses and the social and economic aspects of such use.

An important objective of salinity investigations is to assess the suitability of Colorado River water for various beneficial uses. The following sections discuss the physical and economic effects of salinity on water uses in the Colorado River Basin.

A. In-stream Use

The major in-stream uses (uses where water is not depleted) of water in the Colorado River Basin include hydroelectric power production, propagation of fish and aquatic life, recreation (including water contact sports), and esthetics. Within the range of salinity concentrations expected in the foreseeable future, salinity should have no significant effects on these uses.

B. Irrigation Use

A major portion of the basin water supply is consumptively used for irrigation. Any effects of water quality on this use are thus of major importance. Crops grown in the basin differ in sensitivity to a salt concentration in the soil root zone, with some crops tolerating significantly higher concentrations in the root zone than the more sensitive crops. Also, most crops require a lower salinity concentration in the root zone during the germinating and seedling stage than they do later in the growing cycle. Salinity concentrations in the root zone are affected by the salinity concentration of the irrigation water, method of irrigation, irrigation efficiency, depth and concentration of ground water, drainability and texture of the soil, weather patterns, and other factors. If, however, all other factors remain unchanged, the salinity concentration of the root zone will vary with the salinity concentration of the irrigation water. Thus an increase in the salinity concentration of the irrigation water will decrease the productivity of the salt-sensitive crops if its tolerance limit of salinity concentration in the root zone is exceeded. Because of the many factors affecting the salinity concentration in the root zone, an exact irrigation water concentration that will damage a crop cannot be determined.

Damage to salt-sensitive crops can be prevented by applying additional irrigation water to flush the salts from the soil. If natural drainage or an existing drainage system is inadequate to remove the additional water, it may be necessary to install additional drains.

In the Upper Basin, salinity concentrations during the irrigation season are relatively low except in local areas. The impact of salinity on irrigation in the Upper Basin is thus minimal.

In the Lower Basin, present peak salinity concentrations are approaching critical levels for some salt-sensitive crops, and, while suitable for irrigation of most crops, are high enough that special irrigation practices are used in some cases. Economic losses will occur as salinity levels increase throughout the basin.

C. Industrial Use

Colorado River water has not yet been widely used for industrial purposes within the basin, but extensive use has been made of this water from transmountain diversions outside the basin. Since the quality of the water diverted from the Upper Basin is relatively high, only minimal pretreatment is required for most industrial uses. In the Lower Basin, the higher salinity levels in the diverted flows may require more extensive pretreatment for some types of industrial uses.

The quality of water required for industrial use varies widely and is dependent upon the purposes for which the water is utilized. Within any industrial plant, water may have several functions, however, cooling is the largest single use of industrial water supplied from the Colorado River. Future industrial uses are expected to increase tremendously with the increased requirements for energy.

D. Domestic Use

For domestic water use, it is desirable to have a safe, clear, potable, esthetically pleasing water supply which meets the recommended limits of the Public Health Service Drinking Water Standards of 1962. High salinity levels affect the taste of drinking water and may affect the digestive system in some people. Water hardness, which may increase with increases in salinity concentration, also requires more soap and laundry additives to achieve acceptable cleaning results. If the water becomes too hard, softening of the supply in large-scale municipal plants or in individual home units may be required. Sealing of water heaters and corrosion of pipes also accelerate with increased salinity or hardness levels.

Water quality in the Upper Basin will generally meet the Public Health Service standards with normal levels of treatment--settling, filtration, and disinfection. In some cases only disinfection is required. In contrast to the Upper Basin, the water supply at most points in the Lower Basin does not meet the Public Health Service recommended limits for total dissolved solids, exceeding the maximum acceptable limits at times. Mineralized water supplies with salinity concentrations in the range of those values observed in the Colorado River, however, are commonly accepted in the southwestern United States, with little detriment to the potability of the supply. The use of this mineralized supply imposes an increased treatment cost as hardness levels are high enough that water softening is desirable in addition to normal treatment. One possible solution to the problem would be to mix the more saline water with better quality water from other available sources.

PART IX. COLORADO RIVER SALINITY CONTROL PROGRAM

Section 206 of Title II of the Colorado River Basin Salinity Control Act, Public Law 93-320, of June 24, 1974, directs the Secretary of Interior, commencing on January 1, 1975, and every two years thereafter, to submit, simultaneously, to the President, the Congress and the Advisory Council, a report on the Colorado River salinity control program covering the progress of investigations, planning and construction of salinity control units for the previous fiscal year, the effectiveness of such units, anticipated work needed to be accomplished in the future to meet the objectives of Title II with emphasis on the needs during the five years immediately following the date of each report, and any special problems that may be impeding progress in attaining an effective salinity control program. Section 206 also provides that this report may be included in the Quality of Water-Colorado River Basin biennial progress report.

A Status Report for the Colorado River Water Quality Improvement Program-January 1974 describes the various projects and status of investigations at that time.

A. Projects Authorized for Construction

Title II of Public Law 93-320 authorized the Secretary of the Interior to construct as the initial stage of the Colorado River Water Quality Improvement Program, the Paradox Valley Unit, Colorado; the Grand Valley Unit, Colorado; the Crystal Geyser Unit, Utah; and the Las Vegas Wash Unit, Nevada. The schedule of definite plan reports for projects authorized for construction is shown on Figure 6. This section of the report presents a brief description and summary of the status of investigations for each of the projects authorized for construction. The estimated salinity effects of these projects at downstream stations is shown in Table 20.

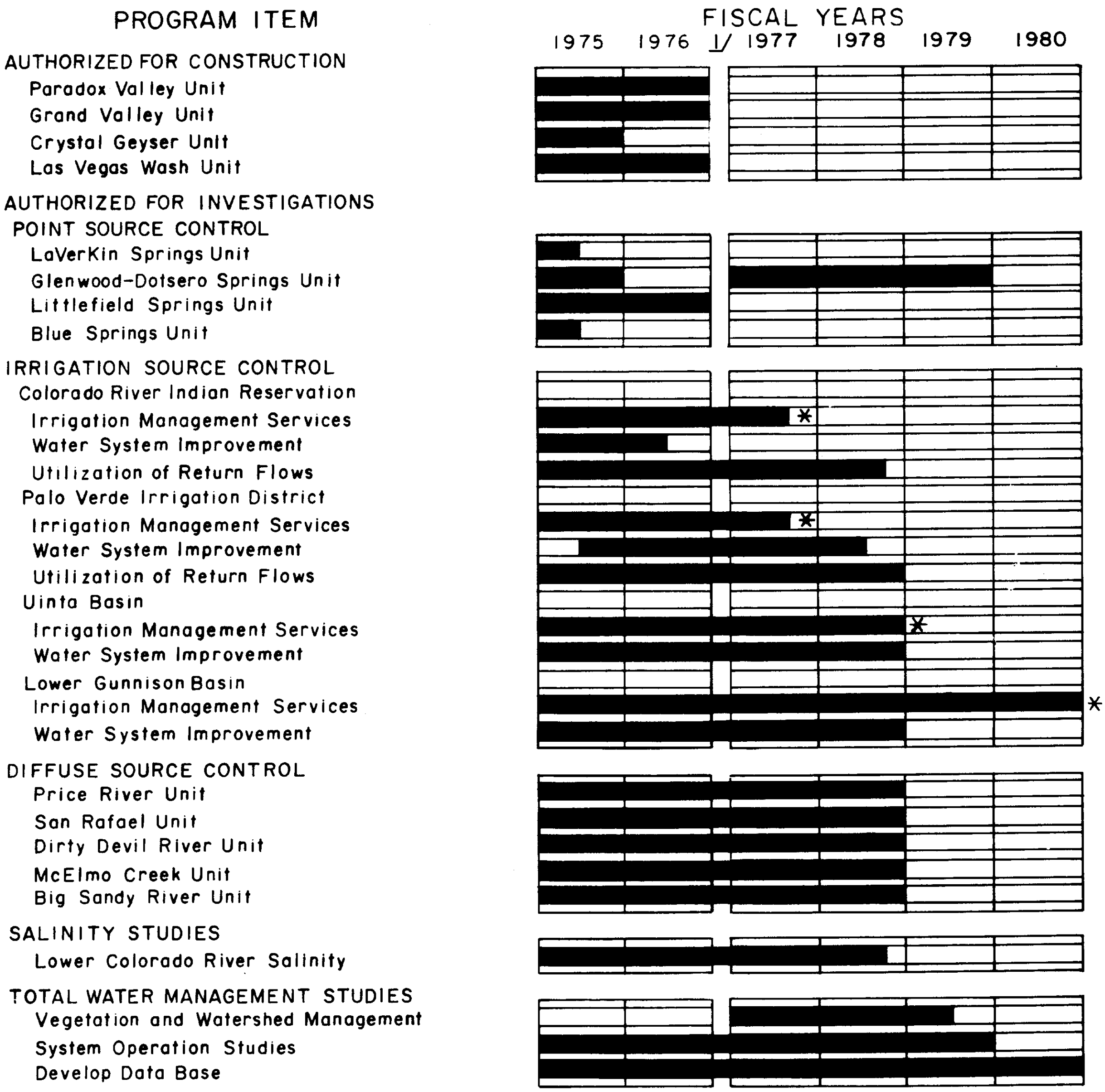
1. Paradox Valley Unit

Paradox Valley, a collapsed salt anticline, is a northwest-southeast trending valley 3 to 5 miles wide located in southwestern Colorado. It has a desert climate, dry and hot in the summer and dry and cold in the winter.

Geologic investigations in the Colorado Plateau have established the existence of a series of five major northwest-southeast trending salt anticlines (elongated swells) about 100 miles long, with the La Sal Mountains, an extrusive mass, perched over the center of the anticline region. Paradox Valley lies along the axis of one of these salt anticlines and is essentially the result of erosion of faulted and uplifted sandstone

INVESTIGATION SCHEDULE

COLORADO RIVER WATER QUALITY IMPROVEMENT PROGRAM



1/ Transition Quarter changing Fiscal Year from beginning July 1, to beginning October 1.

* WATER USER ORGANIZATIONS TAKE OVER PROGRAM OPERATION

Fig. 6

and shale formations from above a residual gypsum cap overlying about 14,000 feet of pure salt and salt-rich shale. The Dolores River remained in its ancient streambed as the uplift and erosion of the valley developed and crosses the valley near its midpoint. West Paradox Creek heads in the La Sal Mountains and flows southeast through the northwestern half of Paradox Valley to the Dolores River. East Paradox Creek, an intermittent stream, drains the southeastern half of Paradox Valley before flowing into the Dolores River.

Previous estimates of salinity contribution from the Paradox Valley were based on spot measurements of the flow and water quality of the Dolores River as it enters and leaves the valley. Stream gaging stations and a water quality sampling program were established in Fiscal Year 1972. Analysis of three years of streamflow and water quality records verified the previous estimate of 200,000 tons per year salinity contribution to the Dolores River as it traverses across the valley.

Topography was obtained by an aerial survey contract with the Forest Service.

To determine the path by which salt was entering the Dolores River, a resistivity survey was conducted along the river and exploratory drill holes and observation wells were drilled. The resistivity study estimated contours of the brine interface so that the exploratory drill holes and observation wells could be located to better define the subsurface water conditions. The five exploratory drill holes and twelve observation wells indicate that a 100-150 foot deep pocket of gravels exist in midvalley to the west of the river and that 15-30 feet of unconsolidated overburden overlies a brecciated gypsiferous NaCl salt rich formation to the east of the river.

Data obtained from the resistivity study and the drilling program indicate salt (or brine) at/or within a few feet of the surface along the east side of the river and plunging to a depth of about 150 feet about a mile to the west of the river.

In the river channel the brine interface surfaces sharply about midvalley. Upstream from this point, the river is unchanged in its freshness, but within several hundred feet downstream the river has almost reached its maximum salinity condition. The brine contribution results in salt concentrations in the Dolores River ranging from less than 200 mg/1 at high flows to 166,000 mg/1 during extreme low flows as measured at the outlet of Paradox Valley.

A 16-inch, 300 foot deep exploratory test well was drilled through 100 feet of deep lensatic river deposits and into the underlying fractured gypsum cap of the salt anticline. Pumping tests of the lensatic gravels and of the fractured gypsum cap indicate that the salt contribution to the Dolores River in this area can be effectively controlled by pumping from the brine zones. The estimated annual removal of salt is 180,000 tons.

The plan proposed to remove the salt would involve the installation of a field of brine wells to lower the fresh water-brine interface and thus, by pumping, eliminate the natural brine inflow to the river. The brine from the wells would be collected and pumped to a solar evaporation reservoir.

The potential Radium Reservoir, located in Dry Creek Basin on the West Fork of Dry Creek about 8 miles southwest of Naturita, Colorado, would function as the solar evaporation site. Mancos shale, an impervious, brackish marine formation, is the surface material of the reservoir site. No leakage is expected from the dam and reservoir. The reservoir would have a total capacity of 70,000 acre-feet and a water surface of 3,375 acres. The average reservoir content allocated to brine inflow would be about 66,000 acre-feet with surface area of 3,200 acres, at a point in time when evaporation equals inflow, based on brine inflow and evaporation rate assumptions. Alternative reservoir sites were evaluated but from the standpoint of reservoir impermeability only one site (Radium Reservoir site) could be utilized.

Analysis of the drawdown in the observation wells when the test well was pumped indicated that the brine-fresh water interplace could be lowered by pumping from either the bottom of the river gravels (100 foot depth) or from the fractured gypsum cap (300 foot depth), however, additonal test wells and piezometers will be needed to determine the number, location, and best zone to pump from to control the salt water flow to the Dolores River.

Topography along the proposed discharge-pipe alinement is being obtained by the U.S. Forest Service. A contract for geologic drilling of Radium Dam site is scheduled for December 1974. A contract for piezometer well access roads is also scheduled for December. The contract for drilling the piezometer wells and installing peizometers, and drilling the test wells and installing the pumps is scheduled for January 1975. Radium Reservoir Basin will be drilled in early 1975 by project personnel to determine the tightness of the basin.

The test wells will be test pumped for 30 days during the period of July to October 1975. The test pumping will be performed when the flow of the Dolores River is low enough to measure a decrease in salt pickup by the river.

Other studies that are scheduled for Fiscal Year 1975 and Fiscal Year 1976 are: Infrared photography of the Dolores River in Paradox

Valley; evaporation studies; H_2S scrubbers research; Environmental Impact studies and preparation of preliminary draft of the Environmental Impact Statement; alternative studies; flood studies; operation studies; sedimentation studies; plan formulation; cooperative agency appraisals; designs and estimates; economic studies; legal studies; and preparation of Definite Plan Report.

The preliminary draft of the Enviromental Impact Statement is scheduled to be circulated in June 1976. After comments have been received, the final draft of the Environmental Impact Statement will be prepared and submitted for review.

Preparation of specifications for construction are scheduled for January 1977 with construction scheduled to begin during the summer of 1977. Assuming adequate funding, construction should be completed in Fiscal Year 1980.

The estimated construction cost, as of April 1973, for the brine wells, pumping plants, pipeline, and reservoir structures is $16 million. The estimated annual operation, maintenance, and replacement costs based on the expected life of equipment and a 6-7/8 percent interest rate are $350,000.

Local benefits would be limited to the effects of decreasing the salinity of the Dolores River in Paradox Valley and downstream. There would be a decrease or elimination of salt encrustations along the river and lowlands adjacent to the river. This could enhance fishery, wildlife, and esthetic values in the downstream reaches. The annual loss of water by evaporation is estimated a maximum of about 5,800 acre-feet. Most of the benefits would occur in the lower Colorado River Basin with an estimated 16 mg/l reduction in the salinity concentration at Imperial Dam. The salinity concentration reduction is estimated to have a value of $3,680,000 annually.

Construction and operation of the Paradox Valley Salinity Control Unit could have the following environmental impacts:

> A noticeable decrease in the low flow salt concentrations in the Dolores River downstream from Paradox Valley with a decrease or elimination of salt encrustations along the river and lowlands adjacent to the river which could enhance fishery, wildlife, and esthetic values in the downstream reaches.
>
> Construction of one or more well installations along the river with associated pumping plants, powerlines, transformer stations, and pipelines would require removal of some of the brush along the river but with minimal effect on wildlife.

Constructing the pipeline to Dry Creek Basin would create a scar which would require a few years to heal. Booster pumping plants would be constructed along the pipeline at several locations along with the associated transformer stations and powerlines. The plant growth along the pipeline and around the pumping stations would probably be reduced but the effect on animal life should be minor.

The evaporation reservoir in Dry Creek Basin would store the salt removed from Paradox Valley, estimated to be 180,000 tons annually. The reservoir would inundate approximately 3,200 acres of land which would be lost for wildlife habitat and stock grazing. This reservoir would probably be sterile and the existing vegetation would be killed by the saline water. After a few years the reservoir would reach an equilibrium between evaporation and inflow and a salt flat would be exposed around the lake each summer, resulting in a minor amount of windblown salt which may damage the vegetation in the vicinity of the reservoir.

Approximately 4 miles of county road would have to be relocated around the evaporation reservoir.

2. Grand Valley Basin Unit

The Grand Valley of Colorado is near the western edge of Mesa County. Grand Junction, the largest city in Colorado west of the Continental Divide, is located in the Valley. The Valley was carved in the Mancos Shale formation (a high salt bearing marine shale) by the Colorado River and its tributaries and for the most part is surrounded by steep, rough terrain. Within the Valley the irrigated lands have developed on recent alluvial plains consisting of broad coalescing alluvial fans and on older and higher alluvial fans, terraces, and mesas. Other lands in this arid setting, where rainfall averages only about 9 inches per year, include the stream flood plains and rough broken land occurring as terrace escarpments, high knobs and remnants of former mesas.

First irrigation in the valley began in 1882 with the construction of what is now the Grand Valley Canal (Grand Valley Irrigation Company). Other private systems were built during the period between 1882 and 1908. Construction of the last major system, the Grand Valley Project under the Reclamation Service, began in 1908 with the major construction completed in 1926. This project consists of two divisions, the Garfield Gravity and the Orchard Mesa Divisions, on the north and south sides of the river, respectively.

A total of about 76,000 acres are served water by these irrigation entities with approximately 42,000 acres under Federal projects. Major crops produced in the valley are corn, sugar beets, small grains, alfalfa, and various orchard crops.

COLORADO RIVER SALINITY CONTROL PROGRAM

The Grand Valley is estimated to contribute an average of about 600,000 tons of salt annually to the Colorado River. Most of these salts are thought to be leached from the soil and underlying Mancos Shale and washed into the river by deep percolation and water delivery system losses.

The Mancos Shale is a very thick sequence of saline drab gray fissile shale that lies between the underlying Dakota sandstone and the overlying Mesa Verde Formation. The thickness of the shale usually varies between 3,000 and 5,000 feet. Due to this great thickness and its easy erodibility, the shale forms most of the large valleys of western Colorado and eastern Utah. Many white patches of salt and alkali are visible on the nonirrigated surfaces and some patches also visible on the irrigated lands where drainage is poor. The salts present in the mancos shale are mostly calcium sulfate with smaller amounts of sodium chloride, sodium sulfate, and magnesium sulfate. Calcium sulfate (gypsum) is commonly found in crystal form in open joints and fractures of the shale.

Due to the compactness of the clay and silt particles making up the shale, the formation is not considered as water bearing at depth. However, the weathered zone near the surface does transmit small quantities of water along joints, fractures, and open bedding planes. This zone is the area from which percolating water, often originating from irrigation of croplands, may dissolve salts present in the shale.

Most of the soils forming the irrigated lands have been derived from Mancos Shale. As a result, the soils may also be a source of salinity.

A gravel and cobble layer also has been found under some of the irrigated areas in the Grand Valley and is belived to serve as an aquifer for ground water. Previous studies have identified areas where the ground water has an upward pressure gradient in the cobble aquifer due to the confining effect of the Mancos Shale beneath and the tight clay soil above. This situation is believed to be responsible for some areas of high water tables. Further studies of the cobble aquifer will be necessary to determine its extent and its influence on the ground water. The gravel and cobble layer may be ancient stream deposits from the Colorado River and may not be continuous throughout the valley.

The programs underway in the Grand Valley are a combination of irrigation management services (IMS) and investigation of water system improvements (WSI). The IMS phase is being implemented. The WSI when implemented, in combination with the IMS program is expected to reduce the contribution of dissolved minerals by an estimated 200,000 tons/year.

The purpose of the irrigation management services (IMS) program is to optimize water management to attain one or more specific goals of maximizing yields, net returns, water use efficiency or minimizing indirect adverse effects. In the Grand Valley, IMS is expected to improve the efficiency of water use and thereby reduce the salt loading from the irrigated lands.

Under the IMS program irrigators are provided professional services relating to the scheduling of irrigation. Research has shown that imprecision regarding the timing and amount of irrigation water applied is one of the major causes of low irrigation efficiencies. In the Grand Valley area, irrigation efficiencies were measured during the 1964 through 1968 period and found to average about 33 percent. Through cooperation with the irrigators in the IMS program it is hoped that efficiencies could be increased to average about 55 percent. Concurrently, improvement of onfarm irrigation systems through the Department of Agriculture programs should result in even higher irrigation efficiencies. These improvements would involve such measures as landforming, lining field ditches, automation of delivery system, use of sprinklers and gated pipe systems.

The IMS program advises the irrigator of the optimum date and amount for his next irrigation. The forecast is made by use of a computer program which predicts future moisture use of the crop. Soil, weather and crop data are imputs for the forecast.

Through cooperation with the irrigation entities and other interested groups, 45 irrigators initiated the Grand Valley Irrigation Management Services Program in 1972. Eighty-seven fields totaling 1,050 acres were scheduled the first year. A good area and crop distribution was obtained. The IMS program was enlarged to serve over 7,000 acres during the 1974 irrigation season. The Federal program is scheduled to be concluded in Fiscal Year 1977 at which time it is expected that local entities will continue the program with only guidance from the Bureau of Reclamation. It is expected that most of the irrigated land in Grand Valley will be served by the IMS program by the time the water system improvement program is completed.

In order for the IMS program to be fully effective it will be necessary to have good on farm distribution systems with measuring devices. Another problem that increases the cost of the IMS program is the small size of the fields, averaging less than 20 acres, and the inability of the canal and lateral system to deliver the irrigation water when needed.

Groundwater observation wells have been installed to determine the water table. It has not been determined whether the high water tables are caused by overirrigation or canal seepage. Additional observation wells will be installed for the Irrigation Management Services and System Improvement Programs. Correlations will be sought between the groundwater salinity and soil salinity at various depths and times to help evaluate the IMS and Water Systems Improvement Programs.

COLORADO RIVER SALINITY CONTROL PROGRAM

Four irrigation entities divert water from the Colorado River. These include the Grand Valley Water Users Association (Bureau of Reclamation Project) and three private companies--The Grand Valley Irrigation Company, The Palisade Irrigation District, and the Mesa County Irrigation District. A fifth irrigation company, The Redlands Power and Water Company, diverts water from the Gunnison River. A number of other small companies have carriage agreements with the major canal companies for delivery of water. There are a total of approximately 210 miles of canals and 500 miles of laterals in the valley, with a few of the laterals and parts of some canals presently being concrete or gunite lined.

Investigations for improving the canals and lateral systems to reduce seepage and improve water delivery were began in Fiscal Year 1972. Capacities were computed for the conveyance systems based on crop consumptive use employing the Jensen-Haise Formula for the cropping patterns and climatic data for the valleys and an improved irrigation efficiency. The cropping pattern was determined by updating a 1969 survey by the Agriculture Engineering Department of Colorado State University. As the capacities arrived at by this method were close to the existing capacities the existing capacities will be used for designing concrete linings for the canals and laterals. On laterals that are in developed areas such as subdivisions, low pressure pipe will be used in lieu of concrete lining. Canal and lateral structures will be designed to improve control of the irrigation water.

Fencing would be installed along both sides of open concrete-lined sections where there is a safety hazard, and safety features are included for structures on canals and large laterals.

In areas where two or more laterals parallel each other very closely, consideration will be given to combining these laterals into a single lateral. Other than this type of combining laterals, the various irrigation companies will not consider any combination of their systems.

An alternative method of delivery of water through laterals by using an underground pipe system was studied for an area comprising about 6,700 acres. This study showed that the cost of this type system would be much greater than for a concrete-lined lateral system. Should further study indicate that an underground pressure system would be more beneficial to areas of the valley, then consideration would be given to use of this type of system.

It is expected that on farm improvement such as lining farm ditches, installing gated pipes, automated irrigation systems, and land leveling will be accomplished by Department of Agricultural programs.

Water quality sample and flow measurement stations have been established on 10 drainages which carry return flow to the Colorado River.

Data collected at these stations will assist in evaluating the present conditions and any salinity reductions resulting from irrigation scheduling and water systems improvements.

A study area has been selected in the valley to acquire detailed information on surface and groundwater quality and sources. A system of observation wells is being drilled to adequately define the water table, and for sampling the groundwater for quality determinations. Piezometers will monitor vertical gradients of water pressure through the soil profile, and gaging stations will measure surface inflow and outflow from the area. Data will be collected to ascertain the change in salinity levels due to irrigation scheduling and/or system improvements by comparison with a control area in which neither irrigation scheduling nor systems improvement would be done.

Modifications are being considered for the drains in the area. As of the present time, sufficient information has not been obtained to arrive at any definite drainage rehabilitation plans. A large number of groundwater observation wells have been installed in the valley and are being monitored to obtain information which might be used for future drainage design. In addition, Colorado State University is conducting several experiments in the valley, one of which is a detailed study of drain spacing requirements.

Other programs and activities which may affect the salinity control program in Grand Valley include:

a. Research on increasing irrigation efficiency and determination of mineral weathering and salt precipitation as a function of irrigation management being done by the Agricultural Research Service under contract with the Bureau of Reclamation.

The Agricultural Research Service is attempting to measure the deep percolation occurring for various irrigation efficiencies and methods with the resulting salt leaching or precipitation. The Agricultural Research Service is also operating seepage meters in the main canals and are working with the Bureau of Reclamation to conduct ponding tests to check some of the seepage meter test results.

b. Research on automated systems by the Colorado Water Conservation Board. The Colorado Water Conservation Board is conducting a pilot demonstration project for automated irrigation systems in the Grand Valley. Their primary objective is to test various modern onfarm irrigation systems and develop them for use in this area. They are currently engaged in work on three systems; an automated border irrigation system, an automated pump back system, and a drip irrigation system.

c. Initiation of conservation practices by the Agricultural Stabilization and Conservation Service in cooperation with the Soil Conservation Service.

The Soil Conservation Service has since the middle 1940's been concerned with drainage, reclamation of salted areas and restoration of productivity. In recent years, their activities have been oriented toward increased irrigation efficiency and reduction of salt contribution to the river from irrigated land. The Agricultural Stabilization and Conservation Service in cooperation with Soil Conservation Service has been involved in cost sharing of conservation practices such as ditch lining, pipelines, land leveling, drainage, and water control structures. Improvements that have been accomplished up to June 30, 1973, in the Grand Valley area include the following:

Concrete lining of lateral and onfarm ditches, 241 miles.
Construction of onfarm pipelines, 86 miles.
Construction of irrigation water control structures, which includes 8,099 structures such as division boxes, turnouts, measuring devices, and check structures.
Landforming on 24,392 acres, which consists of grading to a definite slope to increase irrigation efficiency.
Land smoothing on 3,599 acres, which consists of rough grading not to be a definite slope.
Water management on 56,000 acres. The farms that qualify must have an improved irrigation system, and must conform to irrigation practices outlined in the Soil Conservation Service irrigation guide.

d. The Agricultural Engineering Department, Colorado State University (CSU), is conducting salinity research for the Environmental Protection Agency. They are currently monitoring the salinity of water before and after its use for irrigation. They are monitoring approximately 12 square miles between Grand Junction and Clifton where they are attempting to accurately establish the salt contribution from irrigation on various types of soil and subsurface material. Canals, laterals, and drains throughout this area are frequently sampled and measured to establish salt loading and irrigation efficiency.

A number of fields within this area are actually being irrigated by Colorado State University to insure maximum control and measurement of water. Recorders are employed to check water on and off of the field and salinity measurements are made.

e. The Grand Valley Salinity Coordinating Committee--A group of Federal, state, and local agencies formed to eliminate duplication of effort and bring about a better understanding of salinity control programs.

The results of the above studies where applicable, will be used as imput data for the water systems improvement program.

Base maps and location maps have been prepared, acreages served tabulated, and conveyance capacities determined for all canals and laterals. Design criteria for the canals and laterals and associated structures are being established. Water quality samples are being collected and analyzed for drains and groundwater observation wells throughout the valley.

It is planned to obtain aerial topography by contract during the spring and summer of 1975. Additional groundwater observation wells will be drilled during 1975. Ponding tests will be conducted during the non-irrigation season in the late fall and early spring of 1975 and 1976. Geologic data along with canals and laterals will be collected and analyzed during 1975. Quality data collection will be continued for surface and groundwater return flows. The collected data will be used in making groundwater studies and sedimentation studies, and flood studies on cross drainages during 1975, and 1976. Also during 1975 and 1976, studies will be made to better estimate the salt load reduction resulting from the salinity control programs in Grand Valley. Other studies scheduled for 1975 and 1976 that are needed for completion of the Definite Plan Report in June 1976 are; water rights, designs and estimates, economic, legal, cooperative agency, and valley geologic. Studies for the Environmental Impact Statement are scheduled for 1975. The preliminary draft of the Environmental Impact Statement is scheduled for completion in June 1976 with the review and preparation of the final draft of the Environmental Impact Statement scheduled for December 1976.

Negotiation and drafting of contracts with the canal and lateral owners defining responsibility during construction and operation maintenance and replacement after construction is completed as required by Public Law 93-320, begins in late 1974 and will continue until all contracts are completed.

If the final draft of the Environmental Impact Statement is completed and accpetable by December 1976, specification preparation could begin in 1977 with construction begining in the fall of 1977. Construction would have to be accomplished from November to March during the non-irrigation season and is estimated to take 10 years.

In addition to a reduction in salt loading of the Colorado River a multiplicity of corollary benefits would be generated by the IMS and WSI programs. Under the IMS program the irrigator can expect: (1) increased yield and quality of crops, (2) better use and savings of labor, (3) better use of water, (4) reduced leaching of fertilizers and other agricultural chemicals, and (5) under some conditions, reduced drainage requirements. A survey following the 1972 program revealed that most participants felt they had increased crop yields as a result of the program. Crop census data further suggests that in 1972 the yield of row crops was increased about 5 percent on farms that were either fully or partially under irrigation scheduling. Because of the short period of record available no attempt has been made to impute monetary values to benefits other than the reduction in salt loading.

Other expected local benefits of the IMS and Water Systems Improvement progress include improved control of water deliveries and reduced groundwater and drainage problems. Other beneficiaries would be water users in the lower Colorado River Basin and Mexico.

Based on the Reclamation report "Economic Impacts of Changes in Salinity Levels of the Colorado River" (1973), total benefits for irrigation, municipal, and industrial water have been estimated at $230,000 annually for each mg/l reduction in the salinity concentration at Imperial Dam. A 200,000 ton annual reduction in the salt load contributed by Grand Valley would result in a reduction of about 19 mg/l at Imperial Dam for an estimated annual benefit of $4,370,000. The estimated cost of constructing the water systems improvements is $59,000,000.

The IMS and WSI programs would enhance environmental values within the Grand Valley area and assist in improving water quality conditions downstream. With regard to the former, erosion along drains and washes would be expected to decrease due to reduction in return flows. Water tables would drop and some seep areas would dry up thus reducing insect vector problems. The esthetic appearance of the landscape would be improved with the concrete lining and pipe system.

Safety features incorporated into the designs would provide greater protection for humans, wildlife, and livestock.

Lower groundwater tables and reduced return flows in the drainages will probably decrease phreatophytes and hydrophytes which provide habitat for wildlife in the valley. About 1000 acres are vegetated with hydrophytes (cattails and rushes) and 18,000 acres are vegetated with varying densities of phreatophytes (salt cedar, greaswood, willows and cottonwood). The Environmental Impact Statement is expected to evaluate the impact of the salinity control project on the wildlife and determine if special wildlife areas should be developed in the valley.

Currently, other factors are reducing wildlife habitat. These include ditch burning, spraying, mowing, and urbanization. The Environmental Impact Statement studies will need to determine what percent of habitat loss is due to IMS and WSI and what percent to other factors.

The reduction in return flow could also reduce siltation in the Colorado River and conserve soil. Other broad environmental influences include:

a. Protecting the highly diversified agriculture of the lower Colorado River basin and thus supporting the economy of communities dependent upon such production.

b. Sustaining the high quality of the diet in the United States resulting from the off season availability of vegetable and fruit crops.

c. Using less water for crop production since higher quality water reduces the leaching requirement.

d. Conserving resources since water treatment requirements for municipal and industrial uses would be reduced and plumbing and appliance life would be increased.

As the studies progress, environmental impact analysis is being fitted into the plan formulation process. Data collection activities are underway and evaluation of alternatives and their impacts are being determined.

3. Crystal Geyser Unit

The Crystal Geyser, a privately owned abandoned oil test well, located 3.5 miles south of the town of Green River, Utah, on the east bank of the Green River contributes about 3,000 tons of salt annually to the Colorado River system. The saline water erupts in the form of a geyser at about 5-hour intervals due to carbon dioxide accumulations. The concentration of the water ranges from 11,000 to 14,000 mg/l and the annual flow amounts to about 150 acre-feet. The climate at the geyser is a desert type with an average annual temperature of 52° F. and an average annual precipitation of 6 inches. The vegetation in the geyser area is sparse with tamarisk and scattered cottonwood trees along the edges of the river and cactus, Brigham tea, greasewood and shadscale elsewhere.

The estimated annual removal of salt by the alternative plans is about 3,000 tons, a relatively minor amount. Salinity concentrations of the Colorado River at Imperial Dam would be reduced by an estimated 0.3 mg/l.

A feasibility report for control of the geyser and environmental assessment is now being reviewed. This report is based primarily on an investigation conducted by the Brigham Young University through contract with the Bureau of Reclamation.

Serious consideration was given to plugging the geyser. Important geological facts, however, were brought out in the course of the investigation that discouraged this as a means of control; (1) the well was drilled in an area of eruptive activity already in existence; (2) the well penetrates the edge of the Little Grand Wash Fault and provides a ready outlet for the carbon dioxide buildup at this location; and (3) any plugging of the well would, in all likelihood, cause an eruption to occur at some other location along the fault, possibly in the river channel. For these reasons this means for control of the geyser is not considered desirable.

The plan is to collect the flows and convey them to evaporation ponds about 3 miles downstream. A layered soil cement dike would be constructed on the stream side of the geyser to collect and temporarily store the water from the eruption. The dike would be designed to blend in with the exposed formations. A plastic pipe would convey the water from the temporary storage pond on a uniform rate to the evaporation ponds about 3 miles downstream. The pipeline will cross many small drainages and the Little Grand Wash. Bedrock may also present some difficulties while laying the pipe. The evaporation ponds will be located about 3 miles downstream on a typical river flood plain of lean clay with lenses of silt, sand--sometimes clean, and gravel. The ponds will require lining to assure that no leakage back to the river occurs. About 2 miles of the access road to the geyser will need improvement by grading, installing culverts and possibly gravel surfacing. The access road to the evaporation ponds will also need some improvement.

Completion of a Definite Plan Report and the preliminary Environmental Impact Statement is scheduled for June 1975. Investigations and studies for the Definite Plan Report and Environmental Impact Statement are scheduled as follows: topographic--January 1975, hydrologic and geologic--January and February 1975, designs and estimates--January to March 1975, cooperative studies with other agencies--February to April 1975, environmental assessment completed by June 1975, economic analysis--March and April 1975.

The Preliminary Draft of the Environmental Impact Statement will be circulated for comments in July 1975 and the Final Draft of the Environmental Impact Statement prepared January to March 1976.

If the Final Draft of the Environmental Impact Statement is acceptable and approved, construction bids could be opened in May or June 1976 with construction completed in about 6 months of good construction weather.

The decrease in the salinity concentration at Imperial Dam by about 0.3 mg/l would result in an annual benefit to water users in the Lower Colorado River Basin of $69,000. It is estimated that the Crystal Geyser Unit construction cost will exceed $500,000. About 150 acre-feet of water will be evaporated annually.

The geyser is presently a minor local attraction. With an improved access road and better timing of the eruptions, the geyser could become a minor tourist attraction also.

It is expected that control of the salt loading from this point source would have negligible effect on the macroinvertebrate populations of the Green River below Crystal Geyser because of the insignificant effect on the large volumes of water in the Green River.

The pipeline for delivery of water from the geyser to the evaporation pond would have only a minimal environmental impact. The pipeline would traverse flood plains of the Green River and Little Grand Wash.

Less than an acre of ground would be disturbed in the borrow pit excavation for the dike surrounding the geyser. The evaporation ponds would require about 80 acres of land. Possibilities of wind scattering the salt or of rupture of the ponds would exist. These could cause some damage to vegetation in surrounding areas or enter the Green River. The appearance of the area would be changed by the unnatural white salt flats in the evaporation ponds.

4. Las Vegas Wash Unit

Las Vegas Wash is a natural channel draining the entire Las Vegas Valley watershed area of 2,200 square miles and discharges into the Las Vegas Bay arm of Lake Mead. Located in southern Clark County, Nevada the Las Vegas Valley contains the largest population center in the State. The wash flows through the valley in a generally southeast direction and provides drainage for the three principal cites of North Las Vegas, Las Vegas, and Henderson. Studies evaluating salinity contributed by the wash are concerned mainly with the lower 11 mile portion between Las Vegas and Lake Mead consisting of about 1,800 acres of dense marsh and phreatophyte vegetation.

Historically Las Vegas Wash has been an intermittent stream, discharging only during periods of high rainfall producing storm runoff. With the growth of the communities in the valley, the stream has become perennial. Return flows to the wash are from unlined ponds of industrial plants, from continually increasing discharges of the secondary treated municipal wastewater of the cities and unincorporated areas and from agricultural and municipal irrigation. These sources contribute large amounts of residual nutrient bearing and saline water to the Lower Colorado River via Las Vegas Wash and Lake Mead.

The vigorous development that has taken place in the Las Vegas Valley in recent years has resulted in a steady increase in the wastewater and the flow of the wash. In 1972, 38,040 acre-feet of water carried about 208,000 tons of salt to Lake Mead. Chemical analyses of water samples show the total dissolved solids varied from 3,300 milligrams per liter to 4,600 milligrams per liter and the flow weighted salinity was computed to be 4,230 milligrams per liter.

COLORADO RIVER SALINITY CONTROL PROGRAM

One plan proposed for reducing the salinity contributed to the Colorado River would utilize a desalting process to remove the majority of the dissolved salts from the surfacing groundwater discharges of Las Vegas Wash. This would involve the construction of a surface flow bypass system, a cutoff trench interception system, a pumping system, a desalting plant, a product water pipeline, a brine disposal pipeline, and a brine evaporation system. The facilities would operate on a nearly continuous basis, halting only during high floodflows in the wash. These floodflows would pass over the crest of the interception structure and flow on down the wash to Lake Mead, and project operations would be resumed when they had subsided.

Surface flows upstream from the groundwater interception area, such as the effluent from the advanced water treatment plants and other treated industrial wastes or discharges meeting Environmental Protection Agency requirements, would be collected and carried by a bypass pipeline around the interception facilities and introduced back into the wash downstream. The product water from the desalting plant would be either released back into the lake or made available for use in the valley. Waters diverted from the Colorado River and returning to the lake which would meet the quality standards would be credited to Nevada's 300,000-acre-foot allotment from the Colorado River.

The early studies of this plan indicate that about 139,000 tons of salt per year would be removed from the wash. This would decrease to an average of about 138,000 tons per year as the salts now in storage in the highly saline groundwater is reduced with reduction of seepage from the Basic Management Inc. ponds. The salts would be in the brine discharged from the desalting plant. With a recovery rate of about 90 percent, the brine discharge would be about 1,900 acre-feet per year and would represent a depletion to the Colorado River. Removing 138,000 tons of salt annually would reduce salinity at Imperial Dam by about 13 milligrams per liter.

Several alternatives to the above plan will be investigated. One would be to build an earthfill or concrete dam rising from bedrock as an alternative to the cutoff trench and collection system. This plan would require a more expensive structure and the reservoir would destroy vegetation and wildlife habitat. A second alternative to the desalting plant would be to pick up the flows in the wash and pump them out of the valley for evaporation in the Dry Lake area northeast of Las Vegas. A considerable amount of work on this proposal was conducted by NECON for the Las Vegas Valley Water District and is documented in its November 1972 Project Report "Pollution Abatement Project, Las Vegas Wash and Bay."

An interim alternative solution would be to evaporate the 18 ft^3/s of groundwater initially in evaporation ponds in the valley and add the desalting plant at the time that the need for beneficial use of the water becomes critical. Such a scheme would require a large commitment of land area for evaporation ponds (2,000 acres), which would have to be lined; and even if an area of low cost land were available, this would result in an expensive proposition when considering the addition of the desalting plant at a near future date.

A Definite Plan Report for the Las Vegas Wash Unit is underway and is scheduled to be completed by the end of Fiscal Year 1976. A detailed Environmental Impact Statement is being prepared concurrently. The project could be constructed and in operation by the end of Fiscal Year 1980 if funds are appropriated so construction could start without delay after completion of the Definite Plan Report.

The concept of brine evaporation and/or total evaporation of the saline flows may present a problem because this is a relatively new type of use that may not be compatible with Nevada's water law regarding beneficial use. Such problems may require revisions to the Nevada Revised Statutes.

The planning for the Las Vegas Wash Unit will also require close coordination with the Clark County Wastewater Management Agency and its plans for an advanced wastewater treatment plant and an export pipeline that would deliver wastewater for industrial use by a powerplant.

B. Projects Authorized for Planning

Section 203 (a) (1) of Public Law 93-320 authorized and directed the Secretary of the Interior to expedite completion of the planning reports on units described in the Secretary's report, "Colorado River Water Quality Improvement Program, February 1972", Section 203 (b) (2) directs the Secretary to undertake research on additional methods of accomplishing the objective of this title, (Title II of Public Law 93-320).

There are three categories of projects listed under Section 203, (1) irrigation source control, (2) point source control, and (3) diffuse source control. The Status Report--Colorado River Water Quality Improvement Program--January 1974, discusses the projects listed under the three categories. A brief description and status of the listed projects follows:

1. Irrigation Source Control Projects

Under the CRWQIP, major program emphasis for control of irrigation sources is placed on improved irrigation management through an Irrigation Management Services (IMS) and improved control of water flow in canals, laterals, and drainage systems through a Water Systems Improvements (WSI) program. Basically, the IMS program is a nonstructural management technique for increasing irrigation water efficiency and reducing salt loading. This is a demonstration-type program based on the concept that the water user will take over and operate the program. Under requirements in provisions of Public Law 92-500, this practice is expected to spread to other irrigated areas in the basin. Benefits expected to be derived from IMS irrigation scheduling include increased yields, labor savings, reduced leaching of soils, and reduced drainage requirements.

The WSI program, on the other hand, involves a structural water management tool for improving water delivery conveyances and, thus, reducing drainage seepage and salinity pickup. The lining of canals and laterals would result in decreased deep percolation losses, thus reducing water contact with highly saline soils, shales, and saline groundwaters.

A considerable amount of water diverted for irrigation in the Colorado River Basin is returned to the parent stream. However, the salts become concentrated with use, thus lowering the water quality. In some cases, particularly after repeated use the return flow water becomes undesirable for irrigation or municipal and industrial use without treatment. A few specialized industries however can use water of poor quality for cooling purposes. With the advent of increased need for electric generating and fuel-producing entities, wastewater flows have assumed new importance. In addition to the above program, planning reports evaluating irrigation source control units will also indicate the potential for collection of return flows for industrial use or of treatment to improve the quality of the receiving streams.

<u>Lower Gunnison Basin Unit</u>--The Lower Gunnison Basin Unit encompasses the Gunnison River drainage area below the Curecanti Unit, a feature of the Colorado River Storage Project. Within this area, there are a number of private and Federal projects presently irrigating approximately 160,000 acres. Also included in the area is an additional 17,000 acres of presently nonirrigated land that would be irrigated under projects authorized for construction.

The average gross crop value on lands served by Government facilities in 1971 was $138 per irrigated acre. This value applied to the total basin would give a crop value of approximately 21.5 million dollars.

The Lower Gunnison Basin contributes an estimated 1,100,000 tons of salt annually to the Colorado River. As in the Grand Valley it is believed that a substantial amount of the salt load pickup is caused by excessive irrigation applications and delivery system losses. The valleys in the Lower Gunnison area are generally eroded from the Mancos Shale, a thick gray saline fissile shale 3,000 to 5,000 feet thick. It is believed that water percolating through the weathered shale or soils derived from the Mancos Shale, leaches out the soluble salt which is then carried to the streams.

(1) Irrigation Management Service Program--The Irrigation Management Services program began with the 1974 irrigation season with approximately 2,800 acres scheduled. Initial scheduling was concentrated within the Uncompahgre Project, the largest irrigated area in the basin and one of the first projects authorized for construction (1905) following passage of the Reclamation act. The Irrigation Management Service program will be expanded as rapidly as the water users will participate and funding is available. It is expected that the water users will take over and operate the program by 1980.

(2) Water System Improvement Project--Slightly more than one half of the irrigated acres are part of Federal Projects, most of which are part of the Uncompahgre Project. A feasibility investigation for rehabilitation of the Uncompahgre Project began in Fiscal Year 1973 and will be completed in Fiscal Year 1977. Therefore, the Uncompahgre Project is not a part of the Lower Gunnison Basin Water System Improvement project investigation.

Data collection began in Fiscal Year 1973 and continued through Fiscal Year 1974. Capacity sizing of canals and laterals began in Fiscal Year 1975. Mapping and measurement of the canals and laterals and preparation of feasibility designs and estimates are scheduled to begin in Fiscal Year 1976 with completion of a feasibility report scheduled for Fiscal Year 1978.

The Irrigation Management Service and Water System Improvement programs could reduce the salt pickup by 300,000 tons annually resulting in salinity concentration reduction of 27 mg/l at Imperial Dam. Estimated benefits to the lower basin water users are $6,210,000 annually.

The benefits to local projects and the environmental effects haven't been determined but should be similar to the benefits and environmental effects listed for the Grand Valley Unit.

Uintah Basin Unit--The Uintah Basin lies between the Uinta Mountains on the north and the Tavaputs Plateau on the south in northeastern Utah. The climate in the basin is extremely variable. The summers are normally hot, with low humidity, and the winters are relatively severe.

Extreme fluctuations in precipitation and temperature occur over the area. Average annual precipitation is about 7.5 inches in Roosevelt, Utah, and about 8.5 inches in Altamont, Utah near the areas where irrigation scheduling has been started. The average annual temperature is 47° F. ranging from minus 32° F. to 105° F. Irrigated lands in the Uintah Basin totaling 170,000 acres are located primarily on alluvial materials adjacent to rivers and on benches and mesas. The Uinta Mountains, several peaks of which exceed 13,000 feet, are the main source of water for the Basin. The mountain front stream above the irrigated lands produce high quality water with total dissolved solids ranging from 30 to 350 mg/l. Water quality in the basin deteriorates as return flow from irrigated areas enter the Duchesne River and its tributaries. Concentrations in the Duchesne River below most irrigated land range from 200 to 3,400 mg/l with an average of 680 mg/l.

(1) Irrigation Management Service Program--Irrigation scheduling was begun in the Uintah Basin for the 1973 season when 81 fields with a total of 1,312 acres were scheduled. The program was expanded to schedule about 5,000 acres for the 1974 season. The fields average about 15 acres each. Each field is revisited every week to check field soil moisture conditions and give scheduling information to the participating farmers. Field moisture conditions compared to the computer forecasts showed the forecasts to be good except where groundwater problems exist. Initial scheduling acitvities have been geared to a cross section of the Uintah Basin and a large amount of testing and experimentation has taken place in order to find what type of service can be economically provided and gain wide acceptance by the irrigator. Scheduling all sizes of fields requires an excessive amount of field inspection time. If only larger fields were scheduled the cost of the field visits could be reduced. However, much of the irrigated area in the Uintah Basin is in small fields of 15 acres or less.

Several problems encountered during the two years of the scheduling program are: (a) there is limited water supply. The 1974 season was very dry and storage water was depleted about midway in the season so many of the scheduled fields had no water after July and all fields had periods of stress from insufficient irrigation. Irrigation water in normal years is also short in many areas; (b) many of the canals and laterals are in poor condition and measuring devices are practically nonexistent so that the water user is unable to measure the water applied during an irrigation; (c) irrigation water is delivered on a strict rotation schedule so the water user found it difficult to follow the computer forecast and apply water at the time needed; (d) many fields need a drainage system. Groundwater tables are high in parts of some fields but seldom was a complete field affected by high groundwater.

The Irrigation Management System program will be expanded as rapidly as funds, personnel and the water user acceptance allows. The Bureau will continue to develop the program so that it can eventually be administered by trained personnel working for the water users. Under the present schedule the water users will assume the full cost of the program by Fiscal Year 1978. The ultimate goal is to schedule not only irrigation applications, but water deliveries throughout the distribution systems.

(2) Water Systems Improvement Program--Systems improvement possibilities consist principally of the improvement of irrigation conveyance systems such as lining canals, use of pipe systems, and upgrading diversion and measurement structures.

A study to determine the seepage losses and salt loading from Uintah Indian Irrigation Project canals was begun in June 1973. This study is being conducted with the cooperation of the Bureau of Indian Affairs on canals located near Roosevelt, Fort Duchesne, and Myton, Utah. Seepage from other delivery systems is being measured to determine the affect on salinity pickup. Also the Bonneville,Upalco and Uintah Units of the Central Utah Project will rehabilitate some canals and laterals in their respective service areas.

Data collection will continue through Fiscal Year 1976. Capacity sizing of canals and laterals will begin in Fiscal Year 1975. Mapping and measurement of the canals are scheduled to begin in Fiscal Year 1976, with completion of a feasibility report scheduled for Fiscal Year 1978.

The Uintah Basin contributes about 450,000 tons of salt annually. The Irrigation Management System and Water Systems Improvement programs could reduce the salt load pickup by 100,000 tons annually resulting in a salinity concentration reduction of 9 mg/l at Imperial Dam.Estimated benefits to the lower basin water users are $2,070,000 annually.

The benefits to local areas and the environmental effects haven't been determined but should be similar to the benefits and environmental effects listed for the Grand Valley Unit.

Colorado River Indian Reservation Unit, Arizona--The Colorado River Indian Reservation has a total of 268,850 acres located in the Lower Colorado River Basin below Parker Dam in northern Yuma County, Arizona, and in the eastern part of San Bernardino and Riverside Counties, California.

COLORADO RIVER SALINITY CONTROL PROGRAM

The United States Supreme Court allocated water to irrigate 107,588 acres, of which 99,375 acres are in Arizona and 8,213 acres are in California. The court's allocation also provided for a maximum diversion of 717,148 acre-feet per year. In 1972, there were 62,000 acres irrigated with Colorado River water diverted at Headgate Rock Dam. About 200 miles of canals and laterals delivered water to irrigate this acreage. The irrigation system will be expanded to supply water to irrigate about 93,000 acres in Arizona by 1980. Irrigation return flows are collected in a 100-mile drainage system and returned to the river just below the Palo Verde Diversion Dam. About 30,000 tons of salt were returned to the Colorado River with the measured return flows in 1972 and this will significantly increase as the irrigated acreage increases.

(1) Irrigation Management Services--Irrigation Management System program was initiated on the Colorado River Indian Irrigation Project during 1973. By a letter of agreement dated October 1, 1973, the Bureau of Reclamation, the Bureau of Indian Affairs (BIA), and the Colorado River Indian Tribal Council for the Colorado River Indian Irrigation Project entered into an agreement for developing an Irrigation Management System program within the Colorado River Indian Irrigation Project. Under the agreement, the Bureau of Indian Affairs has assigned one employee to work directly with two Bureau of Reclamation personnel. The Bureau of Indian Affairs employee will at all times remain under the direction and control of the Bureau of Indian Affairs. This representative is being trained in the science of irrigation scheduling by Bureau of Reclamation personnel so that at the end of the demonstration period he will be capable of assuming responsibility for the operation of the program. The Bureau of Indian Affairs is expected to assign additional employees to the Program as benefits are demonstrated to the Colorado River Indian Irrigation Project and to farm owners and operators. Personnel of the Bureau of Indian Affairs will be assigned increasing responsibilities in operation of the program until such time as it is mutually agreed that they are capable of operating the program. At that time, the Bureau of Reclamation personnel will be withdrawn from the Colorado River Indian Irrigation Project and the Council and/or the Bureau of Indian Affairs will assume full operation of the program. Technical liaison will be maintained thereafter by agreement between the Bureau of Reclamation and the Council and/or the Bureau of Indian Affairs in order that the Colorado River Indian Irrigation Project will have access to the computerized program and technical assitance as needed.

A demonstration period of about four years is planned, during which time the water users will become proficient with the operation and appraised of the benefits of the program. This program is scheduled to be completed by June 30, 1977. At the conclusion of the demonstration stage, the Bureau of Indian Affairs and the Colorado River Tribal Council will continue the program, provided that it has a demonstrated benefit.

Two Bureau of Reclamation employees and Bureau of Indian Affairs employee are scheduling irrigations on 4,000 acres at the end of calendar year 1974. The Bureau of Indian Affairs employed a college student during the summer. There are 2,000 additional acres ready to schedule. Early in 1975, they will be added to the program. This 6,000 acres accounts for about 10 percent of the present irrigated acreage in the Colorado River Indian Irrigation Project. The Bureau of Indian Affairs will be encouraged to add an additional full-time man during calendar year 1975. At least one additional man should be added each of the next 5 years.

The existing water measurement system is not adequate for the ultimate needs of the Irrigation Management System program. Irrigation systems improvement with emphasis on selection and installation of the proper water measuring devices would be of great help in assuring success of the Irrigation Management System program.

(2) Water System Improvement--Studies are underway to identify the improvements needed in the distribution system to reduce losses and to determine the amount of reduction in salt loading of the river that can be achieved by improving the distribution system. The Bureau of Indian Affairs and the Colorado River Indian Tribal Council are cooperating with the Bureau of Reclamation in this study. A ponding test on one of the laterals was conducted in January 1974. Results from this test will be used in evaluating losses from the existing lateral system. Various structural improvements will be recommended on the basis of these studies.

The Bureau of Indian Affairs requires concrete-lined canals be built to serve newly developed lands, but there is a need to rehabilitate much of the existing distribution system in order to reduce seepage losses, restore capacity in the system, and provide adequate measuring devices for efficient control of water deliveries.

A feasibility report for the system improvement of the Colorado River Indian Reservation distribution system is scheduled for completion by January 1977. A design layout for a recommended improved system will be included in the report. Preliminary evaluations indicate that the combined Water Systems Improvement Program and Irrigation Management Program will reduce the salt loading of the Colorado River by about 7,000 tons annually. This will lower salt concentrations at Imperial Dam by about 1 milligram per liter.

(3) Utilization of Return Flows--The increase in salinity resulting from irrigation return flows could be prevented or reduced if the return flows could be diverted and a use made of them that would prevent the return of salt to the river. There have been no proposals to use return flows from this project as yet. However, it is reported that the San Diego Gas and Electric Company is considering construction of a nuclear powerplant in Arizona that could use about 40,000 acre-feet of water for cooling. Water from the drain could be a possible source of supply. Reuse of this return flow involves problems somewhat different from those in the Palo Verde area in that there is no presently available source of replacement water to exchange for any depletions of these flows. Until some type of Colorado River augmentation becomes available, these return flows could be depleted only if Arizona accepted the use as a charge against their entitlement to Colorado River water.

Other possibilities of using water with a higher concentration of salts to accomplish the reduction of salt in the river system and for powerplant cooling will be examined. Specific areas of return flows from irrigation on the Fort Mohave Indian Reservation in Arizona and Nevada and the Chemehuevi Indian Reservation in California will be included in the studies.

Palo Verde Irrigation District Unit, California--The Palo Verde Irrigation District is a privately developed district located in Riverside and Imperial Counties, California. Water for irrigation is diverted from the Colorado River at the Palo Verde Diversion Dam and is conveyed through 295 miles of main canals and laterals to serve approximately 91,400 acres of irrigated land within the District. The irrigation return flows are collected in a 153-mile drainage system and returned to the Colorado River. It is estimated that these return flows contribute about 148,000 tons of salt annually to the river.

(1) Irrigation Management Services Program--The Irrigation Management Services Program in the Lower Colorado Region was implemented in the Palo Verde Irrigation District during calendar year 1973. Through improved irrigation management, a reduction can be achieved in the volume of irrigation return flows and

an overall reduction in the amount of salt loading attributed to these flows. The primary technique employed by this program is the development and dissemination of information on the timing of irrigation and the applied amount. A computer program developed by the Bureau of Reclamation is utilized in the process.

An agreement was executed by the Bureau of Reclamation and the Palo Verde Irrigation District on April 27, 1973. As provided for in the agreement, the Bureau and the District will cooperatively conduct an Irrigation Management Services Program using climate, crop, and soil data to provide a method that is expected to improve crop quality and yields and more effectively utilize irrigation water. The demonstration phase of this cooperative program began in 1973 and is scheduled to be completed in June 1977. The District has assigned an employee to work directly with Bureau personnel assigned to the program. The employee will at all times remain under the direction and control of the District. The District's representative will be trained in irrigation scheduling by Bureau personnel, so that at the end of the demonstration period he will be capable of assuming full responsibility for the operation of the program. The District is expected to assign additional employees to the program when benefits are demonstrated to the District and to farm owners and operators. The District personnel will be given increased responsibilities in operation of the program until such time as it is mutually agreed that the District personnel are capable of operating the program by themselves. At this time, the Bureau personnel will be withdrawn from the program on the District level and the District will assume full control. Technical liaison will be maintained thereafter by agreement between the Bureau and the District in order that the District will have access to the computerized program and technical assistance as needed. Development of the program is scheduled for a maximum of 5 years: 1973-77. After this period, the District has agreed to assume operation of the program provided the program's value has been demonstrated.

With the conclusion of calendar year 1974, two Bureau of Reclamation employees were scheduling irrigation on about 9,000 acres (about 10 percent of the total District's irrigated acreage). Some of the 9,000 acres were seeded to three crops during the calendar year. The acreage scheduled has more than doubled during calendar year 1974 over December 31, 1973. Ultimately, 90 percent of the District acreage will be scheduled. High value crops, typical of the irrigated valleys of the southwestern United States, were grown.

At the close of business on June 30, 1974, the District withdrew the support of their employee to the Irrigation Management System program, except to fill-in during emergencies caused by the absence of a Bureau employee. This action greatly slowed the expansion of the Irrigation Management System program and dealt a severe blow to one of the objectives of the program as stated in the agreement, which is to train a District Irrigation Management System team leader around which additional District employees would be trained. The District has continued to provide office space and in every other way has been most helpful.

The District and the Bureau should very soon reinstate the agreement of 1973 and during the next 5 years the District should add at least one new Irrigation Management System technician each year in order to meet our mutual objective.

Annual reports of the Irrigation Management System activities in the Palo Verde Irrigation District are planned. The first report will be for calendar year 1974.

(2) Water Systems Improvement--A study will be made of the water loss from the Palo Verde Irrigation District distribution system to evaluate the need and potential reduction in return flow that would result from an improved distribution system. The improvements needed in the irrigation distribution system will be identified during the investigations.

In 1972, the return flow from this 153-mile drainage system amounted to about 446,580 acre-feet. The discharge of the outfall drain varies from 447 cubic feet per second to 648 cubic feet per second with a salt concentration averaging about 1,827 milligrams per liter. Computations of the total salt load returned to the river indicate that the salt pickup from the Palo Verde Irrigation District was about 148,000 tons in 1972. A report on the Palo Verde Irrigation District is scheduled to be completed by March 1978. It is estimated that the rehabilitation of the irrigation system in conjunction with the irrigation scheduling program will reduce the salt load of the Colorado River by 23,000 tons annually. This will lower the salinity at Imperial Dam by about 3 milligrams per liter.

(3) Utilization of Return Flows--One method of reducing the salinity of the Colorado River would be to use part of the return flows and use them for cooling water in nuclear-fired electric powerplant operations. The cooling water would be disposed of by evaporation after use.

It has been estimated that five nuclear-type powerplants, each with 770 megawatts of capacity, will be needed to meet the electric energy requirements of the San Diego area by about 1990. These plants would require the use of as much as 100,000 acre-feet of water for cooling purposes. If these nuclear powerplants were to be located in the desert area near the Colorado River, the availability of cooling water would be of prime importance. The water requirements could be met by siting the powerplants so that a part of the return flows conveyed to the Colorado River by the drain could be used for cooling purposes. Such a plan would require that the cooling water be reused until it became too salty for recycling, at which time it would be discharged to evaporation ponds for final disposal. However, since all of the waters of the Colorado River, including this return flow, are committed to present water uses, a plan which depleted the return flow can only be used if the water can be replaced from another source. It is physically possible to replace Colorado River return flows used in California with water supplied from the California State Water Project through an exchange agreement with the Metropolitan Water District of Southern California. Such an exchange agreement would require ratification by present users of Colorado River water.

Assuming that each of the powerplant units uses 20,000 acre-feet of return flow with an average salinity of 1,728 milligrams per liter and that this use is replaced with Metropolitan Water District Colorado River releases averaging 751 milligrams per liter under present modified conditions, the result would be to reduce the salt return to the river by about 29,000 tons per year. This would reduce the salinity of the flow at Imperial Dam by about 4 milligrams per liter. If the use were increased to 100,000 acre-feet per year, the reduction in salt would be about 146,000 tons per year and the reduction in salinity at Imperial would be about 19 milligrams per liter.

2. Point Source Control Projects

The four units in the following section have been identified as point source contributors of salt to the Colorado River. They are thermal springs that discharge high concentrations of dissolved salts.

LaVerkin Springs Unit--LaVerkin Springs, located on the Virgin River in the southwestern corner of Utah, contribute an average salt load of 109,000 tons per year with a flow of about 11.5 cubic feet per second that has total dissolved solids averaging 9,650 milligrams per liter. A feasibility report of a plan for collecting and desalting the springs is currently in the process of administrative review and is scheduled to be forwarded to the Commissioner's Office in December 1974.

The desalting plan would use a bypass system, consisting of two small diversion dams and a bypass pipeline, to divert the river around the springs and collect the spring water. Spring flows would be pumped to a reverse osmosis desalting plant. About 5,690 acre-feet per year of product water would be returned to the river and 2,270 acre-feet of brine would be pumped to a solar evaporation pond. The brine water loss and a cooling tower loss of about 200 acre-feet would cause a depletion of about 2,470 acre-feet per year. A salt load of 103,000 tons per year would be removed from the stream, which would reduce the salinity of the river by 9 milligrams per liter at Imperial Dam. The report indicates the cost of salt removal would be $28 per ton. Annual equivalent cost is $2,929,000 and the benefits to irrigation, municipal and industrial water in the United States are $1,070,000.

The LaVerkin Springs Unit studies for controlling the salt discharges from this point source evaluated all reasonably practical means for abating the salt pollution of the springs. The investigations included: locating various potential sites and developing plans for evaporating all of the spring discharge; evaluating the possibility of using the spring water for powerplant cooling water; determining the potential for deep well injection of the spring water; studies of alternative methods of collecting the springflow; and determining the cost of desalting using various methods now technically operational. The effect on the environment was evaluated for each of the potential control methods.

Littlefield Springs Unit—Littlefield Springs are a widely scattered group of springs located along the south side of the Virgin River about 1 mile upstream from Littlefield, Arizona. Littlefield is in the extreme northwestern part of Mohave County about 3 miles east of the Nevada State Line and 5 miles south of the Utah State Line. The principal communities in the vicinity are Littlefield, Arizona, and Mesquite and Bunkerville, Nevada. St. George, the largest community in the area, is located 28 miles upstream from the springs.

Feasibility studies on the unit were started in Fiscal Year 1974 and are scheduled to be completed in Fiscal Year 1976. The area being studies includes the reach of the Virgin River from where it enters the "First Narrows" canyon above the Arizona-Utah State Line to the vicinity of Littlefield. The relationship between the Virgin River and saline springflows in the Littlefield, Arizona area is complex and not completely understood. As the river enters the rugged canyon near the state boundary between Utah and Arizona, it loses up to 70 cubic feet per second of its flow to the alluvium of the bed. During periods of low flow, from May to October, the Virgin River flows underground through the upper part of "The Narrows." Surface flow begins to reappear about 1 mile above the mouth of

"The Narrows" in the form of springs discharging from the riverbed and from the adjacent banks. Flows of 20 cubic feet per second at an average salinity of 2,915 milligrams per liter were measured at the mouth of the canyon in 1973. At a point 2 miles downstream, the flow increased to 43 cubic feet per second with an average salinity of 2,900 milligrams per liter. The stream continues to gain, and at the Geological Survey's gaging station at Littlefield the flow was 70 cubic feet per second and the salinity decreased to 2,470 milligrams per liter. The salinity improvement is attributed, in part, to an inflow of about 3 cubic feet per second of good quality water from Beaver Dam Wash and from springs on the north bank of the river above the gage. The upwelling springs in the lower end of "The Narrows" canyon and the stream gain in the area appear to originate from the flows lost by the river at the upper end of the canyon. However, the flows have been modified in that the springs have a nearly uniform year-round salt concentration and are thermal in nature with a temperature of about 78° F.

The Virgin River disappears during low flow periods after it enters the "First Narrows" canyon and emerges again near the mouth of the canyon about 6 miles upstream from Littlefield Springs. In the area of Littlefield Springs, the river is flanked on the southeast by the Virgin Mountains, on the northwest by the Mormon Mountains, and on the north by the Beaver Mountains.

A program of data collection to determine the flow and salinity of the main springs and the flow and salinity of the Virgin River with special emphasis on the lower part of the Narrows canyon was started in August 1973. Flow measurements and chemical analysis indicate an average combined flow of the springs of 5.7 cubic feet per second and an average salinity of 2,960 milligrams per liter. Based on this, the salt contribution to the river averages 16,700 tons per year. The mineral salts in the springs discharge are chiefly carbonates, sulphates, and chlorides of calcium and sodium. The springs in the lower end of the Narrows canyon and the base streamflow in this area have a salinity and chemical content that is similar to that of the springs.

Studies will be made evaluating collection of the spring and desalting them or conveying them to a suitable location where they would be evaporated. Either plan would remove about 16,000 tons of salt annually from the Colorado River system. A total evaporation plan would deplete the flow of the Virgin River by about 4,100 acre-feet annually. This would reduce the salinity concentration at Imperial Dam by about 2 milligrams per liter.

The effect of depletions upon the agricultural development in the area is a serious problem that would result especially from an evaporation salinity control project.

Blue Springs Unit--The Blue Springs area is located on the lower portion of the Little Colorado River within the Navajo Indian Reservation of north-central Arizona. The springs contribute an average of 160,000 acre-feet per year which have a collective salinity of 2,500 mg/1 and a total salt load of about 550,000 tons per year.

The lower portion of the river flows through a meandering canyon of about a mile in width and half mile depth. The walls of this rugged gorge are a series of nearly vertical cliffs of massive limestone and sandstone separated by steep slopes or benches of shale, siltstone, or thin-bedded sandstone. The bottom can be reached near Blue Springs only by a rugged foot trail from the rim or by helicopter. The springs originate from ground water which moves into the area from the east and south and emerges as springflows where the canyon has penetrated the Redwall and Mauv limestones below the regional water table. There are many spring openings along two relative well-defined reaches.

The spring flows are clear, salty, slightly acidic, and from 65° to 70° F. Chemically, they are typically sodium chloride water, with secondary concentrations of calcium bicarbonate. Large amounts of calcium carbonate precipitate to form a fine white mud on the bottom of the stream.

Preliminary estimates indicate that a 125 m.g.d. desalting plant would be required to remove approximately 300,000 tons of salt annually. This would result in improving the salinity by 23 mg/1 at Imperial Dam. The disposal of the brine is a difficult problem because of the quantity of brine and the difficulty in finding a suitable disposal site.

Full-scale feasibility studies for this project are not planned due to the high expected capital cost of the project and environmental problems resulting from the significant historical and religious value of the area to the Hopi Indians.

Glenwood-Dotsero Springs Unit--The largest point source contributors of dissolved solids to the Upper Colorado River are in the river between the mouth of the Roaring Fork River at Glenwood Springs and the mouth of the Eagle River near Dotsero. These contributions are from thermal springs rising in or near the bed of the river and from groundwater entering this reach of the river. Inflow-outflow measurements indicate this reach of the river contributes approximately 25,000 acre-feet of water containing over 500,000 tons of dissolved solids annually. Based on a 1-year period of data collection, the springs that could be identified and measured have a combined flow of about 16 cubic feet per second and an average dissolved mineral content of approximately 14,200 mg/l. These flows would carry about 225,000 tons of dissolved solids into the Colorado River annually.

The thermal springs and the groundwater inflows to the Colorado River between the mouth of the Roaring Fork River and the Eagle River are widely scattered. The located springs whose flows are considered collectible by conventional methods for desalination treatment are clustered in the vicinity of Glenwood Springs and around a point approximately 2.5 miles downstream from the mouth of the Eagle River called Dotsero. Geologically speaking, the area is located at the southeastern edge of the extensive White River uplift. The Glenwood and Dotsero Springs are situated at opposite ends of Glenwood Canyon which has been created by the Colorado River eroding through very resistant rocks of the uplift. Many faults have been mapped in the area and may be related to the springs.

The thermal springs generally issue from gravels along the river but this water is traveling to the surface through the underlying bedrock. Generally the springs seem to be found in areas where the cavernous Leadville limestone crops out but other formations are also involved. It is also of significance that the Paradox Formation is found in the general vicinity of both spring areas. Chemical analyses of the water from the springs show large amounts of both sodium chloride and calcium sulfate, and the Paradox contains beds of these minerals in the form of halite and gypsum.

Evidence of volcanism as recent as Pleistocene in age occurs in the area and suggests the possibility that hot intrusive bodies may be present in the subsurface. A cinder cone and lava flow are found about 5 miles east of the Dotsero Springs and other similar evidence exists.

In summary, only very generalized geologic data are available on the Glenwood and Dotsero Springs and an extensive exploration program would be necessary to delineate the geology and hydrology.

It is possible, however, to hypothesize that groundwater in the area travels along faults or related fracture zones, dissolves out salts principally from the Paradox Formation, becomes heated by deep-lying intrusive bodies, and returns to the surface as warm, saline springs.

During the preliminary studies to date, several methods of disposing of or treating the saline water have been considered. Methods that could be used to control or eliminate point source flows include evaporative ponds, deep-well injection, plugging or grouting off the springs, diversion for industrial use or various types of treatment plants. After cursory evaluation of each of the alternatives, some type of treatment plant to remove the bulk of the salts is being evaluated in more detail. In addition, this would be the only solution that could salvage the fresh water for return to the Colorado River.

Brief consideration was given to collecting the flows of each spring and conveying the water to evaporative ponds. Since rather large flows are involved (16 cfs total), ponds with a large surface area would be necessary. Also since the topography at both Glenwood Springs and Dotsero is dominated by narrow canyons, it might be necessary to convey the saline water downstream 30 miles or more, possibly to the Rifle, Colorado, area to obtain a suitable site. Moreover, the elevation at Glenwood Springs is about 5,700 feet and the latitude result in a cool climate and a moderate winter snowfall which would further restrict the effectiveness of evaporative ponds.

Deep-well injection has been used in various circumstances to dispose of industrial wastes and has been studied by the Office of Saline Water as a technique for disposal of brine solutions. After a brief review of the geologic conditions at the Glenwood and Dotsero Springs areas, it seems very unlikely that a subsurface formation exists into which the saline water could be injected due to the existence of faults and well-developed joint systems in the vicinity. It might be practical to convey the concentrated brine effluent from a desalting plant several miles downstream for evaporation or deep injection if satisfactory geologic conditions can be found.

Serious consideration was not given to plugging or grouting off the springs since the mode of their occurrence and the complex geology seem to preclude the practicality of this alternative. Also the Glenwood Springs are commercially developed for recreation and these springs supplying the resort areas could not be plugged off without adverse social and economic impacts.

Several types of desalting plants are available and preliminary studies indicated that the multistage flash distallation process is the most thoroughly proven method of treating water similar to the Glenwood-Dotsero Springs. Some approximate cost estimates for treatment plants and associated features were prepared considering an individual plant located near each of the sources or a combined plant to treat both sources.

Investigation of this segment of the Colorado River Water Quality Improvement Program began in April 1972. An on-the-ground appraisal of the area located the various springs and 1 year's measurement of the flow from each spring was obtained on a monthly basis. Total dissolved solids and chemical analyses were determined on all samples.

In April 1973, geophygical studies were conducted in the Dotsero Springs area to determine if it might be feasible to collect the saline water by drill holes. The limited amount of geophysical work indicated that the flows may be along open fractures in the underlying bedrock. Future core drilling is proposed to determine if the flows can be intercepted at depth. Any control plan must preserve the existing highly developed recreation facilities in the Glenwood Springs area.

Substantial investigation remains to meet the programed goal of a feasibility report in Fiscal Year 1979. This work includes preliminary design, economics, geology, and many other aspects including environmental considerations. Further subsurface work including drilling and geophysical surveying is planned especially in the Dotsero area. Economic studies to determine the benefits of desalting will be conducted. More detailed studies of other methods of treating the saline water are planned. Other uses of the water will also be considered.

The pertinent data collected at Dotsero and Glenwood Springs indicate the average total dissolved solids contained in the discharges from these two areas to be approximately 9,300 to 18,000 parts per million (ppm), respectively. The combined weighted average of both areas is about 14,200 ppm. The discharge of the springs at Dotsero has been measured to be about 7 cfs and at Glenwood Springs to be approximately 9 cfs.

Because of the nearly 16 miles separating the two springs areas, a cost estimate was prepared for individual desalting plants at Dotsero and Glenwood Springs. In addition, a cost estimate was made of a single plant to treat the combined discharges of both areas.

A review of the available data indicated that the multistage flash distallation process best met the overall requirements for desalting discharges from the Dotsero and Glenwood Springs areas. A reconnaissance cost estimate was made of the plans considered for treating the saline discharges. The costs of these plans, indexed to July 1973 are $37,700,000 for separate desalting plants for each Spring area with an operation, maintenance and replacement of $6,500,000 and $32,800,000 for a combined desalting plant with an operation, maintenance and replacement of $5,850,000.

These estimates are based on 1 year's collections of quantity and quality data, U.S. Geological Quadrangle Sheets for Topographic and distance estimates, current Bureau of Reclamation planning costs, and the Desalting Handbook for Planners. The estimates are preliminary and subject to change.

Based on the preliminary studies to date, it appears that a desalting treatment plant utilizing the multistage flash distillation process could remove approximately 200,000 tons of salt annually, and the salinity could be reduced about 19 mg/l at Imperial Dam. Benefits to lower Basin water users are estimated to be $4,370,000 annually.

Environmental studies, other than collection of physical data from the study area, have not been initiated at this time. Such studies will be an integral part of feasibility studies. At this time, however, potential environmental effects--both beneficial and adverse--can be outlined as follows.

A reduction in the concentration of total dissolved solids in the river downstream would provide higher quality waters for municipal, industrial and agricultural uses. Some impairment of these uses now occurs. There is also a potential for utilizing spring waters for recreation and waterfowl purposes under the project.

Construction of a treatment plant or plants, brine ponds, pipelines, pumping stations, or other potential features would have potential temporary adverse effects on air and water quality and long-term effects on the landscape. If the combined plant plan were selected, a pipeline would be necessary through scenic Glenwood Canyon which is presently involved in a controversy regarding the location of the proposed route of Interstate Highway No. 70. Construction of a pipeline to carry the Glenwood-Dotsero Springs flow through the canyon, if coordinated with the interstate highway construction or the existing railroad right-of-way, should have little adverse impact.

Studies have not been undertaken to determine if unique or possibly rare plant or animal species have become established in the Glenwood or Dotsero Springs.

An evaporation pond or lake would be needed to evaporate the brine from the desalting plant, industrial uses, or for evaporating the untreated flow of the springs and to store the salt removed from the spring water. These ponds would become sterile within a few years with a salt flat exposed at the upper end during part of the year. Some plants such as willows and tamarisk could possibly become established before the pond became sterile. The dead vegetation would be unsightly. It is also likely that strong winds would pick up the dry salt from the salt flats and carry it to surrounding areas with some damage to the vegetation growing there. Salt would accumulate at the rate of a million tons every 5 years so continued protection would be needed to stabilize the storage ponds.

3. Diffuse Source Control Projects

This method of control deals with salt loading or concentrating effects that occur over comparatively large areas such as the tributary subbasins. The techniques available for control include collection, desalting, evaporation, special use, watershed management, and vegetative control.

Big Sandy River Unit--The Big Sandy River originates in the Wind River Mountains of northwestern Wyoming and flows southerly to the Big Sandy Reservoir and Dam where most of the flow is diverted to irrigate the Eden Project. From Big Sandy Dam,it flows southwesterly to the Green River. Near the mountains, the water is of high quality containing less than 50 mg/l of dissolved solids. After flowing across several miles of desert, the dissolved solids increase to 70-120 mg/l at Big Sandy Reservoir. Below Big Sandy Dam it picks up the irrigation return flows from the Eden Project and many saline seeps along the river channel. No single point source contributes a large amount of salt. However, the Big Sandy River annually discharges approximately 180,000 tons of dissolved solids at concentrations ranging from 300 to 3,900 mg/l to the Green River. The climate is cold and dry in the winter with minimum temperature often 40° F. below zero. The average temperature for December is 13.8° F., January is 9.2° F. and February is 14.5° F. The summers are dry and mild with maximum temperatures only occasionally getting above 90° F.

Because of low winter temperatures, it may be possible to apply natural freezing methods to desalting the water. Small-scale experiments have been conducted by Professor D. L. Stinson of the University of Wyoming 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 almost pure water and the unfrozen brine contains nearly all the salt. The experiments were successful in producing a very low salinity concentration in the effluent.

A research contract was negotiated with the University of Wyoming for Professor Stinson to conduct a pilot demonstration of this method during the winter of 1973-74 in the vicinity of Gasson Bridge which crosses the Big Sandy River about halfway between Farson and Fontenelle and 36 miles northwest of Rock Springs, Wyoming. Water was pumped from Big Sandy River through sprinklers to produce ice piles. The salt brine and nearly pure product water were separated by natural aging and thawing of the ice. Although many problems were encountered in conducting the pilot test, the freezing process produced a product water with concentration of about 100 mg/l compared with a concentration of about 3,000 mg/l when pumped from Big Sandy River.

The water pumped from Big Sandy River at a temperature of 32° F. froze on the sprinkler heads which stopped them from rotating and eventually plugged them. Experiments by Professor Stinson at Wyoming University using 36° F. water, experienced no problems with freezing of the sprinkler heads. It appears that a source of heat may be needed to use natural freezing to desalt the Big Sandy River Water Studies are now underway to determine if a salinity control plan for the Big Sandy River can be developed which would also provide warmer water. If such a plan can be developed, another pilot test will be conducted during the winter of 1975-76, to determine data needed for a feasibility report scheduled for Fiscal Year 1978.

Investigations have not advanced sufficiently to prepare an estimate of cost. The pilot study will provide much of the needed data.

The quantity and quality of the water presently available from the Green River will satisfy industrial requirements in the area. A detriment would occur from evaporation of at least 2,000 acre-feet of remaining brine water. It is estimated that about 80,000 tons per year might be removed by treatment which would reduce salinity concentrations of the Colorado River at Imperial Dam by an estimated 7 mg/l. The principal benefits will accrue in the lower Colorado River Basin which are estimated to be $1,610,000 annually.

Environmental considerations include: (a) Some degradation of natural scenery will result from the construction of a diversion structure, ice field, and evaporating ponds. The salts accumulating in the evaporating ponds may be scattered by wind action. It is expected that construction and operation of these facilities will have negligible effect on animal life and only minor effect on the plant life in the area. The pilot test could give better indications of the effect of the ice piles on plant life. (b) Special consideration in design of the evaporating pond will be required to prevent concentrated dissolved salts from spilling back into the stream system. (c) The diversion of the low flows during the winter may have some effect on plant and animal life on the lower reach of the Big Sandy River. Also the return of low salinity water to the stream during part of the summer may affect the kind of animal and plant life that live in the stream and on banks of the lower reach.

Price, San Rafael, and Dirty Devil River Units--The Price, San Rafael and Dirty Devil Rivers originate in the mountains of the Wasatch and Aquarius Plateaus and provide tributary flows to the Green and Colorado Rivers in east-central Utah. Elevations in these river systems range from about 4,000 feet above sea level on the Colorado River to over 11,000 feet above sea level in the mountain ranges and high plateaus to the west. Drainage areas contain 1,500 1,670, and 4,200 square miles for the Price, San Rafael, and Dirty Devil Rivers, respectively. These study areas are principally desert, with an arid to semiarid climate. The summers are hot and dry and the winters are usually dry and cold. Temperatures range from over 100° F. in summer to well below zero in the winter. For example, Hanksville, Utah, has recorded a high temperature of 112° F. and a low of minus 35° F. Snowfall is generally light and amounts to only a few inches during the winter season, except at the higher elevations, where substantial amounts accumulate on the ground.

The geological formations in these river basins consist primarily of sedimentary rock. About 60 percent of the Dirty Devil drainage and 75 percent of the Price and San Rafael drainages are composed of mudstones, claystones and shales which are the main source of salt loading in these rivers. Much of the irrigated lands are located on salt-producing formations particularly in the upper portions of the Price and San Rafael drainages.

The estimated total dissolved solids contributed by the Price, San Rafael, and Dirty Devil Rivers are 240,000, 190,000, and 200,000 tons, respectively.

The estimated annual removal of salt by potential control programs are 100,000 tons on the Price River and 80,000 tons each for the San Rafael and Dirty Devil Rivers. Salinity concentrations of the Colorado River at Imperial Dam would be reduced by an estimated 9 mg/l for the Price River and 7 mg/l for each of the San Rafael and Dirty Devil Rivers.

Investigations thus far have included field surveys and data gathering. Streamflow and water quality data are being obtained at several locations on each of the rivers. These data and future investigations will locate areas of greatest salt loading. Further studies will be made to determine if other methods such as water systems, improvement, irrigation scheduling and farm management could be used along with selective withdrawal.

Additional samplingsstations will be established as needed in conjunction with geologic investigations of each drainage basin.

Data gathering will continue in Fiscal Year 1975 and feasibility reports are scheduled for Fiscal Year 1978. Investigations have not progressed sufficiently to provide an estimate of costs.

Local benefits of the control programs have not been determined at this time. There would be an annual loss of water by evaporation estimated at 5,000 to 30,000 acre-feet for each river. It will be necessary to evolve procedure for accounting for such losses. The benefits in the lower Colorado River Basin are estimated to be $2,070,000, $1,610,000, and $1,610,000 for the Price, San Rafael and Dirty Devil Rivers, respectively.

Control of the salt loading from these diffuse sources could have the following environmental impacts; Some degradation of natural scenery would result from construction of diversion dams and evaporating ponds or desalting plants. The accumulation of salts in the evaporating ponds may become scattered by wind or may be accidentally discharges into the Colorado River system. Water diverted out at low flows may result in some adverse effects downstream to plant and animal life.

<u>McElmo Creek Unit</u>--McElmo Creek drains 350 square miles which includes the irrigated area in Montezuma Valley in Southwestern

Colorado and 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.

Based on 1 year's data, Upper McElmo Creek and Mud Creek, a tributary of McElmo Creek which drains the south portion of Montezuma Valley, contribute approximately 85,000 tons of salt annually. Upper McElmo Creek and Mud Creek collect return flows from the major portion of the irrigated lands in South Montezuma Valley. These lands are derived from and are underlain by the Mancos Shale Formation.

Based on 3 1/2 years of data, McElmo Creek near the Colorado-Utah State line contributes an average of 130,000 tons of salt annually. Concentrations of McElmo Creek near the Colorado-Utah State line vary from 1,500 to 3,700 mg/1 with an average of 2,650 mg/1.

The estimated annual removal of salt by the proposed program is 40,000 tons. Salinity concentration of the Colorado River at Imperial Dam would be reduced by an estimated 4 mg/1.

Various methods are being considered to remove salts from the flows of McElmo Creek. One method would be to selectively withdraw and evaporate the saline flows of Upper McElmo Creek and Mud Creek. A second method would be to desalt the same saline flows. A reservoir site on Mud Creek is being investigated to evaporate either these saline flows or brine discharge from a desalting plant. Upper McElmo Creek and Mud Creek capture most of the return flows from the irrigated lands in Montezuma Valley.

Gaging stations were installed and water sampling began in Fiscal Year 1972 for collection of data. Continued data collection is scheduled for Fiscal Year 1975. A feasibility report is scheduled for Fiscal Year 1978.

Investigations have not progressed far enough at this time to determine costs or local benefits. If a desalting plant were used to remove the salt, the product water could be used for municipal or industrial purposes. There would be an annual loss of water by evaporation of up to 10,000 acre-feet. Most of the benefits would occur in the lower Colorado River Basin and are estimated to be $920,000 annually.

Control of this source of salinity could have the following environmental impacts: (a) a reduction in the salinity concentrations downstream, (b) reduction of the stream discharge during low flow periods, (c) some degradation of the natural scenery would result from the construction of the works necessary for evaporating or desalting the water. The evaporating ponds would be sterile within a few years and surrounded with dead plant life. At times part of the ponds would be salt flats and the wind could transport the dry salts to the surrounding areas which may damage local vegetation.

PART X. OTHER WATER QUALITY ASPECTS

Although salinity is considered to be the most serious water quality problem in the Colorado River Basin, there are a number of other water quality problems of varying degrees of significance which warrant discussion. The following sections discuss the most significant sources of water quality degradation exclusive of salinity and the effects of such degradations on water uses as measured by various parameters.

A. Pollution Sources Other Than Salinity

1. Municipal Wastes

Municipal wastes are described herein as those liquid-carried wastes of domestic and service industry origin. Within the Colorado River Basin the majority of the discharges from waste water treatment plants enter the river system and are the primary sources of bacteriological and organic pollution. Most of the municipal waste sources in the basin receive secondary treatment plus disinfection which is the minimum degree of treatment required by the Basin States.

Municipalities are required to have their waste discharges meet water quality standards set by the States. At the present time, any pollution from municipal waste sources is confined to those reaches of stream immediately downstream of the waste effluent, and measures are being enforced by the State and Environmental Protection Agency for the control or abatement of pollution from these sources.

2. Industrial Wastes

Industrial wastes are defined as those spent process waters, cooling waters, wash waters, and other waste waters associated with industrial operations. The pollutants derived from industrial wastes other than salinity are toxic materials, oils and grease, floating materials, radioactivity, oxygen-demanding substances, heat, color- taste- odor-producing substances, and bacteria.

With the establishment of Water Quality Standards on interstate streams and compliance schedules for the implementation of these standards, the pollution from industrial waste sources in the basin has been or is being abated or controlled.

3. Agricultural Wastes

Except for salinity, pesticides and fertilizers are the primary water pollutants associated with agriculture in the Colorado River Basin. Here again the Environmental Protection Agency and States are endeavoring to control the discharge of these pollutants into the waterways.

The chlorinated hydrocarbon group, e.g., DDT and Toxaphene, are the most persistent pesticides and are of primary concern because of their long-range impact. Efforts are being made, however, to control use of these types of pesticides. The organic phosphate compounds do not persist in the environment for the period the chlorinated hydrocarbons do, but they are more toxic to fish and humans.

Nitrogen and phosphorus fertilizers are the most commonly used in the basin. Studies conducted in other areas of the United States show a relationship between the concentrations of nutrients from agricultural lands and water quality problems caused by excessive fertilization of aquatic plants. Within the Colorado River Basin the animal waste pollution is minimal because outside surface water has been prevented from entering the feedlots either by directing the drainage away from the operation or by locating the facility in a favorable topographic position. Additional discussion of toxic materials and nutrients are presented later in Part X.

4. Mine Drainage

During 1966 to 1968 approximately 75 locations were sampled to determine the heavy-metal concentrations contributed by mine drainages, tailing piles, and natural sources within the Colorado River Basin. Since that time the State and Environmental Protection Agency have controlled or are controlling much of the pollution from these sources.

B. Water Quality Parameters Other Than Salinity

1. Dissolved Oxygen

The dissolved-oxygen concentration is a measure of the water capacity to support life and assimilate organic wastes. The records show that the dissolved-oxygen concentrations in the Colorado River Basin are generally above established standards. A marked reduction in the concentration can be found during the summer months, however, below some municipal and industrial discharges and in some streams with very low flows. A 1966 investigation indicated that there might be a wide diurnal variation in the oxygen concentrations in some reaches because of the large amount of algae in the streams with oxygen saturation being reached during a sunlit day and minimal concentration occurring at night when oxygen is used by the plants. Samples also have indicated that at some of the lower depths in Flaming Gorge Reservoir anaerobic conditions exist. Releases are made, however, through the powerplant at higher elevations where the oxygen content is greater, thus maintaining sufficient oxygen in the stream below for fish life.

2. Temperature

The Colorado River Basin water temperatures vary widely, reaching the greatest difference during the summer months when they vary from near freezing in the high mountains to above 90° F. in the lower reaches. Warmer temperatures may increase the rate of growth and the decomposition of organic matter and of chemical reaction, resulting in bad odors and tastes, and also decrease the dissolved oxygen concentration available to sustain a fishery.

Changes in water temperature in the basin result primarily from natural climatic conditions. The large reservoirs, however, may affect the stream temperatures for a considerable distance below the reservoir. Temperature records indicate that Flaming Gorge Reservoir has little effect on winter temperatures but cools the summer temperatures of the Green River up to 5° F. at the Green River, Utah, station. The temperature immediately below Flaming Gorge Dam is now reportedly too cold for maximum growth and propagation of fishlife. Plans are underway to modify facilities near the dam to improve this condition. Navajo Reservoir appears to have no effect on the temperatures of the San Juan River at the near Bluff station. Lake Powell appears to warm the winter temperatures of the Colorado River at the Grand Canyon station by up to 10° F. and cool the summer temperatures by about the same amount.

Thermal springs, waste-water discharges, and irrigation return flows may increase the temperatures in the receiving water, but the added heat is usually dissipated in a relatively short distance from the source. Flow depletions and changes in stream channel characteristics may also increase the effects of natural climatic conditions causing cooler or warmer water temperatures.

Temperature increases due to municipal and industrial waste discharges have been minimal; however, the construction of large thermal powerplants in the basin with a return of the cooling water to the streams or reservoirs could present a potential for temperature increase. For this and other reasons it is anticipated that most of the cooling water discharges from powerplants will not be allowed to return to the rivers in the future.

3. pH

The pH of the waters in the Colorado River Basin usually range from about 7 to 8 with the exception of those streams receiving acid mine drainage. In this latter case the pH is lowered to levels which preclude the establishment of aquatic life and the use of the river for a fishery and other purposes.

4. Heavy Metals

Various heavy metals such as copper, lead, zinc, iron, manganese, arsenic, and cyanide are found in the waters of the basin. These have varied from trace amounts to potentially hazardous levels. The presence of these heavy metals is generally contributed by drainage from active and inactive mining operations.

Iron and manganese concentrations occasionally exceed the Public Health Drinking Water Standards in some basin streams. This is particularly evident in the upper reaches of the Colorado and San Juan Rivers and their tributaries. A 1966 water quality survey showed that heavy metal concentrations have a marked effect on the aquatic life. Certain reaches of stream have been completely devoid of bottom organisms and fish because of these toxic effects.

5. Toxic Materials

In addition to the toxic effects of heavy metal concentration, toxic materials are also contributed to the stream through industrial and agricultural operations. Limited long-term monitoring at four surveillance stations located on the Colorado River has in the past detected the pesticides DDD, DDE, DDT, dieldrin, and endrin. A comprehensive evaluation of the effects of pesticides upon water quality cannot be made at this time because of the lack of sufficient water quality data and incomplete knowledge of the physiological and other effects of pesticides in human, wildlife, fish, and other biological forms. The mere presence of a pesticide in water does not necessarily indicate serious pollution. Pesticides were tested for in samples of fish flesh and water taken from the Wahweap and San Juan River arms of Lake Powell. Pesticides found included DDD, DDE, and DDT. All levels were well below the limits set by the Food and Drug Administration.

The Bureau of Sport Fisheries and Wildlife also ran pesticide tests on fish flesh taken from Imperial Reservoir and Lake Havasu. Their results were very similar to those from Lake Powell.

6. Nutrients

Nutrients, primarily nitrogen and phosphorus, are believed to be the most conducive to the growth of algae. The sources of these nutrients are runoff from agricultural lands, municipal and industrial waste waters, and natural runoff. Phosphorus is normally found in only limited quantities in unpolluted water. Sufficient nitrogen is generally available naturally in basin waters to stimulate algae growth.

Las Vegas Wash flows into Las Vegas Bay, an arm of Boulder Basin of Lake Mead, and carries large loads of phosphorous and nitrogen. The principal sources of water in the Wash are effluents from the Clark County sewage treatment plant and the Las Vegas City sewage treatment plant, which make up between 85-95 percent of the total flow. These sources contribute about 80 percent of the nitrogen and 99 percent of the phosphorous loading found in the Wash.

Several investigators have concluded that the nutrients carried in the effluent from Las Vegas Wash contribute to the eutrophication and degradation of Lake Mead. Nitrogen and phosphorous loads entering the Lake through Las Vegas Wash total 600 and 150 tons per year, respectively. Chlorophyll A values (an indicator of algae mass) have been measured in Las Vegas Bay which are 20 to 25 times greater than comparable measurements in the main body of Boulder Basin.

The Environmental Protection Agency has identified these nutrients as a cause of water quality degradation in Las Vegas Bay and, therefore, causing a violation of the nondegradation provisions of the applicable State-Federal water quality standards for Lake Mead and the Colorado River. A notice of violation was issued to the municipalities and industries discharging waste water into the Wash.

The nutrient load entering Lake Mead from the Wash has increased as the municipal discharges to the Wash have increased. These discharges and the corresponding nutrient loading are expected to continue to increase until such time as corrective action is taken.

The nutrient concentrations in some of the other lakes in the basin have reached levels which can support algae growths. An algae growth has been cited as the probable reason for a fish kill which occurred in the Flaming Gorge Reservoir in late 1963.

In the lower reaches of the Colorado River aquatic plant growths have been associated with fertilization by nutrients discharged to irrigation return canals. A small increase in the nutrient levels in the river has been attributed to heavy recreational activities along the river below Davis Dam.

7. Bacteria

The coliform group of bacteria is used as an indicator of pollution. This group is made up of bacteria of diverse origin including that found in the intestinal tract of humans and other warmblooded animals as well as in the soil and on vegetation. High coliform counts in waters indicate the probable presence of pathogenic organisms where bacterial contamination from sewage or animal wastes appears likely. This, however, is only an indicator.

OTHER WATER QUALITY ASPECTS

In recent years analytical procedures have been developed whereby coliform bacteria of fecal origin can be identified. Fecal coliform tests measure bacteria from both man and animal. All the States of the basin have set standards for fecal coliform as the bacterial indicator of pollution.

High bacterial counts were observed at many locations in the Colorado River Basin during the 1966 water quality study. A number of these resulted from raw sewage discharges into a stream and some was because of poor disinfection of the municipal waste-water treatment plant effluents. The raw sewage discharges which were observed during the 1966 survey have been corrected by the addition of ponding or other treatment.

Bacteriological pollution has also been observed in popular recreation areas. For example, the fecal coliform densities in Lake Mead have been observed at densities higher than the standards set for body contact recreation (100/100 ml.).

Bacteriological pollution has an effect on most of the uses cited earlier. In those cases where it exceeds the criteria set for body contact recreation, it results in the closure of swimming areas. With high coliform counts, the use of water as a public water supply could be impared.

8. Radioactivity

An assessment of the radioactivity in the basin waters should also consider strontium 90 (Sr-90) radionuclides associated with atmospheric fallout in addition to radionuclides associated with industrial activities. Strontium 90, like the radionuclide Ra-226, is damaging to human bone cells. The effects of Ra-226 and Sr-90 are additive.

Radioactive pollution from industrial waste-water effluents, i.e., uranium mills, was, prior to 1960, the major source of radioactive pollution in the basin. The majority of the mills have been closed down but a significant portion of the increase of radioactivity originates from the abandoned tailings piles.

Radioactivity does impair the water for beneficial use when concentrations exceed certain limits. For example, the Public Health Drinking Water Standards set a mandatory limit of 3.0 picocuries Ra-226 and 10 picocuries/liter Sr-90. Moreover, the combination of these two radionuclides should conform to the following relationship: $\frac{Sr-90}{10} \div \frac{Ra-226}{3} \leq 1.0$.

9. Mercury

Studies have revealed that mercury concentrations, higher than the present accepted Food and Drug Administration limit for mercury residue in fish for interstate transportation, were found in two species of fish in Navajo Lake, on the San Juan River. The source of the mercury was not definitely determined as it appeared tributary streams did not show this type of contamination.

Tests showed brown trout to contain 1.16 parts per million of mercury residue and bullheads to contain 0.68 p.p.m. The current acceptable FDA level is 0.50 p.p.m. Of the 10 species of fish tested, the brown trout and the bullhead were the only species with concentrations higher than the 0.50 p.p.m. Mercury concentrations in the sample fish ranged from 0.08 in rainbow trout to the 1.16 in the brown trout.

Mercury tests were run on water taken from the river at Lee's Ferry and the surface of Lake Powell. Fish samples were taken when it was found that the river water mercury levels exceeded drinking water standards set by the FDA. However, none of the rainbow trout and flannelmouth suckers taken in the river or the rainbow trout and largemouth bass taken in the lake approached the unsafe limits for edible food as set by the FDA. Similar results were obtained from fish of Imperial Reservoir and Lake Havasu.

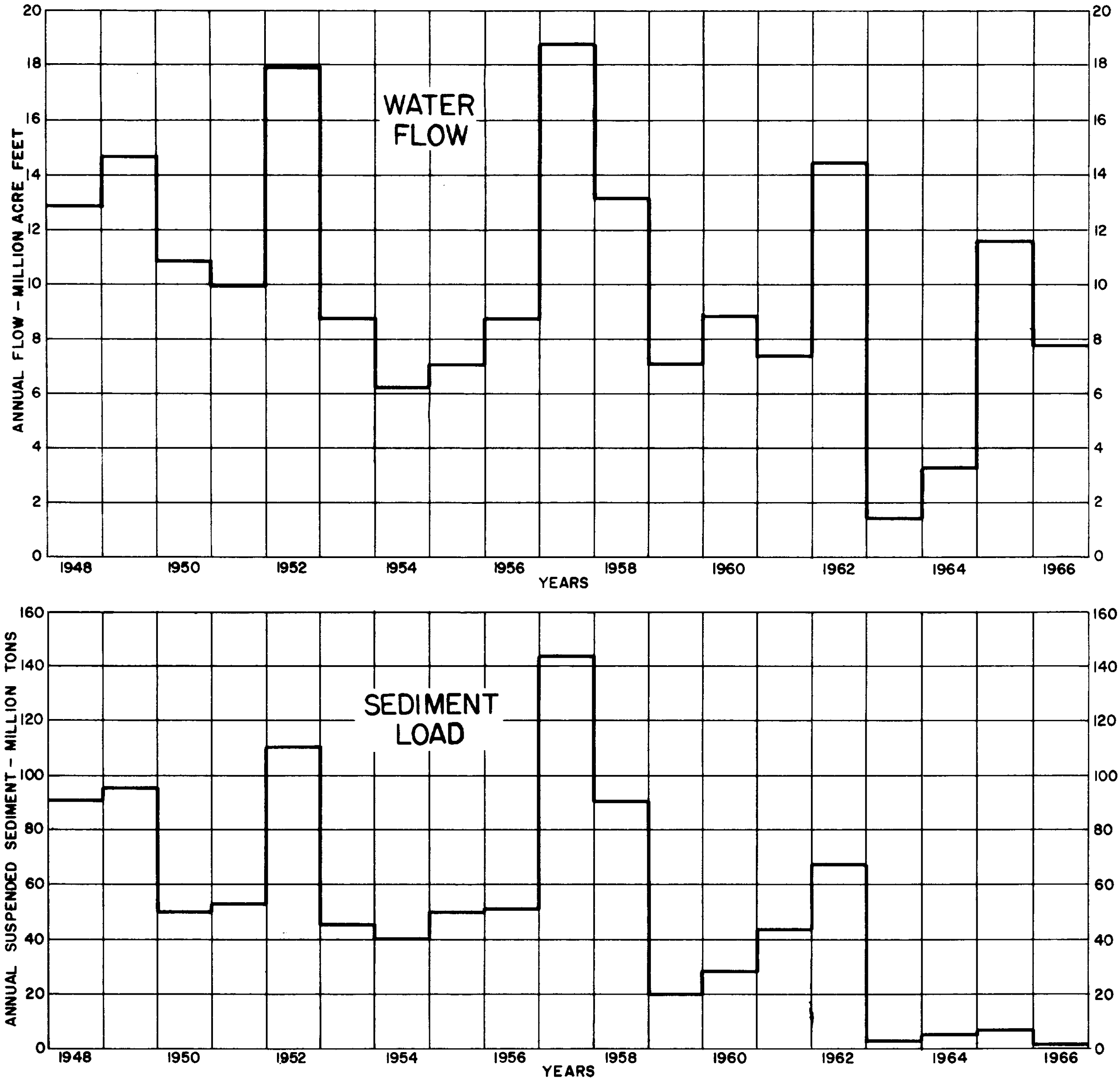
10. Sediment

Prior to construction of the storage units of the Colorado River Storage Project, most of the larger tributaries and the main stem of the Colorado River carried large loads of sediment, particularly in their middle and lower reaches.

For example, in 1957 the suspended sediment load of the Colorado River at Lees Ferry, Arizona, gaging station was recorded at 143 million tons. This sediment was detrimental to water diverters for consumptive use as well as to high-type fishery and other recreational uses. The construction of Fontenelle, Flaming Gorge, Curecanti Unit, Navajo, and Glen Canyon Dams has produced dramatic changes in the sediment load transported by these streams. For example, the relationship between the water and sediment flows at Lees Ferry during the 1948-66 period is illustrated in Figure 7. In 1959 the cofferdam utilized in the construction of Glen Canyon Dam was finished and diversions began through the tunnels. Sediment was deposited behind the cofferdam in 1959 and 1960 at a sufficient rate to gradually fill the cofferdam lake with the result that by 1962 the annual sediment load at Lees Ferry had increased to 67 million tons. This load dropped to 2.2 million tons in calendar year 1963 with the closure of Glen Canyon Dam and initial storage in Lake Powell. Lake Powell and other Colorado River Storage Project reservoirs are now effectively trapping and storing almost all of the sediment originating in the Upper Colorado River Basin. Lake Powell and the other Upper Basin Reservoirs trap approximately 75 to 80 percent of the sediment that normally would flow into Lake Mead. By storing the sediment in the Colorado

River Storage Project reservoirs, the streams immediately below the dams have been changed to relatively clear trout water fisheries as well as desirable boating and recreational areas. Daily sampling at Lees Ferry was discontinued beginning in water year 1966 because of the lack of sediment.

A comparison of the major portion of the inflowing sediment and flow into Lake Powell with the outflow was made by plotting for a number of years the sum of the sediment loads and flows of the Colorado River near Cisco, San Juan River near Bluff and Green River at Green River, Utah, stations. This is shown in Figure 8 as compared to the outflow as shown by the Lees Ferry record in Figure 7.



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

COLORADO RIVER
AT LEES FERRY
SEDIMENT & WATER FLOW

Fig. 7

COMBINED COLORADO RIVER NEAR CISCO GREEN RIVER AT GREEN RIVER, UTAH AND SAN JUAN RIVER NEAR BLUFF

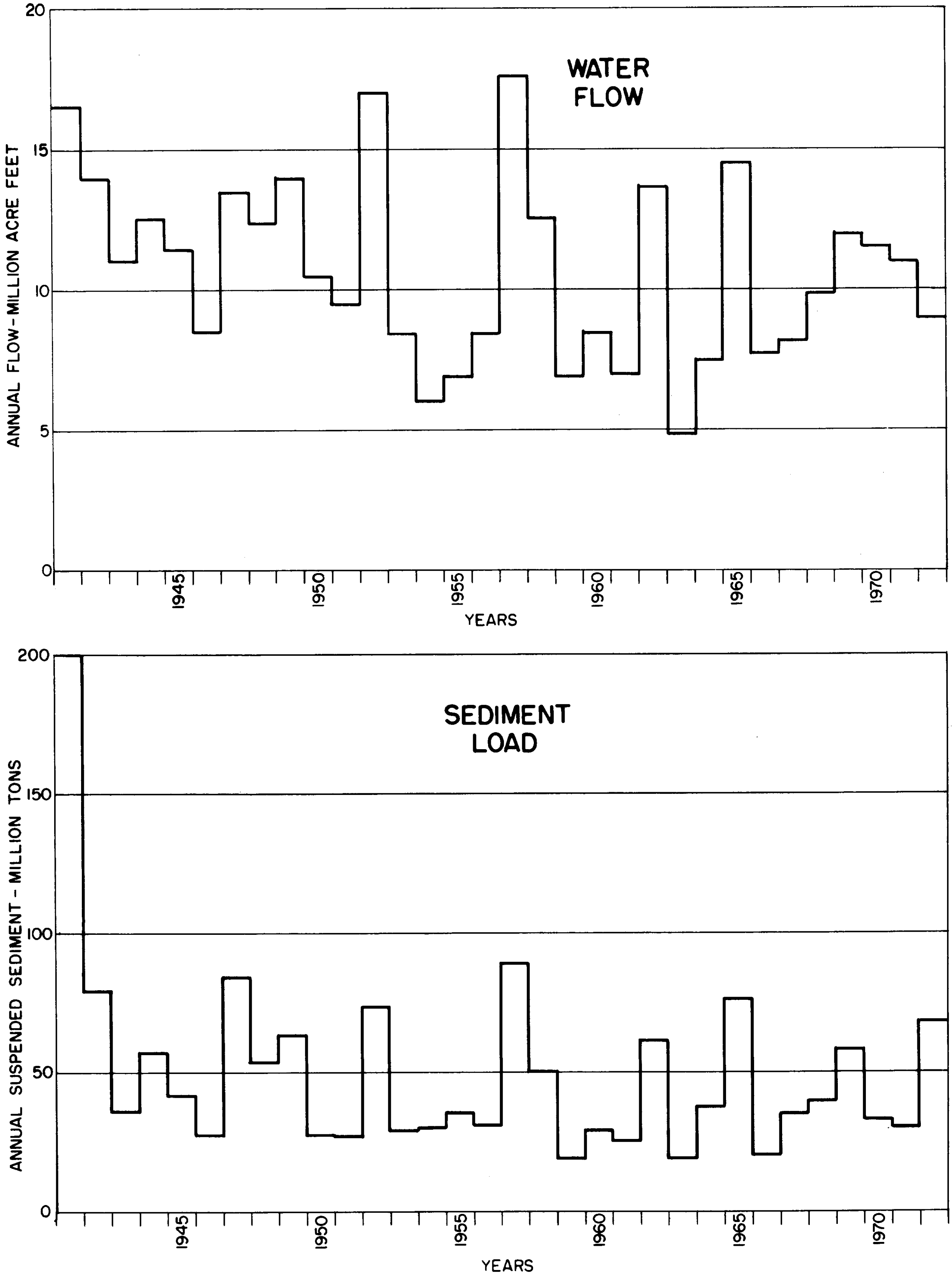


Fig. 8

PART XI CONCLUSIONS

These studies indicate an overall increase in the concentration of total dissolved solids at the various points on the Colorado River and/or its tributaries under the future conditions described. The quality of water is still acceptable for present and some projected uses although quality control measures are necessary in order to keep the future concentrations within usable limits.

Salinity is introduced into the Colorado River system from various sources but the natural source contributes the major portion of total dissolved solids. The addition of large storage units throughout the entire basin has dampened out the longtime and annual fluctuations in water quality.

The dampening influence on water quality fluctuations by many reservoirs in the basin will make it possible to more accurately forecast the quality of water delivery to the many projects and points of diversion in the basin.

The tributaries with exceptionally high dissolved-solids content have minor effect on the dissolved-solids concentration of the lower main stem of the Colorado River as the volume of water and total tonnage of dissolved material represent only a small portion of the total.

The special studies of irrigation projects that have been undertaken and their effect on the chemical quality of water permit these preliminary conclusions:

1. The early years of irrigation are generally the most detrimental to downstream water quality. This is primarily due to leaching of an abundance of soluble salts not previously exposed to a large amount of water.

2. Firm determinations cannot be made during the early years of development regarding the ultimate effect of irrigation. The primary factors in establishing equilibrium are the availability of soluble salts in the soils, the capacity of the ground water reservoirs, and the uniformity of irrigation practice in the area in question.

3. Each irrigated area has a different effect on quality depending upon properties of the soils and substrata in the area, number of years the land has been irrigated, number of times return flow is reused, nature of the aquifers, rainfall, amount of dilution caused by surface wastes, temperature, storage reservoirs, vegetation, and types of return flow channels.

CONCLUSIONS

The recent shortage in energy has caused a great demand for energy related developments such as powerplants and oil shale and coal gasification industries. It is expected these industries will use a large share of the undeveloped water in the future with little or no salt return to the river system.

The rate of leaching of salts from the Flaming Gorge Reservoir area for the 1967-70 and 1971-73 period has decreased significantly from the 1963-66 period. This decrease has contributed to a decrease in salinity below the reservoir for the 1969-1973 period. The range of average monthly temperatures of the Green River below the reservoir has been reduced considerably since closure of the reservoir.

Changes in annual concentrations of dissolved solids at Lees Ferry seem to be detected at Imperial Dam after about 2 years and it also appears that the salinity at Imperial Dam is responsive to annual fluctuations of discharge at Lees Ferry.

A basin-wide program entitled "Colorado River Water Quality Improvement Program," whose purpose is to alleviate salt contributions to the river system, is now underway. Public Law 93-320 signed on June 24, 1974, authorized several projects for the improvement, enhancement, and protection of the quality of water available in the Colorado River for use in the United States and the Republic of Mexico.

Pollution to the Colorado River Basin other than salinity has not been a major problem in the past but must receive careful surveillance and control measures in order that they will not become a major problem in the future.

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Table 1

Colorado River Basin

Historical Flow and Quality of Water Data

Green River near Green River, Wyoming

Units – 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	22	0.73	16
	Feb.	19	.74	14
	Mar.	45	.69	31
	Apr.	95	.54	51
	May	174	.52	90
	June	342	.34	116
1941	July	137	.37	51
	Aug.	81	.46	37
	Sept.	48	.54	26
	Oct.	67	.60	40
	Nov.	53	.64	34
	Dec.	26	.81	21
	Total	1,109	.48	527
	Jan.	24	.79	19
	Feb.	23	.83	19
	Mar.	43	.70	30
	Apr.	200	.41	82
	May	151	.50	75
	June	337	.34	114
1942	July	205	.32	66
	Aug.	58	.52	30
	Sept.	32	.62	20
	Oct.	29	.76	22
	Nov.	26	.81	21
	Dec.	26	.77	20
	Total	1,154	.45	518
	Jan.	28	.78	22
	Feb.	29	.76	22
	Mar.	59	.63	37
	Apr.	200	.41	82
	May	237	.39	92
	June	476	.29	138
1943	July	359	.25	90
	Aug.	121	.39	47
	Sept.	50	.54	27
	Oct.	48	.67	32
	Nov.	43	.67	29
	Dec.	30	.77	23
	Total	1,680	.38	641
	Jan.	25	.80	20
	Feb.	25	.80	20
	Mar.	31	.77	24
	Apr.	267	.37	99
	May	155	.46	71
	June	351	.33	116
1944	July	230	.30	69
	Aug.	60	.50	30
	Sept.	31	.65	20
	Oct.	38	.71	27
	Nov.	31	.74	23
	Dec.	21	.81	17
	Total	1,265	.42	536
	Jan.	24	.79	19
	Feb.	27	.74	20
	Mar.	41	.68	28
	Apr.	78	.58	45
	May	111	.52	58
	June	245	.38	93
1945	July	284	.28	80
	Aug.	125	.39	49
	Sept.	76	.45	34
	Oct.	64	.62	40
	Nov.	42	.69	29
	Dec.	33	.73	24
	Total	1,150	.45	519
	Jan.	32	.75	24
	Feb.	26	.77	20
	Mar.	65	.62	40
	Apr.	131	.48	63
	May	212	.41	87
	June	320	.34	109
1946	July	153	.35	54
	Aug.	74	.47	35
	Sept.	52	.52	27
	Oct.	58	.64	37
	Nov.	51	.67	34
	Dec.	51	.67	34
	Total	1,225	.46	564
	Jan.	26	0.81	21
	Feb.	30	.73	22
	Mar.	141	.47	66
	Apr.	75	.57	43
	May	368	.33	121
	June	501	.29	145
1947	July	327	.26	85
	Aug.	199	.32	64
	Sept.	81	.44	36
	Oct.	75	.59	44
	Nov.	59	.63	37
	Dec.	44	.68	30
	Total	1,926	.37	714
	Jan.	38	.71	27
	Feb.	33	.73	24
	Mar.	64	.62	40
	Apr.	95	.54	51
	May	187	.43	80
	June	396	.31	123
1948	July	121	.39	47
	Aug.	56	.52	29
	Sept.	32	.62	20
	Oct.	36	.72	26
	Nov.	29	.76	22
	Dec.	26	.81	21
	Total	1,113	.46	510
	Jan.	27	.78	21
	Feb.	24	.79	19
	Mar.	45	.69	31
	Apr.	104	.52	54
	May	211	.41	86
	June	372	.32	119
1949	July	179	.36	64
	Aug.	65	.48	31
	Sept.	38	.58	22
	Oct.	52	.65	34
	Nov.	54	.65	35
	Dec.	34	.74	25
	Total	1,205	.45	541
	Jan.	29	.79	23
	Feb.	33	.73	24
	Mar.	102	.53	54
	Apr.	251	.38	95
	May	270	.37	100
	June	582	.34	198
1950	July	427	.23	98
	Aug.	140	.37	52
	Sept.	76	.45	34
	Oct.	66	.61	40
	Nov.	71	.59	42
	Dec.	49	.65	32
	Total	2,096	.38	792
	Jan.	34	.74	25
	Feb.	47	.66	31
	Mar.	70	.59	41
	Apr.	154	.45	69
	May	317	.35	111
	June	528	.28	148
1951	July	349	.25	87
	Aug.	208	.28	58
	Sept.	91	.43	39
	Oct.	81	.53	43
	Nov.	50	.68	34
	Dec.	43	.70	30
	Total	1,972	.36	716
	Jan.	41	.63	26
	Feb.	42	.62	26
	Mar.	52	.63	33
	Apr.	190	.52	99
	May	348	.32	111
	June	399	.27	108
1952	July	171	.33	56
	Aug.	99	.38	38
	Sept.	57	.51	29
	Oct.	42	.64	27
	Nov.	28	.82	23
	Dec.	27	.78	21
	Total	1,496	.40	597
	Jan.	32	0.69	22
	Feb.	33	.70	23
	Mar.	44	.68	30
	Apr.	77	.58	45
	May	74	.57	42
	June	381	.28	107
1953	July	206	.29	60
	Aug.	104	.39	41
	Sept.	39	.56	22
	Oct.	34	.74	25
	Nov.	36	.75	27
	Dec.	24	.88	21
	Total	1,084	.43	465
	Jan.	26	.81	21
	Feb.	27	.74	20
	Mar.	48	.67	32
	Apr.	88	.55	48
	May	282	.28	79
	June	232	.30	70
1954	July	250	.25	62
	Aug.	86	.40	34
	Sept.	47	.55	26
	Oct.	40	.68	27
	Nov.	39	.69	27
	Dec.	18	.89	16
	Total	1,183	.39	462
	Jan.	20	.80	16
	Feb.	20	.80	16
	Mar.	33	.76	25
	Apr.	74	.59	44
	May	127	.39	50
	June	245	.27	66
1955	July	116	.36	42
	Aug.	68	.41	28
	Sept.	35	.57	20
	Oct.	33	.70	23
	Nov.	28	.79	22
	Dec.	39	.74	29
	Total	838	.45	381
	Jan.	42	.69	29
	Feb.	29	.66	19
	Mar.	91	.56	51
	Apr.	158	.45	71
	May	310	.37	115
	June	555	.25	139
1956	July	197	.31	61
	Aug.	98	.38	37
	Sept.	41	.56	23
	Oct.	39	.59	23
	Nov.	35	.69	24
	Dec.	26	.77	20
	Total	1,621	.38	612
	Jan.	22	.77	17
	Feb.	37	.70	26
	Mar.	57	.68	39
	Apr.	60	.62	37
	May	176	.46	81
	June	476	.27	129
1957	July	380	.25	95
	Aug.	117	.35	41
	Sept.	68	.47	32
	Oct.	66	.55	36
	Nov.	48	.67	32
	Dec.	41	.71	29
	Total	1,548	.38	594
	Jan.	33	.76	25
	Feb.	47	.66	31
	Mar.	51	.63	32
	Apr.	99	.56	55
	May	291	.31	90
	June	266	.31	82
1958	July	76	.45	34
	Aug.	51	.53	27
	Sept.	36	.64	23
	Oct.	33	.79	26
	Nov.	32	.78	25
	Dec.	31	.74	23
	Total	1,046	.45	473

To obtain mg/l multiply T/AF by 735

Table I

Colorado River Basin

Historical Flow and Quality of Water Data

Green River near Green River, Wyoming

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	24	0.71	17
	Feb.	25	.72	18
	Mar.	49	.65	32
	Apr.	73	.64	47
	May	79	.51	40
	June	322	.26	84
1959	July	140	.34	48
	Aug.	79	.40	32
	Sept.	42	.55	23
	Oct.	51	.57	29
	Nov.	42	.60	25
	Dec.	27	.74	20
	Total	953	.44	415
	Jan.	27	.74	20
	Feb.	23	.78	18
	Mar.	75	.53	40
	Apr.	84	.49	41
	May	66	.48	32
	June	173	.30	52
1960	July	68	.43	29
	Aug.	38	.45	17
	Sept.	28	.54	15
	Oct.	42	.57	24
	Nov.	47	.49	23
	Dec.	27	.69	19
	Total	698	.47	330
	Jan.	20	.60	12
	Feb.	19	.58	11
	Mar.	30	.57	17
	Apr.	50	.60	30
	May	60	.43	26
	June	162	.27	44
1961	July	47	.43	20
	Aug.	35	.43	15
	Sept.	39	.46	18
	Oct.	41	.51	21
	Nov.	29	.52	15
	Dec.	27	.52	14
	Total	559	.43	243
	Jan.	32	.47	15
	Feb.	48	.48	23
	Mar.	77	.51	38
	Apr.	203	.43	87
	May	256	.36	92
	June	355	.27	96
1962	July	250	.27	68
	Aug.	94	.37	35
	Sept.	38	.58	22
	Oct.	38	.63	24
	Nov.	35	.66	23
	Dec.	25	.88	22
	Total	1,451	.38	545
	Jan.	18	.72	13
	Feb.	18	.72	13
	Mar.	42	.67	28
	Apr.	51	.63	32
	May	100	.45	45
	June	337	.26	88
1963	July	143	.32	46
	Aug.	76	.47	36
	Sept.	77	.43	33
	Oct.	58	.50	29
	Nov.	52	.60	31
	Dec.	30	.60	18
	Total	1,002	.41	412
	Jan.	23	.56	13
	Feb.	22	.59	13
	Mar.	29	.59	17
	Apr.	68	.56	38
	May	138	.32	44
	June	323	.38	123
1964	July	335	.26	87
	Aug.	87	.39	34
	Sept.	37	.65	24
	Oct.	24	.92	22
	Nov.	25	.88	22
	Dec.	25	.84	21
	Total	1,136	.40	458
	Jan.	28	0.79	22
	Feb.	30	.70	21
	Mar.	38	.74	28
	Apr.	44	.86	38
	May	94	.60	56
	June	429	.38	163
1965	July	466	.30	140
	Aug.	184	.36	66
	Sept.	461	.41	189
	Oct.	86	.73	63
	Nov.	75	.65	49
	Dec.	29	.90	26
	Total	1,964	.44	861
	Jan.	37	.76	28
	Feb.	35	.77	27
	Mar.	88	.72	63
	Apr.	138	.50	69
	May	160	.39	62
	June	171	.31	53
1966	July	91	.43	39
	Aug.	56	.52	29
	Sept.	45	.60	27
	Oct.	35	.77	27
	Nov.	30	.83	25
	Dec.	25	.96	24
	Total	911	.52	473
	Jan.	19	1.01	19
	Feb.	19	1.04	20
	Mar.	33	.87	29
	Apr.	129	.54	70
	May	138	.48	66
	June	456	.28	128
1967	July	448	.25	112
	Aug.	88	.39	34
	Sept.	65	.50	32
	Oct.	62	.56	35
	Nov.	49	.64	31
	Dec.	17	1.07	18
	Total	1,523	.39	594
	Jan.	17	1.03	18
	Feb.	16	1.03	16
	Mar.	33	.86	28
	Apr.	31	.93	29
	May	56	.68	38
	June	271	.40	108
1968	July	88	.41	36
	Aug.	136	.40	54
	Sept.	126	.37	47
	Oct.	117	.44	51
	Nov.	54	.58	31
	Dec.	30	.85	26
	Total	975	.49	482
	Jan.	51	.61	31
	Feb.	89	.46	41
	Mar.	80	.56	45
	Apr.	141	.46	65
	May	207	.36	75
	June	302	.28	86
1969	July	154	.34	52
	Aug.	97	.47	46
	Sept.	68	.51	35
	Oct.	81	.49	40
	Nov.	50	.60	30
	Dec.	42	.69	29
	Total	1,362	.42	575
	Jan.	38	.74	28
	Feb.	33	.76	25
	Mar.	58	.60	35
	Apr.	75	.69	52
	May	84	.58	49
	June	204	.37	75
1970	July	127	.36	46
	Aug.	86	.43	37
	Sept.	75	.45	34
	Oct.	62	.55	34
	Nov.	49	.67	33
	Dec.	43	.70	30
	Total	934	.51	478
	Jan.	42	.71	30
	Feb.	47	.62	29
	Mar.	76	.60	45
	Apr.	107	.53	57
	May	280	.41	116
	June	480	.30	143
1971	July	291	.28	81
	Aug.	126	.37	47
	Sept.	77	.46	35
	Oct.	72	.49	35
	Nov.	63	.54	34
	Dec.	87	.51	44
	Total	1,748	.40	696
	Jan.	85	.54	46
	Feb.	77	.56	43
	Mar.	106	.58	62
	Apr.	154	.48	73
	May	294	.40	118
	June	625	.27	169
1972	July	255	.30	78
	Aug.	122	.39	48
	Sept.	75	.48	36
	Oct.	79	.53	42
	Nov.	85	.51	43
	Dec.	51	.61	31
	Total	2,008	.39	789
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
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	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
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	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735

Table I
Colorado River Basin
Historical Flow and Quality of Water Data
Green River near Green River, Wyoming
(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1941	1,109	0.48	349	527
1942	1,154	.45	330	518
1943	1,680	.38	280	641
1944	1,265	.42	311	536
1945	1,150	.45	332	519
1946	1,225	.46	338	564
1947	1,926	.37	272	714
1948	1,113	.46	337	510
1949	1,205	.45	330	541
1950	2,096	.38	278	792
1951	1,972	.36	267	716
1952	1,496	.40	293	597
1953	1,084	.43	315	465
1954	1,183	.39	287	462
1955	838	.45	334	381
1956	1,621	.38	277	612
1957	1,548	.38	282	594
1958	1,046	.45	332	473
1959	953	.44	320	415
1960	698	.47	347	330
1961	559	.43	319	243
1962	1,451	.38	276	545
1963	1,002	.41	302	412
1964	1,136	.40	296	458
1965	1,964	.44	322	861
1966	911	.52	382	473
1967	1,523	.39	287	594
1968	975	.49	363	482
1969	1,362	.42	310	575
1970	934	.51	376	478

Sampled quality record May 1951 to December 1972; remainder by correlation.

Measured flow record January 1941 to September 1945; and April 1951 to December 1972: remainder by correlation.

Table I
Colorado River Basin
Historical Flow and Quality of Water Data
Green River near Green River, Wyoming
(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	1,748	.40	293	696
1972	2,008	.39	289	789
Total	41,935			17,513
Average	1,310	.42	307	547

Table 2

Colorado River Basin

Historical Flow and Quality of Water Data

Green River near Greendale, Utah

Units-1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	27	0.93	25
	Feb.	25	1.16	29
	Mar.	72	.94	68
	Apr.	131	.56	74
	May	276	.58	160
	June	441	.40	175
-1941	July	171	.55	94
	Aug.	110	.73	80
	Sept.	67	.78	52
	Oct.	94	.97	91
	Nov.	71	.93	66
	Dec.	36	1.19	43
	Total	1,521	.63	957
	Jan.	30	1.00	30
	Feb.	31	1.00	31
	Mar.	69	1.07	74
	Apr.	261	.65	170
	May	235	.76	180
	June	434	.44	193
-1942	July	239	.40	97
	Aug.	73	.57	42
	Sept.	40	.72	29
	Oct.	36	1.00	36
	Nov.	35	1.17	41
	Dec.	34	1.06	36
	Total	1,517	.63	959
	Jan.	33	1.09	36
	Feb.	37	.97	36
	Mar.	96	.74	71
	Apr.	262	.48	125
	May	338	.38	130
	June	552	.33	182
-1943	July	393	.29	115
	Aug.	163	.47	76
	Sept.	64	.56	36
	Oct.	60	.72	43
	Nov.	54	.83	45
	Dec.	37	.89	33
	Total	2,089	.44	928
	Jan.	30	.93	28
	Feb.	32	1.00	32
	Mar.	48	1.48	71
	Apr.	345	.55	190
	May	245	.58	142
	June	469	.37	174
-1944	July	278	.39	109
	Aug.	76	.49	37
	Sept.	36	.61	22
	Oct.	47	.83	39
	Nov.	39	.92	36
	Dec.	27	.85	23
	Total	1,672	.54	903
	Jan.	29	.97	28
	Feb.	34	.94	32
	Mar.	65	.88	57
	Apr.	113	.70	79
	May	176	.60	105
	June	310	.46	144
-1945	July	325	.37	120
	Aug.	174	.47	82
	Sept.	103	.43	44
	Oct.	74	.74	55
	Nov.	52	.88	46
	Dec.	42	.81	34
	Total	1,497	.55	826
	Jan.	39	.90	35
	Feb.	33	.85	28
	Mar.	88	.67	59
	Apr.	237	.48	115
	May	298	.44	130
	June	354	.37	133
-1946	July	162	.40	64
	Aug.	81	.57	46
	Sept.	62	.60	37
	Oct.	68	.76	52
	Nov.	63	.82	52
	Dec.	62	.77	48
	Total	1,547	.52	799
	Jan.	32	0.81	26
	Feb.	37	.89	33
	Mar.	195	.62	120
	Apr.	136	.62	84
	May	521	.40	210
	June	628	.36	225
-1947	July	372	.35	131
	Aug.	218	.45	99
	Sept.	91	.53	48
	Oct.	90	.70	63
	Nov.	71	.77	55
	Dec.	56	.87	49
	Total	2,447	.47	1,143
	Jan.	47	.91	43
	Feb.	40	.88	35
	Mar.	102	.79	81
	Apr.	157	.70	110
	May	336	.38	126
	June	454	.36	162
-1948	July	126	.50	63
	Aug.	59	.56	33
	Sept.	33	.76	25
	Oct.	39	.77	30
	Nov.	34	.85	29
	Dec.	31	1.00	31
	Total	1,458	.53	768
	Jan.	31	.90	28
	Feb.	29	.93	27
	Mar.	73	.89	65
	Apr.	152	.69	105
	May	310	.53	165
	June	493	.47	230
-1949	July	205	.52	106
	Aug.	72	.61	44
	Sept.	42	.74	31
	Oct.	70	.93	65
	Nov.	66	.97	64
	Dec.	40	.97	39
	Total	1,583	.61	969
	Jan.	36	1.19	43
	Feb.	45	.95	43
	Mar.	150	.61	92
	Apr.	323	.46	150
	May	416	.46	190
	June	741	.37	275
-1950	July	458	.34	154
	Aug.	153	.51	78
	Sept.	86	.62	53
	Oct.	76	.72	55
	Nov.	80	.75	60
	Dec.	61	.84	51
	Total	2,625	.47	1,244
	Jan.	45	.80	36
	Feb.	61	.82	50
	Mar.	93	.78	73
	Apr.	212	.47	100
	May	395	.45	177
	June	626	.36	225
-1951	July	366	.36	132
	Aug.	228	.44	101
	Sept.	98	.56	55
	Oct.	99	.71	70
	Nov.	57	.91	52
	Dec.	54	.87	47
	Total	2,334	.48	1,118
	Jan.	49	.82	40
	Feb.	52	.81	42
	Mar.	63	.75	47
	Apr.	318	.62	198
	May	600	.39	235
	June	554	.36	201
-1952	July	205	.56	114
	Aug.	121	.60	72
	Sept.	67	.67	45
	Oct.	49	.86	42
	Nov.	37	1.11	41
	Dec.	34	1.18	40
	Total	2,149	.52	1,117
	Jan.	48	0.81	39
	Feb.	48	.85	41
	Mar.	73	.86	63
	Apr.	96	.76	73
	May	110	.64	70
	June	452	.39	175
-1953	July	198	.39	77
	Aug.	105	.54	57
	Sept.	43	.63	27
	Oct.	35	.89	31
	Nov.	42	.98	41
	Dec.	32	.97	31
	Total	1,282	.57	725
	Jan.	28	1.11	31
	Feb.	39	.87	34
	Mar.	62	.81	50
	Apr.	101	.65	66
	May	302	.31	94
	June	223	.36	81
-1954	July	265	.28	73
	Aug.	81	.43	35
	Sept.	45	.69	31
	Oct.	42	.95	40
	Nov.	41	.85	35
	Dec.	20	1.05	21
	Total	1,249	.47	591
	Jan.	24	.75	18
	Feb.	24	.71	17
	Mar.	44	1.11	49
	Apr.	106	.64	68
	May	168	.52	88
	June	288	.33	95
-1955	July	130	.38	49
	Aug.	80	.52	42
	Sept.	38	.58	22
	Oct.	38	.68	26
	Nov.	36	.75	27
	Dec.	45	.82	37
	Total	1,021	.53	538
	Jan.	50	.86	43
	Feb.	38	.76	29
	Mar.	150	.47	70
	Apr.	203	.43	87
	May	368	.39	144
	June	615	.29	178
-1956	July	207	.33	69
	Aug.	104	.42	44
	Sept.	48	.44	21
	Oct.	46	.74	34
	Nov.	39	.82	32
	Dec.	26	.88	23
	Total	1,894	.41	774
	Jan.	28	.86	24
	Feb.	43	.79	34
	Mar.	66	.91	60
	Apr.	86	.67	58
	May	275	.54	148
	June	685	.37	251
-1957	July	433	.36	155
	Aug.	142	.57	81
	Sept.	82	.58	48
	Oct.	77	.69	53
	Nov.	57	1.00	57
	Dec.	46	.91	42
	Total	2,020	.50	1,011
	Jan.	43	.77	33
	Feb.	55	.80	44
	Mar.	66	.71	47
	Apr.	134	.67	90
	May	386	.39	151
	June	335	.38	127
-1958	July	87	.50	44
	Aug.	57	.56	32
	Sept.	39	.69	27
	Oct.	36	.72	26
	Nov.	34	.70	24
	Dec.	38	.84	32
	Total	1,310	.52	677

To obtain mg/l multiply T/AF by 735.

Table 2

Colorado River Basin

Historical Flow and Quality of Water Data

Green River near Greendale, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	29	0.86	25
	Feb.	32	.91	29
	Mar.	65	.92	60
	Apr.	98	.71	70
	May	115	.57	66
	June	368	.36	132
-1959	July	176	.51	90
	Aug.	93	.47	44
	Sept.	58	.79	46
	Oct.	68	.72	49
	Nov.	51	.76	39
	Dec.	37	.99	37
	Total	1,190	.58	687
	Jan.	26	.81	21
	Feb.	29	.86	25
	Mar.	149	.70	104
	Apr.	140	.55	77
	May	127	.58	74
	June	216	.43	93
-1960	July	78	.49	38
	Aug.	43	.47	20
	Sept.	35	.56	20
	Oct.	49	.65	32
	Nov.	54	.67	36
	Dec.	27	.84	23
	Total	973	.58	563
	Jan.	27	.73	20
	Feb.	27	.77	21
	Mar.	64	.86	55
	Apr.	76	.69	52
	May	79	.59	47
	June	192	.32	61
-1961	July	56	.44	25
	Aug.	43	.58	25
	Sept.	55	.68	37
	Oct.	64	.70	45
	Nov.	54	.70	38
	Dec.	44	.78	34
	Total	781	.59	460
	Jan.	43	.65	28
	Feb.	83	.81	67
	Mar.	150	.84	126
	Apr.	374	.55	206
	May	394	.41	162
	June	456	.40	182
-1962	July	297	.39	116
	Aug.	109	.48	52
	Sept.	44	.64	28
	Oct.	48	.79	38
	Nov.	5	.80	4
	Dec.	16	.94	15
	Total	2,019	.51	1,024
	Jan.	23	.91	21
	Feb.	26	.92	24
	Mar.	6	.83	5
	Apr.	8	.87	7
	May	8	.87	7
	June	7	.86	6
-1963	July	6	.83	5
	Aug.	6	.83	5
	Sept.	7	.86	6
	Oct.	8	.87	7
	Nov.	19	.58	11
	Dec.	46	.63	29
	Total	170	.78	133
	Jan.	58	.57	33
	Feb.	56	.57	32
	Mar.	37	.59	22
	Apr.	35	.63	22
	May	91	.64	58
	June	86	.60	52
-1964	July	150	.61	92
	Aug.	122	.61	74
	Sept.	131	.61	80
	Oct.	159	.64	102
	Nov.	139	.60	83
	Dec.	194	.62	120
	Total	1,258	.61	770
	Jan.	216	0.63	136
	Feb.	213	.70	149
	Mar.	233	1.05	245
	Apr.	204	.83	169
	May	66	.80	53
	June	86	.86	74
-1965	July	29	.86	25
	Aug.	31	.87	27
	Sept.	44	.89	39
	Oct.	79	.79	62
	Nov.	120	.73	88
	Dec.	116	.65	75
	Total	1,437	.79	1,142
	Jan.	72	.64	46
	Feb.	72	.65	47
	Mar.	71	.76	54
	Apr.	130	.79	103
	May	83	.78	65
	June	95	.76	72
-1966	July	104	.75	78
	Aug.	118	.72	85
	Sept.	124	.73	91
	Oct.	124	.77	95
	Nov.	85	.81	69
	Dec.	111	.76	84
	Total	1,189	.75	889
	Jan.	142	.74	105
	Feb.	96	.75	72
	Mar.	67	.77	52
	Apr.	85	.81	69
	May	122	.83	101
	June	195	.83	162
-1967	July	171	.85	145
	Aug.	188	.86	162
	Sept.	180	.82	148
	Oct.	188	.87	164
	Nov.	173	.85	147
	Dec.	197	.72	142
	Total	1804	.81	1469
	Jan.	187	.70	131
	Feb.	123	.72	89
	Mar.	76	.83	63
	Apr.	96	.88	84
	May	119	.81	96
	June	97	.77	75
-1968	July	198	.75	148
	Aug.	200	.75	150
	Sept.	181	.75	136
	Oct.	140	.73	102
	Nov.	137	.68	93
	Dec.	137	.68	93
	Total	1691	.75	1260
	Jan.	183	.70	128
	Feb.	219	.73	160
	Mar.	166	.74	123
	Apr.	150	.78	117
	May	191	.78	149
	June	108	.74	80
	July	158	.74	117
-1969	Aug.	194	.72	140
	Sept.	165	.72	119
	Oct.	129	.69	89
	Nov.	129	.63	81
	Dec.	196	.62	122
	Total	1,988	.72	1,425
	Jan.	101	.62	63
	Feb.	78	.62	48
	Mar.	81	.64	52
	Apr.	109	.66	72
	May	64	.67	43
	June	87	.67	58
-1970	July	119	.65	77
	Aug.	127	.68	86
	Sept.	117	.70	82
	Oct.	59	.71	42
	Nov.	66	.68	45
	Dec.	80	.63	50
	Total	1,088	.66	718
	Jan.	55	.61	34
	Feb.	43	.62	26
	Mar.	48	.63	30
	Apr.	81	.63	51
	May	90	.66	59
	June	100	.66	66
1971	July	117	.64	75
	Aug.	151	.65	99
	Sept.	136	.67	91
	Oct.	117	.69	81
	Nov.	171	.66	114
	Dec.	200	.61	123
	Total	1,309	.65	849
	Jan.	170	.59	100
	Feb.	168	.62	104
	Mar.	102	.63	65
	Apr.	140	.65	90
	May	244	.64	156
	June	190	.63	119
1972	July	181	.62	113
	Aug.	161	.64	104
	Sept.	93	.66	62
	Oct.	200	.67	131
	Nov.	215	.67	144
	Dec.	223	.63	140
	Total	2,087	.64	1,328
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
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	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 2
Colorado River Basin
Historical Flow and Quality of Water Data
Green River near Greendale, Utah
(Annual Summary)
Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1941	1,521	0.63	462	957
1942	1,517	.63	465	959
1943	2,089	.44	327	928
1944	1,672	.54	397	903
1945	1,497	.55	406	826
1946	1,547	.52	380	799
1947	2,447	.47	343	1,143
1948	1,458	.53	387	768
1949	1,583	.61	450	969
1950	2,625	.47	348	1,244
1951	2,334	.48	352	1,118
1952	2,149	.52	382	1,117
1953	1,282	.57	416	725
1954	1,249	.47	348	591
1955	1,021	.53	387	538
1956	1,894	.41	300	774
1957	2,020	.50	368	1,011
1958	1,310	.52	380	677
1959	1,190	.58	424	687
1960	973	.58	425	563
1961	781	.59	433	460
1962	2,019	.51	373	1,024
1963	170	.78	575	133
1964	1,258	.61	450	770
1965	1,437	.79	584	1,142
1966	1,189	.75	550	889
1967	1,804	.81	599	1,469
1968	1,691	.75	548	1,260
1969	1,988	.72	526	1,425
1970	1,088	.66	483	718

Sampled quality record October 1956 to December 1972 (fragmentary); remainder by correlation.
Measured flow record entire period.

Table 2
Colorado River Basin
Historical Flow and Quality of Water Data
Green River near Greendale, Utah
(Annual Summary)
Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	1,309	.65	477	849
1972	2,087	.64	468	1328
Total	50,199			28,764
Average	1,569	.57	421	899

Table 3

Colorado River Basin

Historical Flow and Quality of Water Data

Duchesne River near Randlett, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1941	Jan.	25	1.12	28
	Feb.	24	1.29	31
	Mar.	21	1.71	36
	Apr.	20	1.50	30
	May	155	.50	78
	June	232	.38	88
	July	35	1.11	39
	Aug.	18	1.50	27
	Sept.	15	1.60	24
	Oct.	54	.93	50
	Nov.	51	.90	46
	Dec.	44	1.04	46
	Total	694	.75	523
1942	Jan.	40	.90	36
	Feb.	39	1.00	39
	Mar.	39	1.23	48
	Apr.	50	.90	45
	May	83	.72	60
	June	171	.46	79
	July	23	1.43	33
	Aug.	8	2.12	17
	Sept.	5	2.40	12
	Oct.	18	1.50	27
	Nov.	22	1.41	31
	Dec.	28	1.28	36
	Total	526	.88	463
1943	Jan.	26	1.12	29
	Feb.	29	1.17	34
	Mar.	29	1.51	44
	Apr.	43	1.00	43
	May	100	.64	64
	June	103	.62	64
	July	28	1.21	34
	Aug.	23	1.39	32
	Sept.	8	2.00	16
	Oct.	22	1.40	31
	Nov.	24	1.29	31
	Dec.	25	1.28	32
	Total	460	.99	454
1944	Jan.	23	1.08	25
	Feb.	26	1.31	34
	Mar.	43	1.20	52
	Apr.	48	.94	45
	May	128	.57	73
	June	255	.37	94
	July	82	.72	59
	Aug.	8	2.00	16
	Sept.	7	2.14	15
	Oct.	24	1.37	33
	Nov.	26	1.30	34
	Dec.	28	1.32	37
	Total	698	.74	517
1945	Jan.	30	1.00	30
	Feb.	27	1.18	32
	Mar.	32	1.40	45
	Apr.	24	1.29	31
	May	59	.86	51
	June	91	.67	61
	July	30	1.23	37
	Aug.	31	1.19	37
	Sept.	12	1.75	21
	Oct.	21	1.38	29
	Nov.	26	1.27	33
	Dec.	24	1.37	33
	Total	407	1.08	440
1946	Jan.	23	1.13	26
	Feb.	21	1.38	29
	Mar.	29	1.41	41
	Apr.	40	1.00	40
	May	70	.78	55
	June	47	.95	45
	July	5	2.60	13
	Aug.	6	2.33	14
	Sept.	4	2.75	11
	Oct.	17	1.53	26
	Nov.	32	1.22	39
	Dec.	30	1.20	36
	Total	324	1.16	375
1947	Jan.	26	1.07	28
	Feb.	36	1.08	39
	Mar.	36	1.27	46
	Apr.	23	1.30	30
	May	143	.53	76
	June	158	.49	78
	July	33	1.18	39
	Aug.	25	1.28	32
	Sept.	12	1.75	21
	Oct.	17	1.65	28
	Nov.	29	1.21	35
	Dec.	31	1.19	37
	Total	569	.86	489
1948	Jan.	29	1.00	29
	Feb.	26	1.31	34
	Mar.	40	1.20	48
	Apr.	31	1.23	38
	May	70	.79	55
	June	51	.92	47
	July	3	3.00	9
	Aug.	2	3.50	7
	Sept.	1	3.00	3
	Oct.	5	2.40	12
	Nov.	14	1.71	24
	Dec.	26	1.27	33
	Total	298	1.14	339
1949	Jan.	24	1.08	26
	Feb.	23	1.30	30
	Mar.	44	1.20	53
	Apr.	46	.98	45
	May	127	.56	71
	June	230	.39	90
	July	50	.94	47
	Aug.	7	2.14	15
	Sept.	8	2.13	17
	Oct.	25	1.28	32
	Nov.	29	1.21	35
	Dec.	28	1.29	36
	Total	641	.78	497
1950	Jan.	31	1.00	31
	Feb.	26	1.23	32
	Mar.	40	1.30	52
	Apr.	44	1.00	44
	May	97	.67	65
	June	193	.43	83
	July	45	1.00	45
	Aug.	9	2.00	18
	Sept.	13	1.77	23
	Oct.	16	1.56	25
	Nov.	27	1.26	34
	Dec.	33	1.36	45
	Total	574	.87	497
1951	Jan.	26	1.00	26
	Feb.	26	1.31	34
	Mar.	23	1.56	36
	Apr.	14	1.71	24
	May	79	.75	59
	June	124	.73	91
	July	31	1.29	40
	Aug.	26	1.46	38
	Sept.	10	1.90	19
	Oct.	25	1.28	32
	Nov.	32	1.22	39
	Dec.	32	1.22	39
	Total	448	1.06	477
1952	Jan.	28	1.07	30
	Feb.	26	1.31	34
	Mar.	31	1.42	44
	Apr.	111	.60	67
	May	304	.34	103
	June	302	.33	100
	July	70	.79	55
	Aug.	49	.94	46
	Sept.	30	1.20	36
	Oct.	21	1.38	29
	Nov.	26	1.31	34
	Dec.	37	1.11	41
	Total	1,035	.60	619
1953	Jan.	39	0.90	35
	Feb.	33	1.12	37
	Mar.	34	1.41	48
	Apr.	13	1.77	23
	May	15	1.60	24
	June	107	.60	64
	July	13	1.77	23
	Aug.	12	1.75	21
	Sept.	5	2.20	11
	Oct.	9	2.00	18
	Nov.	20	1.40	28
	Dec.	26	1.31	34
	Total	326	1.12	366
1954	Jan.	27	1.11	30
	Feb.	25	1.28	32
	Mar.	20	1.80	36
	Apr.	13	1.77	23
	May	36	1.11	40
	June	5	2.40	12
	July	2	3.00	6
	Aug.	1	4.00	4
	Sept.	6	2.33	14
	Oct.	17	1.59	27
	Nov.	18	1.50	27
	Dec.	18	1.50	27
	Total	188	1.48	278
1955	Jan.	25	1.08	27
	Feb.	21	1.43	30
	Mar.	34	1.38	47
	Apr.	22	1.41	31
	May	45	1.00	45
	June	34	1.09	37
	July	2	3.00	6
	Aug.	8	2.25	17
	Sept.	4	2.50	10
	Oct.	6	2.33	14
	Nov.	15	1.60	24
	Dec.	29	1.21	35
	Total	245	1.32	323
1956	Jan.	27	1.00	27
	Feb.	23	1.35	31
	Mar.	25	1.60	40
	Apr.	17	1.59	27
	May	74	.76	56
	June	90	.68	61
	July	4	2.75	11
	Aug.	2	4.00	8
	Sept.	1	5.00	5
	Oct.	4	2.25	9
	Nov.	17	1.59	27
	Dec.	19	1.21	23
	Total	303	1.07	325
1957	Jan.	21	1.05	22
	Feb.	20	1.05	21
	Mar.	22	1.54	34
	Apr.	12	1.83	22
	May	39	1.23	48
	June	184	.41	75
	July	35	.91	32
	Aug.	18	1.61	29
	Sept.	15	1.47	22
	Oct.	19	1.74	33
	Nov.	41	1.41	58
	Dec.	30	1.07	32
	Total	456	.94	428
1958	Jan.	29	.83	24
	Feb.	31	1.00	31
	Mar.	35	1.37	48
	Apr.	29	1.07	31
	May	141	.46	65
	June	103	.42	43
	July	4	2.50	10
	Aug.	1	4.00	4
	Sept.	3	2.33	7
	Oct.	5	2.60	13
	Nov.	14	1.93	27
	Dec.	21	1.24	26
	Total	416	.79	329

To obtain mg/l multiply T/AF by 735

Table 3

Colorado River Basin

Historical Flow and Quality of Water Data

Duchesne River near Randlett, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	22	1.14	25
	Feb.	24	1.04	25
	Mar.	17	1.29	22
	Apr.	5	2.00	10
	May	4	2.75	11
	June	34	.85	29
1959	July	6	2.00	12
	Aug.	4	2.75	11
	Sept.	4	2.50	10
	Oct.	11	1.54	17
	Nov.	13	1.54	20
	Dec.	22	1.32	29
	Total	166	1.33	221
	Jan.	23	.87	20
	Feb.	23	.83	19
	Mar.	27	1.15	31
	Apr.	8	1.62	13
	May	18	1.17	21
	June	23	.91	21
1960	July	1	4.00	4
	Aug.	1	4.00	4
	Sept.	1	4.00	4
	Oct.	5	2.40	12
	Nov.	12	1.58	19
	Dec.	18	1.33	24
	Total	160	1.20	192
	Jan.	21	1.19	25
	Feb.	19	1.47	28
	Mar.	10	1.50	15
	Apr.	2	3.50	7
	May	3	2.33	7
	June	3	2.67	8
1961	July	1	4.00	4
	Aug.	1	3.00	3
	Sept.	13	1.15	15
	Oct.	19	1.47	28
	Nov.	27	1.11	30
	Dec.	26	1.00	26
	Total	145	1.35	196
	Jan.	21	.81	17
	Feb.	43	.93	40
	Mar.	49	1.04	51
	Apr.	70	.69	48
	May	88	.64	56
	June	146	.47	69
1962	July	27	1.04	28
	Aug.	4	2.75	11
	Sept.	4	2.50	10
	Oct.	15	1.73	26
	Nov.	15	1.60	24
	Dec.	23	1.26	29
	Total	505	.81	409
	Jan.	18	1.17	21
	Feb.	29	1.14	33
	Mar.	10	1.90	19
	Apr.	5	3.20	16
	May	31	.97	30
	June	50	.76	38
1963	July	3	2.67	8
	Aug.	5	2.40	12
	Sept.	14	1.64	23
	Oct.	7	2.43	17
	Nov.	16	1.62	26
	Dec.	22	1.14	25
	Total	210	1.28	268
	Jan.	18	1.00	18
	Feb.	18	.94	17
	Mar.	23	1.04	24
	Apr.	14	1.57	22
	May	72	.68	49
	June	122	.66	81
1964	July	29	.97	28
	Aug.	6	2.17	13
	Sept.	4	2.75	11
	Oct.	5	2.80	14
	Nov.	18	1.67	30
	Dec.	27	1.26	34
	Total	356	.96	341

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	27	1.00	27
	Feb.	21	1.38	29
	Mar.	26	1.54	40
	Apr.	32	1.16	37
	May	71	1.11	79
	June	302	.49	148
1965	July	175	.51	89
	Aug.	57	.96	55
	Sept.	58	1.09	63
	Oct.	47	1.15	54
	Nov.	47	1.13	53
	Dec.	42	1.12	47
	Total	905	.80	721
	Jan.	39	.90	35
	Feb.	38	.74	28
	Mar.	47	1.02	48
	Apr.	35	1.20	42
	May	58	1.07	62
	June	16	1.81	29
1966	July	3	3.00	9
	Aug.	3	3.00	9
	Sept.	6	2.50	15
	Oct.	11	2.36	26
	Nov.	19	1.79	34
	Dec.	31	1.35	42
	Total	306	1.24	379
	Jan.	33	1.01	33
	Feb.	30	.98	29
	Mar.	41	1.44	59
	Apr.	19	1.71	32
	May	56	.82	46
	June	253	.45	114
1967	July	76	.70	53
	Aug.	11	1.89	21
	Sept.	10	2.05	20
	Oct.	12	2.17	26
	Nov.	18	1.74	31
	Dec.	32	1.02	33
	Total	591	.84	497
	Jan.	34	.85	29
	Feb.	34	1.12	38
	Mar.	40	1.49	60
	Apr.	31	1.61	50
	May	45	1.14	51
	June	250	.40	100
1968	July	24	1.23	30
	Aug.	26	1.40	36
	Sept.	13	1.91	25
	Oct.	20	1.77	35
	Nov.	27	1.45	39
	Dec.	38	1.03	39
	Total	582	.91	532
	Jan.	42	.88	37
	Feb.	37	.93	34
	Mar.	52	1.16	60
	Apr.	69	.89	61
	May	183	.43	79
	June	139	.75	104
1969	July	17	1.60	27
	Aug.	9	2.26	20
	Sept.	10	2.27	23
	Oct.	20	1.65	33
	Nov.	22	1.45	32
	Dec.	20	1.05	21
	Total	620	.86	531
	Jan.	14	1.07	15
	Feb.	17	1.12	19
	Mar.	10	1.60	16
	Apr.	3	2.67	8
	May	17	1.24	21
	June	58	1.29	75
1970	July	9	1.67	15
	Aug.	3	2.33	7
	Sept.	5	2.20	11
	Oct.	9	2.22	20
	Nov.	11	1.82	20
	Dec.	7	2.14	15
	Total	163	1.48	242

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	23	1.04	24
	Feb.	31	1.09	34
	Mar.	20	1.04	21
	Apr.	12	1.62	19
	May	28	1.16	32
	June	140	.49	68
1971	July	19	1.27	25
	Aug.	4	2.30	8
	Sept.	9	1.92	16
	Oct.	20	1.76	36
	Nov.	28	1.66	47
	Dec.	26	1.24	32
	Total	360	1.01	362
	Jan.	24	.97	24
	Feb.	35	.91	32
	Mar.	37	1.10	41
	Apr.	13	1.54	19
	May	37	.87	32
	June	116	.51	60
1972	July	6	1.83	11
	Aug.	3	2.49	8
	Sept.	5	2.54	12
	Oct.	22	1.70	38
	Nov.	31	1.31	41
	Dec.	37	.92	34
	Total	366	.96	352
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735

Table 3
Colorado River Basin
Historical Flow and Quality of Water Data
Duchesne River near Randlett, Utah
(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./1)	T.D.S. (Tons)
1941	694	0.75	554	523
1942	526	.88	647	463
1943	460	.99	725	454
1944	698	.74	544	517
1945	407	1.08	795	440
1946	324	1.16	851	375
1947	569	.86	632	489
1948	298	1.14	836	339
1949	641	.78	570	497
1950	574	.87	636	497
1951	448	1.06	783	477
1952	1,035	.60	440	619
1953	326	1.12	825	366
1954	188	1.48	1,087	278
1955	245	1.32	969	323
1956	303	1.07	788	325
1957	456	.94	690	428
1958	416	.79	581	329
1959	166	1.33	979	221
1960	160	1.20	882	192
1961	145	1.35	994	196
1962	505	.81	595	409
1963	210	1.28	938	268
1964	356	.96	704	341
1965	905	.80	586	721
1966	306	1.24	910	379
1967	591	.84	618	497
1968	582	.91	672	532
1969	620	.86	629	531
1970	163	1.48	1,091	242

Sampled quality record December 1950 to September 1951; November 1956 to December 1972; remainder by correlation.

Measured flow record October 1942 to December 1972; remainder by correlation.

Table 3
Colorado River Basin
Historical Flow and Quality of Water Data
Duchesne River near Randlett, Utah
(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	360	1.01	739	362
1972	366	.96	707	352
Total	14,043			12,982
Average	439	.92	680	406

Table 4

Colorado River Basin

Historical Flow and Quality of Water Data

Green River at Green River, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	100	1.01	101
	Feb.	126	1.06	134
	Mar.	216	1.01	218
	Apr.	314	.75	235
	May	1,172	.53	621
	June	1,146	.49	562
-1941	July	359	.63	226
	Aug.	267	1.09	291
	Sept.	182	1.01	184
	Oct.	318	1.00	318
	Nov.	240	.90	216
	Dec.	168	.98	165
	Total	4,608	.71	3,271
	Jan.	112	1.04	117
	Feb.	122	.98	120
	Mar.	264	.94	248
	Apr.	858	.65	557
	May	980	.57	558
	June	1,271	.39	495
-1942	July	414	.57	236
	Aug.	152	.85	129
	Sept.	91	1.10	100
	Oct.	118	1.20	142
	Nov.	124	1.18	146
	Dec.	116	1.22	141
	Total	4,622	.65	2,989
	Jan.	112	1.13	127
	Feb.	130	1.02	132
	Mar.	236	.91	215
	Apr.	569	.57	325
	May	763	.39	298
	June	1,074	.40	430
-1943	July	612	.43	263
	Aug.	300	.83	249
	Sept.	116	.98	114
	Oct.	124	1.10	136
	Nov.	146	1.04	152
	Dec.	112	1.11	124
	Total	4,294	.60	2,565
	Jan.	80	1.20	96
	Feb.	111	1.06	118
	Mar.	253	1.07	271
	Apr.	529	.81	428
	May	924	.48	444
	June	1,391	.30	417
-1944	July	591	.44	260
	Aug.	143	.73	104
	Sept.	73	.96	70
	Oct.	115	1.13	130
	Nov.	119	1.14	136
	Dec.	88	1.23	108
	Total	4,417	.58	2,582
	Jan.	109	1.04	113
	Feb.	128	.99	127
	Mar.	185	1.03	191
	Apr.	291	.84	244
	May	909	.44	400
	June	1,016	.39	396
-1945	July	701	.41	287
	Aug.	335	.74	248
	Sept.	163	.77	125
	Oct.	161	.99	159
	Nov.	149	.99	148
	Dec.	113	1.06	120
	Total	4,260	.60	2,558
	Jan.	123	.95	117
	Feb.	117	.91	106
	Mar.	236	.90	212
	Apr.	528	.60	317
	May	775	.41	318
	June	746	.36	269
-1946	July	264	.47	124
	Aug.	152	.84	128
	Sept.	105	.91	96
	Oct.	149	1.00	149
	Nov.	170	.98	167
	Dec.	154	.94	145
	Total	3,519	.61	2,148
	Jan.	92	1.07	98
	Feb.	151	.86	130
	Mar.	411	.79	325
	Apr.	422	.59	249
	May	1,400	.38	532
	June	1,348	.39	526
-1947	July	656	.40	262
	Aug.	365	.71	259
	Sept.	166	.77	128
	Oct.	181	.91	165
	Nov.	179	.91	163
	Dec.	152	1.01	154
	Total	5,523	.54	2,991
	Jan.	141	.94	132
	Feb.	136	.91	124
	Mar.	313	.86	269
	Apr.	558	.69	385
	May	1,061	.39	414
	June	952	.34	324
-1948	July	268	.54	145
	Aug.	137	.81	111
	Sept.	69	.81	56
	Oct.	92	1.02	94
	Nov.	104	1.05	109
	Dec.	97	1.10	107
	Total	3,928	.58	2,270
	Jan.	100	1.01	101
	Feb.	110	.92	101
	Mar.	276	.92	254
	Apr.	474	.69	327
	May	1,221	.43	525
	June	1,547	.42	650
-1949	July	592	.57	338
	Aug.	172	.77	132
	Sept.	112	.89	100
	Oct.	207	.98	203
	Nov.	190	.90	171
	Dec.	128	1.07	137
	Total	5,129	.59	3,039
	Jan.	141	1.01	142
	Feb.	147	1.01	148
	Mar.	356	.90	321
	Apr.	620	.64	397
	May	1,026	.53	544
	June	1,567	.35	548
-1950	July	734	.49	360
	Aug.	246	.63	155
	Sept.	149	.89	133
	Oct.	153	.96	147
	Nov.	166	.99	164
	Dec.	171	.96	164
	Total	5,476	.59	3,223
	Jan.	113	1.13	128
	Feb.	167	.92	154
	Mar.	204	.93	190
	Apr.	372	.70	260
	May	882	.45	397
	June	1,309	.40	524
-1951	July	627	.43	270
	Aug.	379	.69	261
	Sept.	178	.79	140
	Oct.	211	.99	209
	Nov.	164	1.05	172
	Dec.	132	1.07	142
	Total	4,738	.60	2,847
	Jan.	135	1.01	136
	Feb.	140	.96	134
	Mar.	160	1.05	168
	Apr.	988	.88	869
	May	2,087	.48	1,002
	June	1,809	.36	651
-1952	July	514	.60	309
	Aug.	315	.89	280
	Sept.	184	.96	177
	Oct.	129	1.09	140
	Nov.	122	1.24	151
	Dec.	129	1.20	155
	Total	6,712	.62	4,172
	Jan.	140	1.05	147
	Feb.	141	1.04	147
	Mar.	217	1.00	217
	Apr.	221	.96	212
	May	454	.55	250
	June	1,167	.37	432
-1953	July	376	.48	181
	Aug.	212	.84	178
	Sept.	87	.99	86
	Oct.	86	1.20	104
	Nov.	126	1.15	145
	Dec.	107	1.18	126
	Total	3,334	.67	2,225
	Jan.	107	1.09	117
	Feb.	138	1.03	142
	Mar.	169	1.03	174
	Apr.	270	.75	202
	May	639	.38	243
	June	376	.45	169
-1954	July	346	.46	159
	Aug.	120	.65	78
	Sept.	134	1.02	137
	Oct.	139	1.14	159
	Nov.	120	1.06	127
	Dec.	80	1.25	100
	Total	2,638	.68	1,807
	Jan.	80	1.06	85
	Feb.	86	.92	79
	Mar.	237	.92	218
	Apr.	311	.77	239
	May	678	.39	264
	June	654	.36	236
-1955	July	223	.46	102
	Aug.	161	.83	134
	Sept.	71	.93	66
	Oct.	77	1.08	83
	Nov.	86	1.13	97
	Dec.	127	1.02	130
	Total	2,791	.62	1,733
	Jan.	155	.91	141
	Feb.	100	1.05	105
	Mar.	314	.81	255
	Apr.	460	.53	244
	May	995	.35	348
	June	1,207	.32	386
-1956	July	294	.49	144
	Aug.	169	.67	113
	Sept.	72	.72	52
	Oct.	77	.94	73
	Nov.	99	1.02	101
	Dec.	79	1.05	83
	Total	4,021	.51	2,045
	Jan.	83	.95	79
	Feb.	100	.94	94
	Mar.	237	.89	210
	Apr.	290	.73	212
	May	913	.48	438
	June	1,871	.34	636
-1957	July	1,164	.34	396
	Aug.	386	.79	305
	Sept.	202	.76	153
	Oct.	185	.94	174
	Nov.	228	.96	219
	Dec.	149	.97	144
	Total	5,808	.53	3,060
	Jan.	128	.93	119
	Feb.	184	.86	158
	Mar.	246	.92	227
	Apr.	432	.71	307
	May	1,311	.41	537
	June	1,174	.35	411
-1958	July	224	.62	139
	Aug.	110	.82	91
	Sept.	96	1.07	103
	Oct.	91	1.01	92
	Nov.	102	1.10	113
	Dec.	114	1.09	124
	Total	4,212	.57	2,421

To obtain mg/l multiply T/AF by 735.

Table 4

Colorado River Basin

Historical Flow and Quality of Water Data

Green River at Green River, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1959	Jan.	97	1.13	110
	Feb.	114	.95	108
	Mar.	146	.94	137
	Apr.	219	.76	166
	May	480	.42	202
	June	763	.34	259
	July	346	.51	176
	Aug.	179	.90	161
	Sept.	104	.92	96
	Oct.	178	.86	153
	Nov.	152	.83	126
	Dec.	106	1.02	108
	Total	2,884	.62	1,802
1960	Jan.	95	1.05	100
	Feb.	102	.95	97
	Mar.	320	.83	266
	Apr.	534	.51	272
	May	551	.39	215
	June	683	.33	225
	July	170	.52	88
	Aug.	69	.76	52
	Sept.	59	.93	55
	Oct.	96	1.00	96
	Nov.	105	.90	94
	Dec.	80	1.06	85
	Total	2,864	.57	1,645
1961	Jan.	79	.98	77
	Feb.	94	.87	82
	Mar.	136	.89	121
	Apr.	184	.79	145
	May	342	.41	140
	June	542	.31	168
	July	112	.49	55
	Aug.	80	.91	73
	Sept.	175	.99	173
	Oct.	234	.75	176
	Nov.	161	.80	129
	Dec.	126	.88	111
	Total	2,265	.64	1,450
1962	Jan.	115	.79	91
	Feb.	403	.72	290
	Mar.	401	.95	381
	Apr.	1,093	.56	612
	May	1,350	.36	486
	June	1,074	.38	408
	July	598	.41	245
	Aug.	177	.61	108
	Sept.	98	.98	96
	Oct.	126	1.37	173
	Nov.	94	1.15	108
	Dec.	72	1.10	79
	Total	5,601	.55	3,077
1963	Jan.	71	1.04	74
	Feb.	120	.93	112
	Mar.	99	1.00	99
	Apr.	154	.68	105
	May	399	.40	160
	June	310	.42	130
	July	51	.77	39
	Aug.	72	1.77	127
	Sept.	95	1.57	149
	Oct.	47	1.32	62
	Nov.	74	1.26	93
	Dec.	84	1.08	91
	Total	1,576	.79	1,241
1964	Jan.	109	.76	83
	Feb.	114	.76	87
	Mar.	128	.87	111
	Apr.	190	.89	169
	May	634	.45	285
	June	725	.40	290
	July	344	.54	186
	Aug.	196	.93	182
	Sept.	139	.82	114
	Oct.	196	.78	153
	Nov.	200	.84	168
	Dec.	267	.81	216
	Total	3,243	.63	2,044
1965	Jan.	300	0.73	219
	Feb.	303	.82	248
	Mar.	361	.88	318
	Apr.	518	.79	409
	May	819	.46	377
	June	1,207	.42	507
	July	546	.52	284
	Aug.	228	.94	214
	Sept.	189	.95	180
	Oct.	253	.85	215
	Nov.	239	.92	220
	Dec.	248	.89	221
	Total	5,211	.65	3,412
1966	Jan.	181	.86	156
	Feb.	166	.80	133
	Mar.	393	.80	314
	Apr.	390	.66	257
	May	566	.48	272
	June	325	.55	179
	July	147	.85	125
	Aug.	147	.96	141
	Sept.	157	1.01	159
	Oct.	189	1.01	191
	Nov.	159	1.06	169
	Dec.	146	1.12	164
	Total	2,966	.76	2,260
1967	Jan.	196	.88	172
	Feb.	169	.90	152
	Mar.	256	.95	243
	Apr.	260	.77	200
	May	504	.54	272
	June	1,134	.52	590
	July	508	.63	320
	Aug.	247	.99	245
	Sept.	231	1.06	245
	Oct.	250	1.07	268
	Nov.	243	1.03	250
	Dec.	229	1.31	300
	Total	4,227	.77	3,257
1968	Jan.	249	.87	217
	Feb.	196	.91	178
	Mar.	241	1.05	253
	Apr.	275	.94	258
	May	708	.58	411
	June	1,248	.35	437
	July	426	.65	277
	Aug.	345	1.02	352
	Sept.	241	.93	224
	Oct.	230	.99	228
	Nov.	221	.93	206
	Dec.	209	.88	184
	Total	4,589	.70	3,225
1969	Jan.	282	.81	228
	Feb.	313	.82	257
	Mar.	354	.94	333
	Apr.	658	.69	454
	May	1,095	.45	493
	June	684	.54	369
	July	358	.59	211
	Aug.	270	.96	259
	Sept.	246	.97	239
	Oct.	255	.95	242
	Nov.	236	.88	208
	Dec.	271	.83	225
	Total	5,022	.70	3,518
1970	Jan.	191	.84	160
	Feb.	175	.87	152
	Mar.	194	.89	173
	Apr.	249	.86	214
	May	867	.38	329
	June	1,019	.40	408
	July	420	.52	218
	Aug.	212	.80	170
	Sept.	179	.93	166
	Oct.	174	.94	164
	Nov.	159	1.12	178
	Dec.	145	.95	138
	Total	3,984	.62	2,470
1971	Jan.	154	.84	129
	Feb.	165	.80	132
	Mar.	202	.80	162
	Apr.	479	.54	259
	May	714	.38	272
	June	1,060	.29	311
	July	397	.46	183
	Aug.	197	.82	162
	Sept.	210	.92	193
	Oct.	211	.96	203
	Nov.	263	.92	241
	Dec.	267	.80	214
	Total	4,319	.57	2,461
1972	Jan.	272	.79	215
	Feb.	303	.73	222
	Mar.	323	.72	232
	Apr.	324	.63	204
	May	635	.43	273
	June	834	.35	292
	July	246	.60	148
	Aug.	202	.73	147
	Sept.	123	.92	114
	Oct.	297	.92	274
	Nov.	340	.83	282
	Dec.	286	.78	223
	Total	4,185	.63	2,626
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
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	Total			
	Jan.			
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	July			
	Aug.			
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	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 4
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	0.71	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

Sampled quality record entire period.
Measured flow record entire period.

Table 4
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)
1971	4,319	.57	419	2,461
1972	4,185	.63	461	2,626
Total	132,965			82,434
Average	4,155	.62	456	2,576

Table 5

Colorado River Basin

Historical Flow and Quality of Water Data

San Rafael River near Green River, Utah

Units – 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	2	4.0	8
	Feb.	2	4.0	8
	Mar.	6	3.5	21
	Apr.	1	4.0	4
	May	50	1.2	62
	June	49	1.2	59
-1941	July	7	2.9	20
	Aug.	6	3.3	20
	Sept.	2	4.5	9
	Oct.	5	4.0	20
	Nov.	5	4.2	21
	Dec.	4	4.0	16
	Total	139	1.9	268
	Jan.	6	2.8	17
	Feb.	5	3.6	18
	Mar.	6	3.7	22
	Apr.	14	2.8	39
	May	34	1.4	49
	June	51	1.2	61
-1942	July	6	3.0	18
	Aug.	6	3.2	19
	Sept.	1	5.0	5
	Oct.	2	5.0	10
	Nov.	3	4.7	14
	Dec.	3	4.7	14
	Total	137	2.1	286
	Jan.	4	3.0	12
	Feb.	5	3.4	17
	Mar.	6	3.8	23
	Apr.	15	2.9	44
	May	13	2.1	27
	June	14	2.0	28
-1943	July	2	3.5	7
	Aug.	6	3.2	19
	Sept.	1	5.0	5
	Oct.	2	5.0	10
	Nov.	2	5.0	10
	Dec.	3	3.7	11
	Total	73	2.9	213
	Jan.	2	3.5	7
	Feb.	3	3.0	9
	Mar.	6	3.5	21
	Apr.	1	5.0	5
	May	40	1.3	53
	June	72	1.1	78
-1944	July	9	2.9	26
	Aug.	7	3.1	22
	Sept.	1	5.0	5
	Oct.	2	5.0	10
	Nov.	3	4.7	14
	Dec.	3	4.3	13
	Total	149	1.8	263
	Jan.	3	3.3	10
	Feb.	3	4.0	12
	Mar.	6	3.5	21
	Apr.	1	6.0	6
	May	22	1.6	35
	June	27	1.5	41
-1945	July	6	3.2	19
	Aug.	7	3.4	24
	Sept.	2	4.0	8
	Oct.	3	5.0	15
	Nov.	3	4.7	14
	Dec.	2	4.5	9
	Total	85	2.5	214
	Jan.	2	4.0	8
	Feb.	4	3.3	13
	Mar.	6	3.7	22
	Apr.	11	3.2	35
	May	20	1.8	36
	June	8	2.4	19
-1946	July	1	4.0	4
	Aug.	7	5.4	38
	Sept.	0	0	0
	Oct.	2	5.0	10
	Nov.	5	3.8	19
	Dec.	3	4.3	13
	Total	69	3.1	217
	Jan.	2	4.5	9
	Feb.	5	3.0	15
	Mar.	4	3.8	15
	Apr.	3	4.3	13
	May	33	1.4	46
	June	26	1.8	47
-1947	July	5	3.6	18
	Aug.	20	3.4	68
	Sept.	3	5.0	15
	Oct.	2	6.0	12
	Nov.	4	3.8	15
	Dec.	4	3.5	14
	Total	111	2.6	287
	Jan.	3	3.7	11
	Feb.	6	3.0	18
	Mar.	7	3.6	25
	Apr.	4	3.5	14
	May	16	1.4	23
	June	13	2.2	29
-1948	July	2	4.0	8
	Aug.	6	2.2	13
	Sept.	0	0	0
	Oct.	1	5.0	5
	Nov.	2	5.0	10
	Dec.	2	4.5	9
	Total	62	2.7	165
	Jan.	2	4.0	8
	Feb.	2	4.0	8
	Mar.	9	3.3	30
	Apr.	10	2.2	22
	May	30	1.3	38
	June	52	1.2	64
-1949	July	14	2.7	38
	Aug.	5	3.0	15
	Sept.	3	4.7	14
	Oct.	3	4.7	14
	Nov.	3	4.7	14
	Dec.	2	4.5	9
	Total	135	2.0	274
	Jan.	2	4.5	9
	Feb.	6	3.3	20
	Mar.	5	4.0	20
	Apr.	3	4.7	14
	May	9.	2.2	20
	June	11	2.2	24
-1950	July	9	2.9	26
	Aug.	1	3.0	3
	Sept.	1	5.0	5
	Oct.	1	6.0	6
	Nov.	2	5.5	11
	Dec.	3	4.3	13
	Total	53	3.2	171
	Jan.	2	5.0	10
	Feb.	3	3.7	11
	Mar.	2	5.0	10
	Apr.	1	6.0	6
	May	15	1.9	29
	June	23	1.7	40
-1951	July	3	3.7	11
	Aug.	12	2.2	27
	Sept.	1	5.0	5
	Oct.	6	4.0	24
	Nov.	4	4.5	18
	Dec.	3	5.0	15
	Total	75	2.7	206
	Jan.	3	3.7	11
	Feb.	5	3.6	18
	Mar.	14	3.1	44
	Apr.	24	2.4	58
	May	93	.8	78
	June	128	.9	114
-1952	July	19	1.9	36
	Aug.	12	3.3	40
	Sept.	5	3.8	19
	Oct.	3	4.7	14
	Nov.	4	4.5	18
	Dec.	4	4.0	16
	Total	314	1.5	466
	Jan.	6	2.8	17
	Feb.	7	3.1	22
	Mar.	6	3.2	19
	Apr.	3	4.3	13
	May	2	5.5	11
	June	31	1.5	47
-1953	July	5	3.8	19
	Aug.	9	3.7	33
	Sept.	1	5.0	5
	Oct.	4	4.3	17
	Nov.	4	4.5	18
	Dec.	3	4.8	14
	Total	81	2.9	235
	Jan.	3	4.0	12
	Feb.	5	3.8	19
	Mar.	4	3.8	15
	Apr.	3	4.3	13
	May	8	2.9	23
	June	1	5.0	5
-1954	July	1	5.0	5
	Aug.	1	3.0	3
	Sept.	4	4.0	16
	Oct.	2	4.0	8
	Nov.	2	4.5	9
	Dec.	2	4.5	9
	Total	36	3.8	137
	Jan.	2	4.0	8
	Feb.	2	3.5	7
	Mar.	6	3.5	21
	Apr.	3	3.7	11
	May	4	3.0	12
	June	6	2.8	17
-1955	July	0	0	0
	Aug.	3	3.7	11
	Sept.	0	0	0
	Oct.	0	0	0
	Nov.	1	5.0	5
	Dec.	2	4.5	9
	Total	29	3.5	101
	Jan.	3	3.7	11
	Feb.	3	3.3	10
	Mar.	3	3.3	10
	Apr.	1	5.0	5
	May	11	1.6	18
	June	8	2.0	16
-1956	July	1	4.0	4
	Aug.	1	3.0	3
	Sept.	0	0	0
	Oct.	0	0	0
	Nov.	1	5.0	5
	Dec.	1	5.0	5
	Total	33	2.6	87
	Jan.	2	3.0	6
	Feb.	4	3.0	12
	Mar.	2	5.0	10
	Apr.	1	5.0	5
	May	9	3.1	28
	June	94	.8	79
-1957	July	24	1.5	37
	Aug.	13	2.8	36
	Sept.	4	3.5	14
	Oct.	10	3.3	33
	Nov.	21	2.5	53
	Dec.	5	3.4	17
	Total	189	1.7	330
	Jan.	5	2.6	13
	Feb.	8	2.8	22
	Mar.	6	3.3	20
	Apr.	13	1.6	21
	May	66	.9	60
	June	57	.8	47
-1958	July	2	4.0	8
	Aug.	4	4.5	18
	Sept.	4	4.3	17
	Oct.	1	5.0	5
	Nov.	2	4.0	8
	Dec.	4	3.3	13
	Total	172	1.5	252

To obtain mg/l multiply T/AF by 735.

Table 5

Colorado River Basin

Historical Flow and Quality of Water Data

San Rafael River near Green River, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1959	Jan.	3	3.3	10
	Feb.	4	3.0	12
	Mar.	3	4.0	12
	Apr.	2	3.5	7
	May	1	5.0	5
	June	2	4.0	8
	July	0	0	0
	Aug.	1	3.0	3
	Sept.	1	5.0	5
	Oct.	1	4.0	4
	Nov.	2	4.0	8
	Dec.	1	7.0	7
	Total	21	3.9	81
1960	Jan.	1	6.0	6
	Feb.	2	3.5	7
	Mar.	8	2.8	22
	Apr.	3	3.3	10
	May	8	1.9	15
	June	11	1.5	17
	July	0	0	0
	Aug.	0	0	0
	Sept.	1	4.0	4
	Oct.	8	2.5	20
	Nov.	2	4.5	9
	Dec.	2	4.0	8
	Total	46	2.6	118
1961	Jan.	2	3.5	7
	Feb.	3	2.7	8
	Mar.	2	5.5	11
	Apr.	2	4.0	8
	May	3	3.0	9
	June	2	2.5	5
	July	0	0	0
	Aug.	7	2.9	20
	Sept.	18	2.9	53
	Oct.	3	4.0	12
	Nov.	4	3.5	14
	Dec.	2	4.5	9
	Total	48	3.3	156
1962	Jan.	2	4.0	8
	Feb.	8	2.5	20
	Mar.	6	2.8	17
	Apr.	11	1.3	14
	May	29	1.1	31
	June	37	1.0	37
	July	7	2.6	18
	Aug.	1	4.0	4
	Sept.	3	3.0	9
	Oct.	4	4.5	18
	Nov.	2	5.5	11
	Dec.	2	5.5	11
	Total	112	1.8	198
1963	Jan.	2	5.5	11
	Feb.	4	3.2	13
	Mar.	2	5.5	11
	Apr.	1	6.0	6
	May	6	2.3	14
	June	10	2.2	22
	July	1	2.0	2
	Aug.	9	3.8	34
	Sept.	6	4.3	26
	Oct.	1	6.0	6
	Nov.	2	4.5	9
	Dec.	2	4.5	9
	Total	46	3.5	163
1964	Jan.	1	6.0	6
	Feb.	2	4.0	8
	Mar.	3	3.7	11
	Apr.	1	8.0	8
	May	15	1.9	29
	June	20	1.6	33
	July	4	3.8	15
	Aug.	6	3.7	22
	Sept.	1	4.0	4
	Oct.	0	0	0
	Nov.	1	7.0	7
	Dec.	3	4.7	14
	Total	57	2.7	157
1965	Jan.	4	3.5	14
	Feb.	3	3.7	11
	Mar.	3	4.0	12
	Apr.	6	2.7	16
	May	18	1.6	28
	June	77	.9	70
	July	38	1.6	60
	Aug.	16	2.5	40
	Sept.	5	4.0	20
	Oct.	4	4.5	18
	Nov.	5	4.8	24
	Dec.	5	3.2	16
	Total	184	1.8	329
1966	Jan.	3	3.7	11
	Feb.	3	3.7	11
	Mar.	8	3.5	28
	Apr.	4	3.0	12
	May	4	4.5	18
	June	2	4.0	8
	July	2	4.5	9
	Aug.	1	3.0	3
	Sept.	2	5.0	10
	Oct.	1	8.0	8
	Nov.	1	5.0	5
	Dec.	2	5.0	10
	Total	33	4.0	133
1967	Jan.	1	4.8	5
	Feb.	2	3.8	8
	Mar.	2	4.6	9
	Apr.	1	5.8	6
	May	5	3.2	16
	June	22	2.0	44
	July	7	2.9	21
	Aug.	3	3.3	10
	Sept.	5	3.6	18
	Oct.	2	4.6	9
	Nov.	2	4.5	9
	Dec.	2	5.0	10
	Total	54	3.1	165
1968	Jan.	2	5.0	10
	Feb.	3	4.1	12
	Mar.	3	5.2	16
	Apr.	2	4.8	10
	May	6	3.8	23
	June	25	1.3	33
	July	6	3.6	21
	Aug.	11	3.3	36
	Sept.	4	3.9	16
	Oct.	5	4.3	21
	Nov.	3	4.1	12
	Dec.	2	4.7	9
	Total	72	3.0	219
1969	Jan.	3	4.0	12
	Feb.	3	3.3	10
	Mar.	9	3.6	32
	Apr.	13	1.8	23
	May	38	1.0	39
	June	32	1.4	44
	July	8	2.4	19
	Aug.	9	3.3	30
	Sept.	6	3.8	23
	Oct.	4	4.2	17
	Nov.	4	3.0	12
	Dec.	4	3.3	13
	Total	133	2.1	274
1970	Jan.	2	4.0	8
	Feb.	4	3.5	14
	Mar.	2	6.0	12
	Apr.	2	4.5	9
	May	14	1.5	21
	June	48	1.2	59
	July	9	2.9	26
	Aug.	4	4.0	16
	Sept.	4	4.0	16
	Oct.	3	5.0	15
	Nov.	3	4.7	14
	Dec.	3	4.7	14
	Total	98	2.3	224
1971	Jan.	2	3.0	6
	Feb.	2	4.0	8
	Mar.	3	4.1	13
	Apr.	3	3.3	10
	May	4	4.0	16
	June	5	2.6	13
	July	6	3.2	19
	Aug.	4	4.0	16
	Sept.	2	5.0	10
	Oct.	5	5.3	28
	Nov.	4	4.5	18
	Dec.	2	4.5	9
	Total	42	4.0	166
1972	Jan.	2	4.5	9
	Feb.	3	4.0	12
	Mar.	3	4.0	12
	Apr.	2	4.0	8
	May	2	5.0	10
	June	3	4.7	14
	July	1	6.0	6
	Aug.	1	5.0	5
	Sept.	1	4.0	4
	Oct.	9	3.0	27
	Nov.	4	5.0	20
	Dec.	1	7.0	7
	Total	32	4.2	134
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 5
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

Sampled quality record November 1946 to September 1949; November 1950 to December 1972; remainder by correlation.

Measured flow record October 1945 to December 1972; remainder by correlation.

Table 5
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./1)	T.D.S. (Tons)
1971	42	4.0	2,905	166
1972	32	4.2	3,078	134
Total	2,920			6,689
Average	91	2.30	1,688	209

Table 6

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River near Glenwood Springs, Colorado

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	36	0.75	27
	Feb.	37	.59	22
	Mar.	51	.60	30
	Apr.	85	.47	40
	May	535	.22	118
	June	470	.19	90
- 1941	July	163	.37	60
	Aug.	84	.60	50
	Sept.	67	.60	40
	Oct.	78	.58	45
	Nov.	59	.63	37
	Dec.	48	.67	32
	Total	1,713	.34	591
	Jan.	43	.74	32
	Feb.	41	.68	28
	Mar.	46	.70	32
	Apr.	167	.42	70
	May	389	.24	93
	June	721	.16	116
- 1942	July	230	.27	62
	Aug.	78	.53	41
	Sept.	46	.78	36
	Oct.	53	.75	40
	Nov.	49	.76	37
	Dec.	40	.82	33
	Total	1,903	.33	620
	Jan.	37	.86	32
	Feb.	36	.78	28
	Mar.	48	.75	36
	Apr.	162	.34	55
	May	342	.23	79
	June	582	.18	105
- 1943	July	254	.28	71
	Aug.	109	.45	49
	Sept.	66	.64	42
	Oct.	60	.67	40
	Nov.	67	.54	36
	Dec.	64	.53	34
	Total	1,827	.33	607
	Jan.	37	.76	28
	Feb.	44	.66	29
	Mar.	50	.72	36
	Apr.	85	.51	43
	May	302	.26	78
	June	498	.16	80
- 1944	July	185	.29	54
	Aug.	72	.49	35
	Sept.	45	.71	32
	Oct.	60	.65	39
	Nov.	57	.63	36
	Dec.	59	.56	33
	Total	1,494	.35	523
	Jan.	41	.71	29
	Feb.	37	.68	25
	Mar.	62	.50	31
	Apr.	72	.51	37
	May	347	.22	76
	June	461	.18	83
- 1945	July	268	.26	70
	Aug.	181	.33	60
	Sept.	73	.52	38
	Oct.	78	.49	38
	Nov.	73	.47	34
	Dec.	71	.45	32
	Total	1,764	.31	553
	Jan.	67	.48	32
	Feb.	54	.54	29
	Mar.	64	.55	35
	Apr.	197	.28	55
	May	284	.22	62
	June	362	.22	80
- 1946	July	164	.40	65
	Aug.	83	.51	42
	Sept.	59	.66	39
	Oct.	70	.61	43
	Nov.	61	.59	36
	Dec.	77	.40	31
	Total	1,542	.36	549
	Jan.	52	0.60	31
	Feb.	54	.61	33
	Mar.	68	.53	36
	Apr.	123	.37	46
	May	486	.19	92
	June	606	.17	103
- 1947	July	438	.21	92
	Aug.	147	.38	56
	Sept.	79	.53	42
	Oct.	90	.47	42
	Nov.	80	.49	39
	Dec.	75	.48	36
	Total	2,298	.28	648
	Jan.	76	.45	34
	Feb.	72	.44	32
	Mar.	68	.50	34
	Apr.	162	.37	60
	May	542	.20	108
	June	470	.18	85
- 1948	July	156	.35	55
	Aug.	90	.51	46
	Sept.	57	.67	38
	Oct.	63	.65	41
	Nov.	66	.53	35
	Dec.	59	.61	36
	Total	1,881	.32	604
	Jan.	67	.54	36
	Feb.	56	.57	32
	Mar.	58	.59	34
	Apr.	132	.38	50
	May	364	.23	84
	June	654	.19	124
- 1949	July	356	.24	85
	Aug.	106	.45	48
	Sept.	69	.59	41
	Oct.	61	.70	43
	Nov.	55	.71	39
	Dec.	58	.62	36
	Total	2,036	.32	652
	Jan.	56	.63	35
	Feb.	54	.56	30
	Mar.	80	.44	35
	Apr.	141	.35	49
	May	259	.26	67
	June	429	.20	86
- 1950	July	137	.42	58
	Aug.	79	.50	40
	Sept.	66	.58	38
	Oct.	49	.80	39
	Nov.	53	.70	37
	Dec.	55	.61	34
	Total	1,458	.38	548
	Jan.	59	.56	33
	Feb.	58	.52	30
	Mar.	58	.55	32
	Apr.	104	.40	42
	May	381	.23	88
	June	536	.20	107
- 1951	July	285	.25	71
	Aug.	132	.43	57
	Sept.	77	.58	45
	Oct.	75	.61	46
	Nov.	63	.57	36
	Dec.	63	.51	32
	Total	1,891	.33	619
	Jan.	53	.60	32
	Feb.	47	.62	29
	Mar.	63	.51	32
	Apr.	194	.38	74
	May	597	.23	137
	June	785	.19	149
- 1952	July	245	.34	83
	Aug.	157	.51	80
	Sept.	99	.54	53
	Oct.	77	.58	45
	Nov.	66	.64	42
	Dec.	60	.58	35
	Total	2,443	.32	791
	Jan.	64	0.59	38
	Feb.	53	.57	30
	Mar.	67	.54	37
	Apr.	103	.46	47
	May	229	.32	73
	June	509	.20	102
- 1953	July	171	.41	70
	Aug.	121	.50	60
	Sept.	69	.58	40
	Oct.	64	.63	40
	Nov.	55	.75	41
	Dec.	58	.66	38
	Total	1,563	.39	616
	Jan.	62	.58	36
	Feb.	48	.62	30
	Mar.	62	.58	36
	Apr.	86	.44	38
	May	146	.35	51
	June	89	.52	46
- 1954	July	83	.55	46
	Aug.	74	.58	43
	Sept.	59	.61	36
	Oct.	58	.66	38
	Nov.	48	.71	34
	Dec.	40	.90	36
	Total	855	.55	470
	Jan.	38	.79	30
	Feb.	34	.82	28
	Mar.	43	.79	34
	Apr.	90	.48	43
	May	206	.28	58
	June	217	.31	67
- 1955	July	99	.56	56
	Aug.	86	.66	57
	Sept.	67	.57	38
	Oct.	61	.62	38
	Nov.	55	.69	38
	Dec.	55	.60	33
	Total	1,051	.49	520
	Jan.	52	.60	31
	Feb.	48	.56	27
	Mar.	69	.59	41
	Apr.	120	.44	53
	May	421	.26	110
	June	329	.24	79
- 1956	July	104	.54	56
	Aug.	82	.61	50
	Sept.	73	.55	40
	Oct.	66	.55	36
	Nov.	50	.72	36
	Dec.	41	.78	32
	Total	1,455	.41	591
	Jan.	46	.72	33
	Feb.	44	.68	30
	Mar.	51	.67	34
	Apr.	92	.53	49
	May	350	.32	112
	June	834	.21	175
- 1957	July	571	.22	126
	Aug.	176	.37	65
	Sept.	88	.56	49
	Oct.	75	.60	45
	Nov.	72	.58	42
	Dec.	63	.59	37
	Total	2,462	.32	797
	Jan.	62	.55	34
	Feb.	58	.50	29
	Mar.	73	.52	38
	Apr.	102	.45	46
	May	546	.22	120
	June	439	.21	92
- 1958	July	104	.51	53
	Aug.	67	.59	40
	Sept.	62	.58	36
	Oct.	59	.63	37
	Nov.	54	.68	37
	Dec.	54	.63	34
	Total	1,680	.35	596

To obtain mg/l multiply T/AF by 735.

Table 6

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River near Glenwood Springs, Colorado

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	63	0.54	34
	Feb.	54	.52	28
	Mar.	49	.65	32
	Apr.	81	.54	44
	May	252	.29	73
	June	342	.25	85
- 1959	July	126	.48	61
	Aug.	89	.61	54
	Sept.	73	.56	41
	Oct.	84	.55	46
	Nov.	69	.55	38
	Dec.	59	.53	31
	Total	1,341	.42	567
	Jan.	67	.49	33
	Feb.	55	.50	28
	Mar.	93	.47	44
	Apr.	166	.32	53
	May	288	.25	72
	June	357	.25	89
- 1960	July	122	.49	60
	Aug.	73	.60	44
	Sept.	67	.60	40
	Oct.	61	.62	38
	Nov.	56	.61	34
	Dec.	61	.54	33
	Total	1,466	.39	568
	Jan.	65	.52	34
	Feb.	56	.53	30
	Mar.	55	.59	32
	Apr.	66	.54	36
	May	207	.29	60
	June	203	.28	57
- 1961	July	82	.60	49
	Aug.	80	.59	47
	Sept.	109	.50	54
	Oct.	128	.43	55
	Nov.	81	.50	40
	Dec.	77	.47	36
	Total	1,209	.44	530
	Jan.	80	.44	35
	Feb.	91	.42	38
	Mar.	122	.39	48
	Apr.	347	.32	111
	May	539	.23	125
	June	455	.23	105
- 1962	July	288	.29	84
	Aug.	110	.50	55
	Sept.	74	.58	43
	Oct.	127	.42	53
	Nov.	102	.47	48
	Dec.	72	.57	41
	Total	2,407	.33	786
	Jan.	55	.67	37
	Feb.	53	.63	33
	Mar.	62	.58	36
	Apr.	81	.48	39
	May	175	.31	54
	June	122	.45	55
- 1963	July	66	.66	44
	Aug.	77	.60	46
	Sept.	76	.57	43
	Oct.	63	.61	38
	Nov.	54	.66	36
	Dec.	38	.82	31
	Total	922	.53	492
	Jan.	36	.80	29
	Feb.	33	.78	26
	Mar.	39	.71	28
	Apr.	64	.61	39
	May	210	.32	67
	June	215	.31	67
- 1964	July	99	.63	62
	Aug.	87	.61	53
	Sept.	72	.60	43
	Oct.	65	.64	42
	Nov.	50	.72	36
	Dec.	51	.73	37
	Total	1,021	.52	529
	Jan.	51	0.70	36
	Feb.	44	.72	32
	Mar.	49	.69	34
	Apr.	104	.50	52
	May	263	.30	79
	June	446	.26	116
- 1965	July	271	.31	84
	Aug.	172	.39	67
	Sept.	95	.50	48
	Oct.	95	.44	42
	Nov.	86	.46	39
	Dec.	88	.47	41
	Total	1,764	.38	670
	Jan.	78	0.48	37
	Feb.	70	.45	32
	Mar.	91	.46	42
	Apr.	84	.47	39
	May	186	.30	56
	June	110	.45	50
- 1966	July	89	.51	45
	Aug.	77	.46	35
	Sept.	68	.51	35
	Oct.	72	.60	43
	Nov.	55	.66	36
	Dec.	44	.75	33
	Total	1,024	.47	483
	Jan.	49	.65	32
	Feb.	45	.62	28
	Mar.	67	.59	40
	Apr.	96	.45	43
	May	185	.31	57
	June	250	.28	70
- 1967	July	139	.47	65
	Aug.	90	.57	51
	Sept.	83	.59	49
	Oct.	78	.59	46
	Nov.	69	.57	39
	Dec.	59	.59	35
	Total	1,210	.46	555
	Jan.	53	.61	32
	Feb.	53	.55	29
	Mar.	62	.55	34
	Apr.	95	.46	44
	May	171	.36	62
	June	369	.25	92
- 1968	July	133	.46	61
	Aug.	125	.48	60
	Sept.	79	.53	42
	Oct.	77	.55	42
	Nov.	68	.54	37
	Dec.	65	.59	38
	Total	1,350	.42	573
	Jan.	66	.55	36
	Feb.	56	.57	32
	Mar.	63	.56	35
	Apr.	131	.41	54
	May	283	.28	51
	June	260	.31	81
- 1969	July	174	.38	66
	Aug.	93	.49	46
	Sept.	78	.53	41
	Oct.	94	.55	52
	Nov.	79	.53	42
	Dec.	71	.52	37
	Total	1,448	.40	573
	Jan.	62	.55	34
	Feb.	65	.52	34
	Mar.	72	.51	37
	Apr.	95	.43	41
	May	488	.20	99
	June	471	.21	99
- 1970	July	194	.35	68
	Aug.	109	.46	50
	Sept.	101	.50	50
	Oct.	108	.48	52
	Nov.	92	.50	46
	Dec.	68	.51	35
	Total	1,925	.34	645
	Jan.	72	.49	35
	Feb.	71	.49	35
	Mar.	105	.45	47
	Apr.	174	.32	55
	May	348	.22	77
	June	519	.19	99
1971	July	271	.31	84
	Aug.	121	.44	53
	Sept.	109	.48	52
	Oct.	90	.50	45
	Nov.	86	.47	41
	Dec.	72	.52	37
	Total	2,038	.32	660
	Jan.	67	.52	35
	Feb.	62	.50	31
	Mar.	94	.45	42
	Apr.	116	.36	42
1972	May	255	.24	62
	June	355	.22	79
	July	128	.40	51
	Aug.	97	.44	42
	Sept.	96	.46	44
	Oct.	92	.45	42
	Nov.	87	.43	37
	Dec.	68	.49	33
	Total	1,517	.36	540
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 6
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Glenwood Springs, Colorado

(Annual Summary)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1941	1,713	0.34	254	591
1942	1,903	.33	239	620
1943	1,827	.33	244	607
1944	1,494	.35	257	523
1945	1,764	.31	230	553
1946	1,542	.36	262	549
1947	2,298	.28	207	648
1948	1,881	.32	236	604
1949	2,036	.32	235	652
1950	1,458	.38	276	548
1951	1,891	.33	241	619
1952	2,443	.32	238	791
1953	1,563	.39	290	616
1954	855	.55	404	470
1955	1,051	.49	364	520
1956	1,455	.41	299	591
1957	2,462	.32	238	797
1958	1,680	.35	261	596
1959	1,341	.42	311	567
1960	1,466	.39	285	568
1961	1,209	.44	322	530
1962	2,407	.33	240	786
1963	922	.53	392	492
1964	1,021	.52	381	529
1965	1,764	.38	279	670
1966	1,024	.47	347	483
1967	1,210	.46	337	555
1968	1,350	.42	312	573
1969	1,448	.40	290	573
1970	1,925	.34	246	645

Sampled quality record October 1941 to December 1972; remainder by correlation.
Measured flow record entire period.

Table 6

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River near Glenwood Springs, Colorado

(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	2,038	.32	238	660
1972	1,517	.36	262	540
Total	51,953			19,066
Average	1,624	.37	270	596

Table 7

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River near Cameo, Colorado

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1941	Jan.	65	1.23	80
	Feb.	67	1.15	77
	Mar.	82	1.11	91
	Apr.	133	.83	110
	May	948	.34	322
	June	803	.28	225
	July	315	.47	148
	Aug.	144	.91	131
	Sept.	122	.97	118
	Oct.	166	.88	146
	Nov.	124	.96	119
	Dec.	103	1.11	114
	Total	3,072	.55	1,681
1942	Jan.	90	1.24	112
	Feb.	86	1.19	102
	Mar.	103	1.13	116
	Apr.	334	.62	207
	May	757	.41	310
	June	1,215	.24	292
	July	406	.44	179
	Aug.	139	.85	118
	Sept.	86	1.15	99
	Oct.	94	1.18	111
	Nov.	94	1.24	117
	Dec.	84	1.26	106
	Total	3,488	.54	1,869
1943	Jan.	77	1.30	100
	Feb.	74	1.26	93
	Mar.	89	1.22	109
	Apr.	237	.56	133
	May	509	.32	163
	June	931	.23	214
	July	387	.39	151
	Aug.	192	.73	140
	Sept.	117	.89	104
	Oct.	111	1.00	111
	Nov.	115	.90	103
	Dec.	107	.93	100
	Total	2,946	.52	1,521
1944	Jan.	74	1.24	92
	Feb.	76	1.11	84
	Mar.	81	1.11	90
	Apr.	118	.85	100
	May	564	.36	203
	June	890	.24	214
	July	378	.38	143
	Aug.	123	.80	98
	Sept.	78	1.09	85
	Oct.	99	1.05	104
	Nov.	100	1.01	101
	Dec.	99	1.02	101
	Total	2,680	.53	1,415
1945	Jan.	78	1.15	90
	Feb.	72	1.18	85
	Mar.	95	.99	94
	Apr.	115	.90	104
	May	601	.36	216
	June	794	.27	214
	July	499	.33	165
	Aug.	287	.52	149
	Sept.	118	.83	98
	Oct.	126	.79	100
	Nov.	125	.81	101
	Dec.	117	.89	104
	Total	3,027	.50	1,520
1946	Jan.	109	.90	98
	Feb.	91	.97	88
	Mar.	99	.94	93
	Apr.	285	.45	128
	May	449	.32	144
	June	689	.28	193
	July	267	.51	136
	Aug.	126	.85	107
	Sept.	92	1.01	93
	Oct.	122	.89	109
	Nov.	104	.92	96
	Dec.	121	.82	99
	Total	2,554	.54	1,384
1947	Jan.	82	1.04	85
	Feb.	82	.99	81
	Mar.	107	.96	103
	Apr.	178	.63	112
	May	809	.28	227
	June	1,027	.25	257
	July	732	.27	198
	Aug.	240	.58	139
	Sept.	143	.78	111
	Oct.	153	.80	122
	Nov.	135	.77	104
	Dec.	118	.86	102
	Total	3,806	.43	1,641
1948	Jan.	116	.84	97
	Feb.	111	.81	90
	Mar.	115	.90	104
	Apr.	253	.59	149
	May	920	.30	276
	June	844	.26	219
	July	312	.47	146
	Aug.	161	.77	124
	Sept.	88	1.03	91
	Oct.	109	1.02	111
	Nov.	107	.96	103
	Dec.	90	1.04	94
	Total	3,226	.50	1,604
1949	Jan.	99	.96	95
	Feb.	84	.92	77
	Mar.	98	.98	96
	Apr.	201	.65	131
	May	572	.36	206
	June	1,080	.26	281
	July	594	.34	202
	Aug.	184	.69	127
	Sept.	122	.93	113
	Oct.	125	.98	123
	Nov.	108	1.01	109
	Dec.	101	1.05	106
	Total	3,368	.49	1,666
1950	Jan.	91	1.04	95
	Feb.	88	.95	84
	Mar.	118	.87	103
	Apr.	212	.59	125
	May	418	.40	167
	June	787	.27	212
	July	273	.54	147
	Aug.	125	.87	109
	Sept.	111	.97	108
	Oct.	97	1.19	115
	Nov.	98	1.14	112
	Dec.	98	1.07	105
	Total	2,516	.59	1,482
1951	Jan.	96	1.01	97
	Feb.	88	.95	84
	Mar.	99	1.01	100
	Apr.	151	.70	106
	May	537	.34	183
	June	858	.27	232
	July	471	.36	170
	Aug.	207	.68	141
	Sept.	111	.90	100
	Oct.	120	.92	110
	Nov.	104	.97	101
	Dec.	106	.96	102
	Total	2,948	.52	1,526
1952	Jan.	96	1.01	97
	Feb.	84	1.06	89
	Mar.	113	.99	112
	Apr.	313	.60	188
	May	978	.36	352
	June	1,320	.26	343
	July	449	.44	197
	Aug.	276	.70	193
	Sept.	171	.78	133
	Oct.	123	.97	119
	Nov.	112	1.04	117
	Dec.	99	1.12	111
	Total	4,134	.50	2,051
1953	Jan.	99	1.03	102
	Feb.	80	1.06	85
	Mar.	102	.96	98
	Apr.	136	.78	106
	May	346	.44	152
	June	887	.27	239
	July	294	.52	153
	Aug.	194	.72	140
	Sept.	101	.99	100
	Oct.	101	1.06	107
	Nov.	99	1.13	112
	Dec.	92	1.17	108
	Total	2,531	.59	1,502
1954	Jan.	95	1.00	95
	Feb.	81	1.05	85
	Mar.	94	1.01	95
	Apr.	136	.78	106
	May	296	.48	142
	June	204	.60	123
	July	146	.81	118
	Aug.	105	.97	102
	Sept.	103	1.07	110
	Oct.	125	.97	121
	Nov.	98	1.07	105
	Dec.	82	1.23	101
	Total	1,565	.83	1,303
1955	Jan.	74	1.23	91
	Feb.	67	1.25	84
	Mar.	86	1.13	97
	Apr.	142	.77	110
	May	384	.42	161
	June	448	.37	166
	July	214	.61	130
	Aug.	157	.87	137
	Sept.	100	.94	94
	Oct.	91	1.02	93
	Nov.	94	1.06	100
	Dec.	89	1.07	95
	Total	1,946	.70	1,358
1956	Jan.	81	1.07	87
	Feb.	75	1.11	83
	Mar.	104	.98	102
	Apr.	184	.66	122
	May	685	.34	233
	June	637	.31	197
	July	173	.70	121
	Aug.	115	.95	109
	Sept.	88	.90	79
	Oct.	93	.95	88
	Nov.	83	1.07	89
	Dec.	73	1.21	88
	Total	2,391	.59	1,398
1957	Jan.	80	1.10	88
	Feb.	77	1.10	85
	Mar.	83	1.16	96
	Apr.	151	.83	125
	May	591	.47	278
	June	1,415	.27	382
	July	1,072	.27	289
	Aug.	339	.50	170
	Sept.	157	.78	122
	Oct.	136	.89	121
	Nov.	123	.91	112
	Dec.	102	.96	98
	Total	4,326	.45	1,966
1958	Jan.	92	.93	86
	Feb.	95	.93	88
	Mar.	123	.89	110
	Apr.	171	.76	130
	May	847	.31	263
	June	808	.27	218
	July	193	.67	129
	Aug.	109	.97	106
	Sept.	103	1.03	106
	Oct.	99	1.09	108
	Nov.	94	1.09	102
	Dec.	86	1.12	96
	Total	2,820	.55	1,542

To obtain mg/l multiply T/AF by 735

Table 7

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River near Cameo, Colorado

Units – 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	94	1.02	96
	Feb.	86	1.01	87
	Mar.	83	1.09	90
	Apr.	118	.83	98
	May	392	.40	157
	June	684	.29	198
-1959	July	215	.59	127
	Aug.	131	.87	114
	Sept.	105	.98	103
	Oct.	138	.81	112
	Nov.	116	.87	101
	Dec.	100	.98	98
	Total	2,262	.61	1,381
	Jan.	100	.89	89
	Feb.	91	.95	86
	Mar.	135	.78	105
	Apr.	246	.51	125
	May	432	.37	160
	June	668	.30	200
-1960	July	217	.60	130
	Aug.	117	.89	104
	Sept.	102	.95	97
	Oct.	106	1.00	106
	Nov.	99	1.05	104
	Dec.	100	1.01	101
	Total	2,413	.58	1,407
	Jan.	99	.97	96
	Feb.	85	.94	80
	Mar.	86	1.06	91
	Apr.	103	.91	94
	May	354	.40	142
	June	426	.34	145
-1961	July	138	.81	112
	Aug.	115	.89	102
	Sept.	175	.73	128
	Oct.	200	.59	118
	Nov.	131	.73	96
	Dec.	121	.78	94
	Total	2,033	.64	1,298
	Jan.	115	.78	90
	Feb.	135	.74	100
	Mar.	160	.69	110
	Apr.	513	.40	205
	May	892	.31	277
	June	882	.27	238
-1962	July	545	.37	202
	Aug.	186	.72	134
	Sept.	121	.95	115
	Oct.	173	.74	128
	Nov.	148	.79	117
	Dec.	115	.99	114
	Total	3,985	.46	1,830
	Jan.	95	1.11	105
	Feb.	87	.98	85
	Mar.	98	1.02	100
	Apr.	127	.79	100
	May	323	.40	129
	June	246	.53	130
-1963	July	111	.91	101
	Aug.	115	.92	106
	Sept.	112	.89	100
	Oct.	96	.99	95
	Nov.	90	1.09	98
	Dec.	71	1.32	94
	Total	1,571	.79	1,243
	Jan.	58	1.29	75
	Feb.	55	1.19	65
	Mar.	67	1.13	76
	Apr.	105	.92	97
	May	403	.41	165
	June	465	.35	163
-1964	July	223	.62	138
	Aug.	153	.81	124
	Sept.	116	.86	100
	Oct.	104	1.01	105
	Nov.	94	1.11	104
	Dec.	91	1.08	98
	Total	1,934	.68	1,310
	Jan.	92	1.10	101
	Feb.	78	1.09	85
	Mar.	85	1.15	98
	Apr.	161	.69	111
	May	477	.39	186
	June	920	.28	258
-1965	July	605	.34	206
	Aug.	273	.56	153
	Sept.	172	.75	129
	Oct.	167	.75	125
	Nov.	137	.75	103
	Dec.	138	.75	103
	Total	3,305	.50	1,658
	Jan.	114	.82	93
	Feb.	99	.81	80
	Mar.	133	.77	102
	Apr.	141	.66	93
	May	373	.40	149
	June	277	.48	133
-1966	July	157	.73	115
	Aug.	119	.87	104
	Sept.	101	.94	95
	Oct.	108	.98	106
	Nov.	93	1.05	98
	Dec.	85	1.22	104
	Total	1,800	.71	1,272
	Jan.	86	1.11	95
	Feb.	74	1.06	78
	Mar.	106	.93	99
	Apr.	137	.72	99
	May	328	.43	141
	June	543	.31	168
-1967	July	289	.53	153
	Aug.	137	.83	114
	Sept.	125	.90	112
	Oct.	115	.92	106
	Nov.	104	.95	99
	Dec.	100	1.00	100
	Total	2,144	.64	1,364
	Jan.	89	1.12	100
	Feb.	87	.98	85
	Mar.	96	1.01	97
	Apr.	133	.77	102
	May	326	.43	140
	June	757	.27	204
-1968	July	257	.57	146
	Aug.	224	.67	150
	Sept.	125	.86	108
	Oct.	128	.91	116
	Nov.	113	.95	107
	Dec.	104	.99	103
	Total	2,439	.60	1,458
	Jan.	106	.94	100
	Feb.	86	.99	85
	Mar.	96	.95	91
	Apr.	241	.58	140
	May	561	.34	191
	June	502	.40	201
-1969	July	355	.52	185
	Aug.	152	.79	120
	Sept.	131	.88	115
	Oct.	173	.79	137
	Nov.	131	.85	112
	Dec.	121	1.05	127
	Total	2,655	.60	1,604
	Jan.	105	.96	101
	Feb.	95	.92	87
	Mar.	116	.84	97
	Apr.	154	.64	99
	May	850	.26	224
	June	834	.27	222
-1970	July	363	.45	165
	Aug.	167	.77	128
	Sept.	182	.74	134
	Oct.	171	.78	133
	Nov.	155	.79	122
	Dec.	140	.86	120
	Total	3,332	.49	1,632
	Jan.	138	.82	113
	Feb.	112	.84	94
	Mar.	149	.74	110
	Apr.	293	.48	140
	May	521	.32	165
	June	885	.24	215
1971	July	451	.41	184
	Aug.	179	.72	129
	Sept.	170	.76	130
	Oct.	150	.78	118
	Nov.	137	.78	108
	Dec.	129	.79	102
	Total	3,314	.49	1,608
	Jan.	127	.79	100
	Feb.	119	.87	104
	Mar.	151	.81	122
	Apr.	175	.66	115
	May	394	.39	155
	June	664	.29	192
1972	July	219	.60	132
	Aug.	143	.85	122
	Sept.	150	.81	121
	Oct.	164	.77	126
	Nov.	152	.74	113
	Dec.	128	.81	103
	Total	2,586	.58	1,505
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
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	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 7
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Cameo, Colorado
(Annual Summary)
Units – 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1941	3,072	0.55	402	1,681
1942	3,488	.54	394	1,869
1943	2,946	.52	379	1,521
1944	2,680	.53	388	1,415
1945	3,027	.50	369	1,520
1946	2,554	.54	398	1,384
1947	3,806	.43	317	1,641
1948	3,226	.50	365	1,604
1949	3,368	.49	364	1,666
1950	2,516	.59	433	1,482
1951	2,948	.52	380	1,526
1952	4,134	.50	365	2,051
1953	2,531	.59	436	1,502
1954	1,565	.83	612	1,303
1955	1,946	.70	513	1,358
1956	2,391	.59	430	1,398
1957	4,326	.45	334	1,966
1958	2,820	.55	402	1,542
1959	2,262	.61	449	1,381
1960	2,413	.58	429	1,407
1961	2,033	.64	469	1,298
1962	3,985	.46	338	1,830
1963	1,571	.79	582	1,243
1964	1,934	.68	498	1,310
1965	3,035	.50	369	1,658
1966	1,800	.71	519	1,272
1967	2,144	.64	468	1,364
1968	2,439	.60	439	1,458
1969	2,655	.60	444	1,604
1970	3,332	.49	359	1,632

Sampled quality record entire period.
Measured flow record entire period.

Table 7
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Cameo, Colorado

(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	3,314	.49	357	1,608
1972	2,586	.58	428	1,505
Total	88,847			48,999
Average	2,776	.55	405	1,531

Table 8

Colorado River Basin

Historical Flow and Quality of Water Data

Gunnison River near Grand Junction, Colorado

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	51	1.90	97
	Feb.	50	1.82	93
	Mar.	63	1.67	105
	Apr.	123	1.00	123
	May	871	.40	349
	June	563	.46	259
-1941	July	192	.94	180
	Aug.	95	1.41	134
	Sept.	81	2.11	171
	Oct.	198	1.35	267
	Nov.	121	1.33	161
	Dec.	84	1.58	133
	Total	2,493	.83	2,072
	Jan.	71	1.59	113
	Feb.	62	1.66	103
	Mar.	76	1.64	125
	Apr.	546	.52	284
	May	760	.47	357
	June	688	.38	261
-1942	July	167	.93	156
	Aug.	68	2.18	148
	Sept.	56	2.36	132
	Oct.	57	2.58	147
	Nov.	65	1.92	125
	Dec.	58	1.83	106
	Total	2,674	.77	2,057
	Jan.	57	1.72	98
	Feb.	48	1.60	77
	Mar.	56	1.55	87
	Apr.	289	.44	123
	May	389	.48	187
	June	397	.46	183
-1943	July	113	1.08	122
	Aug.	153	1.43	219
	Sept.	87	1.59	138
	Oct.	69	1.84	127
	Nov.	75	1.59	119
	Dec.	61	1.57	96
	Total	1,784	.88	1,576
	Jan.	51	1.65	84
	Feb.	48	1.44	69
	Mar.	53	1.42	75
	Apr.	102	.97	99
	May	758	.32	242
	June	694	.33	229
-1944	July	230	.69	159
	Aug.	51	1.94	99
	Sept.	45	2.44	110
	Oct.	58	2.31	134
	Nov.	71	1.86	132
	Dec.	64	1.73	111
	Total	2,225	.69	1,543
	Jan.	55	1.58	87
	Feb.	47	1.62	76
	Mar.	52	1.48	77
	Apr.	91	1.00	91
	May	628	.35	220
	June	407	.46	187
-1945	July	163	.85	139
	Aug.	122	1.22	149
	Sept.	46	2.39	110
	Oct.	76	2.00	152
	Nov.	73	1.63	119
	Dec.	58	1.59	92
	Total	1,819	.82	1,499
	Jan.	58	1.55	90
	Feb.	48	1.44	69
	Mar.	58	1.28	74
	Apr.	182	.59	108
	May	228	.59	135
	June	321	.52	167
-1946	July	64	1.62	104
	Aug.	56	2.16	121
	Sept.	54	2.31	125
	Oct.	69	2.06	142
	Nov.	67	1.70	114
	Dec.	56	1.55	87
	Total	1,261	1.06	1,336

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	45	1.67	75
	Feb.	47	1.49	70
	Mar.	55	1.27	70
	Apr.	96	.82	79
	May	455	.39	177
	June	502	.46	231
-1947	July	242	.64	155
	Aug.	120	1.50	180
	Sept.	96	1.63	156
	Oct.	114	1.60	183
	Nov.	96	1.35	130
	Dec.	70	1.41	99
	Total	1,938	.83	1,605
	Jan.	58	1.38	80
	Feb.	65	1.43	93
	Mar.	76	1.38	105
	Apr.	324	.51	165
	May	835	.30	251
	June	546	.40	218
-1948	July	141	.92	129
	Aug.	71	1.84	131
	Sept.	48	2.25	108
	Oct.	57	2.09	119
	Nov.	70	1.84	129
	Dec.	70	1.64	115
	Total	2,361	.70	1,643
	Jan.	51	1.49	76
	Feb.	52	1.48	77
	Mar.	69	1.42	98
	Apr.	236	.57	134
	May	481	.38	183
	June	651	.42	273
-1949	July	265	.65	172
	Aug.	65	1.80	117
	Sept.	53	2.15	114
	Oct.	70	2.09	146
	Nov.	74	1.58	117
	Dec.	54	1.74	94
	Total	2,121	.76	1,601
	Jan.	54	1.57	85
	Feb.	57	2.00	114
	Mar.	60	1.33	80
	Apr.	219	.50	110
	May	309	.45	139
	June	319	.50	160
-1950	July	88	1.43	126
	Aug.	37	2.16	80
	Sept.	46	2.61	120
	Oct.	37	2.65	98
	Nov.	49	2.12	104
	Dec.	60	1.73	104
	Total	1,335	.99	1,320
	Jan.	47	1.64	77
	Feb.	46	1.59	73
	Mar.	55	1.27	70
	Apr.	62	.97	60
	May	265	.51	135
	June	323	.52	168
-1951	July	93	1.06	99
	Aug.	53	1.72	91
	Sept.	37	2.30	85
	Oct.	49	2.41	118
	Nov.	60	1.88	113
	Dec.	46	1.65	76
	Total	1,136	1.03	1,165
	Jan.	53	1.53	81
	Feb.	47	1.48	70
	Mar.	53	1.41	75
	Apr.	342	.46	157
	May	818	.33	270
	June	759	.35	266
-1952	July	200	.79	158
	Aug.	121	1.54	187
	Sept.	76	1.86	141
	Oct.	67	1.90	127
	Nov.	64	2.00	128
	Dec.	72	1.68	121
	Total	2,672	.67	1,781

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	65	1.51	98
	Feb.	50	1.48	74
	Mar.	61	1.26	77
	Apr.	86	1.01	87
	May	230	.57	131
	June	437	.43	188
-1953	July	86	1.13	97
	Aug.	67	1.75	117
	Sept.	46	2.28	105
	Oct.	58	2.40	139
	Nov.	74	1.78	132
	Dec.	52	1.83	95
	Total	1,312	1.02	1,340
	Jan.	49	1.75	86
	Feb.	45	1.58	71
	Mar.	45	1.49	67
	Apr.	70	.84	59
	May	110	.85	93
	June	39	1.92	75
-1954	July	40	2.10	84
	Aug.	31	2.64	82
	Sept.	52	2.50	130
	Oct.	64	1.94	124
	Nov.	51	1.92	98
	Dec.	49	1.90	93
	Total	645	1.65	1,062
	Jan.	46	1.70	78
	Feb.	40	1.67	67
	Mar.	59	1.47	87
	Apr.	108	.74	80
	May	262	.52	136
	June	219	.63	138
-1955	July	46	1.74	80
	Aug.	52	1.86	97
	Sept.	36	2.48	89
	Oct.	38	2.47	94
	Nov.	54	2.08	112
	Dec.	57	1.65	94
	Total	1,016	1.13	1,152
	Jan.	50	1.64	82
	Feb.	44	1.59	70
	Mar.	56	1.30	73
	Apr.	142	.60	85
	May	324	.45	146
	June	262	.53	139
-1956	July	37	1.92	71
	Aug.	29	2.07	60
	Sept.	20	3.15	63
	Oct.	35	2.94	103
	Nov.	55	1.95	107
	Dec.	47	1.87	88
	Total	1,101	.99	1,087
	Jan.	52	1.73	90
	Feb.	55	1.69	93
	Mar.	56	1.36	76
	Apr.	136	.67	91
	May	554	.44	244
	June	1,168	.32	374
-195	July	719	.39	281
	Aug.	224	.83	186
	Sept.	108	1.47	159
	Oct.	106	1.92	204
	Nov.	111	1.33	148
	Dec.	92	1.26	116
	Total	3,381	.61	2,062
	Jan.	66	1.40	92
	Feb.	70	1.50	105
	Mar.	82	1.24	102
	Apr.	254	.57	145
	May	873	.32	279
	June	570	.42	239
-195,	July	65	1.52	99
	Aug.	43	1.74	75
	Sept.	51	2.31	118
	Oct.	52	2.42	126
	Nov.	71	1.82	129
	Dec.	65	1.60	104
	Total	2,262	.71	1,613

To obtain mg/l multiply T/AF by 735.

Table 8

Colorado River Basin

Historical Flow and Quality of Water Data

Gunnison River near Grand Junction, Colorado

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	57	1.58	90
	Feb.	50	1.51	75
	Mar.	52	1.34	70
	Apr.	55	1.10	61
	May	167	.75	125
	June	256	.66	169
-1959	July	34	2.39	81
	Aug.	51	2.01	103
	Sept.	41	2.46	101
	Oct.	96	1.45	139
	Nov.	72	1.39	100
	Dec.	50	1.54	77
	Total	981	1.21	1,191
	Jan.	49	1.46	72
	Feb.	41	1.48	61
	Mar.	87	1.26	110
	Apr.	270	.45	122
	May	259	.45	117
	June	336	.46	155
-1960	July	58	1.33	77
	Aug.	34	2.08	71
	Sept.	38	2.22	84
	Oct.	51	2.34	119
	Nov.	58	1.69	98
	Dec.	51	1.59	81
	Total	1,332	.88	1,167
	Jan.	41	1.65	68
	Feb.	40	1.55	62
	Mar.	55	1.29	71
	Apr.	67	1.05	70
	May	266	.50	133
	June	209	.62	130
-1961	July	34	2.09	71
	Aug.	44	2.07	91
	Sept.	100	1.66	166
	Oct.	107	1.20	128
	Nov.	86	1.20	103
	Dec.	57	1.37	78
	Total	1,106	1.06	1,174
	Jan.	52	1.37	71
	Feb.	58	1.35	78
	Mar.	53	1.22	65
	Apr.	395	.37	146
	May	574	.32	184
	June	477	.37	176
-1962	July	219	.67	147
	Aug.	52	1.72	89
	Sept.	63	1.97	124
	Oct.	70	1.84	129
	Nov.	68	1.62	110
	Dec.	54	1.70	92
	Total	2,135	.66	1,411
	Jan.	48	1.6[illegible]	80
	Feb.	70	1.51	105
	Mar.	82	1.11	91
	Apr.	102	.72	73
	May	188	.53	100
	June	92	1.02	94
-1963	July	37	2.11	78
	Aug.	52	1.99	104
	Sept.	51	2.28	116
	Oct.	55	2.52	139
	Nov.	66	1.70	112
	Dec.	49	1.69	83
	Total	892	1.32	1,176
	Jan.	43	1.58	68
	Feb.	45	1.51	68
	Mar.	43	1.52	65
	Apr.	78	1.00	78
	May	418	.41	171
	June	316	.50	158
-1964	July	83	1.20	100
	Aug.	93	1.61	150
	Sept.	59	1.99	117
	Oct.	53	2.20	117
	Nov.	65	1.85	120
	Dec.	59	1.46	86
	Total	1,355	.96	1,298
	Jan.	55	1.37	75
	Feb.	45	1.28	58
	Mar.	52	1.33	69
	Apr.	228	.52	119
	May	582	.36	210
	June	681	.37	252
-1965	July	472	.47	222
	Aug.	158	.98	155
	Sept.	161	1.29	208
	Oct.	116	1.35	157
	Nov.	63	1.93	122
	Dec.	60	1.58	95
	Total	2,673	.65	1,742
	Jan.	52	1.67	87
	Feb.	37	1.86	69
	Mar.	68	1.30	88
	Apr.	166	.65	108
	May	211	.67	141
	June	125	1.03	129
-1966	July	51	1.75	89
	Aug.	38	2.09	79
	Sept.	58	1.99	115
	Oct.	65	2.03	132
	Nov.	45	2.34	105
	Dec.	55	1.76	97
	Total	971	1.28	1,239
	Jan.	47	1.63	77
	Feb.	42	1.62	68
	Mar.	62	1.16	72
	Apr.	86	.73	63
	May	143	.81	116
	June	152	1.03	157
-1967	July	60	1.78	107
	Aug.	59	1.93	114
	Sept.	70	1.88	132
	Oct.	65	1.88	122
	Nov.	106	1.16	123
	Dec.	165	.73	120
	Total	1,057	1.20	1,271
	Jan.	119	.95	113
	Feb.	96	1.03	99
	Mar.	65	1.20	78
	Apr.	68	.97	66
	May	268	.57	153
	June	258	.56	144
-1968	July	59	1.62	96
	Aug.	107	1.56	167
	Sept.	68	1.86	126
	Oct.	87	1.72	150
	Nov.	133	1.08	144
	Dec.	149	.77	115
	Total	1,477	.98	1,451
	Jan.	146	.80	117
	Feb.	75	1.03	77
	Mar.	145	.70	[illegible]
	Apr.	[illegible]	[illegible]	[illegible]
	May	332	.49	162
	June	194	1.03	200
-1969	July	100	1.37	137
	Aug.	91	1.40	128
	Sept.	119	1.43	170
	Oct.	155	1.27	197
	Nov.	143	.98	140
	Dec.	128	.88	113
	Total	1,932	.87	1,673
	Jan.	129	.78	100
	Feb.	122	.70	85
	Mar.	149	.68	101
	Apr.	137	.69	95
	May	404	.42	169
	June	415	.50	208
-1970	July	174	.79	137
	Aug.	101	1.27	128
	Sept.	196	1.07	209
	Oct.	188	1.13	212
	Nov.	170	.78	133
	Dec.	181	.65	117
	Total	2,366	.72	1,694
	Jan.	196	.54	107
	Feb.	201	.45	90
	Mar.	239	.44	106
	Apr.	266	.40	105
	May	209	.66	139
	June	212	.72	152
1971	July	114	1.07	122
	Aug.	114	.95	108
	Sept.	133	1.08	144
	Oct.	120	1.22	146
	Nov.	132	.88	116
	Dec.	144	.76	109
	Total	2,080	.69	1,444
	Jan.	126	.61	77
	Feb.	110	.61	68
	Mar.	109	.65	71
	Apr.	67	.87	58
	May	115	.86	99
	June	118	.91	107
1972	July	36	1.86	66
	Aug.	38	1.73	66
	Sept.	84	1.42	120
	Oct.	104	1.38	143
	Nov.	125	.89	111
	Dec.	157	.61	95
	Total	1,189	.91	1,081
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 8
Colorado River Basin
Historical Flow and Quality of Water Data
Gunnison River near Grand Junction, Colorado
(Annual Summary)

Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1941	2,493	.83	611	2,072
1942	2,674	.77	565	2,057
1943	1,784	.88	649	1,576
1944	2,225	.69	510	1,543
1945	1,818	.82	606	1,499
1946	1,262	1.06	778	1,336
1947	1,938	.83	609	1,605
1948	2,361	.70	511	1,643
1949	2,121	.76	555	1,601
1950	1,335	.99	727	1,320
1951	1,136	1.03	754	1,165
1952	2,672	.67	490	1,781
1953	1,312	1.02	751	1,340
1954	645	1.65	1,210	1,062
1955	1,017	1.13	833	1,152
1956	1,101	.99	726	1,087
1957	3,381	.61	448	2,062
1958	2,262	.71	524	1,613
1959	981	1.21	892	1,191
1960	1,332	.88	644	1,167
1961	1,106	1.06	778	1,171
1962	2,135	.66	486	1,411
1963	892	1.32	969	1,176
1964	1,355	.96	704	1,298
1965	2,673	.65	479	1,742
1966	971	1.28	938	1,239
1967	1,057	1.20	884	1,271
1968	1,477	.98	722	1,451
1969	1,932	.87	636	1,673
1970	2,366	.72	526	1,694

Sampled quality record entire period.
Measured flow record entire period.

Table 8
Colorado River Basin
Historical Flow and Quality of Water Data
Gunnison River near Grand Junction, Colorado

(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	2,080	.69	510	1,444
1972	1,189	.91	668	1,081
Total	55,083			46,523
Average	1,721	.84	621	1,454

Table 9

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River near Cisco, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1941	Jan.	139	1.86	259
	Feb.	153	1.78	272
	Mar.	207	1.64	339
	Apr.	445	1.00	445
	May	2,355	.42	989
	June	1,582	.46	728
	July	579	.73	423
	Aug.	251	1.67	419
	Sept.	237	1.81	429
	Oct.	579	1.10	637
	Nov.	311	1.18	367
	Dec.	229	1.51	346
	Total	7,067	.80	5,653
1942	Jan.	181	1.67	302
	Feb.	165	1.73	285
	Mar.	228	1.52	347
	Apr.	1,344	.61	820
	May	1,809	.45	814
	June	1,961	.37	725
	July	579	.78	451
	Aug.	185	1.84	340
	Sept.	134	2.46	329
	Oct.	162	2.33	378
	Nov.	186	1.99	370
	Dec.	164	1.96	322
	Total	7,098	.77	5,483
1943	Jan.	153	1.90	291
	Feb.	146	1.85	270
	Mar.	174	1.77	308
	Apr.	709	.64	454
	May	996	.46	458
	June	1,365	.38	518
	July	502	.78	392
	Aug.	368	1.26	463
	Sept.	212	1.85	392
	Oct.	184	1.84	339
	Nov.	215	1.47	317
	Dec.	190	1.56	296
	Total	5,214	.86	4,498
1944	Jan.	140	1.77	248
	Feb.	152	1.56	237
	Mar.	166	1.51	251
	Apr.	304	1.09	331
	May	1,784	.41	732
	June	1,843	.35	645
	July	677	.61	413
	Aug.	149	1.62	241
	Sept.	99	2.54	252
	Oct.	159	2.18	347
	Nov.	196	1.78	348
	Dec.	171	1.70	291
	Total	5,840	.74	4,336
1945	Jan.	149	1.73	258
	Feb.	151	1.74	263
	Mar.	178	1.56	277
	Apr.	328	.88	289
	May	1,495	.36	538
	June	1,311	.37	485
	July	676	.67	453
	Aug.	446	1.01	451
	Sept.	146	1.85	270
	Oct.	217	1.75	380
	Nov.	224	1.41	316
	Dec.	183	1.26	230
	Total	5,504	.76	4,210
1946	Jan.	174	1.37	239
	Feb.	155	1.27	197
	Mar.	191	1.24	236
	Apr.	525	.61	320
	May	726	.49	356
	June	1,027	.42	432
	July	309	.98	303
	Aug.	196	1.66	325
	Sept.	135	2.10	283
	Oct.	206	1.85	382
	Nov.	206	1.56	322
	Dec.	208	1.37	285
	Total	4,058	.91	3,680
1947	Jan.	145	1.58	229
	Feb.	150	1.44	216
	Mar.	189	1.39	263
	Apr.	316	.85	268
	May	1,423	.40	569
	June	1,594	.39	621
	July	985	.47	463
	Aug.	369	1.21	447
	Sept.	259	1.44	373
	Oct.	328	1.47	483
	Nov.	277	1.24	343
	Dec.	223	1.40	312
	Total	6,258	.73	4,587
1948	Jan.	191	1.34	256
	Feb.	210	1.33	280
	Mar.	245	1.36	333
	Apr.	830	.64	531
	May	1,959	.36	705
	June	1,499	.39	585
	July	446	.86	384
	Aug.	225	1.52	342
	Sept.	121	1.88	228
	Oct.	175	1.96	343
	Nov.	204	1.67	341
	Dec.	186	1.66	308
	Total	6,291	.74	4,636
1949	Jan.	188	1.54	289
	Feb.	187	1.35	253
	Mar.	243	1.40	340
	Apr.	615	.67	412
	May	1,289	.41	529
	June	1,910	.37	707
	July	908	.55	499
	Aug.	224	1.58	354
	Sept.	158	2.08	328
	Oct.	226	1.83	414
	Nov.	210	1.71	359
	Dec.	180	1.66	299
	Total	6,338	.75	4,783
1950	Jan.	199	1.52	302
	Feb.	201	1.44	289
	Mar.	209	1.31	274
	Apr.	541	.61	330
	May	764	.51	389
	June	1,113	.42	467
	July	347	1.03	357
	Aug.	109	2.02	220
	Sept.	138	2.12	292
	Oct.	125	2.35	294
	Nov.	161	1.96	316
	Dec.	167	1.75	293
	Total	4,074	.94	3,823
1951	Jan.	153	1.69	258
	Feb.	151	1.51	228
	Mar.	161	1.46	236
	Apr.	173	1.21	209
	May	758	.54	409
	June	1,173	.43	505
	July	529	.68	360
	Aug.	238	1.47	350
	Sept.	131	2.06	270
	Oct.	169	1.99	336
	Nov.	178	1.74	310
	Dec.	172	1.67	287
	Total	3,986	.94	3,758
1952	Jan.	191	1.59	303
	Feb.	155	1.65	256
	Mar.	194	1.48	287
	Apr.	969	.53	514
	May	2,152	.35	753
	June	2,314	.33	764
	July	641	.72	462
	Aug.	358	1.18	422
	Sept.	213	1.58	337
	Oct.	166	1.92	318
	Nov.	177	1.89	334
	Dec.	188	1.66	313
	Total	7,718	.66	5,063
1953	Jan.	185	1.65	306
	Feb.	143	1.63	233
	Mar.	187	1.52	284
	Apr.	250	1.00	250
	May	606	.60	364
	June	1,399	.41	574
	July	353	.95	335
	Aug.	256	1.23	315
	Sept.	128	2.22	284
	Oct.	177	1.89	334
	Nov.	207	1.77	366
	Dec.	171	1.75	299
	Total	4,062	.97	3,944
1954	Jan.	177	1.76	312
	Feb.	143	1.65	236
	Mar.	161	1.46	235
	Apr.	221	.98	217
	May	436	.74	323
	June	217	1.17	254
	July	150	1.69	253
	Aug.	98	2.30	225
	Sept.	171	2.09	358
	Oct.	215	1.59	342
	Nov.	164	1.70	278
	Dec.	140	1.90	266
	Total	2,293	1.44	3,299
1955	Jan.	134	1.84	247
	Feb.	121	1.78	215
	Mar.	198	1.33	263
	Apr.	320	.82	262
	May	752	.50	376
	June	689	.55	379
	July	214	1.21	259
	Aug.	185	1.66	307
	Sept.	108	2.16	233
	Oct.	119	2.19	261
	Nov.	169	1.89	319
	Dec.	176	1.70	299
	Total	3,185	1.07	3,420
1956	Jan.	155	1.69	262
	Feb.	141	1.70	239
	Mar.	187	1.50	281
	Apr.	356	.72	256
	May	1,005	.45	452
	June	924	.44	406
	July	172	1.47	253
	Aug.	119	1.97	234
	Sept.	81	2.38	193
	Oct.	121	2.22	269
	Nov.	165	1.87	308
	Dec.	142	1.94	275
	Total	3,568	.96	3,428
1957	Jan.	164	1.80	296
	Feb.	168	1.55	260
	Mar.	167	1.56	260
	Apr.	398	.86	342
	May	1,375	.44	605
	June	2,859	.29	829
	July	1,952	.37	722
	Aug.	661	.83	549
	Sept.	314	1.21	380
	Oct.	292	1.78	520
	Nov.	299	1.44	431
	Dec.	239	1.71	408
	Total	8,888	.63	5,602
1958	Jan.	200	1.52	304
	Feb.	225	1.34	302
	Mar.	254	1.29	328
	Apr.	756	.53	401
	May	2,032	.31	630
	June	1,560	.40	624
	July	234	1.22	285
	Aug.	109	2.17	236
	Sept.	153	2.14	328
	Oct.	155	1.99	308
	Nov.	190	1.66	315
	Dec.	176	1.63	287
	Total	6,044	.72	4,348

To obtain mg/l multiply T/AF by 735.

Table 9
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Cisco, Utah
Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	168	1.71	287
	Feb.	153	1.41	216
	Mar.	150	1.60	240
	Apr.	163	1.39	227
	May	535	.65	348
	June	924	.50	462
- 1959	July	214	1.15	246
	Aug.	160	1.91	306
	Sept.	124	2.14	265
	Oct.	250	1.43	358
	Nov.	210	1.31	275
	Dec.	163	1.54	251
	Total	3,214	1.08	3,481
	Jan.	164	1.51	248
	Feb.	143	1.51	216
	Mar.	273	1.22	333
	Apr.	629	.51	321
	May	758	.49	371
	June	1,068	.42	448
- 1960	July	250	1.04	260
	Aug.	105	1.96	206
	Sept.	117	2.16	253
	Oct.	153	1.94	297
	Nov.	177	1.67	296
	Dec.	165	1.48	244
	Total	4,002	.87	3,493
	Jan.	156	1.43	223
	Feb.	140	1.52	213
	Mar.	162	1.44	233
	Apr.	206	1.14	235
	May	677	.57	386
	June	664	.51	339
- 1961	July	130	1.62	211
	Aug.	138	2.01	277
	Sept.	316	1.49	471
	Oct.	357	1.07	382
	Nov.	252	1.23	310
	Dec.	197	1.40	276
	Total	3,395	1.05	3,556
	Jan.	182	1.29	235
	Feb.	261	1.12	292
	Mar.	246	1.05	258
	Apr.	1,054	.44	464
	May	1,603	.38	609
	June	1,400	.38	532
- 1962	July	765	.58	444
	Aug.	206	1.42	293
	Sept.	173	1.99	344
	Oct.	263	1.43	376
	Nov.	243	1.31	318
	Dec.	180	1.77	319
	Total	6,576	.68	4,484
	Jan.	163	1.52	248
	Feb.	193	1.51	292
	Mar.	219	1.30	285
	Apr.	245	.91	223
	May	517	.62	320
	June	332	.93	309
- 1963	July	114	1.94	221
	Aug.	168	1.94	326
	Sept.	183	1.80	329
	Oct.	134	2.14	287
	Nov.	179	1.62	290
	Dec.	138	1.84	254
	Total	2,585	1.31	3,384
	Jan.	132	1.85	244
	Feb.	121	1.79	217
	Mar.	128	1.87	239
	Apr.	214	1.11	238
	May	861	.50	430
	June	780	.50	390
- 1964	July	276	1.07	295
	Aug.	241	1.51	364
	Sept.	153	1.88	288
	Oct.	164	1.93	317
	Nov.	182	1.81	329
	Dec.	181	1.59	288
	Total	3,433	1.06	3,639
	Jan.	162	1.55	251
	Feb.	140	1.63	228
	Mar.	154	1.59	245
	Apr.	562	.68	382
	May	1,272	.39	496
	June	1,654	.38	629
- 1965	July	1,116	.52	580
	Aug.	447	.94	420
	Sept.	369	1.21	446
	Oct.	360	1.32	475
	Nov.	249	1.65	411
	Dec.	237	1.39	329
	Total	5,722	.73	4,892
	Jan.	200	1.38	276
	Feb.	169	1.34	226
	Mar.	278	.96	267
	Apr.	438	.61	267
	May	697	.53	369
	June	429	.83	356
- 1966	July	185	1.50	278
	Aug.	120	1.89	227
	Sept.	145	2.01	291
	Oct.	175	1.87	327
	Nov.	153	1.89	289
	Dec.	174	1.71	298
	Total	3,163	1.10	3,471
	Jan.	146	1.77	258
	Feb.	136	1.71	233
	Mar.	185	1.30	240
	Apr.	198	1.31	259
	May	462	.76	351
	June	713	.65	463
- 1967	July	327	1.09	356
	Aug.	175	1.76	308
	Sept.	178	1.77	315
	Oct.	174	1.39	242
	Nov.	211	1.39	293
	Dec.	241	1.18	284
	Total	3,146	1.14	3,602
	Jan.	205	1.18	242
	Feb.	193	1.20	232
	Mar.	171	1.41	241
	Apr.	230	.99	228
	May	667	.60	400
	June	1,171	.44	515
- 1968	July	306	1.08	330
	Aug.	365	1.23	449
	Sept.	159	1.72	273
	Oct.	213	1.63	347
	Nov.	257	1.28	329
	Dec.	248	1.14	283
	Total	4,185	.92	3,869
	Jan.	259	1.04	270
	Feb.	189	1.19	224
	Mar.	250	.97	242
	Apr.	714	.56	400
	May	987	.24	239
	June	731	.60	439
- 1969	July	472	.82	387
	Aug.	199	1.44	287
	Sept.	240	1.47	353
	Oct.	324	1.12	364
	Nov.	289	1.06	305
	Dec.	252	1.06	267
	Total	4,906	.77	3,777
	Jan.	236	1.06	251
	Feb.	220	.95	208
	Mar.	277	.87	241
	Apr.	327	.82	267
	May	1,384	.37	518
	June	1,339	.39	518
- 1970	July	537	.68	366
	Aug.	245	1.20	294
	Sept.	407	1.06	432
	Oct.	360	.99	357
	Nov.	338	.90	305
	Dec.	317	.87	275
	Total	5,987	.67	4,032
	Jan.	332	.78	258
	Feb.	321	.68	216
	Mar.	413	.63	262
	Apr.	580	.50	288
	May	768	.52	398
	June	1,141	.40	457
1971	July	535	.65	349
	Aug.	246	1.16	286
	Sept.	282	1.13	320
	Oct.	280	1.28	357
	Nov.	276	1.12	308
	Dec.	284	1.06	302
	Total	5,458	.70	3,801
	Jan.	267	1.02	273
	Feb.	227	1.03	233
	Mar.	279	1.07	299
	Apr.	202	.98	198
	May	453	.71	320
	June	759	.50	377
1972	July	191	1.20	229
	Aug.	119	1.66	198
	Sept.	201	1.54	309
	Oct.	253	1.35	342
	Nov.	277	1.14	317
	Dec.	257	1.02	263
	Total	3,485	.96	3,358
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
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	July			
	Aug.			
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	Total			
	Jan.			
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	Total			
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	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 9
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./1)	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

Sampled quality record entire period.
Measured flow record entire period.

Table 9
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)
1971	5,458	.70	512	3,801
1972	3,485	.96	708	3,358
Total	157,743			131,390
Average	4,929	.83	612	4,106

Table 10

Colorado River Basin

Historical Flow and Quality of Water Data

San Juan River near Archuleta, New Mexico

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1941	Jan.	22	0.41	9
	Feb.	46	.35	16
	Mar.	98	.38	37
	Apr.	251	.21	53
	May	709	.16	113
	June	560	.12	68
	July	324	.14	46
	Aug.	84	.19	16
	Sept.	68	.24	16
	Oct.	273	.12	33
	Nov.	87	.17	15
	Dec.	52	.21	11
	Total	2,574	.17	430
1942	Jan.	45	.33	15
	Feb.	48	.25	12
	Mar.	54	.42	23
	Apr.	383	.21	82
	May	320	.15	48
	June	310	.12	38
	July	76	.18	14
	Aug.	41	.22	9
	Sept.	28	.25	7
	Oct.	23	.26	6
	Nov.	22	.27	6
	Dec.	16	.38	6
	Total	1,366	.19	266
1943	Jan.	16	.44	7
	Feb.	26	.35	9
	Mar.	55	.38	21
	Apr.	198	.19	37
	May	184	.16	30
	June	134	.15	20
	July	51	.24	12
	Aug.	48	.21	10
	Sept.	28	.25	7
	Oct.	35	.20	7
	Nov.	24	.29	7
	Dec.	19	.32	6
	Total	818	.21	173
1944	Jan.	16	.38	6
	Feb.	19	.32	6
	Mar.	34	.47	16
	Apr.	131	.21	27
	May	371	.16	61
	June	382	.13	49
	July	134	.16	22
	Aug.	45	.20	9
	Sept.	43	.23	10
	Oct.	41	.22	9
	Nov.	21	.29	6
	Dec.	14	.43	6
	Total	1,251	.18	227
1945	Jan.	14	.43	6
	Feb.	22	.45	10
	Mar.	35	.49	17
	Apr.	143	.20	28
	May	278	.16	44
	June	209	.13	28
	July	68	.21	14
	Aug.	40	.22	9
	Sept.	21	.24	5
	Oct.	30	.37	11
	Nov.	19	.37	7
	Dec.	12	.50	6
	Total	891	.21	185
1946	Jan.	14	.43	6
	Feb.	17	.47	8
	Mar.	22	.50	11
	Apr.	66	.23	15
	May	73	.18	13
	June	87	.18	16
	July	27	.33	9
	Aug.	40	.35	14
	Sept.	29	.31	9
	Oct.	36	.31	11
	Nov.	26	.35	9
	Dec.	19	.32	6
	Total	456	.28	127
1947	Jan.	15	0.40	6
	Feb.	24	.38	9
	Mar.	32	.34	11
	Apr.	50	.24	12
	May	186	.17	32
	June	140	.13	18
	July	43	.28	12
	Aug.	73	.30	22
	Sept.	56	.23	13
	Oct.	77	.21	16
	Nov.	37	.22	8
	Dec.	27	.26	7
	Total	760	.22	166
1948	Jan.	27	.26	7
	Feb.	39	.33	13
	Mar.	43	.35	15
	Apr.	246	.20	49
	May	306	.14	43
	June	338	.12	40
	July	79	.16	13
	Aug.	49	.24	12
	Sept.	22	.32	7
	Oct.	23	.35	8
	Nov.	18	.39	7
	Dec.	13	.46	6
	Total	1,203	.18	220
1949	Jan.	16	.44	7
	Feb.	25	.36	9
	Mar.	73	.37	27
	Apr.	228	.24	55
	May	318	.15	48
	June	406	.13	53
	July	199	.15	30
	Aug.	57	.24	14
	Sept.	33	.27	9
	Oct.	30	.30	9
	Nov.	21	.38	8
	Dec.	14	.50	7
	Total	1,420	.19	276
1950	Jan.	16	.37	6
	Feb.	29	.41	12
	Mar.	31	.42	13
	Apr.	116	.19	22
	May	126	.15	19
	June	112	.16	18
	July	44	.27	12
	Aug.	20	.35	7
	Sept.	24	.38	9
	Oct.	20	.35	7
	Nov.	14	.50	7
	Dec.	12	.50	6
	Total	564	.24	138
1951	Jan.	10	.50	5
	Feb.	11	.45	5
	Mar.	20	.45	9
	Apr.	35	.29	10
	May	117	.18	21
	June	94	.17	16
	July	21	.38	8
	Aug.	33	.36	12
	Sept.	22	.36	8
	Oct.	17	.47	8
	Nov.	15	.47	7
	Dec.	18	.44	8
	Total	413	.28	117
1952	Jan.	19	.53	10
	Feb.	19	.53	10
	Mar.	47	.49	23
	Apr.	326	.26	85
	May	396	.16	63
	June	454	.13	59
	July	136	.18	24
	Aug.	66	.26	17
	Sept.	33	.27	9
	Oct.	22	.32	7
	Nov.	16	.44	7
	Dec.	18	.39	7
	Total	1,552	.21	321
1953	Jan.	18	0.39	7
	Feb.	18	.39	7
	Mar.	37	.41	15
	Apr.	75	.24	18
	May	117	.19	22
	June	148	.15	22
	July	41	.32	13
	Aug.	33	.33	11
	Sept.	16	.44	7
	Oct.	23	.43	10
	Nov.	23	.43	10
	Dec.	14	.50	7
	Total	563	.26	149
1954	Jan.	11	.45	5
	Feb.	21	.48	10
	Mar.	28	.46	13
	Apr.	90	.21	19
	May	143	.18	26
	June	67	.19	13
	July	37	.41	15
	Aug.	45	.29	13
	Sept.	30	.43	13
	Oct.	42	.24	10
	Nov.	18	.39	7
	Dec.	13	.46	6
	Total	545	.28	150
1955	Jan.	12	.42	5
	Feb.	13	.31	4
	Mar.	27	.37	10
	Apr.	45	.24	11
	May	132	.18	24
	June	119	.16	19
	July	42	.29	12
	Aug.	67	.28	19
	Sept.	28	.29	8
	Oct.	20	.30	6
	Nov.	17	.35	6
	Dec.	15	.40	6
	Total	537	.24	130
1956	Jan.	16	.38	6
	Feb.	15	.40	6
	Mar.	48	.33	16
	Apr.	79	.20	16
	May	173	.14	24
	June	117	.15	18
	July	25	.32	8
	Aug.	23	.35	8
	Sept.	11	.36	4
	Oct.	12	.42	5
	Nov.	11	.45	5
	Dec.	9	.44	4
	Total	539	.22	120
1957	Jan.	13	.46	6
	Feb.	30	.47	14
	Mar.	46	.43	20
	Apr.	120	.28	34
	May	222	.19	42
	June	480	.13	62
	July	326	.16	52
	Aug.	164	.22	36
	Sept.	67	.19	13
	Oct.	67	.30	20
	Nov.	68	.26	18
	Dec.	44	.30	13
	Total	1,647	.20	330
1958	Jan.	22	.36	8
	Feb.	51	.43	22
	Mar.	77	.42	32
	Apr.	279	.30	84
	May	460	.17	78
	June	270	.13	35
	July	42	.26	11
	Aug.	35	.31	11
	Sept.	40	.30	12
	Oct.	25	.36	9
	Nov.	17	.41	7
	Dec.	14	.43	6
	Total	1,332	.24	315

To obtain mg/l multiply T/AF by 735.

Table 10

Colorado River Basin

Historical Flow and Quality of Water Data

San Juan River near Archuleta, New Mexico

Units-1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1959	Jan.	11	0.46	5
	Feb.	14	.44	6
	Mar.	18	.42	8
	Apr.	37	.30	11
	May	87	.18	16
	June	84	.16	13
	July	18	.32	6
	Aug.	34	.33	11
	Sept.	15	.34	5
	Oct.	60	.30	18
	Nov.	39	.30	12
	Dec.	19	.37	7
	Total	436	.27	118
1960	Jan.	14	.43	6
	Feb.	16	.42	7
	Mar.	175	.34	60
	Apr.	240	.19	46
	May	193	.17	33
	June	232	.13	30
	July	55	.23	13
	Aug.	25	.29	7
	Sept.	23	.31	7
	Oct.	26	.37	10
	Nov.	16	.42	7
	Dec.	14	.54	7
	Total	1,029	.23	233
1961	Jan.	12	.45	5
	Feb.	16	.43	7
	Mar.	43	.44	19
	Apr.	113	.26	29
	May	192	.15	29
	June	122	.16	19
	July	38	.28	11
	Aug.	52	.28	15
	Sept.	58	.25	15
	Oct.	52	.24	12
	Nov.	34	.28	10
	Dec.	18	.31	6
	Total	750	.24	177
1962	Jan.	15	.37	6
	Feb.	42	.38	16
	Mar.	51	.38	20
	Apr.	242	.20	48
	May	228	.14	32
	June	165	.14	23
	July	39	.19	7
	Aug.	29	.25	7
	Sept.	19	.25	5
	Oct.	18	.31	6
	Nov.	14	.33	5
	Dec.	10	.37	4
	Total	872	.21	179
1963	Jan.	7	.39	3
	Feb.	8	.43	4
	Mar.	15	.39	6
	Apr.	31	.38	12
	May	19	.26	5
	June	19	.19	4
	July	20	.18	4
	Aug.	21	.19	4
	Sept.	20	.20	4
	Oct.	24	.23	6
	Nov.	24	.24	6
	Dec.	24	.28	7
	Total	232	.28	65
1964	Jan.	17	.32	6
	Feb.	13	.31	4
	Mar.	13	.32	4
	Apr.	15	.32	5
	May	34	.31	10
	June	82	.28	23
	July	108	.25	27
	Aug.	48	.23	11
	Sept.	26	.22	6
	Oct.	28	.23	6
	Nov.	21	.27	6
	Dec.	32	.28	9
	Total	437	.27	117
1965	Jan.	90	0.29	26
	Feb.	92	.30	28
	Mar.	52	.36	19
	Apr.	85	.35	30
	May	138	.29	40
	June	215	.20	43
	July	102	.18	18
	Aug.	136	.17	23
	Sept.	112	.17	19
	Oct.	131	.13	17
	Nov.	180	.16	29
	Dec.	178	.18	32
	Total	1,511	.21	324
1966	Jan.	168	.21	35
	Feb.	94	.26	24
	Mar.	114	.29	33
	Apr.	181	.28	51
	May	130	.26	34
	June	27	.22	6
	July	28	.17	5
	Aug.	29	.18	5
	Sept.	27	.17	5
	Oct.	91	.18	16
	Nov.	47	.20	9
	Dec.	25	.24	6
	Total	961	.24	229
1967	Jan.	25	.26	6
	Feb.	45	.26	12
	Mar.	70	.26	18
	Apr.	23	.27	6
	May	17	.31	5
	June	18	.35	6
	July	20	.34	7
	Aug.	62	.29	18
	Sept.	59	.26	15
	Oct.	21	.23	5
	Nov.	21	.26	5
	Dec.	21	.28	6
	Total	402	.27	109
1968	Jan.	19	.29	6
	Feb.	20	.26	5
	Mar.	18	.29	5
	Apr.	60	.27	16
	May	49	.26	13
	June	28	.26	7
	July	30	.28	8
	Aug.	39	.27	11
	Sept.	47	.25	12
	Oct.	35	.25	9
	Nov.	23	.24	6
	Dec.	24	.23	6
	Total	392	.27	104
1969	Jan.	40	.22	9
	Feb.	110	.23	25
	Mar.	94	.20	19
	Apr.	110	.25	27
	May	117	.22	26
	June	118	.22	26
	July	98	.22	22
	Aug.	72	.21	15
	Sept.	76	.21	16
	Oct.	96	.20	19
	Nov.	81	.21	17
	Dec.	90	.21	19
	Total	1,102	.22	240
1970	Jan.	51	.22	11
	Feb.	110	.19	21
	Mar.	91	.20	18
	Apr.	26	.23	6
	May	29	.24	7
	June	30	.23	7
	July	31	.19	6
	Aug.	39	.18	7
	Sept.	78	.19	15
	Oct.	110	.22	24
	Nov.	104	.22	23
	Dec.	120	.22	26
	Total	819	.21	171
1971	Jan.	141	.23	32
	Feb.	120	.24	29
	Mar.	68	.22	15
	Apr.	30	.23	7
	May	31	.22	7
	June	29	.24	7
	July	31	.22	7
	Aug.	30	.21	6
	Sept.	30	.22	7
	Oct.	25	.26	6
	Nov.	18	.29	5
	Dec.	65	.21	14
	Total	618	.23	142
1972	Jan.	93	.22	20
	Feb.	84	.26	22
	Mar.	93	.28	26
	Apr.	49	.28	14
	May	31	.24	7
	June	30	.28	9
	July	31	.30	9
	Aug.	38	.24	9
	Sept.	37	.27	10
	Oct.	32	.29	9
	Nov.	30	.27	8
	Dec.	62	.27	17
	Total	610	.26	160
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 10
Colorado River Basin
Historical Flow and Quality of Water Data
San Juan River near Archuleta, New Mexico

(Annual Summary)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./1)	T.D.S. (Tons)
1941	2,574	0.17	123	430
1942	1,366	.19	143	266
1943	818	.21	155	173
1944	1,251	.18	133	227
1945	891	.21	153	185
1946	456	.28	205	127
1947	760	.22	161	166
1948	1,203	.18	134	220
1949	1,420	.19	142	276
1950	564	.24	180	138
1951	413	.28	208	117
1952	1,552	.21	152	321
1953	563	.26	195	149
1954	545	.28	202	150
1955	537	.24	178	130
1956	539	.22	164	120
1957	1,647	.20	147	330
1958	1,332	.24	174	315
1959	436	.27	199	118
1960	1,029	.23	166	233
1961	750	.24	173	177
1962	872	.21	151	179
1963	232	.28	206	65
1964	437	.27	197	117
1965	1,511	.21	158	324
1966	961	.24	175	229
1967	402	.27	199	109
1968	392	.27	195	104
1969	1,102	.22	159	240
1970	819	.21	153	171

Sampled quality record, October 1945 to December 1972; remainder by correlation.

Measured flow record entire period.

Adjusted quality and flow record for station near Blanco, October 1945 to November 1954.

Table 10
Colorado River Basin
Historical Flow and Quality of Water Data
San Juan River near Archuleta, New Mexico

(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	618	.23	169	142
1972	610	.26	193	160
Total	28,602			6,208
Average	894	.22	159	194

Table II

Colorado River Basin

Historical Flow and Quality of Water Data

San Juan River near Bluff, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	78	1.01	79
	Feb.	127	.98	124
	Mar.	211	.78	165
	Apr.	392	.62	243
	May	1,323	.50	662
	June	915	.30	275
-1941	July	526	.30	158
	Aug.	174	.70	122
	Sept.	202	.87	176
	Oct.	655	.64	419
	Nov.	191	.61	117
	Dec.	105	.81	85
	Total	4,899	.54	2,625
	Jan.	81	.93	75
	Feb.	68	.93	63
	Mar.	126	.95	120
	Apr.	602	.51	307
	May	479	.38	182
	June	533	.26	139
-1942	July	150	.48	72
	Aug.	51	.82	42
	Sept.	38	1.00	38
	Oct.	37	1.22	45
	Nov.	39	1.23	48
	Dec.	43	1.26	54
	Total	2,247	.53	1,185
	Jan.	43	1.26	54
	Feb.	49	1.18	58
	Mar.	95	1.09	104
	Apr.	294	.47	138
	May	332	.39	129
	June	254	.38	96
-1943	July	106	.57	60
	Aug.	91	1.01	92
	Sept.	62	.90	56
	Oct.	58	1.00	58
	Nov.	59	.97	57
	Dec.	51	1.12	57
	Total	1,494	.64	959
	Jan.	37	1.16	43
	Feb.	49	1.14	56
	Mar.	76	1.06	81
	Apr.	204	.62	126
	May	640	.36	230
	June	705	.25	176
-1944	July	283	.35	99
	Aug.	61	.85	52
	Sept.	66	.92	61
	Oct.	75	.91	68
	Nov.	52	1.12	58
	Dec.	43	1.19	51
	Total	2,291	.48	1,101
	Jan.	41	1.22	50
	Feb.	63	1.13	71
	Mar.	72	1.03	74
	Apr.	196	.61	120
	May	456	.35	160
	June	377	.29	109
-1945	July	128	.50	64
	Aug.	96	1.13	108
	Sept.	21	1.18	25
	Oct.	62	1.10	68
	Nov.	46	1.04	48
	Dec.	30	1.27	38
	Total	1,588	.59	935
	Jan.	37	1.14	42
	Feb.	36	1.19	43
	Mar.	47	1.04	49
	Apr.	95	.66	63
	May	125	.49	61
-1946	June	204	.40	82
	July	63	.86	54
	Aug.	75	1.12	84
	Sept.	44	.93	41
	Oct.	55	.98	54
	Nov.	60	1.02	61
	Dec.	46	1.02	47
	Total	887	.77	681
	Jan.	31	1.13	35
	Feb.	45	1.07	48
	Mar.	51	.90	46
	Apr.	68	.63	43
	May	329	.38	125
	June	276	.30	83
-1947	July	110	.41	45
	Aug.	294	1.01	296
	Sept.	124	.73	91
	Oct.	207	.79	163
	Nov.	77	.73	56
	Dec.	65	.86	56
	Total	1,677	.65	1,087
	Jan.	52	.83	43
	Feb.	79	.84	66
	Mar.	89	.83	74
	Apr.	358	.37	133
	May	519	.27	140
	June	603	.28	169
-1948	July	147	.41	60
	Aug.	86	.78	67
	Sept.	36	1.11	40
	Oct.	75	1.05	79
	Nov.	55	1.07	59
	Dec.	41	1.12	46
	Total	2,140	.46	976
	Jan.	63	1.11	70
	Feb.	74	.99	73
	Mar.	152	.81	123
	Apr.	338	.45	152
	May	503	.31	156
	June	748	.31	232
-1949	July	342	.33	113
	Aug.	90	.66	59
	Sept.	41	1.05	43
	Oct.	56	1.00	56
	Nov.	45	1.07	48
	Dec.	35	1.23	43
	Total	2,487	.47	1,168
	Jan.	41	1.12	46
	Feb.	49	1.08	53
	Mar.	56	.93	52
	Apr.	136	.46	62
	May	169	.40	68
	June	191	.38	73
-1950	July	68	.72	49
	Aug.	15	1.13	17
	Sept.	42	1.14	48
	Oct.	30	1.07	32
	Nov.	25	1.44	36
	Dec.	32	1.34	43
	Total	854	.68	579
	Jan.	30	1.30	39
	Feb.	29	1.41	41
	Mar.	34	1.15	39
	Apr.	34	.85	29
	May	142	.51	72
	June	188	.36	68
-1951	July	30	.80	24
	Aug.	49	1.06	52
	Sept.	45	1.07	48
	Oct.	35	1.23	43
	Nov.	39	1.10	43
	Dec.	36	1.28	46
	Total	691	.79	544
	Jan.	88	1.16	102
	Feb.	40	1.20	48
	Mar.	87	1.03	90
	Apr.	453	.42	190
	May	618	.30	185
-1952	June	769	.24	185
	July	238	.42	100
	Aug.	83	.69	57
	Sept.	56	.93	52
	Oct.	38	1.05	40
	Nov.	41	1.29	53
	Dec.	43	1.26	54
	Total	2,554	.45	1,156
	Jan.	42	1.24	52
	Feb.	36	1.17	42
	Mar.	56	1.02	57
	Apr.	107	.64	68
	May	156	.44	69
	June	267	.27	72
-1953	July	77	.84	65
	Aug.	71	1.15	82
	Sept.	12	1.50	18
	Oct.	54	1.28	69
	Nov.	55	1.13	62
	Dec.	34	1.31	45
	Total	967	.73	701
	Jan.	32	1.34	43
	Feb.	36	1.17	42
	Mar.	48	1.02	49
	Apr.	113	.53	60
	May	218	.39	85
	June	120	.48	58
-1954	July	120	1.03	123
	Aug.	66	.86	57
	Sept.	89	1.19	106
	Oct.	95	.75	71
	Nov.	39	1.05	41
	Dec.	35	1.26	44
	Total	1,011	.77	779
	Jan.	31	1.26	39
	Feb.	34	1.12	38
	Mar.	63	1.00	63
	Apr.	62	.74	46
	May	186	.38	71
	June	208	.32	67
-1955	July	65	.88	57
	Aug.	142	1.07	152
	Sept.	28	.82	23
	Oct.	25	1.00	25
	Nov.	31	1.26	39
	Dec.	35	1.34	47
	Total	910	.73	667
	Jan.	40	1.22	49
	Feb.	34	1.29	44
	Mar.	74	.83	61
	Apr.	107	.50	54
	May	241	.35	84
	June	203	.31	63
-1956	July	31	1.10	34
	Aug.	36	1.33	48
	Sept.	4	1.50	6
	Oct.	13	1.54	20
	Nov.	30	1.23	37
	Dec.	25	1.40	35
	Total	838	.64	535
	Jan.	38	1.26	48
	Feb.	64	1.05	67
	Mar.	71	.97	69
	Apr.	171	.55	94
	May	327	.48	157
	June	787	.28	220
-1957	July	566	.38	215
	Aug.	364	.63	229
	Sept.	142	.68	97
	Oct.	150	.86	129
	Nov.	141	.72	102
	Dec.	88	.81	71
	Total	2,909	.51	1,498
	Jan.	53	1.02	54
	Feb.	119	.92	109
	Mar.	159	.87	139
	Apr.	413	.48	198
	May	743	.26	193
-1958	June	507	.25	126
	July	74	.65	48
	Aug.	43	1.02	43
	Sept.	61	.95	58
	Oct.	47	1.04	49
	Nov.	43	1.23	53
	Dec.	36	1.28	46
	Total	2,298	.49	1,116

To obtain mg/l multiply T/AF by 735.

Table 11

Colorado River Basin

Historical Flow and Quality of Water Data

San Juan River near Bluff, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)	Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)	Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	30	1.39	42		Jan.	122	0.77	94		Jan.	164	.48	79
	Feb.	31	1.36	42		Feb.	120	.70	84		Feb.	144	.48	69
	Mar.	32	1.27	41		Mar.	85	.93	79		Mar.	101	.57	57
	Apr.	39	.94	37		Apr.	165	.62	102		Apr.	69	.74	51
	May	111	.52	58		May	288	.45	130		May	86	.77	67
	June	156	.39	61		June	419	.38	159		June	123	.49	61
-1959	July	18	.81	15	-1965	July	295	.45	133	1971	July	66	.83	54
	Aug.	64	1.13	72		Aug.	218	.65	142		Aug.	108	1.36	146
	Sept.	11	1.53	17		Sept.	177	.56	99		Sept.	52	1.12	58
	Oct.	92	.86	79		Oct.	190	.60	114		Oct.	100	1.14	113
	Nov.	82	.82	67		Nov.	232	.50	116		Nov.	59	1.12	66
	Dec.	46	1.02	47		Dec.	235	.54	127		Dec.	110	.77	85
	Total	712	.81	578		Total	2,546	.54	1,379		Total	1,182	.77	906
	Jan.	37	1.26	47		Jan.	198	0.54	107		Jan.	119	.61	72
	Feb.	43	1.09	47		Feb.	129	.65	84		Feb.	109	.61	67
	Mar.	260	.73	190		Mar.	199	.68	135		Mar.	119	.54	64
	Apr.	336	.32	108		Apr.	252	.48	121		Apr.	65	.69	44
	May	285	.34	97		May	267	.42	112		May	81	.69	56
	June	382	.27	103		June	127	.56	71		June	118	.61	72
-1960	July	92	.53	49	-1966	July	54	1.01	55	1972	July	17	1.14	19
	Aug.	18	1.11	20		Aug.	44	1.30	57		Aug.	31	1.44	44
	Sept.	17	1.24	21		Sept.	42	1.25	52		Sept.	56	.99	56
	Oct.	58	1.13	66		Oct.	94	.66	62		Oct.	348	1.00	349
	Nov.	39	1.22	48		Nov.	70	.86	60		Nov.	97	.97	94
	Dec.	40	1.27	51		Dec.	72	1.11	80		Dec.	100	.79	79
	Total	1,607	.53	847		Total	1,548	.64	996		Total	1,260	.81	1,016
	Jan.	35	1.33	47		Jan.	58	1.07	62		Jan.			
	Feb.	41	1.31	54		Feb.	64	.92	59		Feb.			
	Mar.	66	1.02	67		Mar.	79	.71	56		Mar.			
	Apr.	157	.56	88		Apr.	31	1.15	36		Apr.			
	May	285	.32	91		May	78	.76	59		May			
	June	227	.31	70		June	89	.91	81		June			
-1961	July	43	.83	36	-1967	July	39	1.35	53		July			
	Aug.	87	1.05	91		Aug.	151	1.29	195		Aug.			
	Sept.	109	.88	96		Sept.	94	.96	90		Sept.			
	Oct.	98	.77	75		Oct.	31	1.46	45		Oct.			
	Nov.	72	.93	67		Nov.	38	1.26	48		Nov.			
	Dec.	44	1.22	54		Dec.	39	1.20	47		Dec.			
	Total	1,264	.66	836		Total	791	1.05	831		Total			
	Jan.	36	1.24	45		Jan.	36	1.22	44		Jan.			
	Feb.	94	.95	89		Feb.	54	1.29	70		Feb.			
	Mar.	73	.99	72		Mar.	50	1.25	62		Mar.			
	Apr.	315	.37	117		Apr.	83	.75	62		Apr.			
	May	346	.30	104		May	148	.54	80		May			
	June	297	.32	95		June	240	.37	89		June			
-1962	July	88	.59	52	-1968	July	82	.93	76		July			
	Aug.	23	1.02	23		Aug.	176	1.04	183		Aug.			
	Sept.	26	1.41	37		Sept.	41	1.00	41		Sept.			
	Oct.	104	1.32	137		Oct.	56	1.09	61		Oct.			
	Nov.	45	1.34	60		Nov.	49	1.18	58		Nov.			
	Dec.	33	1.40	46		Dec.	45	1.07	48		Dec.			
	Total	1,480	.59	877		Total	1,060	.82	874		Total			
	Jan.	25	1.66	42		Jan.	83	1.04	86		Jan.			
	Feb.	39	1.44	56		Feb.	131	.61	80		Feb.			
	Mar.	40	1.25	50		Mar.	143	.73	104		Mar.			
	Apr.	64	.78	50		Apr.	216	.54	117		Apr.			
	May	95	.72	68		May	271	.40	108		May			
-1963	June	47	.82	39		June	238	.45	107		June			
	July	15	1.60	24	-1969	July	202	.57	115		July			
	Aug.	48	1.57	75		Aug.	101	.88	89		Aug.			
	Sept.	70	1.09	76		Sept.	118	.76	90		Sept.			
	Oct.	41	1.32	54		Oct.	208	.83	173		Oct.			
	Nov.	47	1.10	52		Nov.	118	.64	75		Nov.			
	Dec.	48	1.03	49		Dec.	109	.65	71		Dec.			
	Total	579	1.10	635		Total	1,938	.63	1,215		Total			
	Jan.	44	1.14	50		Jan.	75	.77	58		Jan.			
	Feb.	30	1.27	38		Feb.	130	.49	64		Feb.			
	Mar.	28	1.46	41		Mar.	116	.57	66		Mar.			
	Apr.	30	1.40	42		Apr.	49	.96	47		Apr.			
	May	103	.57	59		May	140	.45	63		May			
	June	121	.58	70		June	138	.49	67		June			
-1964	July	113	.76	86		July	74	.73	54		July			
	Aug.	131	1.07	140	-1970	Aug.	66	1.09	72		Aug.			
	Sept.	56	1.36	76		Sept.	308	.71	219		Sept.			
	Oct.	37	1.26	47		Oct.	142	.59	84		Oct.			
	Nov.	42	1.43	60		Nov.	137	.58	80		Nov.			
	Dec.	60	1.20	72		Dec.	149	.54	80		Dec.			
	Total	795	.98	781		Total	1,524	.63	954		Total			

To obtain mg/l multiply T/AF by 735.

Table II
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	460	954

Sampled quality record entire period.
Measured flow records entire period.

Table II
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)
1971	1,182	.77	563	906
1972	1,260	.81	593	1,016
Total	51,028			31,017
Average	1,595	.61	447	969

Table 12

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River at Lees Ferry, Arizona

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	348	1.36	474
	Feb.	423	1.29	546
	Mar.	669	1.12	749
	Apr.	1,091	.79	862
	May	4,974	.45	2,239
	June	4,004	.38	1,522
-1941	July	1,666	.51	850
	Aug.	798	1.16	925
	Sept.	608	1.35	821
	Oct.	1,797	1.09	1,959
	Nov.	903	.94	849
	Dec.	576	1.19	685
	Total	17,857	.70	12,481
	Jan.	407	1.34	545
	Feb.	396	1.28	507
	Mar.	630	1.16	731
	Apr.	2,844	.55	1,564
	May	3,209	.46	1,476
	June	4,202	.29	1,219
-1942	July	1,317	.57	751
	Aug.	454	1.08	490
	Sept.	275	1.59	438
	Oct.	334	1.58	528
	Nov.	368	1.58	582
	Dec.	357	1.54	550
	Total	14,793	.63	9,381
	Jan.	330	1.50	494
	Feb.	332	1.41	469
	Mar.	516	1.19	614
	Apr.	1,450	.67	971
	May	2,158	.43	928
	June	2,729	.40	1,092
-1943	July	1,429	.47	672
	Aug.	793	1.09	864
	Sept.	447	1.15	514
	Oct.	378	1.60	604
	Nov.	456	1.35	616
	Dec.	395	1.36	537
	Total	11,413	.73	8,375
	Jan.	278	1.50	418
	Feb.	344	1.32	454
	Mar.	509	1.31	668
	Apr.	1,027	.89	914
	May	3,251	.47	1,528
	June	4,136	.32	1,323
-1944	July	1,782	.45	802
	Aug.	417	1.07	446
	Sept.	229	1.50	343
	Oct.	342	1.66	567
	Nov.	384	1.51	579
	Dec.	320	1.51	483
	Total	13,019	.65	8,525
	Jan.	325	1.48	481
	Feb.	352	1.39	489
	Mar.	437	1.28	559
	Apr.	755	.99	748
	May	2,805	.44	1,234
	June	2,761	.37	1,021
-1945	July	1,668	.47	784
	Aug.	1,011	.89	900
	Sept.	370	1.28	474
	Oct.	505	1.51	763
	Nov.	443	1.34	594
	Dec.	337	1.35	454
	Total	11,769	.72	8,501
	Jan.	366	1.28	468
	Feb.	319	1.24	396
	Mar.	496	1.15	570
	Apr.	1,013	.83	841
	May	1,732	.47	814
	June	1,993	.43	857
	July	730	.73	533
-1946	Aug.	478	1.28	612
	Sept.	310	1.62	502
	Oct.	403	1.50	604
	Nov.	466	1.30	607
	Dec.	445	1.22	542
	Total	8,751	.84	7,346
	Jan.	277	1.40	388
	Feb.	357	1.29	462
	Mar.	654	1.09	713
	Apr.	780	.78	608
	May	3,121	.39	1,217
	June	3,275	.40	1,310
-1947	July	1,926	.43	828
	Aug.	1,203	.98	1,179
	Sept.	584	1.13	660
	Oct.	818	1.17	958
	Nov.	585	1.07	626
	Dec.	466	1.21	564
	Total	14,046	.68	9,513
	Jan.	406	1.18	479
	Feb.	458	1.14	522
	Mar.	645	1.14	735
	Apr.	1,703	.64	1,090
	May	3,507	.38	1,333
	June	3,339	.34	1,135
-1948	July	980	.65	637
	Aug.	531	1.23	653
	Sept.	230	1.40	322
	Oct.	331	1.65	545
	Nov.	408	1.46	595
	Dec.	347	1.40	485
	Total	12,885	.66	8,531
	Jan.	337	1.39	469
	Feb.	361	1.25	451
	Mar.	706	1.18	834
	Apr.	1,307	.78	1,020
	May	3,098	.43	1,332
	June	4,419	.41	1,812
-1949	July	2,137	.52	1,111
	Aug.	576	1.00	576
	Sept.	313	1.51	473
	Oct.	509	1.48	753
	Nov.	473	1.31	619
	Dec.	368	1.37	504
	Total	14,604	.68	9,954
	Jan.	350	1.41	493
	Feb.	399	1.23	490
	Mar.	650	1.11	721
	Apr.	1,217	.74	900
	May	1,971	.49	966
	June	2,979	.37	1,102
-1950	July	1,377	.67	923
	Aug.	422	1.02	430
	Sept.	330	1.47	485
	Oct.	342	1.47	502
	Nov.	350	1.55	542
	Dec.	415	1.31	544
	Total	10,802	.75	8,098
	Jan.	315	1.43	451
	Feb.	361	1.25	451
	Mar.	418	1.19	497
	Apr.	531	1.00	531
	May	1,645	.57	938
	June	2,886	.41	1,184
-1951	July	1,357	.48	651
	Aug.	787	1.11	874
	Sept.	411	1.32	542
	Oct.	412	1.47	606
	Nov.	445	1.41	628
	Dec.	333	1.44	480
	Total	9,901	.79	7,833
	Jan.	476	1.23	586
	Feb.	379	1.26	478
	Mar.	440	1.31	576
	Apr.	2,267	.74	1,677
	May	5,081	.41	2,083
	June	5,192	.36	1,869
-1952	July	1,573	.55	865
	Aug.	821	1.06	870
	Sept.	542	1.31	710
	Oct.	368	1.43	527
	Nov.	386	1.55	599
	Dec.	378	1.47	556
	Total	17,903	.64	11,396
	Jan.	393	1.36	53[illegible]
	Feb.	365	1.30	475
	Mar.	458	1.22	558
	Apr.	529	1.07	566
	May	1,047	.69	723
	June	2,992	.38	1,137
-1953	July	950	.64	608
	Aug.	661	1.19	787
	Sept.	258	1.59	410
	Oct.	321	1.77	568
	Nov.	414	1.50	621
	Dec.	341	1.46	498
	Total	8,729	.86	7,485
	Jan.	319	1.46	466
	Feb.	342	1.30	444
	Mar.	393	1.24	487
	Apr.	546	1.00	546
	May	1,277	.56	715
	June	792	.63	499
-1954	July	647	.87	563
	Aug.	321	1.19	382
	Sept.	389	1.66	645
	Oct.	512	1.43	733
	Nov.	349	1.39	485
	Dec.	278	1.51	421
	Total	6,165	1.04	6,386
	Jan.	244	1.58	386
	Feb.	243	1.39	338
	Mar.	580	1.29	748
	Apr.	617	1.05	649
	May	1,570	.56	879
	June	1,586	.49	777
-1955	July	571	.70	399
	Aug.	510	1.40	713
	Sept.	230	1.60	368
	Oct.	214	1.70	363
	Nov.	275	1.67	458
	Dec.	326	1.44	470
	Total	6,966	.94	6,548
	Jan.	373	1.28	477
	Feb.	280	1.39	390
	Mar.	511	1.16	592
	Apr.	898	.75	673
	May	2,190	.48	1,051
	June	2,594	.39	1,012
-1956	July	557	.75	418
	Aug.	356	1.33	473
	Sept.	166	1.48	246
	Oct.	186	1.74	324
	Nov.	300	1.58	474
	Dec.	247	1.55	383
	Total	8,658	.75	6,513
	Jan.	284	1.46	415
	Feb.	323	1.34	433
	Mar.	498	1.23	613
	Apr.	828	.90	745
	May	2,569	.56	1,439
	June	5,645	.39	2,201
-1957	July	4,015	.43	1,727
	Aug.	1,604	.78	1,251
	Sept.	822	1.03	847
	Oct.	748	1.54	1,150
	Nov.	848	1.39	1,179
	Dec.	516	1.25	646
	Total	18,700	.68	12,646
	Jan.	397	1.27	504
	Feb.	536	1.18	632
	Mar.	696	1.10	766
	Apr.	1,574	.64	1,007
	May	3,992	.46	1,836
	June	3,678	.40	1,471
	July	628	.74	465
-1958	Aug.	286	1.43	409
	Sept.	319	1.69	540
	Oct.	310	1.63	505
	Nov.	357	1.65	589
	Dec.	366	1.52	556
	Total	13,139	.71	9,280

To obtain mg/l multiply T/AF by 735.

Table 12

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River at Lees Ferry, Arizona

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
-1959	Jan.	315	1.48	466
	Feb.	315	1.36	428
	Mar.	344	1.37	471
	Apr.	420	1.16	487
	May	1,025	.70	718
	June	1,836	.48	881
	July	782	.63	493
	Aug.	425	1.43	608
	Sept.	246	1.68	413
	Oct.	502	1.41	708
	Nov.	499	1.21	604
	Dec.	352	1.39	489
	Total	7,061	.96	6,766
-1960	Jan.	305	1.54	470
	Feb.	318	1.34	426
	Mar.	745	1.18	879
	Apr.	1,610	.62	998
	May	1,564	.51	798
	June	2,239	.43	963
	July	647	.69	446
	Aug.	208	1.38	287
	Sept.	193	1.90	367
	Oct.	341	1.67	569
	Nov.	345	1.47	507
	Dec.	275	1.39	382
	Total	8,790	.81	7,092
-1961	Jan.	266	1.48	394
	Feb.	331	1.34	444
	Mar.	362	1.34	485
	Apr.	567	1.02	578
	May	1,153	.59	680
	June	1,588	.45	715
	July	369	.89	328
	Aug.	336	1.65	554
	Sept.	710	1.61	1,143
	Oct.	725	1.01	732
	Nov.	527	1.04	548
	Dec.	380	1.22	464
	Total	7,314	.97	7,065
-1962	Jan.	349	1.24	433
	Feb.	791	1.03	815
	Mar.	598	1.13	676
	Apr.	2,391	.71	1,698
	May	3,633	.44	1,599
	June	2,876	.45	1,294
	July	1,717	.57	979
	Aug.	469	1.02	478
	Sept.	315	1.61	507
	Oct.	539	1.52	819
	Nov.	428	1.28	548
	Dec.	333	1.42	473
	Total	14,439	.71	10,319
-1963	Jan.	169	1.69	286
	Feb.	369	1.35	498
	Mar.	188	1.35	254
	Apr.	60	1.44	86
	May	62	1.30	81
	June	140	1.13	158
	July	90	.95	86
	Aug.	62	.96	60
	Sept.	60	.90	54
	Oct.	61	.88	54
	Nov.	60	.95	57
	Dec.	63	1.34	84
	Total	1,384	1.27	1,758
-1964	Jan.	71	1.33	94
	Feb.	231	1.33	307
	Mar.	388	1.29	500
	Apr.	771	1.24	956
	May	319	1.22	389
	June	60	1.24	74
	July	60	1.25	75
	Aug.	174	1.24	216
	Sept.	156	.69	108
	Oct.	268	.63	169
	Nov.	347	.84	292
	Dec.	398	1.00	398
	Total	3,243	1.10	3,578
-1965	Jan.	558	0.98	547
	Feb.	515	1.02	525
	Mar.	556	1.01	562
	Apr.	1,222	1.03	1,259
	May	2,284	.95	2,170
	June	2,323	.88	2,044
	July	727	.48	349
	Aug.	871	.41	357
	Sept.	750	.40	300
	Oct.	659	.43	283
	Nov.	589	.47	277
	Dec.	531	.63	335
	Total	11,585	.78	9,008
-1966	Jan.	451	0.73	329
	Feb.	483	.76	367
	Mar.	622	.76	473
	Apr.	825	.77	635
	May	978	.72	704
	June	754	.71	535
	July	658	.66	434
	Aug.	682	.65	443
	Sept.	622	.66	411
	Oct.	551	.65	358
	Nov.	584	.66	385
	Dec.	529	.69	365
	Total	7,739	.70	5,439
-1967	Jan.	614	.76	467
	Feb.	534	.79	422
	Mar.	690	.89	614
	Apr.	788	1.03	812
	May	879	.93	817
	June	698	.99	691
	July	641	.81	519
	Aug.	693	.71	492
	Sept.	596	.75	447
	Oct.	415	.73	303
	Nov.	460	.76	350
	Dec.	552	.82	453
	Total	7,560	.84	6,387
-1968	Jan.	633	.93	589
	Feb.	464	.97	450
	Mar.	858	1.02	875
	Apr.	968	1.02	987
	May	943	1.05	990
	June	894	1.00	894
	July	827	.81	670
	Aug.	685	.70	480
	Sept.	635	.70	444
	Oct.	620	.69	428
	Nov.	616	.67	413
	Dec.	639	.79	505
	Total	8,782	.88	7,725
-1969	Jan.	570	.92	524
	Feb.	461	.94	434
	Mar.	708	.99	698
	Apr.	871	1.06	920
	May	763	.98	744
	June	875	.91	798
	July	956	.88	837
	Aug.	930	.76	710
	Sept.	794	.72	570
	Oct.	630	.77	487
	Nov.	706	.80	562
	Dec.	814	.77	623
	Total	9,078	.87	7,907
-1970	Jan.	706	.84	593
	Feb.	445	.90	401
	Mar.	486	.96	466
	Apr.	942	.94	888
	May	900	.92	824
	June	800	.86	690
	July	769	.86	658
	Aug.	773	.79	608
	Sept.	701	.77	542
	Oct.	498	.76	380
	Nov.	459	.80	365
	Dec.	670	.81	545
	Total	8,149	.85	6,960
1971	Jan.	492	.75	369
	Feb.	416	.85	354
	Mar.	640	.91	581
	Apr.	1,011	.90	908
	May	926	.87	803
	June	894	.79	705
	July	943	.77	724
	Aug.	876	.75	660
	Sept.	776	.68	525
	Oct.	584	.71	415
	Nov.	764	.71	539
	Dec.	937	.71	662
	Total	9,259	.78	7,245
1972	Jan.	806	.74	594
	Feb.	444	.74	331
	Mar.	378	.85	321
	Apr.	782	.88	686
	May	902	.82	741
	June	863	.78	676
	July	915	.75	684
	Aug.	1,005	.75	755
	Sept.	931	.71	663
	Oct.	631	.73	459
	Nov.	671	.74	499
	Dec.	1,017	.79	799
	Total	9,345	.77	7,208
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
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	Mar.			
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	Oct.			
	Nov.			
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	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 12
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River at Lees Ferry, Arizona
(Annual Summary)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./1)	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

Sampled quality record November 1942 to October 1945, October 1947 to December 1972; remainder by correlation.
Measured flow record entire period.

Table 12
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River at Lees Ferry, Arizona

(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	9,259	.78	575	7,245
1972	9,345	.77	567	7,208
Total	333,828			253,249
Average	10,432	.76	558	7,914

Table 13

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River near Grand Canyon, Arizona

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	434	1.42	616
	Feb.	515	1.31	675
	Mar.	838	1.17	980
	Apr.	1,209	.87	1,052
	May	4,976	.50	2,488
	June	4,100	.45	1,845
-1941	July	1,753	.55	964
	Aug.	861	1.29	1,111
	Sept.	659	1.43	942
	Oct.	1,904	1.14	2,171
	Nov.	953	.98	934
	Dec.	594	1.22	725
	Total	18,796	.77	14,503
	Jan.	430	1.40	602
	Feb.	435	1.33	579
	Mar.	653	1.25	816
	Apr.	2,763	.60	1,658
	May	3,163	.49	1,550
	June	4,241	.32	1,357
-1942	July	1,345	.59	794
	Aug.	486	1.15	559
	Sept.	294	1.67	491
	Oct.	356	1.67	575
	Nov.	386	1.67	645
	Dec.	373	1/1.50	560
	Total	14,925	.68	10,186
	Jan.	347	1/1.49	517
	Feb.	351	1/1.48	519
	Mar.	580	1/1.26	731
	Apr.	1,417	1/ .83	1,176
	May	2,161	1/ .57	1,232
	June	2,676	1/ .49	1,311
-1943	July	1,459	1/ .60	875
	Aug.	834	1/1.17	976
	Sept.	494	1/1.40	692
	Oct.	408	1.69	690
	Nov.	477	1.47	701
	Dec.	420	1.46	613
	Total	11,624	.86	10,033
	Jan.	298	1.61	480
	Feb.	363	1.23	446
	Mar.	551	1.41	777
	Apr.	1,099	.95	1,044
	May	3,206	.55	1,763
	June	4,144	.41	1,699
-1944	July	1,854	.52	964
	Aug.	456	1.14	520
	Sept.	251	1.61	404
	Oct.	362	1.78	644
	Nov.	401	1.64	658
	Dec.	345	1.59	549
	Total	13,330	.75	9,948
	Jan.	356	1.55	552
	Feb.	381	1.48	564
	Mar.	472	1.41	666
	Apr.	804	1.01	812
	May	2,803	.52	1,458
	June	2,754	.48	1,322
-1945	July	1,732	.56	970
	Aug.	1,071	1.05	1,125
	Sept.	394	1.38	544
	Oct.	524	1.63	854
	Nov.	465	1.51	702
	Dec.	359	1.47	528
	Total	12,115	.83	10,097
	Jan.	384	1.41	541
	Feb.	333	1.38	460
	Mar.	514	1.29	663
	Apr.	1,016	.94	955
	May	1,775	.53	941
	June	1,995	.54	1,077
-1946	July	784	.82	643
	Aug.	567	1.50	850
	Sept.	372	1.71	636
	Oct.	419	1.62	679
	Nov.	492	1.36	684
	Dec.	468	1.31	613
	Total	9,119	.96	8,742
	Jan.	303	1.50	455
	Feb.	371	1.38	512
	Mar.	653	1.18	771
	Apr.	785	.92	722
	May	3,088	.48	1,482
	June	3,233	.48	1,552
-1947	July	1,953	.50	976
	Aug.	1,329	1.17	1,555
	Sept.	640	1.26	806
	Oct.	894	1.28	1,144
	Nov.	608	1.14	693
	Dec.	490	1.28	627
	Total	14,347	.79	11,295
	Jan.	427	1.27	542
	Feb.	458	1.28	586
	Mar.	669	1.25	836
	Apr.	1,732	.74	1,282
	May	3,392	.45	1,526
	June	3,358	.40	1,343
-1948	July	1,009	.73	737
	Aug.	587	1.33	781
	Sept.	242	1.65	399
	Oct.	336	1.82	612
	Nov.	434	1.61	699
	Dec.	365	1.25	456
	Total	13,009	.75	9,799
	Jan.	363	1.51	548
	Feb.	374	1.36	509
	Mar.	796	1.20	955
	Apr.	1,337	.92	1,230
	May	2,959	.48	1,420
	June	4,303	.48	2,065
-1949	July	2,128	.58	1,234
	Aug.	632	1.12	708
	Sept.	340	1.65	561
	Oct.	521	1.58	823
	Nov.	488	1.36	664
	Dec.	381	1.41	537
	Total	14,622	.77	11,254
	Jan.	358	1.56	558
	Feb.	414	1.35	559
	Mar.	670	1.21	811
	Apr.	1,192	.88	1,049
	May	1,941	.59	1,145
	June	2,925	.47	1,375
-1950	July	1,401	.76	1,065
	Aug.	444	1.13	502
	Sept.	343	1.56	535
	Oct.	359	1.67	600
	Nov.	355	1.75	621
	Dec.	434	1.48	642
	Total	10,836	.87	9,462
	Jan.	326	1.59	518
	Feb.	366	1.45	531
	Mar.	429	1.35	579
	Apr.	535	1.17	626
	May	1,552	.67	1,040
	June	2,800	.49	1,372
-1951	July	1,397	.57	796
	Aug.	833	1.18	983
	Sept.	452	1.46	660
	Oct.	425	1.67	710
	Nov.	466	1.61	750
	Dec.	353	1.61	568
	Total	9,934	.92	9,133
	Jan.	593	1.28	759
	Feb.	396	1.42	562
	Mar.	435	1.46	635
	Apr.	2,209	.84	1,855
	May	5,062	.52	2,632
	June	5,203	.46	2,393
-1952	July	1,590	.65	1,033
	Aug.	833	1.18	983
	Sept.	596	1.43	852
	Oct.	393	1.52	597
	Nov.	396	1.64	649
	Dec.	400	1.58	632
	Total	18,106	.75	13,582
	Jan.	408	1.46	596
	Feb.	378	1.42	537
	Mar.	478	1.35	645
	Apr.	533	1.21	645
	May	989	.87	860
	June	2,932	.47	1,378
-1953	July	980	.76	745
	Aug.	703	1.30	914
	Sept.	290	1.73	502
	Oct.	325	1.88	611
	Nov.	428	1.63	698
	Dec.	360	1.56	562
	Total	8,804	.99	8,693
	Jan.	333	1.58	526
	Feb.	353	1.40	494
	Mar.	424	1.34	568
	Apr.	566	1.11	628
	May	1,211	.68	823
	June	798	.68	543
-1954	July	669	.95	636
	Aug.	349	1.32	461
	Sept.	415	1.67	693
	Oct.	526	1.52	800
	Nov.	360	1.47	529
	Dec.	296	1.60	474
	Total	6,300	1.14	7,175
	Jan.	261	1.70	444
	Feb.	269	1.50	404
	Mar.	586	1.35	791
	Apr.	621	1.15	714
	May	1,515	.59	894
	June	1,596	.55	878
-1955	July	618	.77	476
	Aug.	668	1.39	929
	Sept.	265	1.63	432
	Oct.	236	1.84	434
	Nov.	298	1/1.88	560
	Dec.	354	1/1.52	538
	Total	7,287	1.03	7,494
	Jan.	398	1/1.42	565
	Feb.	310	1.30	403
	Mar.	511	1.21	618
	Apr.	878	.82	720
	May	2,125	.49	1,041
	June	2,584	.45	1,163
-1956	July	598	.82	490
	Aug.	383	1.31	502
	Sept.	185	1.58	292
	Oct.	202	1.86	376
	Nov.	325	1.69	549
	Dec.	274	1.66	455
	Total	8,773	.82	7,174
	Jan.	343	1.45	497
	Feb.	370	1.37	507
	Mar.	541	1.26	682
	Apr.	812	.93	755
	May	2,501	.57	1,426
	June	5,541	.40	2,216
-1957	July	4,033	.40	1,613
	Aug.	1,672	.88	1,471
	Sept.	884	1.13	999
	Oct.	784	1.46	1,144
	Nov.	892	1.42	1,266
	Dec.	537	1.28	687
	Total	18,910	.70	13,263
	Jan.	415	1.31	544
	Feb.	536	1.24	665
	Mar.	749	1.13	846
	Apr.	1,580	.77	1,220
	May	3,900	.45	1,755
	June	3,763	.41	1,542
-1958	July	683	.91	622
	Aug.	337	1/1.31	440
	Sept.	379	1/1.32	500
	Oct.	346	1/1.53	530
	Nov.	385	1/1.53	590
	Dec.	388	1/1.55	600
	Total	13,461	.73	9,854

To obtain mg/l multiply T/AF by 735.

1/ Correlated.

Table 13

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River near Grand Canyon, Arizona

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	334	1/1.56	520
	Feb.	326	1/1.53	500
	Mar.	365	1/1.53	560
-1959	Apr.	423	1.27	537
	May	1,011	.78	789
	June	1,804	.53	956
	July	795	.69	549
	Aug.	488	1.50	731
	Sept.	271	1.82	493
	Oct.	528	1.47	777
	Nov.	569	1.25	712
	Dec.	394	1.33	524
	Total	7,308	1.05	7,648
	Jan.	348	1.41	490
	Feb.	353	1.40	495
	Mar.	820	1.15	942
-1960	Apr.	1,650	.63	1,036
	May	1,580	.55	870
	June	2,212	.46	1,011
	July	678	.73	497
	Aug.	233	1.42	331
	Sept.	218	1.92	418
	Oct.	382	1.81	692
	Nov.	380	1.59	603
	Dec.	300	1.49	448
	Total	9,154	.86	7,833
	Jan.	291	1.58	460
	Feb.	353	1.39	490
	Mar.	379	1.40	530
-1961	Apr.	587	1.04	608
	May	1,147	.66	760
	June	1,692	.47	788
	July	417	.98	409
	Aug.	374	1.76	658
	Sept.	748	1.82	1,360
	Oct.	772	1.23	949
	Nov.	570	1.23	701
	Dec.	409	1.32	539
	Total	7,739	1.07	8,252
	Jan.	369	1.35	498
	Feb.	832	1.02	847
	Mar.	610	1.19	726
-1962	Apr.	2,467	.70	1,730
	May	3,716	.45	1,654
	June	2,850	.46	1,318
	July	1,821	.57	1,031
	Aug.	512	1.03	526
	Sept.	318	1.58	502
	Oct.	557	1.57	877
	Nov.	443	1.34	592
	Dec.	344	1.50	516
	Total	14,839	.73	10,817
	Jan.	182	1.84	334
	Feb.	374	1.33	496
	Mar.	203	1.37	279
-1963	Apr.	72	1.56	112
	May	79	1.49	118
	June	148	1.09	162
	July	108	1.14	123
	Aug.	112	1.29	145
	Sept.	122	1.43	175
	Oct.	77	1.39	107
	Nov.	76	1.39	106
	Dec.	77	1.74	134
	Total	1,630	1.41	2,291
	Jan.	79	1.75	138
	Feb.	245	1.52	373
	Mar.	382	1.47	562
-1964	Apr.	796	1.33	1,058
	May	356	1.36	485
	June	77	1.65	127
	July	84	1.75	147
	Aug.	287	1.31	376
	Sept.	191	1.05	200
	Oct.	298	.77	230
	Nov.	371	.87	323
	Dec.	416	1.04	431
	Total	3,582	1.24	4,450
	Jan.	608	1.06	644
	Feb.	539	1.09	588
	Mar.	568	1.09	619
	Apr.	1,251	1.04	1,301
	May	2,282	1.03	2,350
	June	2,282	.89	2,038
-1965	July	724	.59	427
	Aug.	879	.86	755
	Sept.	767	.51	391
	Oct.	675	.51	344
	Nov.	612	.53	322
	Dec.	586	.69	406
	Total	11,773	.86	10,185
	Jan.	529	0.79	418
	Feb.	524	.87	455
	Mar.	718	.81	582
	Apr.	865	.81	700
	May	1,011	.79	799
	June	789	.77	609
-1966	July	698	.75	523
	Aug.	694	.68	471
	Sept.	623	.75	468
	Oct.	567	.74	419
	Nov.	589	.71	418
	Dec.	620	.76	471
	Total	8,227	.77	6,333
	Jan.	648	.84	544
	Feb.	564	.86	485
	Mar.	704	.97	683
	Apr.	801	1.09	873
	May	861	1.00	861
	June	711	1.02	725
-1967	July	693	.92	638
	Aug.	786	.82	644
	Sept.	713	.90	642
	Oct.	459	.86	395
	Nov.	495	.83	411
	Dec.	597	.90	537
	Total	8,032	.93	7,438
	Jan.	658	1.01	664
	Feb.	534	1.04	555
	Mar.	900	1.03	927
	Apr.	1,078	1.02	1,100
	May	976	1.11	1,083
	June	925	1.03	953
-1968	July	865	.93	804
	Aug.	775	.81	628
	Sept.	675	.80	540
	Oct.	647	.79	511
	Nov.	675	.80	540
	Dec.	665	.77	512
	Total	9,373	.94	8,817
	Jan.	628	.99	621
	Feb.	509	1.10	560
	Mar.	727	1.05	763
	Apr.	927	1.05	973
	May	799	1.03	822
-1969	June	870	.98	853
	July	994	.95	944
	Aug.	1,002	.83	832
	Sept.	842	.82	691
	Oct.	662	.80	527
	Nov.	751	.80	601
	Dec.	832	.81	674
	Total	9,543	.93	8,861
	Jan.	768	.88	676
	Feb.	494	.96	474
	Mar.	510	1.00	510
	Apr.	969	.94	911
	May	946	.96	908
-1970	June	821	.90	739
	July	815	.88	717
	Aug.	798	.87	691
	Sept.	756	.85	641
	Oct.	542	.84	455
	Nov.	483	.82	396
	Dec.	700	.79	553
	Total	8,602	.89	7,671
	Jan.	544	.77	418
	Feb.	430	.85	364
	Mar.	645	1.08	693
	Apr.	1,000	1.07	1,075
	May	933	.90	810
	June	896	.80	721
1971	July	933	.81	753
	Aug.	932	.87	809
	Sept.	801	.81	652
	Oct.	675	.85	573
	Nov.	786	.85	665
	Dec.	994	.77	762
	Total	9,569	.87	8,295
	Jan.	840	.76	640
	Feb.	471	.83	393
	Mar.	364	.94	343
	Apr.	793	.92	731
	May	912	.84	765
	June	890	.81	724
1972	July	872	.80	698
	Aug.	996	.80	798
	Sept.	945	.81	765
	Oct.	917	1.00	898
	Nov.	730	.82	582
	Dec.	1,070	.78	839
	Total	9,800	.84	8,176
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
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	Total			
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	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 13
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Grand Canyon, Arizona
(Annual Summary)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1941	18,796	0.77	567	14,503
1942	14,925	.68	502	10,186
1943	11,624	.86	634	10,033
1944	13,330	.75	549	9,948
1945	12,115	.83	613	10,097
1946	9,119	.96	705	8,742
1947	14,347	.79	579	11,295
1948	13,009	.75	554	9,799
1949	14,622	.77	566	11,254
1950	10,836	.87	642	9,462
1951	9,934	.92	676	9,133
1952	18,106	.75	551	13,582
1953	8,804	.99	726	8,693
1954	6,300	1.14	837	7,175
1955	7,287	1.03	756	7,494
1956	8,773	.82	601	7,174
1957	18,910	.70	516	13,263
1958	13,461	.73	538	9,854
1959	7,308	1.05	769	7,648
1960	9,154	.86	629	7,833
1961	7,739	1.07	784	8,252
1962	14,839	.73	536	10,817
1963	1,630	1.41	1,030	2,291
1964	3,582	1.24	913	4,450
1965	11,773	.86	636	10,185
1966	8,227	.77	566	6,333
1967	8,032	.93	681	7,438
1968	9,373	.94	691	8,817
1969	9,543	.93	685	8,861
1970	8,602	.89	656	7,671

Table 13
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Grand Canyon, Arizona

(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	9,569	.87	637	8,295
1972	9,800	.84	616	8,176
Total	343,469			288,754
Average	10,733	.84	618	9,024

Table 14

Colorado River Basin

Historical Flow and Quality of Water Data

Virgin River at Littlefield, Arizona

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1941	Jan.	15	2.39	35
	Feb.	31	1.97	61
	Mar.	62	.82	51
	Apr.	62	.84	52
	May	131	.46	60
	June	19	1.75	34
	July	22	2.45	54
	Aug.	20	3.02	62
	Sept.	6	3.29	18
	Oct.	23	3.22	74
	Nov.	19	2.26	43
	Dec.	17	2.28	39
	Total	427	1.37	583
1942	Jan.	20	2.25	44
	Feb.	16	2.28	35
	Mar.	20	1.88	38
	Apr.	50	1.01	51
	May	28	1.56	44
	June	5	3.15	16
	July	4	3.31	14
	Aug.	9	3.29	29
	Sept.	4	3.31	13
	Oct.	9	3.41	31
	Nov.	10	2.78	29
	Dec.	11	2.72	31
	Total	186	2.01	375
1943	Jan.	18	2.32	42
	Feb.	21	2.14	45
	Mar.	36	1.28	47
	Apr.	34	1.36	46
	May	11	2.27	26
	June	4	3.35	13
	July	4	3.31	14
	Aug.	13	3.35	42
	Sept.	6	3.46	20
	Oct.	9	3.40	30
	Nov.	10	2.79	28
	Dec.	13	2.51	32
	Total	179	2.15	385
1944	Jan.	13	2.47	33
	Feb.	15	2.31	35
	Mar.	26	1.64	42
	Apr.	25	1.66	42
	May	49	1.05	51
	June	11	2.32	25
	July	4	3.32	13
	Aug.	4	3.31	13
	Sept.	4	3.31	14
	Oct.	5	3.30	16
	Nov.	13	2.48	32
	Dec.	12	2.65	31
	Total	181	1.92	347
1945	Jan.	11	2.68	30
	Feb.	17	2.15	38
	Mar.	20	1.87	38
	Apr.	20	1.83	36
	May	25	1.55	39
	June	5	3.22	15
	July	5	3.31	15
	Aug.	26	3.06	79
	Sept.	8	3.19	25
	Oct.	20	3.14	62
	Nov.	10	2.75	29
	Dec.	14	2.47	35
	Total	181	2.43	441
1946	Jan.	13	2.48	32
	Feb.	10	2.74	27
	Mar.	10	2.63	28
	Apr.	12	2.49	29
	May	5	3.31	15
	June	4	3.32	13
	July	6	3.40	21
	Aug.	13	3.17	42
	Sept.	4	3.31	13
	Oct.	37	2.18	81
	Nov.	33	1.85	61
	Dec.	22	2.12	47
	Total	169	2.42	409
1947	Jan.	15	2.34	35
	Feb.	12	2.46	30
	Mar.	13	2.32	31
	Apr.	16	2.17	34
	May	17	1.98	33
	June	4	3.31	14
	July	5	3.30	16
	Aug.	14	2.97	41
	Sept.	4	3.31	14
	Oct.	8	3.34	27
	Nov.	9	2.89	27
	Dec.	14	2.46	34
	Total	131	2.56	336
1948	Jan.	11	2.78	29
	Feb.	12	2.47	30
	Mar.	13	2.42	31
	Apr.	20	1.87	37
	May	10	2.47	25
	June	4	3.32	14
	July	4	3.31	14
	Aug.	5	3.31	18
	Sept.	6	3.39	20
	Oct.	6	3.34	20
	Nov.	10	2.87	27
	Dec.	10	2.85	29
	Total	111	2.65	294
1949	Jan.	13	2.52	32
	Feb.	14	2.42	35
	Mar.	18	2.07	36
	Apr.	30	1.43	44
	May	28	1.53	43
	June	12	2.11	25
	July	4	3.19	14
	Aug.	4	3.20	13
	Sept.	7	3.27	23
	Oct.	9	3.07	26
	Nov.	11	2.68	29
	Dec.	13	2.51	34
	Total	163	2.17	354
1950	Jan.	15	2.20	33
	Feb.	16	2.00	32
	Mar.	14	2.26	31
	Apr.	15	2.05	31
	May	6	2.87	19
	June	4	3.28	13
	July	12	3.38	40
	Aug.	6	3.43	19
	Sept.	6	3.35	20
	Oct.	5	3.40	17
	Nov.	9	3.14	28
	Dec.	10	2.91	30
	Total	118	2.65	313
1951	Jan.	11	2.77	30
	Feb.	8	2.84	22
	Mar.	8	2.83	23
	Apr.	7	3.17	22
	May	10	2.74	27
	June	4	3.37	12
	July	6	3.34	20
	Aug.	16	3.27	55
	Sept.	6	3.20	20
	Oct.	7	3.24	22
	Nov.	9	2.94	26
	Dec.	20	2.42	49
	Total	112	2.93	328
1952	Jan.	21	2.34	49
	Feb.	11	2.52	28
	Mar.	27	1.74	48
	Apr.	80	.76	60
	May	71	.68	49
	June	12	1.75	21
	July	4	3.27	14
	Aug.	5	3.43	18
	Sept.	6	3.34	20
	Oct.	6	3.40	20
	Nov.	10	2.84	29
	Dec.	14	2.53	34
	Total	267	1.46	390
1953	Jan.	14	2.36	32
	Feb.	9	2.70	24
	Mar.	7	2.98	21
	Apr.	6	3.27	20
	May	5	3.27	16
	June	4	3.34	14
	July	8	3.46	28
	Aug.	13	3.04	40
	Sept.	4	3.38	13
	Oct.	7	3.31	24
	Nov.	10	3.07	29
	Dec.	11	2.83	31
	Total	98	3.00	292
1954	Jan.	15	2.49	37
	Feb.	12	2.36	29
	Mar.	17	1.98	33
	Apr.	23	1.64	38
	May	10	2.35	23
	June	5	3.36	18
	July	8	3.42	26
	Aug.	10	3.44	34
	Sept.	9	3.56	32
	Oct.	9	3.48	30
	Nov.	9	3.13	29
	Dec.	13	2.71	36
	Total	140	2.61	365
1955	Jan.	12	2.60	31
	Feb.	12	2.51	30
	Mar.	11	2.53	27
	Apr.	6	3.14	19
	May	5	3.18	16
	June	4	3.39	13
	July	10	3.61	37
	Aug.	40	3.69	149
	Sept.	5	3.26	15
	Oct.	5	3.51	19
	Nov.	10	3.05	31
	Dec.	13	2.60	34
	Total	133	3.16	421
1956	Jan.	15	2.53	38
	Feb.	11	2.59	29
	Mar.	8	2.87	22
	Apr.	6	3.13	18
	May	4	3.23	15
	June	4	3.34	15
	July	8	3.53	27
	Aug.	4	3.35	13
	Sept.	4	3.35	12
	Oct.	4	3.39	14
	Nov.	6	3.50	21
	Dec.	8	3.29	25
	Total	82	3.05	249
1957	Jan.	12	2.77	33
	Feb.	14	2.32	32
	Mar.	10	2.64	26
	Apr.	6	2.99	18
	May	15	2.04	31
	June	9	2.85	25
	July	4	3.31	13
	Aug.	9	3.41	31
	Sept.	4	3.27	12
	Oct.	14	3.02	44
	Nov.	21	2.45	51
	Dec.	15	2.04	31
	Total	133	2.61	347
1958	Jan.	10	2.49	24
	Feb.	19	1.83	35
	Mar.	41	1.43	59
	Apr.	64	1.02	65
	May	69	1.05	73
	June	7	2.29	16
	July	6	3.17	19
	Aug.	5	3.22	18
	Sept.	22	3.13	70
	Oct.	8	3.16	24
	Nov.	11	2.62	28
	Dec.	10	2.67	26
	Total	272	1.68	457

To obtain mg/l multiply T/AF by 735.

Table 14

Colorado River Basin

Historical Flow and Quality of Water Data

Virgin River at Littlefield, Arizona

Units – 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	10	2.58	27
	Feb.	13	2.30	31
	Mar.	9	2.67	24
	Apr.	4	3.05	13
	May	4	3.07	13
	June	4	3.24	12
-1959	July	4	3.32	13
	Aug.	12	3.35	40
	Sept.	4	3.20	13
	Oct.	5	3.30	15
	Nov.	13	2.90	36
	Dec.	9	2.69	23
	Total	91	2.87	260
	Jan.	11	2.48	28
	Feb.	10	2.38	24
	Mar.	10	2.45	24
	Apr.	6	2.91	17
	May	5	3.03	14
	June	3	3.16	10
-1960	July	4	3.18	12
	Aug.	3	3.20	11
	Sept.	6	3.51	20
	Oct.	6	3.05	19
	Nov.	12	2.80	35
	Dec.	8	2.71	22
	Total	84	2.79	236
	Jan.	8	2.76	21
	Feb.	7	2.80	20
	Mar.	8	2.84	23
	Apr.	4	3.11	14
	May	4	3.14	12
	June	4	3.14	12
-1961	July	8	3.22	27
	Aug.	17	3.58	60
	Sept.	22	3.36	73
	Oct.	5	3.41	19
	Nov.	8	3.07	23
	Dec.	13	2.69	34
	Total	108	3.14	338
	Jan.	10	2.73	28
	Feb.	30	1.65	50
	Mar.	17	2.09	35
	Apr.	33	1.21	40
	May	9	2.24	19
	June	4	3.32	12
-1962	July	4	3.29	13
	Aug.	3	3.46	11
	Sept.	7	3.28	24
	Oct.	7	3.32	21
	Nov.	6	3.18	20
	Dec.	7	2.75	20
	Total	137	2.14	293
	Jan.	9	2.54	23
	Feb.	9	2.56	23
	Mar.	6	3.14	19
	Apr.	4	3.43	15
	May	4	3.41	13
	June	3	3.44	11
-1963	July	3	3.48	12
	Aug.	11	3.33	36
	Sept.	14	3.54	48
	Oct.	5	3.32	18
	Nov.	10	3.00	28
	Dec.	7	2.96	20
	Total	85	3.14	266
	Jan.	7	2.96	20
	Feb.	7	2.88	21
	Mar.	7	2.99	20
	Apr.	13	2.22	28
	May	11	2.22	24
	June	3	3.50	10
-1964	July	4	3.63	14
	Aug.	14	3.81	53
	Sept.	3	3.63	11
	Oct.	3	3.58	12
	Nov.	6	3.32	22
	Dec.	9	2.98	26
	Total	87	3.01	261

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	9	2.78	25
	Feb.	8	2.75	22
	Mar.	8	2.62	21
	Apr.	30	2.00	60
	May	23	1.52	35
	June	9	2.11	19
-1965	July	3	3.67	11
	Aug.	5	3.40	17
	Sept.	6	3.00	18
	Oct.	6	3.00	18
	Nov.	21	1.90	40
	Dec.	26	1.58	41
	Total	154	2.12	327
	Jan.	13	2.31	30
	Feb.	11	2.45	27
	Mar.	14	1.50	29
	Apr.	17	1.70	29
	May	6	3.00	18
	June	3	4.00	12
-1966	July	3	4.00	12
	Aug.	3	3.67	11
	Sept.	4	3.50	14
	Oct.	6	3.33	20
	Nov.	9	2.78	25
	Dec.	73	1.99	145
	Total	162	2.30	372
	Jan.	13	2.66	34
	Feb.	9	2.67	25
	Mar.	10	2.76	29
	Apr.	11	2.63	30
	May	20	1.88	37
	June	7	2.80	19
-1967	July	4	3.57	14
	Aug.	7	3.32	25
	Sept.	14	3.41	46
	Oct.	7	3.13	21
	Nov.	9	2.71	25
	Dec.	13	2.49	32
	Total	124	2.72	337
	Jan.	13	2.60	33
	Feb.	15	2.19	32
	Mar.	12	2.16	27
	Apr.	15	2.03	30
	May	17	1.80	30
	June	5	2.81	13
-1968	July	6	3.52	20
	Aug.	14	3.09	45
	Sept.	3	3.60	12
	Oct.	6	3.41	20
	Nov.	7	3.05	22
	Dec.	11	2.79	30
	Total	124	2.53	314
	Jan.	48	1.52	73
	Feb.	34	1.82	62
	Mar.	39	1.49	58
	Apr.	82	.87	71
	May	83	.71	59
-1969	June	14	1.86	26
	July	6	3.17	19
	Aug.	4	3.75	15
	Sept.	9	3.56	32
	Oct.	8	3.13	25
	Nov.	12	2.75	33
	Dec.	12	2.42	29
	Total	351	1.43	502
	Jan.	13	2.08	27
	Feb.	9	2.44	22
	Mar.	12	2.83	34
	Apr.	4	3.50	14
	May	5	3.20	16
-1970	June	4	3.25	13
	July	6	3.33	20
	Aug.	8	3.12	25
	Sept.	5	3.60	18
	Oct.	5	3.40	17
	Nov.	10	3.20	32
	Dec.	11	2.45	27
	Total	92	2.88	265

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	10	2.45	26
	Feb.	9	2.48	23
	Mar.	9	2.74	23
	Apr.	5	3.17	16
	May	9	2.49	22
	June	4	3.29	12
1971	July	4	3.32	13
	Aug.	19	3.08	58
	Sept.	5	3.35	17
	Oct.	9	2.94	28
	Nov.	10	2.75	27
	Dec.	21	1.96	41
	Total	114	2.69	305
	Jan.	11	2.66	28
	Feb.	9	2.70	24
	Mar.	6	3.08	17
	Apr.	4	3.32	13
	May	4	3.41	12
	June	15	3.21	48
1972	July	4	3.52	14
	Aug.	11	3.22	36
	Sept.	24	3.45	82
	Oct.	17	2.73	48
	Nov.	12	2.35	29
	Dec.	12	2.62	30
	Total	129	2.96	381
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 14
Colorado River Basin
Historical Flow and Quality of Water Data
Virgin River at Littlefield, Arizona

(Annual Summary)

Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./1)	T.D.S. (Tons)
1941	427	1.37	1,000	583
1942	186	2.01	1,480	375
1943	179	2.15	1,580	385
1944	181	1.92	1,410	347
1945	181	2.43	1,790	441
1946	169	2.42	1,780	409
1947	131	2.56	1,890	336
1948	111	2.65	1,950	294
1949	163	2.17	1,600	354
1950	118	2.65	1,950	313
1951	112	2.93	2,150	328
1952	267	1.46	1,070	390
1953	98	3.00	2,190	292
1954	140	2.61	1,920	365
1955	133	3.16	2,330	421
1956	82	3.05	2,230	249
1957	133	2.61	1,920	347
1958	272	1.68	1,230	457
1959	91	2.87	2,100	260
1960	84	2.79	2,060	236
1961	108	3.14	2,300	338
1962	137	2.14	1,570	293
1963	85	3.14	2,300	266
1964	87	3.01	2,200	261
1965	154	2.12	1,560	327
1966	162	2.30	1,690	372
1967	124	2.72	1,980	337
1968	124	2.53	1,860	314
1969	351	1.43	1,051	502
1970	92	2.88	2,117	265

Table 14
Colorado River Basin
Historical Flow and Quality of Water Data
Virgin River at Littlefield, Arizona

(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	114	2.69	1,976	307
1972	129	2.96	2,194	381
Total	4,925			11,143
Average	154	2.26	1,662	348

Table 15

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River below Hoover Dam, Arizona - Nevada

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	589	1.08	636
	Feb.	500	1.11	555
	Mar.	552	1.10	607
	Apr.	518	1.08	560
	May	1,435	1.08	1,550
	June	1,810	1.07	1,935
-1941	July	951	1.06	1,007
	Aug.	1,429	.97	1,386
	Sept.	1,576	.94	1,481
	Oct.	1,641	.94	1,543
	Nov.	1,817	.93	1,690
	Dec.	2,071	.94	1,947
	Total	14,889	1.00	14,897
	Jan.	2,011	1.00	2,011
	Feb.	1,550	.99	1,535
	Mar.	1,425	1.00	1,425
	Apr.	1,301	1.00	1,301
	May	1,343	1.00	1,343
	June	1,561	1.01	1,577
-1942	July	1,285	.99	1,272
	Aug.	846	.99	838
	Sept.	1,025	.98	1,005
	Oct.	1,163	.95	1,105
	Nov.	1,095	.90	986
	Dec.	1,157	.85	983
	Total	15,762	.98	15,381
	Jan.	1,109	.87	965
	Feb.	823	.89	732
	Mar.	971	.94	913
	Apr.	915	.95	869
	May	1,029	.94	967
	June	1,040	.93	967
-1943	July	1,109	.91	1,009
	Aug.	1,042	.92	959
	Sept.	1,042	.91	948
	Oct.	1,179	.90	1,061
	Nov.	1,179	.86	1,014
	Dec.	1,277	.86	1,098
	Total	12,715	.90	11,502
	Jan.	1,303	.88	1,147
	Feb.	1,269	.97	1,231
	Mar.	1,307	.96	1,254
	Apr.	1,170	.97	1,135
	May	1,216	.98	1,192
	June	1,097	.95	1,042
-1944	July	1,111	.93	1,033
	Aug.	1,211	.92	1,113
	Sept.	1,132	.89	1,007
	Oct.	1,226	1/.94	1,152
	Nov.	1,186	1/.99	1,174
	Dec.	1,199	.94	1,127
	Total	14,427	.94	13,607
	Jan.	1,239	.93	1,152
	Feb.	1,100	1/.96	1,056
	Mar.	1,250	2/.96	1,200
	Apr.	1,042	1/.95	990
	May	1,068	1/.90	961
	June	1,014	2/.91	923
-1945	July	861	.92	792
	Aug.	885	1/.93	823
	Sept.	869	1/.90	782
	Oct.	1,080	1/.88	950
	Nov.	1,042	1/.90	938
	Dec.	1,062	1/.89	945
	Total	12,512	.92	11,512
	Jan.	1,116	.87	971
	Feb.	1,047	1/.95	994
	Mar.	1,004	.88	884
	Apr.	*872	.89	*776
	May	903	1/.96	867
	June	817	1/.92	752
-1946	July	838	.90	754
	Aug.	751	1/.91	683
	Sept.	759	2/.91	691
	Oct.	857	1/.92	788
	Nov.	762	2/.91	693
	Dec.	859	1/.90	773
	Total	*10,585	.91	*9,626
	Jan.	984	0.90	886
	Feb.	886	.91	806
	Mar.	956	.92	879
	Apr.	859	1/.99	850
	May	951	1/1.03	979
	June	919	1/.95	873
-1947	July	925	.96	888
	Aug.	865	1/.92	796
	Sept.	843	2/.92	776
	Oct.	828	1/.92	762
	Nov.	880	2/.92	810
	Dec.	1,063	1/.92	978
	Total	10,959	.94	10,283
	Jan.	1,169	2/.93	1,087
	Feb.	1,138	1/.93	1,058
	Mar.	1,150	1/.93	1,070
	Apr.	1,202	1/.97	1,166
	May	1,142	1/.93	1,062
	June	1,076	1/.88	947
-1948	July	1,156	1/.86	994
	Aug.	968	2/.86	833
	Sept.	981	1/.85	834
	Oct.	917	1/.80	734
	Nov.	1,028	.88	905
	Dec.	1,124	1/.91	1,023
	Total	13,051	.90	11,713
	Jan.	1,212	.83	1,006
	Feb.	1,214	1/.84	1,020
	Mar.	1,291	1/.85	1,097
	Apr.	1,178	1/.86	1,013
	May	1,026	1/.83	852
	June	986	.87	858
-1949	July	1,020	.84	857
	Aug.	1,062	.80	850
	Sept.	1,141	.78	890
	Oct.	1,176	.75	882
	Nov.	1,022	1/.83	848
	Dec.	1,238	.87	1,077
	Total	13,566	.83	11,250
	Jan.	1,277	.83	1,060
	Feb.	1,132	.81	917
	Mar.	1,246	.85	1,059
	Apr.	1,089	.85	926
	May	1,120	1/.84	941
	June	960	1/.83	797
-1950	July	982	.79	776
	Aug.	872	1/.82	715
	Sept.	824	1/.79	651
	Oct.	848	.89	755
	Nov.	815	.88	717
	Dec.	851	.86	732
	Total	12,016	.84	10,046
	Jan.	928	.87	807
	Feb.	756	.87	658
	Mar.	860	.91	783
	Apr.	796	.93	740
	May	898	.92	826
	June	691	.91	629
-1951	July	783	.92	720
	Aug.	907	.93	844
	Sept.	848	.92	780
	Oct.	756	.93	703
	Nov.	818	.93	761
	Dec.	829	.91	754
	Total	9,870	.91	9,005
	Jan.	1,070	.90	963
	Feb.	1,212	.93	1,127
	Mar.	1,371	.94	1,289
	Apr.	1,385	.94	1,302
	May	1,532	.94	1,440
	June	1,432	.91	1,303
-1952	July	1,304	.83	1,082
	Aug.	1,307	.79	1,033
	Sept.	1,359	.73	992
	Oct.	1,291	.69	891
	Nov.	1,215	.66	802
	Dec.	1,338	.88	1,177
	Total	15,816	.85	13,401
	Jan.	1,227	0.93	1,141
	Feb.	1,043	.91	949
	Mar.	1,046	.93	973
	Apr.	971	.94	913
	May	998	.91	908
	June	819	.89	729
-1953	July	897	.87	780
	Aug.	968	.87	842
	Sept.	968	.86	832
	Oct.	802	.86	690
	Nov.	749	.86	644
	Dec.	814	.85	692
	Total	11,302	.89	10,093
	Jan.	836	.88	736
	Feb.	721	.94	678
	Mar.	911	.95	865
	Apr.	975	.94	916
	May	1,101	.93	1,024
	June	929	.94	873
-1954	July	1,027	.94	965
	Aug.	888	.97	861
	Sept.	933	.97	905
	Oct.	776	.94	729
	Nov.	676	.95	642
	Dec.	741	.97	719
	Total	10,514	.94	9,913
	Jan.	725	.99	718
	Feb.	705	1.04	733
	Mar.	906	1.08	978
	Apr.	882	1.11	979
	May	928	1.12	1,039
	June	680	1.12	762
-1955	July	847	1.11	940
	Aug.	789	1.12	884
	Sept.	622	1.11	690
	Oct.	526	1.12	589
	Nov.	487	1.12	545
	Dec.	492	1.09	536
	Total	8,589	1.09	9,393
	Jan.	583	1.09	635
	Feb.	499	1.10	549
	Mar.	769	1.12	861
	Apr.	840	1.14	958
	May	748	1.15	860
	June	784	1.17	917
-1956	July	782	1.19	931
	Aug.	696	1.17	814
	Sept.	610	1.15	702
	Oct.	490	1.16	568
	Nov.	554	1.12	620
	Dec.	457	1.10	503
	Total	7,812	1.14	8,918
	Jan.	534	1.07	571
	Feb.	470	1.08	508
	Mar.	739	1.11	820
	Apr.	890	1.09	970
	May	769	1.07	823
	June	828	1.06	878
-1957	July	786	1.05	825
	Aug.	786	1.03	810
	Sept.	785	1.02	801
	Oct.	697	1.02	711
	Nov.	958	.99	948
	Dec.	1,081	.94	1,016
	Total	9,323	1.04	9,681
	Jan.	1;245	.90	1,120
	Feb.	846	.94	795
	Mar.	1,435	.90	1,292
	Apr.	1,473	.88	1,296
	May	1,115	.84	937
	June	819	.85	696
-1958	July	894	.85	760
	Aug.	911	.83	756
	Sept.	792	.83	657
	Oct.	728	.82	597
	Nov.	746	.82	612
	Dec.	873	.83	725
	Total	11,877	.86	10,243

To obtain mg/l multiply T/AF by 735.
*Revised
1/ Estimated or partially estimated.
2/ Average of adjacent values.

Table 15

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River below Hoover Dam, Arizona - Nevada

Units - 1000

Year	Month	Flow (A.F.)	Concen-tration (T./A.F.)	T.D.S. (Tons)
1959	Jan.	795	0.85	676
	Feb.	648	.83	537
	Mar.	827	.88	728
	Apr.	916	.91	834
	May	949	.86	816
	June	760	.85	646
	July	848	.84	713
	Aug.	894	.83	742
	Sept.	773	.81	626
	Oct.	693	.82	568
	Nov.	607	.81	492
	Dec.	572	.81	463
	Total	9,282	.84	7,841
1960	Jan.	629	.86	541
	Feb.	512	.89	456
	Mar.	710	.89	632
	Apr.	909	.93	845
	May	856	.93	796
	June	1,015	.92	934
	July	984	.89	876
	Aug.	959	.93	892
	Sept.	806	.93	749
	Oct.	556	.92	512
	Nov.	489	.92	450
	Dec.	572	.92	526
	Total	8,997	.91	8,209
1961	Jan.	591	.93	549
	Feb.	577	.94	543
	Mar.	936	.95	889
	Apr.	904	.97	877
	May	943	.95	896
	June	842	.94	791
	July	822	.94	772
	Aug.	739	.96	709
	Sept.	690	.96	663
	Oct.	539	.93	502
	Nov.	517	.94	486
	Dec.	486	.95	462
	Total	8,586	.95	8,139
1962	Jan.	482	.93	448
	Feb.	497	1/.94	467
	Mar.	798	1/.94	750
	Apr.	902	1/.95	857
	May	887	1.00	887
	June	799	1/.94	751
	July	824	1/.91	750
	Aug.	857	1/.87	746
	Sept.	716	1.00	716
	Oct.	634	1/.86	545
	Nov.	613	1/.90	552
	Dec.	606	1/.93	564
	Total	8,615	1/.93	8,033
1963	Jan.	482	.99	478
	Feb.	575	1/.97	558
	Mar.	871	1/.95	828
	Apr.	865	1/.94	813
	May	911	.93	847
	June	764	1/.92	702
	July	908	1/.91	826
	Aug.	857	.90	771
	Sept.	724	.89	645
	Oct.	527	.90	475
	Nov.	464	.89	413
	Dec.	585	.90	526
	Total	8,533	1/.92	7,882
1964	Jan.	633	.93	589
	Feb.	583	.94	548
	Mar.	800	.95	760
	Apr.	859	.98	842
	May	844	.98	827
	June	719	.99	712
	July	866	.98	849
	Aug.	731	.99	724
	Sept.	623	.99	616
	Oct.	591	1.01	596
	Nov.	445	1.02	454
	Dec.	469	1.06	497
	Total	8,163	.98	8,014
1965	Jan.	489	1.08	528
	Feb.	498	1.09	543
	Mar.	786	1.15	903
	Apr.	698	1.14	796
	May	872	1.14	994
	June	786	1.08	848
	July	815	1.08	880
	Aug.	817	1.11	907
	Sept.	655	1.12	734
	Oct.	535	1.05	562
	Nov.	418	1.03	430
	Dec.	423	1.06	449
	Total	7,792	1.10	8,574
1966	Jan.	252	1.03	260
	Feb.	436	1.02	445
	Mar.	785	1.05	824
	Apr.	846	1.05	888
	May	887	1.03	914
	June	783	1.06	831
	July	889	1.01	897
	Aug.	839	.98	822
	Sept.	672	1.00	672
	Oct.	467	.96	448
	Nov.	473	.93	440
	Dec.	448	.93	416
	Total	7,777	1.01	7,857
1967	Jan.	500	.94	470
	Feb.	574	.92	528
	Mar.	847	.91	771
	Apr.	771	.90	694
	May	889	.93	827
	June	782	.94	735
	July	832	.90	749
	Aug.	755	.90	679
	Sept.	494	.93	459
	Oct.	576	.93	536
	Nov.	556	.91	506
	Dec.	356	.92	328
	Total	7,932	.92	7,282
1968	Jan.	396	.94	372
	Feb.	496	.92	456
	Mar.	850	.93	791
	Apr.	883	.93	821
	May	853	.95	810
	June	752	.93	699
	July	757	.94	712
	Aug.	693	.97	672
	Sept.	663	.97	643
	Oct.	486	.98	476
	Nov.	457	.99	452
	Dec.	553	1.00	553
	Total	7,839	.95	7,457
1969	Jan.	549	1.02	560
	Feb.	552	1.02	563
	Mar.	825	1.02	841
	Apr.	894	1.02	912
	May	834	1.00	834
	June	753	1.02	768
	July	772	1.01	780
	Aug.	693	1.02	707
	Sept.	618	1.00	618
	Oct.	523	1.00	523
	Nov.	426	1.00	426
	Dec.	453	1.01	458
	Total	7,892	1.01	7,990
1970	Jan.	603	1.04	627
	Feb.	536	1.03	552
	Mar.	753	1.03	776
	Apr.	919	1.02	937
	May	927	.97	899
	June	780	1.00	780
	July	792	.98	776
	Aug.	676	1.00	677
	Sept.	507	.97	492
	Oct.	583	1.01	589
	Nov.	450	1.07	481
	Dec.	497	1.09	542
	Total	8,023	1.01	8,128
1971	Jan.	561	1.07	598
	Feb.	663	1.00	663
	Mar.	860	1.01	872
	Apr.	913	1.04	954
	May	861	1.04	894
	June	741	1.00	741
	July	740	.98	727
	Aug.	741	.99	732
	Sept.	623	1.00	622
	Oct.	503	1.01	509
	Nov.	452	1.02	463
	Dec.	506	1.01	522
	Total	8,164	1.02	8,297
1972	Jan.	568	1.08	612
	Feb.	636	1.02	646
	Mar.	905	.98	855
	Apr.	877	.97	854
	May	866	.97	841
	June	795	.99	790
	July	769	.98	755
	Aug.	756	.96	723
	Sept.	634	.95	602
	Oct.	517	.95	490
	Nov.	397	.98	387
	Dec.	379	.99	375
	Total	8,099	.98	7,962
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

1/Estimated or partially estimated.

Table 15
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River below Hoover Dam, Arizona, Nevada
(Annual Summary)
Units - 1000

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

Measured flow record entire period.

Table 15
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River below Hoover Dam, Arizona-Nevada

(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	8,164	1.02	747	8,297
1972	8,099	.98	723	7,962
Total	331,279			312,129
Average	10,352	.94	693	9,754

Table 16

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River below Parker Dam, Arizona–California

Units – 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	627	1.11	698
	Feb.	561	1.14	642
	Mar.	750	1.14	854
	Apr.	608	1.12	679
	May	1,359	1.12	1,524
	June	1,628	1.11	1,808
-1941	July	998	1.10	1,098
	Aug.	1,332	1.04	1,381
	Sept.	1,528	.98	1,495
	Oct.	1,585	.98	1,550
	Nov.	1,731	.95	1,641
	Dec.	2,042	1.04	2,116
	Total	14,749	1.05	15,486
	Jan.	1,957	1.09	1,963
	Feb.	1,482	1.00	1,480
	Mar.	1,494	.99	1,476
	Apr.	1,136	1.01	1,143
	May	1,588	1.01	1,602
	June	1,536	1.01	1,549
-1942	July	1,226	.98	1,197
	Aug.	880	1.07	939
	Sept.	797	1.00	794
	Oct.	845	.99	833
	Nov.	1,041	.99	1,028
	Dec.	1,213	.89	1,084
	Total	15,195	.99	15,088
	Jan.	1,015	.93	948
	Feb.	746	.88	657
	Mar.	886	.97	863
	Apr.	877	.95	837
	May	957	.97	933
	June	976	.98	961
-1943	July	1,086	.90	981
	Aug.	990	.91	904
	Sept.	1,006	.90	908
	Oct.	1,160	.92	1,062
	Nov.	1,149	.87	1,003
	Dec.	1,231	.87	1,076
	Total	12,079	.92	11,133
	Jan.	1,241	.90	1,121
	Feb.	1,223	.92	1,131
	Mar.	1,297	.96	1,240
	Apr.	1,164	.98	1,136
	May	1,116	.98	1,089
	June	983	.99	969
-1944	July	1,035	.95	988
	Aug.	1,148	.96	1,098
	Sept.	1,114	.89	994
	Oct.	1,178	.88	1,042
	Nov.	1,156	.88	1,023
	Dec.	1,187	.94	1,110
	Total	13,842	.93	12,941
	Jan.	1,186	.94	1,121
	Feb.	1,061	.91	969
	Mar.	1,232	.94	1,152
	Apr.	985	.94	929
	May	970	.94	915
	June	919	.99	914
-1945	July	913	.92	844
	Aug.	770	.90	694
	Sept.	824	.91	751
	Oct.	1,038	.85	884
	Nov.	1,036	.89	924
	Dec.	1,099	.90	992
	Total	12,033	.92	11,089
	Jan.	1,041	.90	939
	Feb.	1,028	.96	991
	Mar.	944	.89	843
	Apr.	830	1.04	867
	May	873	.94	825
	June	754	.92	696
-1946	July	801	.91	731
	Aug.	722	.89	642
	Sept.	730	.91	665
	Oct.	759	.91	691
	Nov.	789	.91	720
	Dec.	870	.91	794
	Total	10,141	.93	9,404

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	953	.91	870
	Feb.	899	.92	829
	Mar.	940	.94	888
	Apr.	797	.97	777
	May	905	.99	892
	June	860	.98	847
-1947	July	844	.97	822
	Aug.	892	.96	860
	Sept.	819	.98	800
	Oct.	837	.91	765
	Nov.	880	.87	768
	Dec.	1,037	.83	862
	Total	10,663	.94	9,980
	Jan.	1,160	.96	1,109
	Feb.	1,160	.92	1,062
	Mar.	1,107	.91	1,009
	Apr.	1,083	.92	999
	May	1,115	.91	1,016
	June	989	.93	923
-1948	July	1,108	.90	999
	Aug.	986	.89	880
	Sept.	941	.88	831
	Oct.	918	.86	791
	Nov.	978	.81	793
	Dec.	1,106	.92	1,019
	Total	12,651	.90	11,431
	Jan.	1,229	.89	1,099
	Feb.	1,192	.85	1,015
	Mar.	1,236	.84	1,044
	Apr.	1,116	.88	985
	May	983	1.05	866
	June	923	.89	824
-1949	July	952	.89	849
	Aug.	1,013	.84	852
	Sept.	1,099	.83	913
	Oct.	1,148	.80	918
	Nov.	1,011	.77	778
	Dec.	1,158	.74	855
	Total	13,060	.84	10,998
	Jan.	1,080	.86	931
	Feb.	1,036	.85	882
	Mar.	1,209	.84	1,017
	Apr.	998	.88	879
	May	1,066	.88	941
	June	900	.87	785
-1950	July	897	.85	765
	Aug.	833	.84	698
	Sept.	704	.84	590
	Oct.	651	.86	558
	Nov.	542	.87	473
	Dec.	557	.89	494
	Total	10,473	.86	9,013
	Jan.	550	.89	488
	Feb.	501	.89	448
	Mar.	730	.90	657
	Apr.	765	.89	682
	May	675	.90	607
	June	862	.90	779
-1951	July	945	.91	862
	Aug.	945	.89	840
	Sept.	723	.88	636
	Oct.	709	.90	638
	Nov.	560	.90	502
	Dec.	707	.91	642
	Total	8,672	.90	7,781
	Jan.	1,104	.91	1,008
	Feb.	1,134	.89	1,012
	Mar.	1,424	.89	1,273
	Apr.	1,300	.92	1,202
	May	1,443	.95	1,366
	June	1,419	.95	1,341
-1952	July	1,263	.90	1,142
	Aug.	1,296	.85	1,105
	Sept.	1,321	.81	1,074
	Oct.	1,234	.76	935
	Nov.	1,172	.71	829
	Dec.	1,303	.69	895
	Total	15,413	.86	13,182

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	1,198	.68	813
	Feb.	1,020	.83	848
	Mar.	947	.90	853
	Apr.	808	.93	753
	May	953	.92	880
	June	956	.92	882
-1953	July	1,093	.89	973
	Aug.	1,056	.86	909
	Sept.	823	.85	700
	Oct.	634	.86	544
	Nov.	527	.86	455
	Dec.	634	.87	550
	Total	10,649	.86	9,160
	Jan.	797	.86	685
	Feb.	661	.85	560
	Mar.	782	.86	673
	Apr.	864	.86	746
	May	1,015	.91	927
	June	883	.94	834
-1954	July	1,000	.93	934
	Aug.	982	.93	918
	Sept.	754	.94	706
	Oct.	636	.94	599
	Nov.	638	.94	601
	Dec.	659	.94	618
	Total	9,671	.91	8,801
	Jan.	734	.95	699
	Feb.	598	.96	574
	Mar.	733	.98	722
	Apr.	758	.99	753
	May	792	1.02	804
	June	866	1.06	914
-1955	July	963	1.10	1,060
	Aug.	849	1.09	924
	Sept.	694	1.07	740
	Oct.	499	1.08	540
	Nov.	369	1.10	407
	Dec.	286	1.09	312
	Total	8,141	1.04	8,449
	Jan.	317	1.11	352
	Feb.	365	1.12	407
	Mar.	628	1.13	708
	Apr.	684	1.12	766
	May	671	1.10	735
	June	787	1.12	880
-1956	July	865	1.13	976
	Aug.	823	1.12	920
	Sept.	634	1.15	728
	Oct.	486	1.10	536
	Nov.	321	1.12	359
	Dec.	288	1.15	330
	Total	6,869	1.12	7,697
	Jan.	243	1.15	279
	Feb.	349	1.13	395
	Mar.	589	1.12	657
	Apr.	731	1.09	796
	May	645	1.09	704
	June	783	1.08	845
-1957	July	890	1.06	941
	Aug.	817	1.04	848
	Sept.	661	1.01	670
	Oct.	503	1.02	513
	Nov.	781	1.03	802
	Dec.	1,005	1.04	1,044
	Total	7,997	1.06	8,494
	Jan.	1,285	1.00	1,280
	Feb.	565	.95	536
	Mar.	1,345	.91	1,229
	Apr.	1,333	.89	1,191
	May	1,013	.87	883
	June	854	.86	735
-1958	July	930	.86	803
	Aug.	867	.84	729
	Sept.	714	.83	590
	Oct.	610	.84	510
	Nov.	623	.84	521
	Dec.	753	.85	639
	Total	10,892	.89	9,646

To obtain mg/l multiply T/AF by 735.

Table 16

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River below Parker Dam, Arizona-California

Units-1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	677	0.84	566
	Feb.	593	.83	495
	Mar.	690	.84	579
	Apr.	832	.85	707
	May	706	.88	620
	June	797	.89	709
-1959	July	962	.86	829
	Aug.	873	.81	706
	Sept.	682	.82	557
	Oct.	558	.84	471
	Nov.	405	.84	342
	Dec.	411	.83	343
	Total	8,186	.85	6,924
	Jan.	428	.82	352
	Feb.	474	.82	388
	Mar.	760	.83	630
	Apr.	810	.87	705
	May	740	.88	651
	June	879	.90	794
-1960	July	986	.89	880
	Aug.	868	.90	780
	Sept.	640	.89	568
	Oct.	490	.87	428
	Nov.	397	.90	356
	Dec.	322	.91	293
	Total	7,794	.88	6,826
	Jan.	379	.92	347
	Feb.	453	.91	414
	Mar.	742	.92	684
	Apr.	725	.92	669
	May	705	.94	664
	June	822	.94	776
-1961	July	900	.93	841
	Aug.	710	.93	661
	Sept.	606	.92	556
	Oct.	412	.91	374
	Nov.	319	.94	300
	Dec.	202	.92	186
	Total	6,975	.93	6,472
	Jan.	334	.93	310
	Feb.	374	.93	346
	Mar.	692	.94	652
	Apr.	756	1/.96	729
	May	686	1/.97	667
	June	778	1.00	775
-1962	July	882	.97	859
	Aug.	821	.99	816
	Sept.	644	.97	627
	Oct.	471	.98	460
	Nov.	434	.97	423
	Dec.	287	1.00	286
	Total	7,159	.97	6,950
	Jan.	350	1.00	349
	Feb.	467	1.00	466
	Mar.	735	.99	731
	Apr.	690	.99	685
	May	708	.97	687
	June	840	.95	802
-1963	July	933	.92	862
	Aug.	819	.91	747
	Sept.	630	.91	572
	Oct.	438	.88	385
	Nov.	334	.88	294
	Dec.	307	.89	272
	Total	7,251	.94	6,852
	Jan.	363	.91	329
	Feb.	479	.90	432
	Mar.	640	.91	582
	Apr.	652	.91	596
	May	598	.92	552
	June	742	.95	706
	July	864	.95	824
-1964	Aug.	795	.95	754
	Sept.	589	.96	564
	Oct.	409	.96	393
	Nov.	275	.96	264
	Dec.	245	1.00	246
	Total	6,651	.94	6,242
	Jan.	290	1.01	294
	Feb.	423	1.00	424
	Mar.	634	1.03	651
	Apr.	581	1.06	614
	May	604	1.07	645
	June	710	1.11	790
-1965	July	846	1.09	924
	Aug.	867	1.08	940
	Sept.	599	1.08	648
	Oct.	385	1.11	426
	Nov.	220	1.10	243
	Dec.	197	.95	187
	Total	6,356	1.07	6,786
	Jan.	177	.73	129
	Feb.	413	1.04	428
	Mar.	604	1.08	655
	Apr.	729	1.08	785
	May	699	1.10	766
	June	790	1.12	887
-1966	July	901	1.07	966
	Aug.	852	1.04	890
	Sept.	585	1.07	626
	Oct.	357	.96	343
	Nov.	256	1.00	256
	Dec.	320	.97	311
	Total	6,683	1.05	7,042
	Jan.	306	.98	299
	Feb.	431	1.01	434
	Mar.	677	.98	664
	Apr.	608	.98	594
	May	648	.98	635
	June	726	1.01	733
-1967	July	835	.95	794
	Aug.	749	.98	734
	Sept.	490	.97	474
	Oct.	435	.95	413
	Nov.	247	.93	230
	Dec.	170	.96	163
	Total	6,322	.98	6,167
	Jan.	351	.94	330
	Feb.	450	.89	400
	Mar.	680	.93	632
	Apr.	700	.93	652
	May	626	.97	608
	June	722	.95	685
-1968	July	779	.96	745
	Aug.	725	.95	686
	Sept.	585	.98	573
	Oct.	404	.98	394
	Nov.	309	.99	306
	Dec.	312	1.00	312
	Total	6,643	.95	6,323
	Jan.	254	1.01	256
	Feb.	467	1.02	476
	Mar.	740	.95	703
	Apr.	713	1.03	734
	May	640	1.08	692
-1969	June	674	1.05	708
	July	765	1.03	787
	Aug.	733	.99	726
	Sept.	488	.99	483
	Oct.	434	.97	420
	Nov.	220	1.03	227
	Dec.	310	1.02	317
	Total	6,438	1.01	6,529
	Jan.	367	1.03	378
	Feb.	442	1.04	460
	Mar.	654	1.02	667
	Apr.	750	1.04	780
	May	657	1.03	676
-1970	June	706	1.03	727
	July	792	1.00	792
	Aug.	675	1.02	688
	Sept.	530	1.01	535
	Oct.	454	1.03	468
	Nov.	304	1.04	316
	Dec.	328	1.09	358
	Total	6,659	1.03	6,845
	Jan.	339	1.07	363
	Feb.	486	1.03	503
	Mar.	743	1.04	771
	Apr.	746	1.07	796
	May	661	1.05	691
	June	743	1.01	751
1971	July	877	1.02	896
	Aug.	690	1.02	704
	Sept.	565	1.01	570
	Oct.	397	1.04	414
	Nov.	309	1.03	319
	Dec.	355	1.04	371
	Total	6,911	1.03	7,149
	Jan.	346	1.05	362
	Feb.	480	1.07	513
	Mar.	747	1.07	797
	Apr.	766	1.05	806
	May	700	1.02	714
	June	689	1.01	694
1972	July	875	1.00	872
	Aug.	716	.97	694
	Sept.	574	.98	562
	Oct.	224	.99	221
	Nov.	283	.97	274
	Dec.	389	1.00	389
	Total	6,789	1.02	6,898
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
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	Total			
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	Dec.			
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	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 16
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River below Parker Dam, Arizona – California

(Annual Summary)
Units – 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (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

1/ Partially estimated.
Records furnished by Metropolitan Water District of Southern California

Table 16
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River below Parker Dam, Arizona-California

(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./1)	T.D.S. (Tons)
1971	6,911	1.03	761	7,149
1972	6,789	1.02	747	6,898
Total	300,005			283,758
Average	9,375	.95	695	8,867

Table 17

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River at Imperial Dam, Arizona - California

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	642	1.10	706
	Feb.	535	1.15	615
	Mar.	743	.90	669
	Apr.	562	1.04	584
	May	1,150	1.11	1,277
	June	1,605	1.21	1,942
-1941	July	965	1.17	1,129
	Aug.	1,192	1.09	1,299
	Sept.	1,444	.99	1,430
	Oct.	1,505	1.02	1,535
	Nov.	1,671	1.02	1,704
	Dec.	2,010	1.04	2,090
	Total	14,024	1.07	14,980
	Jan.	1,876	1.08	2,026
	Feb.	1,590	1.09	1,733
	Mar.	1,476	1.09	1,609
	Apr.	1,080	1.11	1,199
	May	1,524	1.10	1,676
	June	1,465	1.11	1,626
-1942	July	1,199	1.11	1,331
	Aug.	844	1.09	920
	Sept.	742	1.11	824
	Oct.	761	1.08	822
	Nov.	981	1.03	1,010
	Dec.	1,176	.97	1,141
	Total	14,714	1.08	15,917
	Jan.	1,011	.94	950
	Feb.	729	.92	671
	Mar.	846	.95	804
	Apr.	802	.96	770
	May	842	.98	825
	June	876	.98	858
-1943	July	972	.95	923
	Aug.	910	.94	855
	Sept.	917	.94	862
	Oct.	1,094	.94	1,028
	Nov.	1,124	.93	1,045
	Dec.	1,222	.89	1,088
	Total	11,345	.94	10,679
	Jan.	1,209	.89	1,076
	Feb.	1,216	.94	1,143
	Mar.	1,289	.97	1,250
	Apr.	1,126	1.00	1,126
	May	1,055	1.01	1,066
	June	900	1.02	918
-1944	July	920	.99	911
	Aug.	1,041	.97	1,010
	Sept.	1,041	.94	979
	Oct.	1,123	.92	1,033
	Nov.	1,142	.89	1,016
	Dec.	1,143	.89	1,017
	Total	13,205	.95	12,545
	Jan.	1,160	.99	1,137
	Feb.	1,047	.97	1,016
	Mar.	1,193	.97	1,157
	Apr.	947	.98	928
	May	905	1.00	905
	June	860	.99	851
-1945	July	817	.96	784
	Aug.	718	.94	675
	Sept.	745	.92	685
	Oct.	912	.88	803
	Nov.	1,011	.89	900
	Dec.	1,075	.93	1,000
	Total	11,390	.95	10,841
	Jan.	1,008	.94	948
	Feb.	1,005	.92	925
	Mar.	927	.94	871
	Apr.	759	.96	729
	May	786	.98	770
	June	658	.99	651
-1946	July	719	.97	697
	Aug.	666	.94	626
	Sept.	639	.95	607
	Oct.	707	.97	686
	Nov.	757	.96	727
	Dec.	855	.94	804
	Total	9,486	.95	9,041

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	933	0.95	886
	Feb.	872	.95	828
	Mar.	934	.98	915
	Apr.	737	1.02	752
	May	827	1.01	835
	June	787	1.02	803
-1947	July	743	1.01	750
	Aug.	830	.99	822
	Sept.	733	1.00	733
	Oct.	753	.95	715
	Nov.	851	.90	766
	Dec.	1,041	.87	906
	Total	10,041	.97	9,711
	Jan.	1,106	.97	1,073
	Feb.	1,135	.94	1,067
	Mar.	1,092	.95	1,037
	Apr.	1,007	.94	947
	May	1,051	.95	998
	June	916	.95	870
-1948	July	1,003	.95	953
	Aug.	906	.94	852
	Sept.	871	.91	793
	Oct.	901	.89	802
	Nov.	945	.86	813
	Dec.	1,103	.94	1,037
	Total	12,036	.93	11,242
	Jan.	1,237	.92	1,138
	Feb.	1,183	.88	1,041
	Mar.	1,226	.88	1,079
	Apr.	1,084	.91	986
	May	927	.92	853
	June	871	.93	810
-1949	July	860	.92	791
	Aug.	934	.88	822
	Sept.	996	.86	857
	Oct.	1,103	.83	915
	Nov.	1,000	.93	930
	Dec.	1,146	.77	882
	Total	12,567	.88	11,104
	Jan.	1,088	.89	968
	Feb.	994	.87	865
	Mar.	1,169	.88	1,029
	Apr.	936	.90	842
	May	1,002	.91	912
	June	841	.89	748
-1950	July	822	.89	732
	Aug.	758	.88	667
	Sept.	643	.87	559
	Oct.	603	.94	567
	Nov.	510	.95	485
	Dec.	540	.95	513
	Total	9,906	.90	8,887
	Jan.	558	.95	530
	Feb.	498	.96	478
	Mar.	635	.96	610
	Apr.	744	.96	714
	May	606	.99	600
	June	703	.98	689
-1951	July	820	.98	804
	Aug.	853	.95	810
	Sept.	697	.93	648
	Oct.	682	.96	655
	Nov.	559	.97	542
	Dec.	698	.98	684
	Total	8,053	.96	7,764
	Jan.	1,058	.95	1,005
	Feb.	1,107	.96	1,063
	Mar.	1,424	.92	1,310
	Apr.	1,279	.97	1,241
	May	1,345	1.00	1,345
	June	1,309	.99	1,296
-1952	July	1,182	.97	1,147
	Aug.	1,178	.92	1,084
	Sept.	1,219	.87	1,061
	Oct.	1,240	.84	1,042
	Nov.	1,176	.78	917
	Dec.	1,298	.75	974
	Total	14,815	.91	13,485

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	1,216	0.77	936
	Feb.	1,022	.89	910
	Mar.	911	.95	865
	Apr.	756	1.01	764
	May	856	1.01	865
	June	811	1.00	811
-1953	July	980	.96	941
	Aug.	931	.95	884
	Sept.	776	.93	722
	Oct.	644	.96	618
	Nov.	522	.97	506
	Dec.	620	.95	589
	Total	10,045	.94	9,411
	Jan.	783	.94	736
	Feb.	661	.94	621
	Mar.	723	.94	680
	Apr.	773	.94	727
	May	929	1.05	975
	June	804	1.03	828
-1954	July	885	1.01	894
	Aug.	887	1.03	914
	Sept.	719	1.02	733
	Oct.	620	1.03	639
	Nov.	602	1.02	614
	Dec.	644	1.03	663
	Total	9,030	1.00	9,024
	Jan.	739	1.00	739
	Feb.	593	1.03	611
	Mar.	678	1.07	725
	Apr.	716	1.09	780
	May	729	1.13	824
	June	746	1.20	895
-1955	July	882	1.21	1,067
	Aug.	811	1.18	957
	Sept.	638	1.17	746
	Oct.	499	1.20	599
	Nov.	379	1.24	470
	Dec.	298	1.29	384
	Total	7,708	1.14	8,797
	Jan.	298	1.31	390
	Feb.	344	1.24	427
	Mar.	546	1.24	677
	Apr.	646	1.23	795
	May	594	1.26	748
	June	666	1.25	833
-1956	July	753	1.25	941
	Aug.	717	1.22	875
	Sept.	583	1.24	723
	Oct.	479	1.24	594
	Nov.	343	1.28	439
	Dec.	297	1.30	386
	Total	6,266	1.25	7,828
	Jan.	258	1.36	351
	Feb.	314	1.32	414
	Mar.	520	1.23	640
	Apr.	667	1.18	787
	May	581	1.19	691
	June	651	1.19	775
-1957	July	794	1.22	969
	Aug.	759	1.08	820
	Sept.	616	1.12	690
	Oct.	511	1.16	593
	Nov.	695	1.14	792
	Dec.	978	1.10	1,076
	Total	7,344	1.17	8,598
	Jan.	1,299	1.05	1,364
	Feb.	637	1.07	682
	Mar.	1,253	1.06	1,328
	Apr.	1,280	1.02	1,306
	May	1,016	1.00	1,016
	June	769	1.01	777
-1958	July	812	.96	780
	Aug.	802	.97	778
	Sept.	655	.97	635
	Oct.	624	1.01	630
	Nov.	592	1.00	592
	Dec.	761	.97	738
	Total	10,500	1.01	10,626

To obtain mg/l multiply T/AF by 735.

Table 17

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River at Imperial Dam, Arizona - California

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	674	0.99	667
	Feb.	592	.99	586
	Mar.	618	1.02	630
	Apr.	770	1.01	778
	May	646	1.05	678
	June	679	1.03	699
-1959	July	824	.99	816
	Aug.	821	1.04	854
	Sept.	644	1.04	670
	Oct.	565	1.03	582
	Nov.	421	1.04	438
	Dec.	441	1.01	445
	Total	7,695	1.02	7,843
	Jan.	449	1.02	458
	Feb.	436	1.00	436
	Mar.	651	.99	644
	Apr.	762	.99	754
	May	650	1.07	696
	June	736	1.07	788
-1960	July	845	1.07	904
	Aug.	777	1.06	824
	Sept.	606	1.09	661
	Oct.	481	1.10	529
	Nov.	360	1.14	410
	Dec.	354	1.15	407
	Total	7,107	1.06	7,511
	Jan.	342	1.18	404
	Feb.	400	1.15	460
	Mar.	648	1.10	713
	Apr.	666	1.08	719
	May	618	1.14	705
	June	691	1.08	746
-1961	July	755	1.09	823
	Aug.	671	1.12	752
	Sept.	541	1.14	617
	Oct.	427	1.10	470
	Nov.	312	1.12	349
	Dec.	222	1.18	262
	Total	6,293	1.12	7,020
	Jan.	337	1.11	374
	Feb.	304	1.14	347
	Mar.	597	1.06	633
	Apr.	689	1.06	730
	May	619	1.11	688
	June	648	1.12	725
-1962	July	741	1.11	822
	Aug.	730	1.12	818
	Sept.	593	1.11	658
	Oct.	458	1.15	527
	Nov.	439	1.16	509
	Dec.	303	1.18	358
	Total	6,458	1.11	7,189
	Jan.	337	1.14	384
	Feb.	393	1.11	436
	Mar.	615	1.10	676
	Apr.	647	1.09	705
	May	602	1.09	656
	June	691	1.06	733
-1963	July	775	1.04	806
	Aug.	757	1.02	772
	Sept.	595	1.04	619
	Oct.	461	1.08	498
	Nov.	340	1.12	381
	Dec.	309	1.13	350
	Total	6,522	1.08	7,016
	Jan.	337	1.12	377
	Feb.	415	1.07	444
	Mar.	562	1.06	595
	Apr.	609	1.07	652
	May	530	1.10	583
	June	576	1.15	663
-1964	July	719	1.09	784
	Aug.	679	1.09	740
	Sept.	539	1.14	615
	Oct.	396	1.22	483
	Nov.	281	1.26	354
	Dec.	257	1.27	326
	Total	5,900	1.12	6,616

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	271	1.26	341
	Feb.	332	1.26	418
	Mar.	548	1.20	658
	Apr.	566	1.15	651
	May	548	1.22	669
	June	558	1.22	680
-1965	July	709	1.26	893
	Aug.	737	1.28	943
	Sept.	540	1.31	708
	Oct.	400	1.29	516
	Nov.	257	1.33	342
	Dec.	237	1.22	290
	Total	5,703	1.25	7,109
	Jan.	203	1.13	229
	Feb.	334	1.21	404
	Mar.	517	1.21	626
	Apr.	622	1.22	758
	May	576	1.24	715
	June	637	1.31	835
-1966	July	729	1.20	874
	Aug.	733	1.18	865
	Sept.	532	1.21	643
	Oct.	389	1.23	478
	Nov.	263	1.28	337
	Dec.	314	1.18	369
	Total	5,849	1.22	7,133
	Jan.	301	1.21	364
	Feb.	369	1.16	428
	Mar.	593	1.12	664
	Apr.	558	1.15	642
	May	550	1.16	638
	June	595	1.16	690
-1967	July	673	1.08	727
	Aug.	672	1.09	732
	Sept.	450	1.16	522
	Oct.	412	1.12	461
	Nov.	268	1.22	327
	Dec.	174	1.35	235
	Total	5,615	1.15	6,430
	Jan.	342	1.18	404
	Feb.	366	1.10	403
	Mar.	566	1.10	623
	Apr.	622	1.09	678
	May	532	1.18	628
	June	580	1.10	638
-1968	July	625	1.14	713
	Aug.	609	1.16	706
	Sept.	494	1.17	578
	Oct.	399	1.21	483
	Nov.	297	1.25	371
	Dec.	309	1.25	386
	Total	5,741	1.15	6,611
	Jan.	271	1.30	352
	Feb.	376	1.18	444
	Mar.	601	1.12	675
	Apr.	638	1.20	766
	May	550	1.19	655
	June	553	1.17	647
-1969	July	622	1.16	721
	Aug.	628	1.18	740
	Sept.	443	1.23	544
	Oct.	417	1.22	509
	Nov.	225	1.32	297
	Dec.	292	1.29	376
	Total	5,616	1.20	6,726
	Jan.	352	1.20	423
	Feb.	352	1.21	424
	Mar.	558	1.17	653
	Apr.	677	1.16	788
	May	540	1.22	661
	June	549	1.20	658
-1970	July	623	1.19	738
	Aug.	577	1.20	695
	Sept.	440	1.22	535
	Oct.	423	1.24	525
	Nov.	299	1.24	370
	Dec.	315	1.29	407
	Total	5,705	1.21	6,877

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	324	1.32	427
	Feb.	391	1.23	482
	Mar.	612	1.19	728
	Apr.	627	1.20	751
	May	524	1.22	637
	June	579	1.17	679
1971	July	676	1.14	772
	Aug.	600	1.14	687
	Sept.	472	1.16	550
	Oct.	390	1.23	480
	Nov.	300	1.30	389
	Dec.	334	1.28	428
	Total	5,829	1.20	7,010
	Jan.	341	1.28	435
	Feb.	389	1.24	481
	Mar.	618	1.19	735
	Apr.	644	1.17	756
	May	560	1.18	659
	June	559	1.16	648
1972	July	667	1.15	766
	Aug.	633	1.12	708
	Sept.	484	1.17	567
	Oct.	295	1.38	407
	Nov.	267	1.28	343
	Dec.	340	1.24	424
	Total	5,797	1.20	6,929
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
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	Apr.			
	May			
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	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

To obtain mg/l multiply T/AF by 735.

Table 17
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River at Imperial Dam, Arizona — California

(Annual Summary)
Units – 1000

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

Table 17
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River at Imperial Dam, Arizona – California

(Annual Summary)

Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
1971	5,829	1.20	885	7,010
1972	5,797	1.20	879	6,929
Total	278,305			288,500
Average	8,697	1.04	762	9,016

Table 18

Summary of Historical, Present Modified and Estimated Future Water Conditions at Eighteen Stations Colorado River Basin 1/

Station	Historical condition: Flow (AF)	Historical: T.D.S. (T)	Historical: Concentration (T/AF)	Historical: Concentration (mg/l)	Present modified condition 1972: Flow adjustment (AF)	1972: Flow (AF)	1972: T.D.S. adjustment (T)	1972: T.D.S. (T)	1972: Concentration (T/AF)	1972: Concentration (mg/l)	1980 condition: Flow adjustment (AF)	1980: Flow (AF)	1980 Zero pickup: T.D.S. adjustment (T)	1980 Zero pickup: T.D.S. (T)	1980 Zero pickup: Concentration (T/AF)	1980 Zero pickup: Concentration (mg/l)	1980 T.D.S. pickup at 2T/A: T.D.S. adjustment (T)	1980 pickup: T.D.S. (T)	1980 pickup: (T/AF)	1980 pickup: (mg/l)	1990 condition: Flow adjustment (AF)	1990: Flow (AF)	1990 Zero pickup: T.D.S. adjustment (T)	1990 Zero pickup: T.D.S. (T)	1990 Zero pickup: Concentration (T/AF)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Green River near Green River, Wyoming	1,310	547	0.42	307	-26	1,284	+11	558	0.43	319	-38	1,246	-17	541	0.43	319	-17	541	0.43	319	-240	1,006	-97	444	0.44
Green River near Greendale, Utah	1,569	899	0.57	421	+25	1,594	+57	956	0.60	441	-48	1,546	-17	939	0.61	446	-17	939	0.61	446	-270	1,276	-110	829	0.65
Duchesne River near Randlett Utah	439	406	0.92	680	-24	415	-1	405	0.98	717	-94	321	-17	388	1.21	888	-12	393	1.22	899	-106	215	-10	378	1.76
Green River at Green River, Utah	4,155	2,576	0.62	456	-28	4,127	+68	2,644	0.64	471	-203	3,924	-49	2,595	0.66	486	-43	2,601	0.66	486	-524	3,400	-167	2,428	0.71
San Rafael River near Green River, Utah	91	209	2.30	1,688	-13	78	+2	211	2.71	1.988	-12	66	-8	203	3.08	2,261	-8	203	3.08	2,261	-9	57	-9	194	3.40
Colorado River near Glenwood Springs, Colorado	1,624	596	0.37	270	-178	1,446	-3	593	0.41	301	-124	1,322	-33	560	0.42	311	-33	560	0.42	311	-79	1,243	-6	554	0.45
Colorado River near Cameo, Colorado	2,776	1,531	0.55	405	-224	2,552	-7	1,524	0.60	439	-207	2,345	-37	1,487	0.63	466	-37	1,487	0.63	466	-166	2,179	-39	1,448	0.66
Gunnison River near Grand Junction, Colorado	1,721	1,454	0.84	621	-24	1,697	+20	1,474	0.87	638	0	1,697	0	1,474	0.87	638	0	1,474	0.87	638	-77	1,620	-14	1,460	0.90
Colorado River near Cisco, Utah	4,929	4,106	0.83	612	-305	4,624	+39	4,145	0.90	659	-207	4,417	-37	4,108	0.93	684	-37	4,108	0.93	683	-428	3,989	-85	4,023	1.01
San Juan River near Archuleta, New Mexico	894	194	0.22	159	+9	903	+10	204	0.23	166	-290	613	-57	147	0.24	176	-57	147	0.24	176	-328	285	-75	72	0.25
San Juan River near Bluff, Utah	1,595	969	0.61	447	-22	1,573	+29	998	0.63	466	-280	1,293	-56	942	0.73	535	+27	1,025	0.79	583	-364	929	-98	844	0.91
Colorado River at Lees Ferry, Arizona	10,432	7,914	0.76	558	-62	10,370	+652	8,566	0.83	607	-751	9,619	-191	8,375	0.87	640	-102	8,464	0.88	647	-1,503	8,116	-525	7,850	0.97
Adjusted Lees Ferry	10,432	7,914	0.76	558	-62	10,370	+652	8,566	0.83	607	-751	9,619	-191	8,375	0.87	640	-102	8,464	0.88	647	-1,389	8,230 2/	-415	7,960	0.97
Colorado River near Grand Canyon, Arizona	10,733	9,024	0.84	618	-62	10,671	+652	9,676	0.91	667	-751	9,920	-191	9,485	0.96	703	-102	9,574	0.97	710	-1,389	8,531	-415	9,070	1.06
Virgin River at Littlefield, Arizona	154	348	2.26	1,662	0	154	0	348	2.26	1,662	-39	115	-2	346	3.01	2,212	+7	355	3.09	2,270	0	115	0	346	3.01
Colorado River below Hoover Dam, Ariz.-Nev.	10,352	9,754	0.94	693	-137	10,215	+656	10,410	1.02	749	-840	9,375	-184	10,226	1.09	802	-77	10,333	1.10	810	-1,456	7,919	-402	9,824	1.24
Colorado River above Parker Dam Ariz.-Calif.	9,941	9,402	0.95	695	-74	9,867	+645	10,047	1.02	749	-867	9,000	-194	9,853	1.09	805	-73	9,974	1.11	815	-1,484	7,516	-424	9,429	1.25
Colorado River below Parker Dam, Ariz.-Calif.	9,375	8,867	0.95	695	-720	8,655	-54	8,813	1.02	749	-867	7,788	-287	8,526	1.09	805	-182	8,631	1.11	815	-1,045	6,743	-67	8,459	1.25
Colorado River at Imperial Dam, Ariz.-Calif	8,697	9,016	1.04	762	-818	7,879	+58	9,074	1.15	847	-1,026	6,853	-287	8,787	1.28	943	-103	8,971	1.31	963	-1,053	5,800	-67	8,720	1.50

1/ Without water quality improvement projects.
2/ Includes storage release or augmentation required to satisfy Mexico obligation.

Table 18

Summary of Historical, Present Modified and Estimated Future Water Conditions at Eighteen Stations Colorado River Basin 1/

(Units: 1,000 except concentrations)

	1980 condition								1990 condition										2000 condition									
	Zero pickup				T.D.S. pickup at 2T/A						Zero pickup				T.D.S. pickup at 2T/A						Zero pickup				T.D.S. pickup at 2T/A			
Flow (AF)	T.D.S. adjustment (T)	T.D.S. (T)	Concentration (T/AF)	Concentration (mg/l)	T.D.S. adjustment (T)	T.D.S. (T)	(T/AF)	(mg/l)	Flow adjustment (AF)	Flow (AF)	T.D.S. adjustment (T)	T.D.S. (T)	Concentration (T/AF)	Concentration (mg/l)	T.D.S. adjustment (T)	T.D.S. (T)	(T/AF)	(mg/l)	Flow adjustment (AF)	Flow (AF)	T.D.S. adjustment (T)	T.D.S. (T)	Concentration (T/AF)	Concentration (mg/l)	T.D.S. adjustment (T)	T.D.S. (T)	(T/AF)	(mg/l)
13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
1,246	-17	541	0.43	319	-17	541	0.43	319	-240	1,006	-97	444	0.44	324	-97	444	0.44	324	0	1,006	0	444	0.44	324	0	444	0.44	324
1,546	-17	939	0.61	446	-17	939	0.61	446	-270	1,276	-110	829	0.65	477	-110	829	0.65	477	-27	1,249	-12	817	0.65	480	-12	817	0.65	480
321	-17	388	1.21	888	-12	393	1.22	899	-106	215	-10	378	1.76	1,292	+1	394	1.83	1,346	-50	165	0	378	2.29	1,683	+42	436	2.64	1,942
3,924	-49	2,595	0.66	486	-43	2,601	0.66	486	-524	3,400	-167	2,428	0.71	524	-120	2,481	0.73	536	-230	3,170	-85	2,343	0.74	543	-43	2,438	0.77	565
66	-8	203	3.08	2,261	-8	203	3.08	2,261	-9	57	-9	194	3.40	2,502	-9	194	3.40	2,502	0	57	0	194	3.40	2,502	0	194	3.40	2,502
1,322	-33	560	0.42	311	-33	560	0.42	311	-79	1,243	-6	554	0.45	327	-6	554	0.45	327	-60	1,183	-6	548	0.46	340	-6	548	0.46	340
2,345	-37	1,487	0.63	466	-37	1,487	0.63	466	-166	2,179	-39	1,448	0.66	488	-39	1,448	0.66	488	-154	2,025	-40	1,408	0.70	511	-2	1,446	0.71	525
1,697	0	1,474	0.87	638	0	1,474	0.87	638	-77	1,620	-14	1,460	0.90	662	+12	1,486	0.92	674	-9	1,611	-2	1,458	0.91	665	-2	1,484	0.92	677
4,417	-37	4,108	0.93	684	-37	4,108	0.93	683	-428	3,989	-85	4,023	1.01	741	-31	4,077	1.02	751	-217	3,772	-50	3,973	1.05	774	+12	4,089	1.08	797
613	-57	147	0.24	176	-57	147	0.24	176	-328	285	-75	72	0.25	185	-75	72	0.25	185	0	285	0	72	0.25	185	0	72	0.25	185
1,293	-56	942	0.73	535	+27	1,025	0.79	583	-364	929	-98	844	0.91	668	+206	1,231	1.33	974	-40	889	-25	819	0.92	677	-25	1,206	1.36	997
9,619	-191	8,375	0.87	640	-102	8,464	0.88	647	-1,503	8,116	-525	7,850	0.97	711	-120	8,344	1.03	756	-549	7,567	-215	7,635	1.01	742	-111	8,233	1.09	801
9,619	-191	8,375	0.87	640	-102	8,464	0.88	647	-1,389	8,230 2/	-415	7,960	0.97	711	-3	8,461	1.03	756	0	8,230 2/	+344	8,304	1.01	742	+511	8,972	1.09	801
9,920	-191	9,485	0.96	703	-102	9,574	0.97	710	-1,389	8,531	-415	9,070	1.06	782	-3	9,571	1.12	825	0	8,531	+344	9,414	1.10	811	+511	10,082	1.18	869
115	-2	346	3.01	2,212	+7	355	3.09	2,270	0	115	0	346	3.01	2,212	0	355	3.09	2,270	0	115	0	346	3.01	2,212	0	355	3.09	2,270
9,375	-184	10,226	1.09	802	-77	10,333	1.10	810	-1,456	7,919	-402	9,824	1.24	912	+22	10,355	1.31	961	-65	7,854	+355	10,179	1.30	953	+533	10,888	1.39	1,019
9,000	-194	9,853	1.09	805	-73	9,974	1.11	815	-1,484	7,516	-424	9,429	1.25	922	+23	9,997	1.33	978	-65	7,451	+355	9,784	1.31	966	+541	10,538	1.41	1,040
7,788	-287	8,526	1.09	805	-182	8,631	1.11	815	-1,045	6,743	-67	8,459	1.25	922	+338	8,969	1.33	978	-23	6,720	+365	8,824	1.31	966	+535	9,504	1.41	1,040
6,853	-287	8,787	1.28	943	-103	8,971	1.31	963	-1,053	5,800	-67	8,720	1.50	1,105	+353	9,324	1.61	1,182	0	5,800	+365	9,085	1.57	1,152	+535	9,859	1.70	1,250

Table 19
Projects depleting Colorado River water
Additional depletions from 1972 to 2000

	Year 1980		Year 1990		Year 2000	
	New depletion 1000 (ac.-ft.)	New irrigation land (acres)	New depletion 1000 (ac.-ft.)	New irrigation land (acres)	New depletion 1000 (ac.-ft.)	New irrigation land (acres)
Above the gage Green River near Green River, Wyoming						
Seedskadee, Wyoming including Westvaco and others	38	1/	278	1/	278	1/
Non-Federal energy related industry	0	1/	0	1/	0	1/
Between the above gage and the gage Green River near Greendale, Utah						
Lyman, Wyoming	10	0	10	0	10	0
Utah Power & Light and others, Wyoming	0	1/	30	1/	57	1/
Above the gage Duchesne River near Randlett, Utah						
Central Utah Project, Utah						
Bonneville Unit	84	2/	160	2/	160	2/
Upalco Unit	0	0	10	0	10	0
Uintah Unit	10	2,600	30	7,800	30	7,800
Deferred Indian Lands	0	0	0	0	50	21,300
Between the gages Green River near Greendale, Utah, and Duchesne River near Randlett, Utah and the gage Green River at Green River, Utah						
Four County, Colorado	0	2/	40	2/	40	2/
Hayden-Craig Steamplant, Colorado	12	1/	20	1/	20	1/
Cheyenne-Laramie, Wyoming	10	2/	16	2/	24	2/
Savery-Pot Hook, Colorado-Wyoming	0	0	27	17,920	27	17,920
Central Utah Project						
Jensen Unit	15	440	15	440	15	440
Non-Federal Energy related industry	24	1/	91	1/	236	1/
Above the gage San Rafael near Green River, Utah						
Utah Power & Light, Emery County, Utah	12	1/	21	1/	21	1/
Above the gage Colorado River near Glenwood Springs, Colorado						
Denver-Englewood, Colorado Springs, Pueblo, Colorado	59	2/	109	2/	169	2/
Green Mountain M&I, Colorado	45	1/	45	1/	45	1/
Homestake Project, Colorado	20	2/	49	2/	49	2/
Between the above gage and gage Colorado River near Cameo, Colorado						
Independence Pass	14	2/	14	2/	14	2/
Fryingpan-Arkansas, Colorado	69	2/	69	2/	69	2/
Ruedi M&I, Colorado	0	1/	33	1/	33	1/
West Divide, Colorado	0	0	30	0	76	19,000
Non-Federal Energy related industry	0	1/	24	1/	72	1/
Above the gage Gunnison River near Grand Junction, Colorado						
Fruitland Mesa, Colorado	0	0	26	12,900	26	12,900
Dallas Creek, Colorado	0	0	46	3,900	46	3,900
Non-Federal Energy related industry	0	1/	5	1/	14	1/
Between the gages Colorado River near Cameo, Colorado, and Gunnison River near Grand Junction, Colorado, and the gage Colorado River near Cisco, Utah						
Dolores, Colorado	3/0	0	140	32,000	140	32,000
San Miguel, Colorado	0	0	40	14,000	85	26,000
Non-Federal Energy related industry	0	1/	5	1/	14	1/
Above the gage San Juan River near Archuleta, New Mexico						
San Juan-Chama, New Mexico	110	2/	110	2/	110	2/
Navajo Indian Irrigation, New Mexico	4/180	39,000	508	110,000	508	110,000
Between the above gage and the gage San Juan River near Bluff, Utah						
Farmington M&I	0	1/	5	1/	5	1/
Animas-La Plata, Colorado-New Mexico	0	0	146	46,500	146	46,500
Expansion Hogback, New Mexico	5	2,500	10	5,000	10	5,000
Four Corners Powerplant, New Mexico	19	1/	19	1/	19	1/
Navajo M&I Contracts	48	1/	100	1/	100	1/
Return flow--Dolores and Navajo Indian Irrigation, Colorado and New Mexico	-90	3/ 4/	-307	3/ 4/	-307	3/ 4/
Non-Federal Energy related industry	8	1/	53	1/	93	1/
Between the gages Green River at Green River, Utah; San Rafael River near Green River, Utah; Colorado River near Cisco, Utah; and San Juan River near Bluff, Utah; and the gage Colorado River at Lee's Ferry, Arizona						
Resources, Inc., Utah	12	1/	102	1/	102	1/
Navajo Powerplant, Arizona	34	1/	34	1/	34	1/
Other M&I, Arizona	3	1/	3	1/	3	1/
Non-Federal Energy related industry	0	1/	88	1/	150	1/
Subtotal Upper Basin	751	44,540	2,254	250,460	2,803	302,760

1/ In-basin depletion without irrigated lands.
2/ Transmountain diversion.
3/ In-basin transfer from Dolores River drainage to the San Juan River drainage--estimated 53,000-acre-foot return flow to the San Juan River.
4/ Diversion at Navajo Reservoir, estimated 254,000-acre-foot return flow to the San Juan River below the gage near Archuleta, New Mexico.

Table 19 (continued)
Projects depleting Colorado River water
Additional depletions from 1972 to 2000

	Year 1980 New depletion 1000 (ac.-ft.)	Year 1980 New irrigation land (acres)	Year 1990 New depletion 1000 (ac.-ft.)	Year 1990 New irrigation land (acres)	Year 2000 New depletion 1000 (ac.-ft.)	Year 2000 New irrigation land (acres)
Between the gage Colorado River at Lee's Ferry and the gage Colorado River near Grand Canyon, Arizona	0	0	0	0	0	0
Above the gage Virgin River at Littlefield, Arizona						
Dixie Project, Utah5/.	39	4,625	39	4,625	39	4,625
Between the gages Colorado River near Grand Canyon, Arizona, and Virgin River at Littlefield, Arizona, and the gage Colorado River below Hoover Dam, Arizona-Nevada						
Southern Nevada Water Project, Nevada6/.	45	8/	107	8/	161	8/
Other Nevada Projects.	5	8/	10	8/	21	8/
Between the above gage and the gage Colorado River below Parker Dam, Arizona-California						
Mojave Steam Plant, Nevada	9	8/	19	8/	19	8/
Fort Mojave Indians, Arizona, California, and Nevada	28	7,000	48	12,000	64	16,000
Chemehuevi Indians, California	0	0	7	1,900	7	1,900
Kingman, Arizona	6	8/	14	8/	18	8/
Mojave Valley I&D District, Arizona.	3	8/	5	8/	6	8/
Lake Havasu I&D District, Arizona.	3	8/	6	8/	7	8/
Salvage.	-22	0	-44	0	-66	0
Central Arizona, Arizona7/						
California diversions limited to 4.4 million acre-feet7/	0	0	-439	0	-481	0
Between the above gage and the gage Colorado River at Imperial Dam, Arizona-California						
Colorado River Indian Reservation, Arizona-California.	159	39,704	189	47,250	189	47,250
Salvage.	0	0	-22	0	-45	0
Subtotal Lower Basin	275	51,329	-61	65,775	-61	69,775
Total Colorado River	1,026	95,869	2,193	316,235	2,742	372,535

5/ Includes a transmountain diversion to Great Basin.

6/ Prior to July 1, 2006, the required water for the Mohave Steam Plant is considered to be a portion of the total allocation of Southern Nevada Project water.

7/ The Central Arizona Project diversions will vary depending on the depletions by other projects on the river and depending on the total amount of water available from the system in a given year. Maximum annual diversions to Central Arizona could be 2,172,000 acre-feet. With the full depletions by the projects tabulated, the consumptive use to California would be reduced to an annual 4,400,000 acre-feet from its 1972 consumptive use of 5,230,600 acre-feet. This reduction would assure a full supply to the tabulated projects in Arizona in addition to supplying water for the Central Arizona Project. (Bureau of Reclamation water supply studies, based upon the 1906-70 runoff period in the Colorado River Basin, result in average diversions for the Central Arizona Project of 1,078,000 acre-feet and 900,000 acre-feet in the year 2000 and the year 2030, respectively.)

8/ In-basin depletion without new irrigated lands.

Table 20

Estimated Effects of Salinity Control Projects at Five Stations 1/

1980 Conditions

Station	Without Salinity Control							With Salinity Control							Difference			
	Zero pickup				Pickup at 2 T/A			Zero pickup				Pickup at 2 T/A						
	Flow	T.D.S.	Concentration		T.D.S.	Concentration		Flow	T.D.S.	Concentration		T.D.S.	Concentration		Flow	T.D.S.	Concentration	
	1,000 AF	1,000 tons	T/AF	mg/l	1,000 tons	T/AF	mg/l	1,000 AF	1,000 tons	T/AF	mg/l	1,000 tons	T/AF	mg/l	1,000 AF	1,000 tons	T/AF	mg/l
Colorado River at Lees Ferry, Arizona	9,619	8,375	0.87	640	8,464	0.88	647	9,615	8,142	0.85	622	8,231	0.86	629	-4	-233	-0.02	-18
Adjusted Lees Ferry	9,619	8,375	0.87	640	8,464	0.88	647	9,615	8,142	0.85	622	8,231	0.86	629	-4	-233	-0.02	-18
Colorado River below Hoover Dam, Ariz.-Nev.	9,375	10,226	1.09	802	10,333	1.10	810	9,369	9,855	1.05	773	9,962	1.06	781	-6	-371	-0.04	-29
Colorado River above Parker Dam, Ariz.-Calif.	9,000	9,853	1.09	805	9,974	1.11	815	8,994	9,482	1.05	775	9,603	1.07	785	-6	-371	-0.04	-30
Colorado River below Parker Dam, Ariz.-Calif.	7,788	8,526	1.09	805	8,631	1.11	815	7,782	8,204	1.05	775	8,309	1.07	785	-6	-322	-0.04	-30
Colorado River at Imperial Dam, Ariz. - Calif.	6,853	8,787	1.28	943	8,971	1.31	963	6,847	8,465	1.23	909	8,649	1.26	929	-6	-322	-0.05	-34

1990 Conditions

Station	Without Salinity Control							With Salinity Control							Difference			
	Zero pickup				Pickup at 2 T/A			Zero pickup				Pickup at 2 T/A						
	Flow	T.D.S.	Concentration		T.D.S.	Concentration		Flow	T.D.S.	Concentration		T.D.S.	Concentration		Flow	T.D.S.	Concentration	
	1,000 AF	1,000 tons	T/AF	mg/l	1,000 tons	T/AF	mg/l	1,000 AF	1,000 tons	T/AF	mg/l	1,000 tons	T/AF	mg/l	1,000 AF	1,000 tons	T/AF	mg/l
Colorado River at Lees Ferry, Arizona	8,116	7,850	0.97	711	8,344	1.03	756	8,112	7,467	0.92	677	7,961	0.98	722	-4	-383	-0.05	-34
Adjusted Lees Ferry	8,230	7,960	0.97	711	8,461	1.03	756	8,230	7,576	0.92	677	8,077	0.98	722	0	-384	-0.05	-34
Colorado River below Hoover Dam, Ariz.-Nev.	7,919	9,824	1.24	912	10,355	1.31	961	7,917	9,302	1.17	864	9,833	1.24	913	-2	-522	-0.07	-48
Colorado River above Parker Dam, Ariz.-Calif.	7,516	9,429	1.25	922	9,997	1.33	978	7,514	8,907	1.18	871	9,475	1.26	927	-2	-522	-0.07	-51
Colorado River below Parker Dam, Ariz.-Calif.	6,743	8,459	1.25	922	8,969	1.33	978	6,743	7,993	1.18	871	8,503	1.26	927	0	-466	-0.07	-51
Colorado River at Imperial Dam, Ariz.-Calif.	5,800	8,720	1.50	1,105	9,324	1.61	1,182	5,800	8,254	1.42	1,046	8,858	1.53	1,123	0	-466	-0.08	-59

2000 Conditions

Station	Without Salinity Control							With Salinity Control							Difference			
	Zero pickup				Pickup at 2 T/A			Zero pickup				Pickup at 2 T/A						
	Flow	T.D.S.	Concentration		T.D.S.	Concentration		Flow	T.D.S.	Concentration		T.D.S.	Concentration		Flow	T.D.S.	Concentration	
	1,000 AF	1,000 tons	T/AF	mg/l	1,000 tons	T/AF	mg/l	1,000 AF	1,000 tons	T/AF	mg/l	1,000 tons	T/AF	mg/l	1,000 AF	1,000 tons	T/AF	mg/l
Colorado River at Lees Ferry, Arizona	7,567	7,635	1.01	742	8,233	1.09	801	7,563	7,252	0.96	705	7,850	1.04	764	-4	-383	-0.05	-37
Adjusted Lees Ferry	8,230	8,304	1.01	742	8,972	1.09	801	8,230	7,892	0.96	705	8,560	1.04	764	0	-412	-0.05	-37
Colorado River below Hoover Dam, Ariz.-Nev.	7,854	10,179	1.30	953	10,888	1.39	1,019	7,852	9,629	1.23	902	10,338	1.32	968	-2	-550	-0.07	-51
Colorado River above Parker Dam, Ariz.-Calif.	7,451	9,784	1.31	966	10,538	1.41	1,040	7,449	9,234	1.24	911	9,988	1.34	985	-2	-550	-0.07	-55
Colorado River below Parker Dam, Ariz.-Calif.	6,720	8,824	1.31	966	9,504	1.41	1,040	6,720	8,330	1.24	911	9,010	1.34	985	0	-494	-0.07	-55
Colorado River at Imperial Dam, Ariz.-Calif.	5,800	9,085	1.57	1,152	9,859	1.70	1,250	5,800	8,591	1.48	1,089	9,365	1.61	1,187	0	-494	-0.09	-63

1/ Includes Crystal Geyser, Paradox Valley, Grand Valley, and Las Vegas Wash. Other salinity control projects may be constructed before year 2000 but were omitted because the schedule for their completion has not yet been determined.