

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

GOODWIN J. KNIGHT, Governor
HARVEY O. BANKS, Director of Water Resources

INVESTIGATION
OF THE
SACRAMENTO-SAN JOAQUIN DELTA

Report No. 4

QUANTITY AND QUALITY OF
WATERS APPLIED TO AND
DRAINED FROM THE
DELTA LOWLANDS



JULY 1956

TABLE OF CONTENTS

| | Page |
|---|------|
| ACKNOWLEDGMENT | v |
| ORGANIZATION | vi |
| PART I - INTRODUCTION | 1 |
| Purpose of This Investigation | 3 |
| Area Under Investigation. | 4 |
| Related Investigations and Reports | 5 |
| Scope of This Investigation and Report | 5 |
| PART II - WATER APPLIED TO IRRIGATED CROPS OF THE DELTA LOWLANDS | 7 |
| Irrigation Practices. | 7 |
| Soil Types. | 8 |
| Land Use | 9 |
| Crops Investigated | 9 |
| Unit Application of Water | 9 |
| Major Crops on North Mineral Soils | 11 |
| Major Crops on Middle Organic Soils | 12 |
| Major Crops on South Mineral Soils | 12 |
| Minor Crops. | 13 |
| Total Applied Water | 13 |
| Waters Applied for Leaching Purposes | 14 |
| Precipitation | 15 |
| PART III - WATERS DRAINED FROM THE DELTA LOWLANDS. . | 16 |
| Drainage Practices. | 16 |
| Quantity of Drainage Water Pumped | 17 |

Table of Contents - Continued

| | Page |
|---|------|
| PART IV - WATER SUPPLY AND DISPOSAL. | 19 |
| Consumptive Use | 19 |
| Subsurface Inflow | 20 |
| PART V - QUALITY OF WATER | 22 |
| Quality of Applied Water | 22 |
| Quality of Drainage Waters. | 24 |
| Channel-Water Degradation by Drainage Water . | 26 |
| PART VI - SUMMARY AND CONCLUSION | 28 |
| Summary | 28 |
| Conclusion. | 30 |

TABLES

(Following Text)

Table No.

- 1 Land Use - Delta Lowlands, 1955
- 2 Irrigated Crops - Delta Lowlands, 1955
- 3 Water Applied to Certain Irrigated Crops During 1954,
Delta Lowlands - North Mineral Soil
- 4 Water Applied to Certain Irrigated Crops During 1954,
Delta Lowlands - Middle Organic Soil
- 5 Water Applied to Certain Irrigated Crops During 1954,
Delta Lowlands - South Mineral Soil
- 6 Seasonal Use of Applied Water - Delta Lowlands, 1954
- 7 Monthly Distribution of Applied Water to Irrigated
Crops, Delta Lowlands, 1954
- 8 Average Precipitation in Sacramento-San Joaquin Delta
- 9 Precipitation on Delta Lowlands

Tables - Continued

Table No.

- 10 Drainage From Delta Lowlands
- 11 Consumptive Use Requirements, Delta Lowlands, 1955
- 12 Water Supply and Disposal, Delta Lowlands
- 13 Weight of Salts in Applied Irrigation Water, Delta Lowlands
- 14 Average Quality of Applied Water, Delta Lowlands
- 15 Weight of Salts in Drainage Water, Delta Lowlands
- 16 Average Quality of Drainage Water, Delta Lowlands

PLATES

(Following Tables)

Plate No.

- 1 Lowlands of the Sacramento-San Joaquin Delta
- 2 Subdivision Units of the Sacramento-San Joaquin Delta
- 3 Lowlands Drainage Rates - May through October, 1954
- 4 Lowlands Drainage Rates - November, 1954, through February, 1955
- 5 Lowlands Drainage Rates - March, 1955, through October, 1955
- 6 Comparison of Water Supply and Disposal - Delta Lowlands
- 7 Lowlands Drained Salt Rates - May through October, 1954
- 8 Lowlands Drained Salt Rates - November, 1954, through February, 1955
- 9 Lowlands Drained Salt Rates - March, 1955, through October, 1955

ACKNOWLEDGMENT

Valuable assistance and data used in this investigation were contributed by many individuals and by public and private agencies. Their cooperation is gratefully acknowledged; it greatly facilitated the collection and compilation of data contained in this report.

ORGANIZATION

Water Project Authority
of the
State of California

Frank B. Durkee, Director of Public Works
Chairman

Edmund G. Brown
Attorney General

Charles G. Johnson
State Treasurer

John M. Peirce
Director of Finance

Robert C. Kirkwood
State Controller

Harvey O. Banks, State Engineer
Executive Officer

Isabel C. Nessler
Acting Secretary

- - - - -

Effective July 5, 1956, the Water Project Authority was abolished and its functions, duties and responsibilities assigned to the Department of Water Resources by Chapter 52, Statutes of 1956.

| | |
|------------------|---|
| Harvey O. Banks | Director of Water Resources |
| W. J. Shelton | Deputy Director of Water Resources |
| William L. Berry | Chief, Division of Water Resources Planning |

Activities covered by this report were conducted
by the staff of the Water Project Authority under
the direction of

Irvin M. Ingerson Principal Hydraulic Engineer

assisted by

Wayne MacRostie Supervising Hydraulic Engineer

- - - -

The field and office work for this investigation were
supervised by and this report was prepared by

Sam Kabakov Senior Hydraulic Engineer

Field and Office Assistants

| | |
|----------------------|------------------------------|
| William G. Brigance | Assistant Civil Engineer |
| George W. Deatherage | Assistant Hydraulic Engineer |
| Walter Fisher | Assistant Hydraulic Engineer |
| Roger R. Lindholm | Assistant Hydraulic Engineer |

INVESTIGATION
of the
SACRAMENTO-SAN JOAQUIN DELTA

Report No. 4

QUANTITY AND QUALITY OF WATERS
APPLIED TO AND DRAINED FROM
THE DELTA LOWLANDS

* * *

PART I - INTRODUCTION

This series of five reports is designed to furnish new and additional factual data collected during the past three years, with analyses thereof, that are germane to those hydrologic problems in the State's water development programs which involve the use of Delta channels as conveyance conduits and as sources of diversion.

The Sacramento-San Joaquin Delta lies in the Central Valley of California and embraces the confluent channels and tributaries of the Sacramento River entering from the north, the Mokelumne and Calaveras Rivers entering from the east, and of the San Joaquin River entering from the south. The Delta is comprised of a block of nearly 400,000 acres of irrigated agricultural land interlaced by more than 600 miles of tidal channels which in turn surround more than 50 islands lying at or below sea-level and which are protected by levees.

The strategic geographic location of the Delta makes it the pivotal conveyance link across which the surplus water supplies of the northern portion of the State must be transported to the water-deficient areas of the central and southern portion to permit the continued agricultural, industrial, and municipal growth of those areas. The Central Valley Project has been designed, constructed, and put into operation to take advantage of the Delta channels to convey some 5,000 second-feet of the surplus Sacramento Valley waters to the south into the San Joaquin Valley. The plans of the Feather River Project call for the transfer and conveyance of an additional 11,000 second-feet through these same tidal Delta channels.

Despite the recognized importance of the pivotal position the Delta plays, or will play, in major programs of water development in California, there has been a dearth of geologic, hydraulic, hydrologic, and salinic information of the physical phenomena present. Such information is essential for intelligent planning of water transfer across the Delta area. On the other hand, the fruition of such water transfer plans must include solutions to problems of flood control, water utilization, and water disposal within the Delta area itself. The solutions will involve plans for optimum fresh-water distribution, saline-water drainage disposal, and degrees of channel salinity control to satisfy agricultural and industrial needs. The data and their analyses as presented in this series of reports are germane and essential to solutions of these Delta problems.

An investigation so comprehensive as to cover and report upon all of the facets of pertinent knowledge concerning the Delta area would be prohibitive in cost at this time. This series of reports perforce is limited to some of these facets, namely, ground water geology, water source and water utilization phenomena on two of the Delta islands, quantities and qualities of applied water and of drainage water in the Delta, and the extent of sea-water incursion in Delta channels.

This report is the fourth in this series and deals with some of the hydrographic and salinic aspects of water supply and water disposal in the Delta.

Purpose of This Investigation

One purpose of this investigation was to determine the monthly and seasonal quantities of water applied to the irrigated crops in the Delta Lowlands. This investigation was initiated in 1954 prior to, but in anticipation of, the "Sacramento River and Delta Trial Water Distribution Agreement for 1955" in which the State agreed to undertake "studies to ascertain the quantity of water required by water users diverting in and from the Delta".

Another purpose of this investigation was to determine the extent and sources of degradation in quality of the channel waters as they move from the Sacramento River to the Tracy Pumping Plant.

Area Under Investigation

For purposes of this report, the area under investigation, as delineated on Plate 1, will be called the "Delta Lowlands" and includes lands bordering the Sacramento and San Joaquin Rivers and their distributaries within the Delta area. The Delta Lowlands refer to those areas in the Sacramento-San Joaquin Delta consisting generally of the lands lying below an elevation of plus five, mean sea-level datum, and which, for the most part, consume water not susceptible to direct measurement since such water is largely derived from Delta channels by percolation or by numerous unratable siphons.

The Delta Lowlands comprise a land and water area of approximately 469,000 acres of which about 374,000 acres are developed for agricultural purposes and of which approximately 292,000 acres were irrigated in 1955.

The surface soils in the area embrace a large number of soil classes. The sedimentary mineral soil classes range from loamy sand to clay while the organic soil classes range from mucky loam to peat. Generally the organic soils are concentrated in the central part of the Delta. The purest organic soils (peats) vary in thickness from zero to over 30 feet and overlie mineral soils. Sedimentary soils generally lie along the Delta channels and cover the island areas lying above sea level.

Related Investigations and Reports

The following investigations and reports covering the Sacramento-San Joaquin Delta and adjacent areas were reviewed in connection with the current investigation:

California State Department of Public Works, Division of Water Resources. "Variation and Control of Salinity in Sacramento-San Joaquin Delta and Upper San Francisco Bay", Bulletin No. 27, 1931.

- - -"Putah Creek Cone Investigation", December 1955.

- - -"Sacramento River and Sacramento-San Joaquin Delta, Trial Water Distribution 1955, Summary Report of Data", January 1956.

- - -Water Quality Investigations, Report No. 7 "Quality of Ground Water in the Stockton Area, San Joaquin County", March 1955.

California State Water Resources Board. "San Joaquin County Investigation" Bulletin No. 11, June 1955.

United States Department of Agriculture, Bureau of Plant Industry. "Soil Survey, Dixon Area, California".

- - -"Soil Survey, Tracy Area, California".

- - -"Soil Survey, Sacramento-San Joaquin Delta Area California".

University of California, College of Agriculture. "Soils of Sacramento County". Weir, Walter W., April 1950.

Scope of This Investigation and Report

The period of field investigation covered by this report extended from May, 1954, through October, 1955.

Field observations covered the following activities:

(1) determining the amount of water applied on sample fields for

the six major irrigated crops of the Delta Lowlands; (2) collecting surface water samples from drains and from Delta channels for mineral analyses; and (3) observing specific conductance of surface waters in drains and in Delta channels. Office studies included: (1) determining the quantity of waters applied to the Delta Lowlands; (2) determining from specific conductance observations the concentration of dissolved minerals in surface waters in drains and in Delta channels; and (4) the quantitative net degradation of water in Delta channels by saline drainage water from the Delta lands was determined from observed data giving both the quality and the quantity of water applied to and drained from those lands.

This report is divided into six parts: (1) Introduction, (2) Water Applied to Irrigated Crops of the Delta Lowlands, (3) Water Drained from the Delta Lowlands, (4) Water Supply and Disposal, (5) Quality of Water, and (6) Summary and Conclusions.

PART II - WATER APPLIED TO IRRIGATED CROPS OF THE DELTA LOWLANDS

This section deals with the determination of the amounts of water applied on the six major irrigated crops of the Delta Lowlands. The term "applied water" as used in this report refers only to that water which is diverted from channels by pumps or siphons and generally delivered for irrigation use in the immediate vicinity.

Irrigation Practices

Irrigation practices throughout the Delta Lowlands vary with the crop, soil type, depth to water table, quality of channel water available, and the irrigator's past experience and judgment.

In the areas of highly organic soil, subirrigation is used extensively. In this method temporary ditches, spaced about 30 feet apart and approximately 6 inches wide and 12 to 18 inches deep, are used to distribute the water through the fields. Raising the water level in the ditches by means of control structures causes horizontal movement of water through the soil resulting in subirrigation of the crops.

In the moderately organic and in the mineral soils, row crops are generally irrigated by the use of furrow-type irrigation. Alfalfa and pasture are generally irrigated by the use of strip-check irrigation. Sprinkler irrigation is used on many higher-elevation mineral and organic soil areas in the Delta both for its beneficial leaching effects as well as for the better control over the water than can be achieved in furrow irrigation.

Most irrigation takes place in the late Spring and Summer. However, some irrigators apply a large quantity of water in the early Spring before planting to increase the moisture content of the soil in the expectation of early seed germination.

The increase in salinity of the channel waters during the summer period causes some farm operators in the western portion of the Delta to cease irrigation during that period because of the deleterious effects of applying highly-saline water to crops. Waters are applied in the fall and winter seasons primarily to leach accumulated salts from the soils.

Some irrigators divert waters to their lands during the summer in excess of their requirements because ample water is available at practically no additional cost to them. Water conservation would be enhanced if more careful use of water were practiced.

Soil Types

A division of the Delta by soil types was estimated from data on soil maps embracing the Delta area compiled jointly by the United States Department of Agriculture and University of California. For purposes of this investigation the agricultural lands in the Delta area were divided, as shown on Plate 1, into three soil types: (1) north mineral, (2) middle organic, and (3) south mineral. These types cover approximately 121,000 acres, 192,000 acres, and 61,000 acres respectively. These acreages comprise,

respectively, about 33 per cent, 51 per cent, and 16 per cent of the total Delta Lowlands area developed for agricultural purposes.

Land Use

A comprehensive land-use survey was made in 1955 by the State Division of Water Resources, the results of which are detailed in that Division's report titled "Sacramento River and Sacramento-San Joaquin Delta, Trial Water Distribution 1955, Summary Report of Data". A summary from that report is shown in Table 1. For purposes of this investigation the areas of the exterior water surface and of the islands in the channels were excluded, leaving an area of 419,439 acres considered as the "Delta Lowlands".

Crops Investigated

As shown in Table 1 the seven major crops grown in 1955 on the Delta Lowlands were: (1) asparagus, (2) field corn, (3) alfalfa, (4) sugar beets, (5) tomatoes, (6) pasture, and (7) milo. Table 2 herein shows the irrigated acreages and the percentage of total irrigated area for each of the seven major crops and for all other crops as a single value.

Unit Application of Water

Quantities of water applied were estimated by measurements on six of the seven irrigated major crops in the Delta area in 38 sample fields totaling 3,369 acres. Locations of these

fields are shown on Plate 1. Each of these 38 sample fields was investigated separately and records of applied-water quantities were obtained. The fields were selected as typifying the soil, irrigation practices, and crops grown on each of the three soil types in the Delta Lowlands. As expected, irrigation practices, soil types in the Delta, and varying amounts of seepage, resulted in varying amounts of water applied to the irrigated crops. The length of the irrigation season also varied, for different crops, from one to eight months.

Although this investigation started in May, 1954, quantities of water applied to the sample fields earlier in the year were estimated from data on power consumption and/or from water users' records.

The unit applied-water factor for the seventh major crop, milo, was estimated from other available data. The estimated applied water during the irrigation season for milo, as determined from experiments by the University of California at Davis, is 1.0 acre-foot per acre. Data in the Division of Water Resources report "San Joaquin County Investigation" indicates that 0.7 acre-foot per acre was applied to an 80-acre test plot of milo. For purposes of this present report, 1.0 acre-foot per acre was used as the applied-water factor for milo for the entire Delta area. No measurements were made for certain major crops in each of the three soil-type areas because of (1) lack of cooperation by farmers in granting permission to make the measurements or in keeping the necessary records and (2) inability to

find an area encompassing only the one crop and containing a distribution system that would permit determination of the quantity of water applied to that crop. Therefore, values for such major crops were assumed to approximate the values for those crops in comparable areas for which actual applied water measurements were made.

The subdivision unit numbers referred to in tables described subsequently in this report designate subdivisions of the Sacramento-San Joaquin Delta of which the Delta Lowlands encompass all or part of all of the units except numbers 1, 4 and 5. The locations of the units are shown on Plate 2.

Major Crops on North Mineral Soils. Monthly and seasonal applications of water to crops of the north mineral soils area are shown in Table 3. The depths of applied-water during the irrigation season for five of the major crops were: field corn, 1.5 feet; alfalfa, 2.3 feet; sugar beets, 1.9 feet; tomatoes, 2.5 feet; and pasture, 2.2 feet.

The Division of Water Resources in its report "Putah Creek Cone Investigation, December 1955", determined certain applied-water factors on areas at the northern edge of the Delta. The weighted mean value of applied water for pasture reported therein was 3.9 acre-feet per acre, based upon a 430-acre area. This value was considered a reasonable applied-water factor for pasture and it was used in this report because the sample field for pasture in the present investigation, due to its small size of only five acres, was not considered representative of that crop.

A value of 0.7 acre-foot per acre for asparagus as determined for the south mineral soils area, was also used for the north mineral soils area.

Major Crops on Middle Organic Soils. Monthly and seasonal applications of water to crops of the middle organic soils area are shown in Table 4. The depths of applied-water during the irrigation season for four of the major crops were: asparagus, 1.4 feet; field corn, 3.6 feet; sugar beets, 3.3 feet; and tomatoes, 3.4 feet.

A value of 2.3 acre-feet per acre for alfalfa, as determined for the north mineral soils area, was assumed to approximate the unit quantity of water applied to alfalfa in the middle organic soils area.

A value of 3.9 acre-feet per acre for pasture, as determined for the north mineral soils area, was assumed as the unit quantity of water applied to pasture in the middle organic soils area.

Major Crops on South Mineral Soils. Monthly and seasonal applications of water to crops of the south mineral soils area are shown in Table 5. The depths of applied-water during the irrigation season for the six major crops were: asparagus, 0.7 foot; field corn, 1.5 feet; alfalfa, 4.2 feet; sugar beets, 3.7 feet; tomatoes, 2.6 feet; and pasture, 8.2 feet.

The applied-water values for two sample plots for pasture indicated an excessive annual use of water (over 10 acre-feet per acre) as compared to the other two plots. The Division of Water Resources in its report "San Joaquin County Investigation, June 1955", determined the weighted mean applied-water value for pasture on areas at the southeast edge of the Delta to be 4.5 acre-feet per acre as based upon a 240-acre area. However, for purposes of this report, the weighted average of 4.8 acre-feet per acre for the remaining two sample plots of pasture in Unit 27, as shown in Table 5, was used as the applied-water factor for pasture in the south mineral soils area.

Minor Crops. To determine the total quantity of irrigation water applied to the Delta Lowlands during the irrigation season, it was necessary to estimate unit applied-water values for the minor irrigated crops. This was done by calculating the weighted average unit depth of water applied to the major irrigated crops in each of the soil-type areas. These values for the north mineral, middle organic, and south mineral soils areas are 2.1, 2.3 and 2.4 acre-feet per acre, respectively. These weighted averages were multiplied by their respective soil-type areas; these quantities were then used as the estimated amount of water applied to the minor crops for inclusion in the evaluation of total water applied to the Lowlands.

Total Applied Water

The total seasonal amounts of applied water on irrigated crops of the Delta Lowlands were determined from the 1955 land-use survey data and the unit applied-water values described heretofore.

The total seasonal applications by soil type and by crop and the totals for the Delta Lowlands are shown in Table 6. The total irrigation seasonal use of applied water for the Delta Lowlands amounted to about 656,000 acre-feet or an average of 2.25 acre-feet per irrigated acre.

The monthly distribution of applied irrigation water was calculated for each of the aforesaid subdivisions from its crop pattern and applicable monthly applied-water values. Table 7 shows the monthly distribution of applied irrigation water by units, monthly percentages of seasonal totals, and monthly average unit applied-water values in acre-feet per acre. The monthly distribution of seasonal applied-water values varied from one per cent each in March and October to a maximum of 33 per cent (about 216,000 acre-feet) in July.

Waters Applied for Leaching Purposes

Water is applied to the Delta Lowlands for leaching excess salts from the soil, thereby lowering the salinity of the soil solution in the root zone. As will be shown hereinafter, evidence indicates that the concentration of salts in the soil increases during the summer season. These salts must subsequently be removed from the soils, otherwise the increasing saline concentration would accumulate and adversely affect plant growth.

Leaching waters are usually applied during the fall and winter months. No attempt was made during this investigation to determine the quantity of water applied for leaching purposes

because of the wide variations in leaching practices and because of the relative unimportance on channel demands of leaching water requirements since ample water of good quality is usually available during the late fall and winter seasons.

Precipitation

Precipitation, although not part of the "applied water" as considered in this report, does affect month by month the irrigation and leaching practices, and the quantities and qualities of drainage water as will be discussed later.

Data shown in Table 8 from the United States Weather Bureau Reports titled "Climatological Data, California" for the seven weather stations in and near the Delta, are considered representative of precipitation on the Delta. The average rainfall for the Delta Lowlands is assumed to be the arithmetic average of precipitation at those seven stations. Table 8 also shows the monthly rainfall at these stations for the period May, 1954, through October, 1955, and the monthly average for the Delta.

Monthly total quantities of precipitation on the Delta Lowlands, estimated by multiplying the aforesaid average depths of precipitation by the 419,439 acres of the Delta Lowlands are given in Table 9. The total precipitation for the March through October irrigation season in 1955 amounted to about 150,000 acre-feet.

PART III - WATERS DRAINED FROM THE DELTA LOWLANDS

Concurrent with the observations of water applied for irrigation in the Delta Lowlands, observations were made to determine the quantities of waters drained from those lands. Permission was secured from property owners to test and rate their drainage pumping plants and to secure their power consumption records. These data were used to calculate the water quantities pumped from the interior drain canals into the tidal channels.

Drainage Practices

In general, each island or tract in the Delta Lowlands has one or more drainage systems wherein the drainage waters first enter small drainage ditches leading to larger main drains and then terminate at the pumping plants. These plants, usually float-actuated between predetermined water levels in the main drains, pump water intermittently from the main drains into the contiguous channels.

Drainage pumps used in the Delta vary in combinations of the following types and sizes: 3- to 50-inch discharge pipe, 3- to 500-horsepower motor, horizontally or vertically mounted, double or single suction centrifugal type, mixed-flow or axial-flow propeller type, direct or belt connected to gasoline or diesel internal combustion engine or to an electric motor. The most common drainage-pump installation in the Delta area is a 30 to 75 horsepower, direct connected, electric-motor driven, axial-flow propeller-type pump.

Quantity of Drainage Water Pumped

The quantity of drainage water pumped from 82 per cent of the area in the Delta Lowlands for the period May, 1954, through October, 1955, by means of 162 pumping plants involving 255 pumps, was determined from pump test data and power consumption records. For the same period, drainage pumped by 64 pumps at 44 pumping plants servicing 16 per cent of the Delta Lowlands, was estimated by assuming that the plant rating factors were similar to comparable measured installations or by correlation with drainage-per-acre values in adjacent areas. The remaining 2 per cent of the area covers lands either drained by gravity or urbanized, and their drainage contributions were estimated by correlation with drainage-per-acre values in adjacent areas.

Table 10 shows the combined measured and estimated monthly total drainage from each subdivision unit within the Delta Lowlands and the monthly average unit drainage in acre-feet per acre. During the period of investigation the monthly total drainage varied from a low of about 30,000 acre-feet in October, 1955, to a maximum of approximately 96,000 acre-feet in January, 1955.

The average monthly unit drainage values in acre-feet per acre are shown graphically on Plates 3, 4 and 5 for three periods: May through October, 1954; November, 1954, through February, 1955; and March through October, 1955. A comparison of these three plates indicates that the average monthly drainage in

the Delta during the winter is greater than during the other seasons as indicated by the small area during the winter from which drainage was between zero and 0.10 acre-feet per acre per month. This increase is due to a combination of greater precipitation and lower consumptive use demands at that time. Also during the winter a noticeable increase occurred in the area from which drainage was between 0.31 and 0.60 acre-foot per acre per month. It may also be noted that certain areas in the northern and southern parts of the Delta show the results of high irrigation efficiency and minor seepage problems since the drainage from those areas remained in the zero to 0.10 acre-foot per acre per month category throughout the entire period of investigation. The higher elevation of those lands compared to lands in the central portion of the Delta probably accounts for the lesser seepage.

PART IV - WATER SUPPLY AND DISPOSAL

The water supply to islands of the Delta Lowlands consists of (1) applied irrigation water, (2) subsurface inflow, and (3) precipitation. Water disposal consists of (1) drainage water, and (2) consumptive use. Ground water storage changes account for any imbalance between supply and disposal. Of the foregoing items, applied irrigation water, precipitation, and drainage have been discussed and evaluated heretofore. This chapter presents an evaluation of consumptive use and a derivation of subsurface inflow under assumptions as to ground water storage changes.

Consumptive Use

The monthly total quantities of consumptive use of water were taken from the Division of Water Resources report titled "Sacramento River and Sacramento-San Joaquin Delta Trial Water Distribution 1955, Summary Report of Data". These quantities were derived by multiplying 1955 crop acreages by appropriate unit consumptive use values. Monthly consumptive use quantities within the Delta Lowlands are shown in Table 11 of this report. It will be noted that these values varied from about 22,000 acre-feet in January, 1955, to about 211,000 acre-feet in August, 1955. Of the annual consumptive use requirements of 1,160,000 acre-feet, about 1,036,000 acre-feet were consumed during the March through October irrigation season.

Subsurface Inflow

Subsurface inflow to islands of the Delta Lowlands was derived by means of the hydrologic equation. This equation provides that inflow to an area must equal disposal therefrom plus or minus changes in ground water storage. The measurable and estimable sources of water supply are the applied irrigation water and precipitation. The measurable and estimable water disposal consists of return drainage water and consumptive use. The unknown and practically unmeasurable terms in the hydrologic equations pertaining to Delta islands are (1) ground water storage changes, (2) contribution to the islands by seepage from contiguous channels, and/or (3) rising water from deep-seated and remote sources. Items 2 and 3 are discussed together herein as subsurface inflow.

The measurable and estimable values of water supply and disposal in the Delta Lowlands are presented in Table 12, which summarizes data presented heretofore. As shown, the partial water supply during the March through October, 1955, period consisted of about 805,000 acre-feet of applied irrigation water and of precipitation. During that period, water disposal consisted of approximately 1,453,000 acre-feet of drainage and of consumptive use. Therefore, during this period the excess of water disposal over the measurable water supply was approximately 648,000 acre-feet. Because of the irrigation and drainage practices in the Delta area, it properly may be assumed that the ground-water storage change during the March through October

period is comparatively insignificant. Therefore, it is concluded that the 648,000 acre-feet is indicative, during that period, of the magnitude of subsurface inflow.

The data presented in Table 12 are shown graphically on Plate 6. In this plate, for each month, the total measurable water supply is shown on the right side of the double column and the water disposal on the left side of the double column. It is to be noted that no applied irrigation water values were determined for the months of November, 1954, through February, 1955. In spite of this omission, an inspection of the plate shows that, except for the month of December, 1954, the water disposal exceeded the measurable and estimable water supply in every month during the 18-month period from May, 1954, through October, 1955, indicating subsurface inflow.

PART V - QUALITY OF WATER

An inspection of water analyses from the files of the Division of Water Resources shows that generally the quality of Delta channel water becomes progressively poorer as the water moves from the northern to the southern part of the Delta, that is, from the Sacramento River toward the Tracy Pumping Plant of the Central Valley Project. One possible cause of this degradation is the effect of sea-water intrusion, which effect is discussed in Report No. 5 in this series of reports on the Sacramento-San Joaquin Delta.

Another possible source of the degradation is the salt contributed to the channels by the drainage waters from the Delta islands. To evaluate this possibility the salt contribution to the Delta channels was determined from observations and computations involving the qualities and quantities of waters applied to and drained from the Delta Lowlands. The quantities of those waters have been discussed and presented heretofore.

Quality of Applied Water

The quality of applied water was determined in the field from specific-conductance data collected at random tide phases at 62 sampling points in the Delta channels at approximately six-week intervals during 18 continuous months of 1954 and 1955. At 22 of these sampling points, water samples were also collected at 3-month intervals, and subjected to complete mineral analyses. Correlations were determined between specific conductance of the

water and the sum of concentrations of mineral constituents in parts per million (ppm). By interpolation; a monthly average concentration was determined for the water at each sampling point. These monthly concentrations and the monthly applied-water quantities for each subdivision unit were used to determine the monthly tons of salt in the irrigation water applied to each unit of the Delta Lowlands. These monthly quantities, as well as values for tons-per-irrigated acre, are shown in Table 13. The monthly total salts in applied irrigation water varied from a minimum of about 2,100 tons in March, 1955, to a maximum of approximately 70,000 tons during August, 1954. Since no applied-water values were determined for the period November, 1954, through February, 1955, no salt tonnages are shown for those months. However, it is to be noted that water applied for leaching during this period of winter runoff from the Central Valley, would have been of generally good quality.

The monthly average quality of applied irrigation water within each subdivision unit was determined as an arithmetical average of the monthly water qualities at all of the sampling points within that unit. Table 14 shows that these values ranged from 70 ppm in Unit 27 during May, 1954, to about 1,800 ppm in Unit 14 during August, 1955. Also shown in this table are the weighted monthly averages for the entire Delta as computed from data in Table 13. These averages ranged from 86 ppm in May, 1954, to 300 ppm in August, 1954. Since applied-water values were not determined for the period November, 1954, through February, 1955, no weighted averages for that period could be calculated.

The data in Tables 13 and 14 involve only the salt content of applied surface water. They do not concern the salt in water entering the islands by seepage from channels or from other sources. Although the quality of such additional supplies is uncertain, it is indicated in Reports No. 2 and 3 that the ground water inflow to Medford and McDonald Islands was largely channel water. Available data are not sufficient at this time to indicate whether or not this is true for the Delta Lowlands as a whole. However, if for purposes of a rough approximation, it is hypothesized that the rate of ground water inflow to the islands of the Delta Lowlands is constant, and that the quality of such inflow equals the approximate Delta-wide average annual quality of channel waters of about 260 ppm, about 33,000 tons of salt per month in addition to those amounts shown in Table 13 would enter such islands.

An inspection of the average concentrations of applied water in Table 14 indicates that peak concentrations of salts in the channels occur in the late summer months. Evidence presented in Report No. 5 shows that this condition is due largely to seawater incursion caused by a combination of high consumptive use, including high water-surface evaporation losses, and by the relatively low fresh-water inflow to the Delta at that time.

Quality of Drainage Waters

The quality of water drained from the Delta Lowlands was determined in a manner similar to that described in preceding section under the heading, "Quality of Applied Water". Specific

conductance field measurements at approximately six-week intervals were made of the drainage water at 196 sampling points. Water samples were also collected at 24 of these points at approximately three-month intervals and subjected to complete mineral analyses. The estimated quantities of drainage water, presented heretofore, and the drainage-water qualities were used to determine the amount of salt discharged at pumping plants in each unit. Table 15 shows the estimated monthly salt tonnage discharged to the channels within each unit and the monthly total discharge in tons-per-acre for the Delta Lowlands as a whole. The total salt tonnage discharged in the drainage water during the 18-month period varied from a minimum of about 19,000 tons in October, 1955, to a maximum of approximately 113,000 tons in January, 1955.

The data in Table 15 were converted to show, in Table 16, the weighted average concentration of drainage water in each subdivision unit and for the entire Delta Lowlands area. Total dissolved solids in drainage water varied from about 120 ppm in June, 1955, in Unit 3 to about 1,600 ppm in February, 1955, in Unit 17. The Delta average ranged between about 300 ppm in June, 1954, to 865 ppm in January, 1955. An inspection of Table 16 indicates that the average concentration of the drainage water remains comparatively constant between May and October. During this period in each year, the concentration increased from about 300 to approximately 475 ppm.

Values of average monthly salt discharge in tons-per-acre from the Delta Lowlands are shown graphically on Plates 7, 8,

and 9 for three periods: May through October, 1954; November, 1954, through February, 1955; and March through October, 1955. An inspection of these plates indicates that there was a larger area contributing high tonnages of salt per-acre-per-month during the winter than during other seasons. This is shown by the large areas in the categories of 0.21 to 0.50, and 0.51 to 0.80 tons-per-acre-per-month of salt removed during the winter months.

Channel-Water Degradation by Drainage Water. An inspection of the data shown in Tables 13 and 15 reveals that during summer months salt inflow to Delta Lowlands islands exceeds salt drainage therefrom. This is true even without taking into account the relatively large amounts of salt carried by subsurface inflow to the islands mentioned heretofore, and salts introduced by fertilization and other agricultural practices. In other months of the year, salt removal exceeds salt inflow. Thus the Delta lands act as a salt reservoir by first storing some of the salts that enter the islands during the summer and then by releasing those salts during the winter through leaching and/or drainage of precipitation. This indicates that agricultural practices within the Delta Lowlands during the summer, when the problem of water quality there is most critical, do not degrade good quality Sacramento River water as it moves through the Delta to the Tracy Pumping Plant but rather enhances its quality by removing a portion of its salt content. In the winter months, when the accumulated surplus salts are discharged to the channels, there is usually sufficient surplus flow through the Delta to dilute and to carry out to the ocean the leached salts. However, it should

be noted that the preceding statement applied to conditions as of 1954-55. Any additional upstream regulation or a "dry" year, such as 1924 or 1931, will decrease the winter flows through the Delta to the extent that leached salts may not be completely removed from the area. These findings are important and are the first available demonstrated conclusions relating to Delta channel water degradation by drainage waters.

PART VI - SUMMARY AND CONCLUSION

As a result of field investigation and analysis of other available data and on the basis of the estimates and assumptions discussed hereinbefore, the following summary and conclusion are presented:

Summary

1. The Delta Lowlands comprises the major portion of the Sacramento-San Joaquin Delta. The area, as shown on Plate 1, covers about 469,000 acres of which about 374,000 acres are developed for agricultural purposes and of which about 292,000 acres were irrigated in 1955.

2. Approximately 62 per cent of the Delta Lowlands was irrigated during the period of investigation, May, 1954, through October, 1955. The March through October seasonal demand for water applied to irrigated crops was approximately 656,000 acre-feet, with the maximum monthly demand of about 216,000 acre-feet occurring in July. These quantities were determined (a) from detailed investigations for the six irrigated major crops on 38 sample fields totalling 3,369 acres, and (b) from estimates for the other crops.

3. Monthly precipitation on the Delta Lowlands during the period of investigation varied from zero in summer months to about 128,000 acre-feet in December, 1954. The total precipitation during the period March through October, 1955, amounted to approximately 150,000 acre-feet.

4. Drainage water, returned monthly to the channels from the Delta Lowlands during the period of investigation, varied between approximately 30,000 acre-feet in October, 1955, and 96,000 acre-feet in January, 1955. During the irrigation season the maximum drainage pumping occurred during July, 1954, and amounted to about 81,000 acre-feet. During the period of March through October, 1955, the drainage amounted to approximately 417,000 acre-feet.

5. The estimated consumptive use in the Delta Lowlands during the period of investigation, based on the 1955 crop pattern, varied from approximately 22,000 acre-feet in January to about 211,000 acre-feet in August. On that basis the annual consumptive-use requirements are approximately 1,160,000 acre-feet, of which 1,036,000 acre-feet are consumed during the March through October irrigation season.

6. During the March through October, 1955, irrigation season, the difference between the approximately 805,000 acre-feet of water supply and the 1,453,000 acre-feet of water disposal, amounting to about 648,000 acre-feet of water must come from a combination of ground water storage changes (considered herein to be comparatively insignificant because of irrigation and drainage practices in the Delta) and from subsurface inflow comprising seepage from contiguous channels and/or rising water from deep-seated and remote sources.

7. The estimated quantity of salt in the irrigation water applied to the Delta Lowlands during the irrigation season

varied from approximately 2,100 tons in March, 1955, to about 70,000 tons in August, 1954, with a total of about 187,000 tons for the March-through-October season. The average concentration of total dissolved solids in applied irrigation water varied from about 100 to 300 ppm during that period.

8. Under the hypothesis that subsurface inflow to the Delta Lowlands is constant and that the quality of such inflow equals the average annual quality of channel waters, roughly 33,000 tons of salt per month would be introduced by subsurface inflow.

9. The estimated amount of salt discharged in the drainage waters from the Delta Lowlands during the period of investigation varied from approximately 19,000 tons in October to about 113,000 tons in January, 1955, with a total of about 248,000 tons for the March-through-October period. The average concentration of total dissolved solids in the drainage water varied from about 300 ppm in June, 1954, to 865 ppm in January, 1955

Conclusion

The Delta Lowlands act as a salt reservoir, storing salts obtained largely from the channels during the summer, when water quality in such channels is most critical and returning such accumulated salts to the channels during the winter when water quality there is least important. Therefore agricultural practices in that area enhanced rather than degraded the good quality Sacramento River water enroute to the Tracy Pumping Plant.

TABLE 1

LAND USE - DELTA LOWLANDS - 1955

In acres

| <u>Crop</u> | | <u>Crop</u> | |
|--------------------------------|--------|----------------------------------|--------------|
| Pasture | | | |
| Sudan | 522 | Fruit & Nuts | 5,141 |
| Miscellaneous | 22,475 | Grapes | 110 |
| Alfalfa | 34,481 | Native Vegetation | |
| Rice | 2,103 | Lush | 897 |
| Field Crops | | Medium | 7,891 |
| Beans | 420 | Dry | 3,116 |
| Field Corn | 47,557 | Fallow & Bare | 1,360 |
| Milo | 20,972 | Idle Crop Land | 1,103 |
| Grain & Hay | 79,709 | Duck Ponds | 203 |
| Peas | 97 | Urban | 6,914 |
| Safflower | 770 | Tule & Swamp | 4,581 |
| Sunflower | 2,204 | Levee & Berm | 16,616 |
| Sugar Beets | 30,181 | Interior Water Surface | <u>5,585</u> |
| Truck Crops | | Subtotal | 419,439 |
| Asparagus | 80,325 | Exterior Water Surface | 42,168 |
| Celery | 1,083 | Islands in Channels | <u>7,027</u> |
| Onions | 1,193 | Total | 468,634 |
| Potatoes | 8,539 | | |
| Tomatoes | 30,099 | | |
| Seed & Miscellaneous | 3,192 | | |

TABLE 2

IRRIGATED CROPS
DELTA LOWLANDS, 1955

| <u>Crop</u> | <u>Area in acres</u> | <u>Per cent of total irrigated area</u> |
|-----------------------|--------------------------|---|
| Asparagus | 80,325 | 28 |
| Field Corn | 47,557 | 16 |
| Alfalfa | 34,481 | 12 |
| Sugar Beets | 30,181 | 10 |
| Tomatoes | 30,099 | 10 |
| Pasture | 22,997 | 8 |
| Milo | 20,972 | 7 |
| All others | <u>25,055</u> | <u>9</u> |
| Total | 291,667 | 100 |

TABLE 3

WATER APPLIED TO CERTAIN IRRIGATED CROPS DURING 1954
DELTA LOWLANDS - NORTH MINERAL SOIL

| Crop | Unit | Sample field acreage | Depth per month - in inches | | | | | | | Total | |
|-------------|------|----------------------|-----------------------------------|------|------|------|--------|-----------|---------|-------|------|
| | | | April | May | June | July | August | September | October | | |
| Field corn | 19 | 14 | | | | 11.8 | 5.8 | | | | 17.6 |
| | | | Weighted mean depth: 17.6" (1.5') | | | | | | | | |
| Alfalfa | 6 | 87 | 1.9 | 3.9 | 3.8 | 5.5 | 4.5 | 1.4 | 0.6 | | 21.6 |
| | 6 | 55 | | | 8.4 | 8.0 | 6.5 | 9.4 | 10.0 | | 42.3 |
| | 19 | 14 | | 1.5 | 3.7 | 3.5 | 3.5 | 2.0 | | | 14.2 |
| Total | | 156 | | | | | | | | | |
| | | | Weighted mean depth: 28.2" (2.3') | | | | | | | | |
| Sugar Beets | 6 | 45 | | 4.7 | 11.2 | 16.5 | 2.2 | | | | 32.4 |
| | 6 | 44 | | 2.7 | 7.5 | 7.0 | 1.9 | | | | 19.4 |
| | 7 | 32 | | | 6.1 | 5.1 | | | | | 13.1 |
| Total | | 121 | | | | | | | | | |
| | | | Weighted mean depth: 22.6" (1.9') | | | | | | | | |
| Tomatoes | 6 | 45 | | 19.0 | 8.1 | 15.5 | 5.0 | | | | 47.6 |
| | 6 | 37 | | 2.3 | 2.4 | 2.5 | 3.5 | | | | 10.7 |
| | 7 | 20 | | | 10.7 | 8.8 | 3.4 | | | | 22.9 |
| Total | | 102 | | | | | | | | | |
| | | | Weighted mean depth: 29.4" (2.5') | | | | | | | | |
| Pasture | 19 | 5 | 11.8 | | 5.0 | 5.3 | 3.8 | | | | 25.9 |
| | | | Weighted mean depth: 25.9" (2.2') | | | | | | | | |

TABLE 4

WATER APPLIED TO CERTAIN IRRIGATED CROPS DURING 1954
DELTA LOWLANDS - MIDDLE ORGANIC SOIL

| Crop | Unit | Sample field acreage | Depth per month - in inches | | | | | Total |
|-------------|------|-------------------------|-----------------------------------|------|------|--------|-----------|-------|
| | | | May | June | July | August | September | |
| Asparagus | 25 | 774 | 4.7 | 4.7 | 5.8 | 6.4 | 2.7 | 24.3 |
| | 16 | <u>728</u> | 0.7 | 0.7 | 0.9 | 1.1 | 5.7 | 8.4 |
| | | 1,502 | Weighted mean depth: 16.6" (1.4') | | | | | |
| Field Corn | 20 | 85 | | | 16.9 | | | 16.9 |
| | 24 | 75 | | | 30.9 | 30.9 | | 61.8 |
| | 24 | 90 | | | 34.7 | 29.3 | | 64.0 |
| | 16 | <u>78</u> | 10.5 | 10.5 | 6.2 | 7.6 | 6.0 | 30.3 |
| | | 328 | Weighted mean depth: 43.3" (3.6') | | | | | |
| Sugar Beets | 20 | 115.5 | 5.2 | 10.2 | 12.6 | 8.7 | 3.9 | 40.6 |
| | 22 | <u>35.3</u> | | | 25.7 | 7.9 | | 33.6 |
| | | 150.8 | Weighted mean depth: 39.0" (3.3') | | | | | |
| Tomatoes | 20 | 54.5 | | 1.2 | 4.1 | | | 5.3 |
| | 18 | <u>102.0</u> | | 25.9 | 19.8 | 14.2 | | 59.9 |
| | | 156.5 | Weighted mean depth: 40.9" (3.4') | | | | | |

TABLE 5

WATER APPLIED TO CERTAIN IRRIGATED CROPS DURING 1954
DELTA LOWLANDS - SOUTH MINERAL SOIL

| Crop | Unit | Sample field acreage | Depth per month - in inches | | | | | | | | | | | | Total | | |
|-------------|------|----------------------|-----------------------------|------|------|-----------------------------------|------|-----------------------------------|------|------|-------|------|-------|--|-------|-------|--|
| | | | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Total | | | | |
| Asparagus | 24 | 68 | | | | | | | | | | | 7.9 | | | 7.9 | |
| | | | | | | Weighted mean depth: 7.9" (0.7') | | | | | | | | | | | |
| Field Corn | 24 | 75 | | | | | | 4.2 | 7.0 | 4.6 | 1.8 | | | | | 17.6 | |
| | | | | | | Weighted mean depth: 17.6" (1.5') | | | | | | | | | | | |
| Alfalfa | 24 | 22.0 | | | | 10.1 | | 5.8 | 18.6 | 6.3 | 6.0 | | | | | 46.8 | |
| | 24 | 53.0 | | | | | 11.0 | 9.7 | 14.5 | 6.1 | 6.4 | | | | | 47.7 | |
| | 25 | 88.5 | | | | | 4.0 | 1.4 | 10.4 | 4.7 | 0.3 | | | | | 20.8 | |
| | 26 | 32.0 | | | | | | 28.9 | 34.1 | 26.2 | 33.0 | | | | | 122.2 | |
| | 27 | 31.0 | | | | | | 10.6 | 6.9 | 5.7 | 9.5 | | | | | 52.7 | |
| | 27 | 31.0 | | | 5.0 | | 5.8 | 9.0 | 5.2 | 10.2 | 5.3 | | | | | 51.9 | |
| | 27 | 32.8 | | | | | 8.5 | 9.2 | 13.0 | 10.2 | 11.5 | | | | | 64.2 | |
| | 27 | 32.5 | | 1.0 | | | 7.1 | 8.0 | 13.3 | 12.3 | 2.5 | | | | | 49.8 | |
| | | 322.8 | | | | | | Weighted mean depth: 50.4" (4.2') | | | | | | | | | |
| Sugar Beets | 24 | 76 | | | | 4.4 | 4.4 | 7.7 | 10.6 | 13.2 | 4.7 | | | | | 45.0 | |
| | | | | | | Weighted mean depth: 45.0" (3.7') | | | | | | | | | | | |
| Tomatoes | 24 | 55 | | | | | | 2.3 | 11.8 | 16.8 | 2.5 | | | | | 33.4 | |
| | 24 | 68 | | | | | | 6.4 | 4.3 | 7.2 | 11.1 | | | | | 29.0 | |
| | | 123 | | | | | | Weighted mean depth: 31.0" (2.6') | | | | | | | | | |
| Pasture | 26 | 40.0 | | | | | | 28.8 | 34.2 | 26.1 | 33.0 | | | | | 122.1 | |
| | 27 | 62.3 | 5.6 | | 5.1 | 18.4 | 21.2 | 17.0 | 26.7 | 12.6 | 16.5 | | | | | 127.4 | |
| | 27 | 32.8 | | | | 8.5 | 11.4 | 9.2 | 13.0 | 10.2 | 11.5 | | | | | 64.2 | |
| | 27 | 32.5 | | 1.0 | | | 7.1 | 8.0 | 13.3 | 12.3 | 2.5 | | | | | 49.8 | |
| | | 167.6 | | | | Weighted mean depth: 98.7" (8.2') | | | | | | | | | | | |

TABLE 6

IRRIGATION SEASONAL USE OF APPLIED WATER - DELTA LOWLANDS - 1954

| Crop | Irrigated Area in Acres | | | | Total | Seasonal Applied Water Acre-feet/acre | | | Seasonal Applied Water Acre-feet | | | Total for Delta Lowlands |
|-------------------------------------|-------------------------|----------------------|---------------------|---------|-------|---------------------------------------|----------------------|---------------------|----------------------------------|----------------------|---------------------|--------------------------|
| | North Mineral Soils | Middle Organic Soils | South Mineral Soils | Total | | North Mineral Soils | Middle Organic Soils | South Mineral Soils | North Mineral Soils | Middle Organic Soils | South Mineral Soils | |
| Asparagus | 6,878 | 53,096 | 20,351 | 80,325 | 0.7 | 1.4 | 0.7 | 4,820 | 74,330 | 14,250 | 93,400 | |
| Corn | 13,681 | 30,342 | 3,534 | 47,557 | 1.5 | 3.6 | 1.5 | 20,520 | 109,230 | 5,300 | 135,050 | |
| Alfalfa | 14,081 | 9,478 | 10,922 | 34,481 | 2.3 | 2.3 | 4.2 | 32,390 | 21,800 | 45,870 | 100,060 | |
| Sugar Beets | 20,514 | 8,573 | 1,094 | 30,181 | 1.9 | 3.3 | 3.7 | 38,980 | 28,290 | 4,050 | 71,320 | |
| Tomatoes | 13,284 | 9,899 | 6,916 | 30,099 | 2.5 | 3.4 | 2.6 | 33,210 | 33,660 | 17,980 | 84,850 | |
| Pasture | 13,266 | 2,887 | 6,844 | 22,997 | 3.9 | 3.9 | 4.8 | 51,740 | 11,260 | 32,850 | 95,850 | |
| Milo | 8,189 | 10,194 | 2,589 | 20,972 | 1.0 | 1.0 | 1.0 | 8,190 | 10,190 | 2,590 | 20,970 | |
| All other crops | 17,463 | 5,041 | 2,611 | 25,055 | 2.1 | 2.3 | 2.4 | 36,550 | 11,590 | 6,270 | 54,410 | |
| Total | 107,296 | 129,510 | 54,861 | 291,667 | | | | 226,400 | 300,350 | 129,160 | 655,910 | |
| Weighted average acre-feet per acre | | | | | | | | 2.11 | 2.32 | 2.35 | 2.25 | |

TABLE 7

MONTHLY DISTRIBUTION OF APPLIED WATER TO IRRIGATED CROPS
 DELTA LOWLANDS
 1954
 In acre-feet

| Unit | Irrigated acreage | March | April | May | June | July | Aug. | Sept. | Oct. | Seasonal Total |
|----------------------------|-------------------|-------|-------|-------|--------|--------|--------|-------|------|----------------|
| 2 | 5394 | 110 | 460 | 790 | 2040 | 3730 | 2940 | 1130 | 110 | 11310 |
| 3 | 4074 | 80 | 320 | 560 | 1430 | 2630 | 2070 | 790 | 80 | 7960 |
| 6 | 24900 | 510 | 2040 | 3570 | 9180 | 16820 | 13250 | 5100 | 510 | 50980 |
| 7 | 6025 | 130 | 500 | 870 | 2240 | 4090 | 3230 | 1240 | 130 | 12430 |
| 8 | 16518 | 360 | 1450 | 2550 | 6540 | 11990 | 9450 | 3640 | 360 | 36340 |
| 9 | 7779 | 190 | 760 | 1330 | 3430 | 6290 | 4960 | 1910 | 190 | 19060 |
| 10 | 8447 | 150 | 600 | 1060 | 2710 | 4980 | 3920 | 1510 | 150 | 15080 |
| 11 | 11142 | 280 | 1110 | 1940 | 5000 | 9170 | 7220 | 2780 | 280 | 27780 |
| 12 | 12916 | 320 | 1290 | 2260 | 5810 | 10660 | 8400 | 3230 | 320 | 32290 |
| 13 | 10413 | 290 | 1150 | 2010 | 5160 | 9460 | 7450 | 2870 | 290 | 28680 |
| 14 | 4319 | 90 | 370 | 650 | 1670 | 3070 | 2420 | 930 | 90 | 9290 |
| 15 | 13445 | 400 | 1580 | 2770 | 7130 | 13070 | 10300 | 3960 | 400 | 39610 |
| 16 | 13598 | 330 | 1340 | 2330 | 6000 | 11000 | 8660 | 3330 | 330 | 33320 |
| 17 | 6130 | 110 | 430 | 760 | 1950 | 3580 | 2820 | 1080 | 110 | 10840 |
| 18 | 12792 | 350 | 1410 | 2480 | 6370 | 11680 | 9200 | 3540 | 350 | 35380 |
| 19 | 12943 | 330 | 1300 | 2280 | 5860 | 10740 | 8470 | 3250 | 330 | 32560 |
| 20 | 16534 | 400 | 1610 | 2810 | 7230 | 13260 | 10440 | 4020 | 400 | 40170 |
| 21 | 10666 | 210 | 820 | 1440 | 3690 | 6770 | 5340 | 2050 | 210 | 20530 |
| 22 | 14465 | 270 | 1080 | 1890 | 4860 | 8910 | 7020 | 2700 | 270 | 27000 |
| 23 | 19812 | 350 | 1410 | 2460 | 6330 | 11610 | 9150 | 3520 | 350 | 35180 |
| 24 | 24156 | 500 | 2010 | 3520 | 9060 | 16600 | 13080 | 5030 | 500 | 50300 |
| 25 | 25912 | 530 | 2120 | 3700 | 9530 | 17460 | 13760 | 5290 | 530 | 52920 |
| 26 | 651 | 20 | 90 | 150 | 400 | 730 | 570 | 220 | 20 | 2200 |
| 27 | 8636 | 250 | 990 | 1730 | 4440 | 8150 | 6420 | 2470 | 250 | 24700 |
| Total | 291667 | 6560 | 26240 | 45910 | 118060 | 216450 | 170540 | 65590 | 6560 | 655910 |
| Per cent of seasonal total | | 1.0 | 4.0 | 7.0 | 18.0 | 33.0 | 26.0 | 10.0 | 1.0 | 100 |
| Average acre-feet per acre | | 0.02 | 0.09 | 0.16 | 0.41 | 0.74 | 0.58 | 0.23 | 0.02 | 2.25 |

TABLE 8

AVERAGE PRECIPITATION IN SACRAMENTO-SAN JOAQUIN DELTA

| Station | In inches | | | | | | | | | | | | | | | | | |
|-------------------|-----------|------|------|------|-------|------|------|------|------|------|------|------|------|------|------|------|-------|------|
| | 1954 | | | | | | 1955 | | | | | | | | | | | |
| | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. |
| Antioch | 0.39 | 0.05 | 0 | 0 | 0 | 0.02 | 1.53 | 3.44 | 2.59 | 1.26 | 0.92 | 1.40 | 0.74 | 0 | 0 | 0 | 0.03 | 0.15 |
| Benson's Ferry | 0.46 | 0.01 | 0 | 0.02 | 0 | 0.01 | 2.43 | 3.92 | 2.28 | 1.14 | 0.40 | 2.24 | 0.47 | 0 | 0 | 0 | 0.44 | 0.33 |
| Davis | 0.16 | 0.16 | 0 | 0.08 | 0 | 0 | 2.98 | 3.91 | 2.68 | 1.24 | 0.40 | 2.17 | 0.64 | 0 | 0 | 0 | 0.92 | 0.44 |
| Lodi | 0.26 | 0.08 | 0 | 0.04 | 0 | 0.01 | 2.34 | 4.32 | 3.40 | 1.39 | 0.17 | 3.09 | 0.51 | 0 | 0 | 0 | 1.10 | 0.13 |
| Sacra- mento | 0.21 | 0 | 0 | 0.35 | 0 | 0.02 | 3.35 | 4.93 | 3.14 | 1.33 | 0.37 | 2.75 | 0.67 | 0.01 | 0 | 0 | 0.95 | 0.57 |
| Stock- ton | 0.28 | 0.40 | 0 | 0 | 0 | 0 | 2.23 | 3.19 | 3.84 | 1.03 | 0.57 | 2.38 | 1.02 | 0 | 0 | 0 | 0.01 | 0.12 |
| Tracy | 0.37 | 0.42 | 0 | 0 | 0 | 0 | 1.45 | 1.85 | 2.94 | 0.77 | 1.91 | 1.12 | 0.83 | 0 | 0 | 0 | 0 | 0.03 |
| AVERAGE | 0.30 | 0.16 | 0 | 0.07 | 0 | 0.01 | 2.33 | 3.65 | 2.98 | 1.17 | 0.68 | 2.16 | 0.70 | 0 | 0 | 0 | 0.49 | 0.25 |

TABLE 9
PRECIPITATION ON DELTA LOWLANDS

In acre-feet

| 1954 | | 1955 | |
|---------------------|--------|---------------------|--------|
| May | 10486 | January | 104161 |
| June | 5593 | February | 40895 |
| July | 0 | March | 23768 |
| August | 2447 | April | 75499 |
| September | 0 | May | 24467 |
| October | 350 | June | 0 |
| November | 81441 | July | 0 |
| December | 127579 | August | 0 |
| | | September | 17127 |
| | | October | 8738 |

TABLE 10
DRAINAGE FROM DELTA LOWLANDS

| Unit | Acreage | In acre-feet | | | | | | | | | | | | Total | Acres per Acre | | | | |
|-------|---------|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|----------------|-------|-------|-------|-------|
| | | 1954 | | | | | | 1955 | | | | | | | | | | | |
| | | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. |
| 2 | 11202 | 45 | 0 | 0 | 0 | 0 | 179 | 0 | 672 | 582 | 90 | 0 | 90 | 0 | 0 | 0 | 0 | 0 | 134 |
| 3 | 5465 | 639 | 552 | 662 | 526 | 234 | 147 | 225 | 387 | 594 | 558 | 475 | 403 | 541 | 401 | 667 | 573 | 299 | 43 |
| 6 | 33027 | 617 | 388 | 339 | 299 | 359 | 358 | 1480 | 2541 | 2944 | 2159 | 771 | 401 | 293 | 235 | 314 | 269 | 227 | 320 |
| 7 | 7510 | 510 | 117 | 104 | 60 | 64 | 44 | 183 | 379 | 669 | 367 | 221 | 229 | 259 | 189 | 214 | 120 | 122 | 59 |
| 8 | 22103 | 4126 | 2984 | 2227 | 2935 | 2997 | 3932 | 2867 | 1917 | 1046 | 1086 | 1752 | 2018 | 2354 | 3267 | 3817 | 2830 | 2411 | 1577 |
| 9 | 16085 | 1238 | 1628 | 2074 | 2081 | 1495 | 952 | 696 | 979 | 841 | 252 | 401 | 1057 | 742 | 1301 | 1408 | 1647 | 1067 | 710 |
| 10 | 11067 | 395 | 865 | 1057 | 975 | 350 | 261 | 313 | 486 | 637 | 352 | 245 | 443 | 535 | 757 | 874 | 860 | 624 | 450 |
| 11 | 14365 | 1620 | 1697 | 1337 | 1350 | 770 | 530 | 753 | 1383 | 1516 | 865 | 637 | 889 | 792 | 1349 | 1433 | 1411 | 591 | 417 |
| 12 | 16877 | 2408 | 3144 | 3559 | 2971 | 1450 | 1029 | 1481 | 2916 | 3105 | 1689 | 1690 | 2582 | 2171 | 3921 | 3927 | 3690 | 971 | 621 |
| 13 | 16641 | 886 | 1529 | 2022 | 1602 | 357 | 459 | 529 | 1288 | 1303 | 777 | 767 | 1081 | 964 | 1575 | 2356 | 2022 | 1049 | 435 |
| 14 | 14671 | 1730 | 2131 | 2053 | 926 | 648 | 1227 | 1483 | 2166 | 1961 | 1645 | 1983 | 2307 | 1614 | 1773 | 2264 | 846 | 545 | 891 |
| 15 | 26424 | 2583 | 2463 | 3005 | 2879 | 2055 | 2957 | 3425 | 4851 | 5721 | 2871 | 2782 | 2544 | 1801 | 2425 | 2805 | 3398 | 2079 | 2021 |
| 16 | 18343 | 2114 | 2434 | 2321 | 3181 | 2147 | 1521 | 1076 | 2804 | 4008 | 1470 | 1041 | 1854 | 1707 | 2457 | 2336 | 2044 | 1811 | 1511 |
| 17 | 10191 | 992 | 955 | 1379 | 1013 | 739 | 1159 | 1185 | 3597 | 3198 | 1039 | 1291 | 1823 | 1585 | 1613 | 2000 | 1499 | 1153 | 603 |
| 18 | 18504 | 4710 | 8676 | 11051 | 8210 | 6748 | 6994 | 4025 | 5759 | 4836 | 2425 | 1942 | 1439 | 3509 | 5603 | 10156 | 8081 | 3432 | 2884 |
| 19 | 17917 | 2507 | 3570 | 4636 | 4307 | 2688 | 1516 | 1268 | 2753 | 2454 | 1221 | 826 | 1301 | 2618 | 3160 | 3759 | 3282 | 1963 | 1275 |
| 20 | 21302 | 5456 | 9197 | 10223 | 10410 | 4627 | 4582 | 5639 | 10209 | 14637 | 3840 | 2016 | 3533 | 6521 | 110456 | 11726 | 11870 | 8521 | 3505 |
| 21 | 14846 | 3154 | 4000 | 5245 | 4705 | 2698 | 2691 | 3792 | 7388 | 7472 | 2765 | 1935 | 2350 | 3873 | 5340 | 5398 | 4576 | 3392 | 2175 |
| 22 | 19357 | 12368 | 15756 | 15252 | 12942 | 8629 | 9306 | 8637 | 10635 | 12773 | 7385 | 5127 | 3949 | 10734 | 16862 | 15557 | 12826 | 6142 | 5302 |
| 23 | 24493 | 2396 | 3032 | 3917 | 3259 | 1974 | 3790 | 3514 | 9308 | 11828 | 3229 | 2103 | 1843 | 2018 | 2481 | 2056 | 2818 | 1663 | 1981 |
| 24 | 32879 | 2125 | 2500 | 2964 | 2839 | 1849 | 2103 | 2795 | 8907 | 9189 | 3410 | 2053 | 2135 | 2355 | 2649 | 2862 | 2929 | 2285 | 1974 |
| 25 | 33212 | 2335 | 2197 | 3773 | 2289 | 1237 | 892 | 971 | 3812 | 3678 | 2188 | 1958 | 2540 | 2233 | 2553 | 3574 | 3217 | 2068 | 922 |
| 26 | 2810 | 96 | 131 | 144 | 149 | 99 | 88 | 140 | 399 | 412 | 150 | 92 | 95 | 107 | 133 | 155 | 153 | 113 | 93 |
| 27 | 10148 | 669 | 627 | 1231 | 949 | 343 | 100 | 60 | 195 | 264 | 127 | 311 | 722 | 487 | 584 | 948 | 1209 | 588 | 114 |
| Total | 419439 | 55719 | 70573 | 80575 | 70857 | 44557 | 46817 | 46537 | 85731 | 95668 | 41960 | 32419 | 37628 | 49813 | 71084 | 80606 | 72170 | 43116 | 30017 |
| | | 0.43 | 0.17 | 0.19 | 0.17 | 0.11 | 0.11 | 0.11 | 0.20 | 0.23 | 0.10 | 0.08 | 0.09 | 0.12 | 0.17 | 0.19 | 0.17 | 0.10 | 0.07 |

TABLE 11
 CONSUMPTIVE USE REQUIREMENTS, DELTA LOWLANDS
 1955
 In acre-feet

| | | | |
|-------------------|---------|---------------------|---------------|
| January | 22,371 | July. | 191,744 |
| February. | 26,108 | August. | 211,339 |
| March | 35,001 | September | 156,805 |
| April | 84,015 | October | 91,609 |
| May | 129,609 | November. | 42,593 |
| June | 136,679 | December. | <u>32,915</u> |
| | | Total | 1,160,323 |

WATER SUPPLY AND DISPOSAL
DELTA LOWLANDS
In acre-feet

| | 1954 | | | | | | | | | | | | |
|----------------------|--------|--------|--------|--------|--------|--------|-------|--------|--|--|--|--|--|
| | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | | | | | |
| Water Supply | | | | | | | | | | | | | |
| Applied Water | 45910 | 118060 | 216450 | 170540 | 65590 | 6560 | - | - | | | | | |
| Precipitation | 10486 | 5593 | 0 | 2447 | 0 | 350 | 81441 | 127579 | | | | | |
| Total Water Supply | 56396 | 123653 | 216450 | 172987 | 65590 | 6910 | - | - | | | | | |
| Water Disposal | | | | | | | | | | | | | |
| Drainage | 55719 | 70573 | 80575 | 70857 | 44557 | 46817 | 46537 | 85731 | | | | | |
| Consumptive Use | 129609 | 136679 | 191744 | 211339 | 156805 | 91164 | 42573 | 32915 | | | | | |
| Total Water Disposal | 185328 | 207252 | 272319 | 282196 | 201362 | 137981 | 89110 | 118646 | | | | | |

| | 1955 | | | | | | | | | | | | |
|----------------------|--------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--|--|--|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | | | |
| Water Supply | | | | | | | | | | | | | |
| Applied Water | - | - | 6560 | 26240 | 45910 | 118060 | 216450 | 170540 | 65590 | 6560 | | | |
| Precipitation | 104161 | 40895 | 23768 | 75499 | 24467 | 0 | 0 | 0 | 17127 | 8738 | | | |
| Total Water Supply | - | - | 30328 | 101739 | 70377 | 118060 | 216450 | 170540 | 82717 | 15298 | | | |
| Water Disposal | | | | | | | | | | | | | |
| Drainage | 95668 | 41960 | 32419 | 37628 | 49813 | 71084 | 80606 | 72170 | 43116 | 30017 | | | |
| Consumptive Use | 22371 | 26108 | 35001 | 84015 | 129609 | 136679 | 191744 | 211339 | 156805 | 91164 | | | |
| Total Water Disposal | 118039 | 68068 | 67420 | 121643 | 179422 | 207763 | 272350 | 283509 | 199921 | 121181 | | | |

TABLE 13

WEIGHT OF SALTS IN APPLIED IRRIGATION WATER
DELTA LOWLANDS

In tons

| Unit | Irrigated acreage | 1954 | | | | | | 1955 | | | | | | | |
|---------|----------------------|------|-------|-------|-------|-------|------|------|------|-------|-------|-------|-------|-------|------|
| | | May | June | July | Aug. | Sept. | Oct. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. |
| 2 | 5394 | 97 | 433 | 721 | 628 | 275 | 16 | 14 | 43 | 118 | 311 | 650 | 616 | 268 | 15 |
| 3 | 4074 | 64 | 292 | 501 | 456 | 184 | 12 | 10 | 33 | 81 | 214 | 440 | 394 | 176 | 12 |
| 66 | 24900 | 408 | 1824 | 3044 | 2956 | 1180 | 82 | 67 | 241 | 466 | 1324 | 2700 | 2380 | 985 | 94 |
| 7 | 6025 | 91 | 439 | 718 | 721 | 275 | 22 | 17 | 62 | 110 | 323 | 645 | 554 | 272 | 26 |
| 8 | 16518 | 250 | 1032 | 2219 | 1851 | 797 | 71 | 48 | 195 | 375 | 819 | 1860 | 1710 | 718 | 60 |
| 9 | 7779 | 166 | 957 | 1292 | 1134 | 499 | 39 | 57 | 185 | 284 | 443 | 1061 | 918 | 439 | 39 |
| 10 | 8447 | 133 | 553 | 840 | 896 | 427 | 34 | 49 | 158 | 212 | 391 | 820 | 725 | 333 | 33 |
| 11 | 11142 | 243 | 1041 | 1634 | 1611 | 707 | 46 | 42 | 148 | 230 | 721 | 1447 | 1248 | 609 | 59 |
| 12 | 12916 | 228 | 1130 | 1943 | 1840 | 760 | 52 | 42 | 156 | 283 | 814 | 1769 | 1463 | 725 | 58 |
| 13 | 10413 | 183 | 885 | 1725 | 1804 | 687 | 49 | 40 | 142 | 222 | 737 | 1647 | 1500 | 679 | 58 |
| 14 | 4319 | 74 | 643 | 6249 | 4880 | 553 | 24 | 19 | 150 | 96 | 868 | 3225 | 6137 | 1002 | 42 |
| 15 | 13445 | 290 | 1416 | 5050 | 7287 | 2031 | 121 | 126 | 374 | 471 | 1057 | 4143 | 5115 | 1864 | 142 |
| 16 | 13598 | 488 | 1069 | 3981 | 6527 | 1817 | 137 | 171 | 352 | 526 | 980 | 3068 | 4795 | 1767 | 141 |
| 17 | 6130 | 121 | 329 | 935 | 1558 | 523 | 61 | 66 | 150 | 249 | 366 | 818 | 1189 | 494 | 49 |
| 18 | 12792 | 256 | 1049 | 2320 | 2666 | 891 | 67 | 70 | 224 | 307 | 936 | 2225 | 2015 | 915 | 81 |
| 19 | 12943 | 236 | 733 | 2133 | 1809 | 641 | 59 | 52 | 168 | 236 | 726 | 1739 | 1694 | 690 | 61 |
| 20 | 16534 | 291 | 1426 | 3067 | 3096 | 1116 | 102 | 120 | 381 | 505 | 1279 | 2868 | 2500 | 1187 | 112 |
| 21 | 10666 | 172 | 763 | 1796 | 1925 | 742 | 80 | 88 | 300 | 460 | 884 | 1363 | 1482 | 725 | 81 |
| 22 | 14465 | 278 | 860 | 2170 | 2970 | 973 | 85 | 119 | 332 | 406 | 926 | 1915 | 2092 | 860 | 83 |
| 23 | 19812 | 328 | 1257 | 3001 | 3797 | 1480 | 152 | 180 | 574 | 870 | 1507 | 2827 | 2813 | 1178 | 119 |
| 24 | 24156 | 393 | 3143 | 6843 | 6068 | 2607 | 252 | 244 | 963 | 1710 | 3069 | 6098 | 4698 | 2190 | 263 |
| 25 | 25912 | 428 | 3306 | 8409 | 7844 | 3325 | 304 | 224 | 998 | 1782 | 3423 | 7459 | 6047 | 2893 | 293 |
| 26 | 651 | 15 | 184 | 339 | 287 | 131 | 12 | 7 | 37 | 74 | 132 | 298 | 250 | 117 | 14 |
| 27 | 8636 | 165 | 2767 | 6221 | 5031 | 2403 | 248 | 245 | 955 | 1368 | 3063 | 6709 | 4830 | 2302 | 251 |
| Total | | 5398 | 27531 | 67151 | 69642 | 25024 | 2127 | 2117 | 7321 | 11441 | 25313 | 57794 | 57165 | 23388 | 2186 |
| Tons/Ac | | 0.02 | 0.09 | 0.23 | 0.24 | 0.09 | 0.01 | 0.01 | 0.03 | 0.04 | 0.09 | 0.20 | 0.20 | 0.08 | 0.01 |

TABLE 14

AVERAGE QUALITY OF APPLIED WATER
DELTA LOWLANDS

| Unit | Sum of the mineral constituents in parts per million | | | | | | | | | | | | | | | | | | |
|-----------|--|------|------|------|-------|------|------|------|------|------|------|------|-----|------|------|------|-------|------|------|
| | 1954 | | | | | | 1955 | | | | | | | | | | | | |
| | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. |
| 2 | 90 | 156 | 142 | 157 | 179 | 105 | 65 | 109 | 99 | 111 | 91 | 68 | 110 | 112 | 128 | 154 | 174 | 100 | 119 |
| 3 | 84 | 150 | 140 | 162 | 171 | 106 | 82 | 87 | 89 | 113 | 88 | 75 | 106 | 110 | 123 | 140 | 164 | 109 | 106 |
| 6 | 84 | 146 | 133 | 164 | 170 | 118 | 96 | 91 | 85 | 100 | 96 | 87 | 96 | 106 | 118 | 132 | 142 | 136 | 130 |
| 7 | 77 | 144 | 129 | 164 | 163 | 122 | 103 | 86 | 80 | 96 | 95 | 91 | 93 | 106 | 116 | 126 | 161 | 146 | 134 |
| 8 | 72 | 116 | 136 | 144 | 161 | 144 | 94 | 80 | 85 | 113 | 98 | 99 | 108 | 92 | 114 | 133 | 145 | 123 | 113 |
| 9 | 92 | 205 | 151 | 168 | 192 | 149 | 152 | 185 | 202 | 219 | 220 | 179 | 157 | 95 | 124 | 136 | 169 | 152 | 160 |
| 10 | 92 | 150 | 124 | 168 | 208 | 169 | 176 | 183 | 190 | 216 | 242 | 194 | 147 | 106 | 121 | 136 | 162 | 163 | 165 |
| 11 | 92 | 153 | 131 | 164 | 187 | 122 | 108 | 102 | 95 | 102 | 109 | 98 | 87 | 106 | 116 | 127 | 161 | 155 | 148 |
| 12 | 74 | 143 | 134 | 161 | 173 | 119 | 98 | 83 | 79 | 111 | 96 | 89 | 92 | 103 | 122 | 128 | 165 | 133 | 122 |
| 13 | 67 | 126 | 134 | 178 | 176 | 124 | 99 | 114 | 132 | 126 | 102 | 91 | 81 | 105 | 128 | 148 | 174 | 148 | 129 |
| 14 | 84 | 283 | 1496 | 1482 | 437 | 200 | 212 | 124 | 150 | 171 | 156 | 298 | 108 | 382 | 772 | 1864 | 792 | 344 | 343 |
| 15 | 77 | 146 | 284 | 520 | 377 | 222 | 197 | 247 | 284 | 266 | 231 | 174 | 125 | 109 | 233 | 365 | 346 | 261 | 189 |
| 16 | 154 | 131 | 266 | 554 | 401 | 306 | 330 | 409 | 432 | 453 | 380 | 193 | 166 | 120 | 205 | 407 | 390 | 313 | 367 |
| 17 | 117 | 124 | 192 | 406 | 356 | 406 | 504 | 480 | 458 | 509 | 443 | 257 | 241 | 138 | 168 | 310 | 336 | 329 | 523 |
| 18 | 76 | 121 | 146 | 213 | 185 | 141 | 128 | 139 | 168 | 164 | 146 | 117 | 91 | 108 | 140 | 161 | 190 | 170 | 159 |
| 19 | 76 | 92 | 146 | 157 | 145 | 132 | 56 | 75 | 94 | 104 | 115 | 95 | 76 | 91 | 119 | 147 | 156 | 136 | 116 |
| 20 | 76 | 145 | 170 | 218 | 204 | 187 | 197 | 168 | 158 | 195 | 221 | 174 | 132 | 130 | 159 | 176 | 217 | 206 | 203 |
| 21 | 88 | 152 | 195 | 265 | 266 | 281 | 341 | 275 | 227 | 283 | 306 | 269 | 235 | 176 | 148 | 204 | 260 | 284 | 323 |
| 22 | 108 | 130 | 179 | 311 | 265 | 231 | 299 | 299 | 297 | 321 | 324 | 226 | 158 | 140 | 158 | 219 | 234 | 225 | 261 |
| 23 | 98 | 146 | 190 | 305 | 309 | 319 | 384 | 389 | 399 | 395 | 377 | 299 | 260 | 175 | 179 | 226 | 246 | 250 | 332 |
| 24 | 82 | 255 | 303 | 341 | 381 | 370 | 367 | 311 | 265 | 335 | 359 | 352 | 357 | 249 | 270 | 264 | 320 | 387 | 439 |
| 25 | 85 | 255 | 354 | 419 | 462 | 422 | 391 | 332 | 255 | 307 | 310 | 346 | 354 | 264 | 314 | 323 | 402 | 406 | 438 |
| 26 | 75 | 339 | 341 | 370 | 436 | 449 | 336 | 227 | 104 | 228 | 275 | 302 | 364 | 242 | 300 | 323 | 392 | 500 | 522 |
| 27 | 70 | 458 | 561 | 576 | 715 | 730 | 810 | 728 | 613 | 688 | 721 | 709 | 581 | 507 | 605 | 553 | 685 | 739 | 772 |
| Wtd. Avg. | 86 | 171 | 228 | 300 | 280 | 238 | | | | | 237 | 205 | 183 | 158 | 196 | 246 | 262 | 245 | |

TABLE 15

WEIGHT OF SALTS IN DRAINAGE WATER
DELTA LOWLANDS

In tons

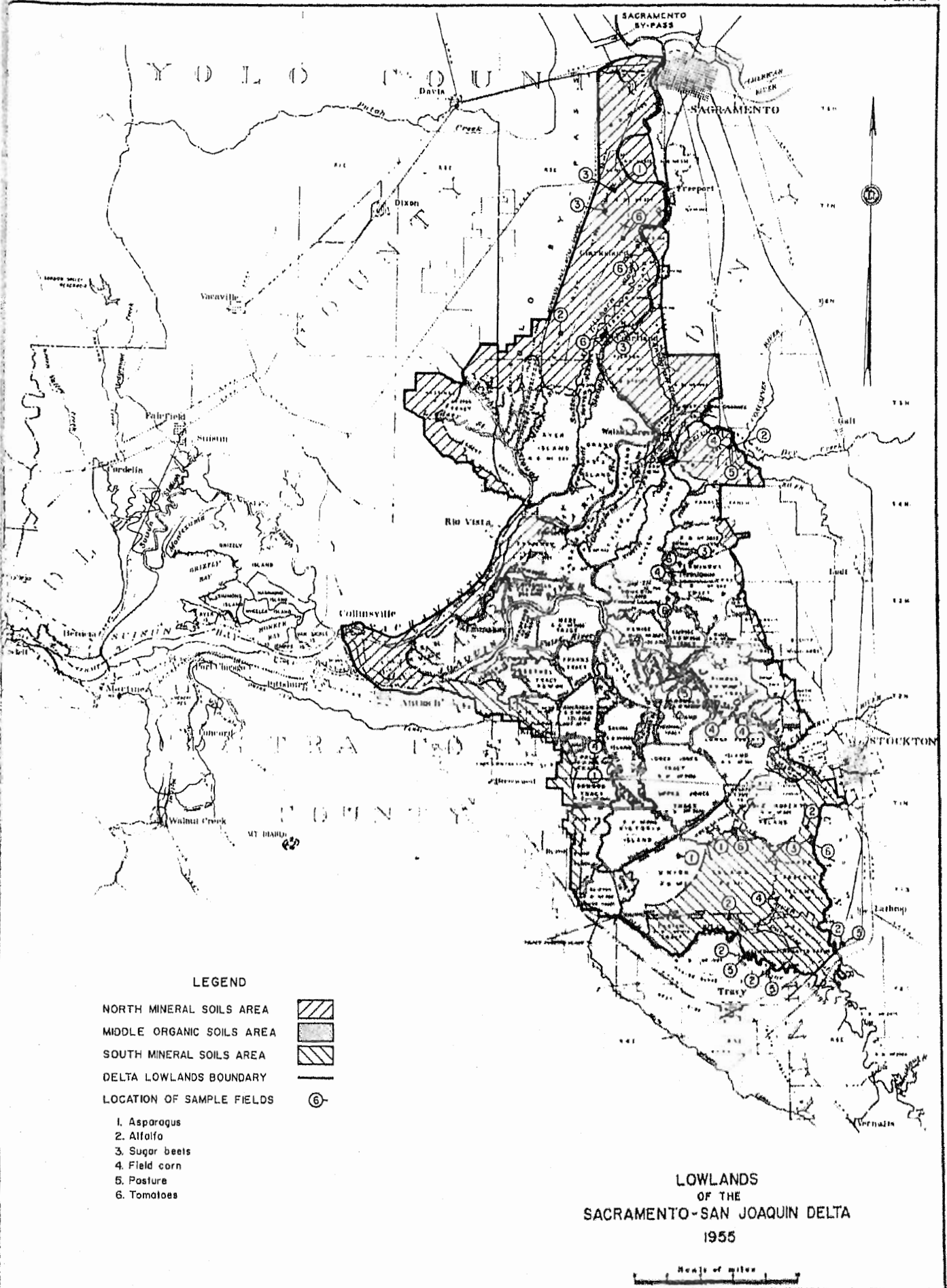
| Unit | Acreage | 1954 | | | | | | | | 1955 | | | | | | | | | |
|--------------|---------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. |
| 2 | 11202 | 47 | 0 | 0 | 0 | 0 | 195 | 0 | 782 | 677 | 96 | 0 | 82 | 0 | 0 | 0 | 0 | 0 | 112 |
| 3 | 5465 | 210 | 199 | 201 | 129 | 73 | 59 | 69 | 138 | 210 | 183 | 126 | 108 | 95 | 65 | 132 | 125 | 74 | 8 |
| 6 | 33027 | 194 | 108 | 60 | 67 | 99 | 143 | 794 | 2023 | 2286 | 2076 | 786 | 301 | 104 | 72 | 50 | 52 | 49 | 116 |
| 7 | 7510 | 157 | 52 | 37 | 24 | 26 | 20 | 102 | 248 | 439 | 263 | 170 | 160 | 147 | 83 | 85 | 42 | 46 | 30 |
| 8 | 22103 | 1074 | 842 | 640 | 936 | 921 | 1097 | 769 | 819 | 409 | 580 | 913 | 926 | 688 | 813 | 916 | 828 | 802 | 559 |
| 9 | 16085 | 556 | 731 | 772 | 1012 | 734 | 482 | 512 | 824 | 724 | 297 | 482 | 992 | 365 | 537 | 498 | 647 | 427 | 340 |
| 10 | 11067 | 192 | 411 | 397 | 271 | 110 | 92 | 115 | 241 | 399 | 237 | 170 | 299 | 286 | 410 | 236 | 208 | 153 | 135 |
| 11 | 14365 | 381 | 385 | 301 | 377 | 236 | 157 | 367 | 966 | 1067 | 578 | 404 | 497 | 269 | 460 | 286 | 357 | 167 | 129 |
| 12 | 16877 | 708 | 923 | 900 | 966 | 480 | 346 | 498 | 1540 | 2112 | 1045 | 906 | 1245 | 864 | 1565 | 1275 | 1135 | 314 | 235 |
| 13 | 16641 | 362 | 798 | 542 | 555 | 155 | 208 | 311 | 1106 | 1138 | 585 | 495 | 593 | 408 | 512 | 696 | 724 | 489 | 214 |
| 14 | 14671 | 1124 | 1656 | 2590 | 1435 | 798 | 1098 | 1582 | 2981 | 3188 | 2675 | 3029 | 2941 | 1514 | 1685 | 2634 | 1177 | 616 | 1190 |
| 15 | 26424 | 1645 | 1489 | 1748 | 2610 | 1999 | 2844 | 3737 | 6457 | 7708 | 4201 | 3741 | 3131 | 1294 | 1769 | 1731 | 2589 | 2089 | 1878 |
| 16 | 18343 | 1121 | 1343 | 1406 | 3112 | 2129 | 1452 | 1391 | 4408 | 5800 | 2510 | 1966 | 2026 | 1243 | 1574 | 1503 | 1555 | 1433 | 1203 |
| 17 | 10191 | 883 | 814 | 1162 | 960 | 781 | 1286 | 1572 | 6423 | 5662 | 2284 | 2159 | 3500 | 2293 | 1307 | 1436 | 1148 | 1014 | 615 |
| 18 | 18504 | 1347 | 2503 | 2946 | 3442 | 2621 | 2603 | 2557 | 4768 | 4086 | 2218 | 1710 | 1026 | 1217 | 2182 | 2676 | 2526 | 1362 | 1206 |
| 19 | 17917 | 940 | 1374 | 2410 | 2094 | 1169 | 979 | 1146 | 2774 | 3263 | 1515 | 862 | 1026 | 906 | 1198 | 1319 | 1314 | 852 | 646 |
| 20 | 21302 | 3264 | 4998 | 4823 | 6347 | 3491 | 3531 | 5150 | 12081 | 19485 | 5251 | 2751 | 4732 | 5523 | 8032 | 6505 | 7016 | 7544 | 3138 |
| 21 | 14846 | 1288 | 1596 | 2070 | 2233 | 1657 | 2028 | 2778 | 7489 | 9865 | 2750 | 1362 | 1651 | 2235 | 2343 | 2195 | 1801 | 1566 | 1320 |
| 22 | 19357 | 3025 | 3727 | 4708 | 6408 | 3815 | 3663 | 4251 | 7863 | 11986 | 6086 | 3447 | 2109 | 3753 | 5317 | 5385 | 4816 | 2304 | 2365 |
| 23 | 24493 | 1144 | 1192 | 1647 | 1730 | 907 | 1796 | 1865 | 6754 | 15843 | 3542 | 1647 | 1274 | 1153 | 1200 | 1175 | 1033 | 612 | 846 |
| 24 | 32879 | 1365 | 1548 | 1878 | 1852 | 1329 | 1591 | 2690 | 10325 | 11369 | 4393 | 2590 | 2569 | 2507 | 1907 | 1676 | 1765 | 1351 | 2128 |
| 25 | 33212 | 1501 | 1451 | 2337 | 1602 | 894 | 658 | 691 | 3789 | 4086 | 2234 | 1758 | 2295 | 2109 | 2288 | 2839 | 2525 | 1784 | 763 |
| 26 | 2810 | 63 | 80 | 96 | 98 | 66 | 73 | 121 | 456 | 513 | 192 | 118 | 120 | 119 | 95 | 83 | 86 | 66 | 91 |
| 27 | 10148 | 538 | 534 | 1253 | 1075 | 383 | 112 | 41 | 138 | 243 | 115 | 290 | 826 | 523 | 632 | 935 | 1342 | 709 | 131 |
| Total | 419439 | 23129 | 28754 | 34924 | 39335 | 24873 | 26513 | 33109 | 85393 | 112558 | 45906 | 31882 | 34429 | 29615 | 36046 | 36266 | 34811 | 25823 | 19398 |
| Tons/ Ac. | | 0.06 | 0.07 | 0.08 | 0.09 | 0.06 | 0.06 | 0.08 | 0.20 | 0.27 | 0.11 | 0.08 | 0.08 | 0.07 | 0.09 | 0.09 | 0.08 | 0.06 | 0.05 |

TABLE 16






AVERAGE QUALITY OF DRAINAGE WATER
DELTA LOWLANDS

Sum of mineral constituents in parts per million

| Unit | 1954 | | | | | | | | | | | | 1955 | | | | | | | | | | | |
|-----------|------|------|------|------|-------|------|------|------|------|------|------|------|------|------|------|------|-------|------|--|--|--|--|--|--|
| | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | | | | | | |
| 2 | 768 | 0 | 0 | 0 | 0 | 801 | 855 | 855 | 855 | 855 | 0 | 670 | 0 | 0 | 0 | 0 | 614 | | | | | | | |
| 3 | 242 | 265 | 223 | 180 | 229 | 295 | 262 | 262 | 260 | 241 | 195 | 197 | 129 | 119 | 145 | 160 | 137 | | | | | | | |
| 6 | 231 | 205 | 130 | 165 | 203 | 294 | 585 | 585 | 571 | 707 | 749 | 552 | 261 | 225 | 117 | 142 | 266 | | | | | | | |
| 7 | 226 | 327 | 261 | 294 | 299 | 334 | 481 | 481 | 482 | 527 | 565 | 514 | 417 | 323 | 292 | 257 | 374 | | | | | | | |
| 8 | 191 | 207 | 211 | 234 | 226 | 205 | 314 | 314 | 287 | 393 | 383 | 337 | 215 | 183 | 176 | 215 | 261 | | | | | | | |
| 9 | 330 | 330 | 274 | 357 | 361 | 372 | 619 | 619 | 633 | 866 | 883 | 690 | 362 | 303 | 260 | 289 | 352 | | | | | | | |
| 10 | 357 | 349 | 276 | 204 | 231 | 259 | 364 | 364 | 460 | 495 | 510 | 496 | 393 | 398 | 198 | 178 | 220 | | | | | | | |
| 11 | 173 | 167 | 165 | 205 | 225 | 218 | 513 | 513 | 517 | 491 | 466 | 411 | 250 | 251 | 147 | 186 | 227 | | | | | | | |
| 12 | 216 | 216 | 186 | 239 | 243 | 247 | 388 | 388 | 500 | 455 | 394 | 354 | 293 | 293 | 239 | 226 | 278 | | | | | | | |
| 13 | 300 | 384 | 197 | 255 | 319 | 333 | 631 | 631 | 642 | 553 | 474 | 403 | 311 | 239 | 217 | 263 | 362 | | | | | | | |
| 14 | 478 | 571 | 927 | 1139 | 905 | 658 | 1012 | 1012 | 1195 | 1123 | 937 | 937 | 689 | 699 | 855 | 1023 | 982 | | | | | | | |
| 15 | 468 | 444 | 428 | 666 | 715 | 707 | 978 | 978 | 990 | 1075 | 988 | 905 | 528 | 536 | 454 | 560 | 683 | | | | | | | |
| 16 | 390 | 406 | 445 | 719 | 729 | 702 | 1155 | 1155 | 1064 | 1255 | 1388 | 803 | 535 | 471 | 473 | 559 | 585 | | | | | | | |
| 17 | 654 | 626 | 619 | 697 | 777 | 816 | 1312 | 1312 | 1301 | 1616 | 1229 | 1411 | 1063 | 596 | 528 | 563 | 750 | | | | | | | |
| 18 | 210 | 212 | 196 | 308 | 285 | 274 | 609 | 609 | 621 | 672 | 647 | 524 | 255 | 286 | 194 | 230 | 307 | | | | | | | |
| 19 | 276 | 283 | 382 | 357 | 320 | 475 | 741 | 741 | 977 | 912 | 767 | 580 | 254 | 279 | 258 | 294 | 372 | | | | | | | |
| 20 | 440 | 399 | 347 | 448 | 555 | 566 | 870 | 870 | 978 | 1005 | 1003 | 984 | 623 | 565 | 408 | 434 | 658 | | | | | | | |
| 21 | 300 | 293 | 290 | 349 | 451 | 554 | 745 | 745 | 970 | 731 | 517 | 516 | 424 | 322 | 299 | 289 | 446 | | | | | | | |
| 22 | 180 | 174 | 227 | 364 | 325 | 289 | 543 | 543 | 690 | 606 | 494 | 393 | 257 | 232 | 254 | 276 | 328 | | | | | | | |
| 23 | 351 | 289 | 309 | 390 | 338 | 348 | 533 | 533 | 984 | 806 | 576 | 508 | 420 | 356 | 420 | 269 | 314 | | | | | | | |
| 24 | 472 | 455 | 466 | 479 | 528 | 556 | 852 | 852 | 909 | 947 | 927 | 884 | 782 | 529 | 430 | 443 | 792 | | | | | | | |
| 25 | 472 | 485 | 455 | 514 | 531 | 542 | 731 | 731 | 817 | 750 | 660 | 664 | 694 | 659 | 584 | 577 | 608 | | | | | | | |
| 26 | 482 | 449 | 490 | 483 | 490 | 610 | 840 | 840 | 915 | 941 | 943 | 928 | 817 | 525 | 394 | 413 | 719 | | | | | | | |
| 27 | 591 | 626 | 748 | 833 | 821 | 823 | 520 | 520 | 677 | 666 | 685 | 841 | 789 | 795 | 725 | 816 | 845 | | | | | | | |
| Wtd. Avg. | 305 | 299 | 319 | 408 | 410 | 416 | 523 | 523 | 865 | 804 | 723 | 673 | 437 | 373 | 331 | 355 | 440 | 475 | | | | | | |

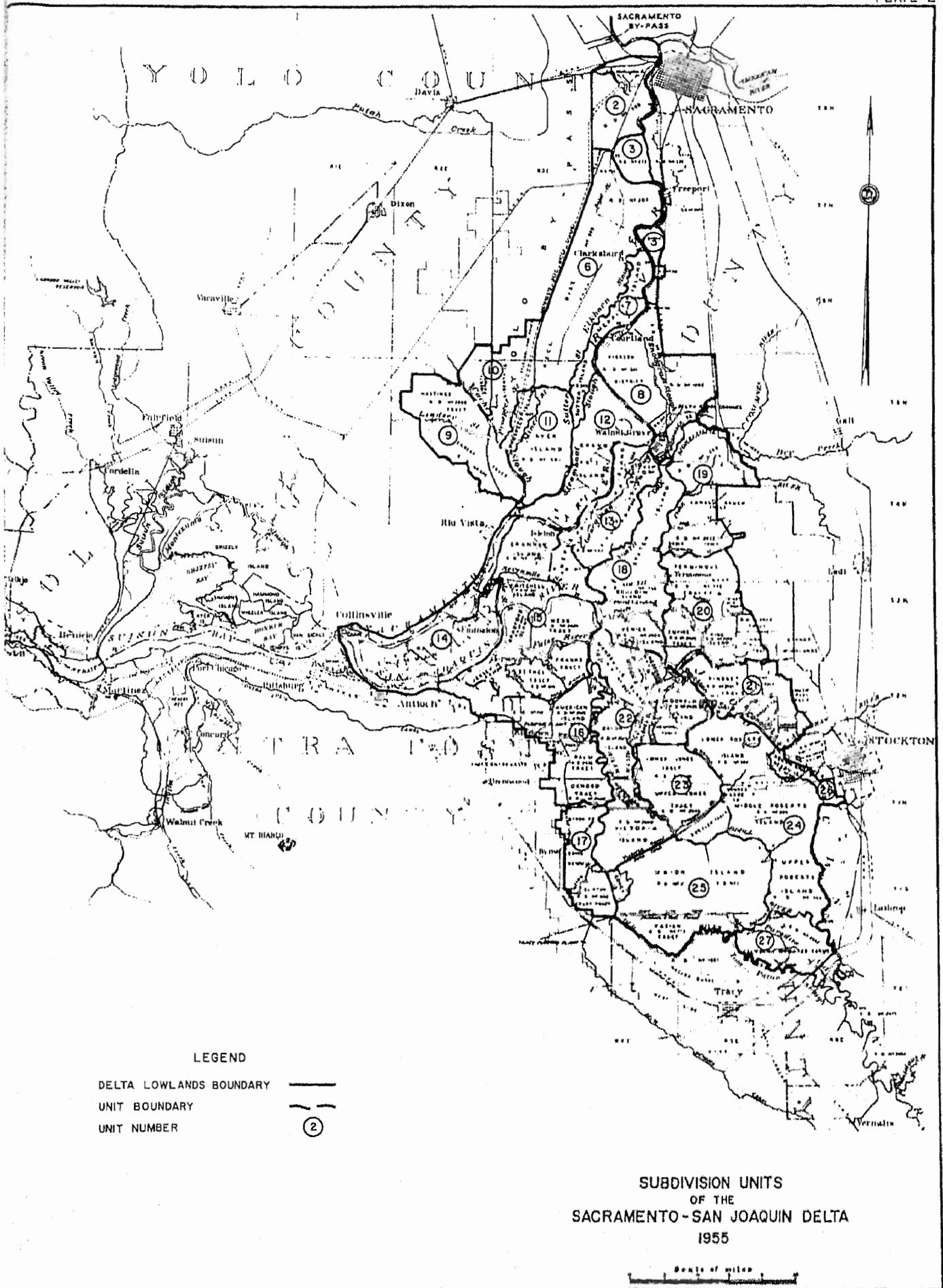


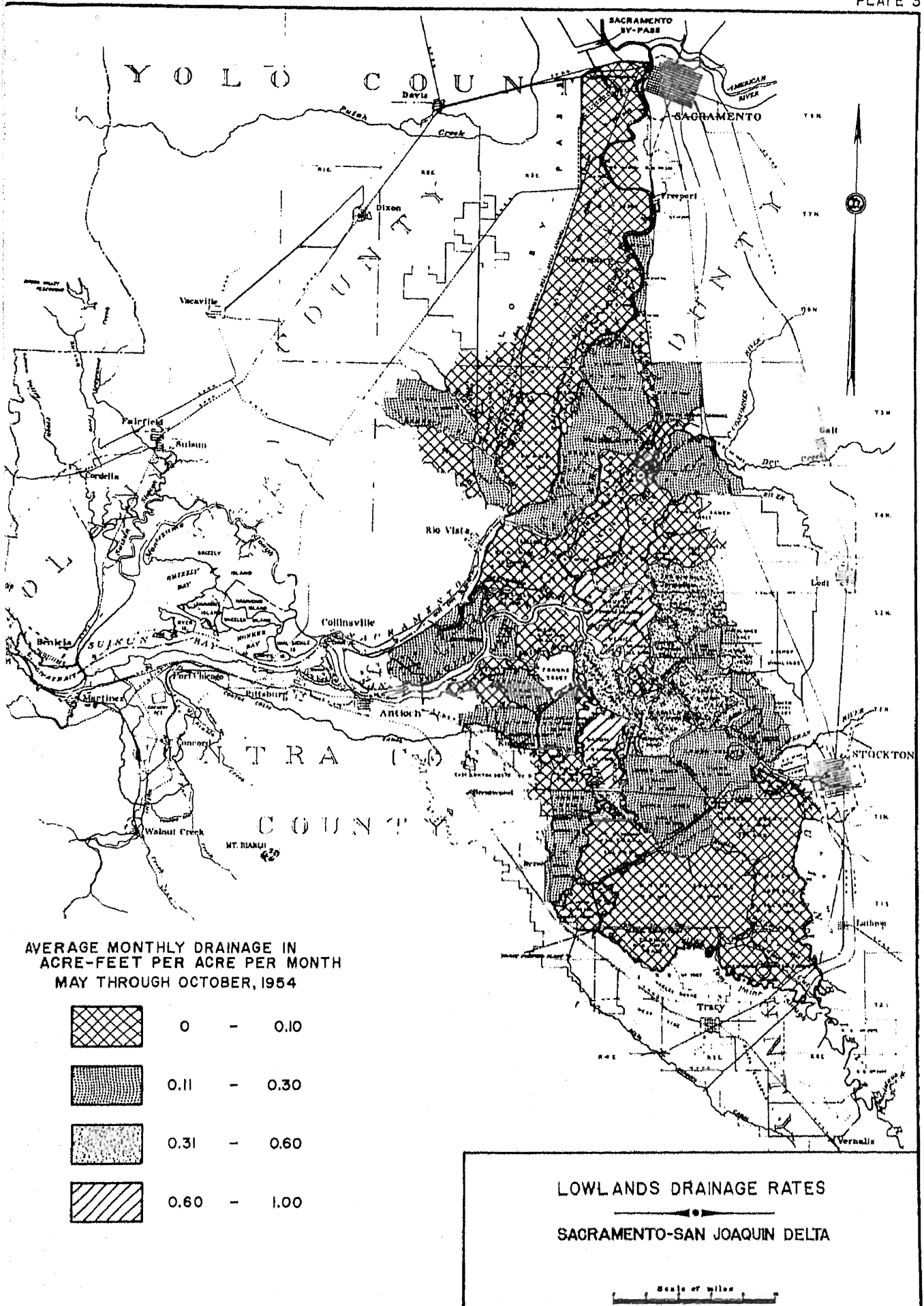
LEGEND

- NORTH MINERAL SOILS AREA 
 - MIDDLE ORGANIC SOILS AREA 
 - SOUTH MINERAL SOILS AREA 
 - DELTA LOWLANDS BOUNDARY 
 - LOCATION OF SAMPLE FIELDS 
1. Asparagus
 2. Alfalfa
 3. Sugar beets
 4. Field corn
 5. Pasture
 6. Tomatoes




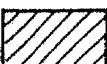
LOWLANDS
OF THE
SACRAMENTO-SAN JOAQUIN DELTA
1955

Miles of miles



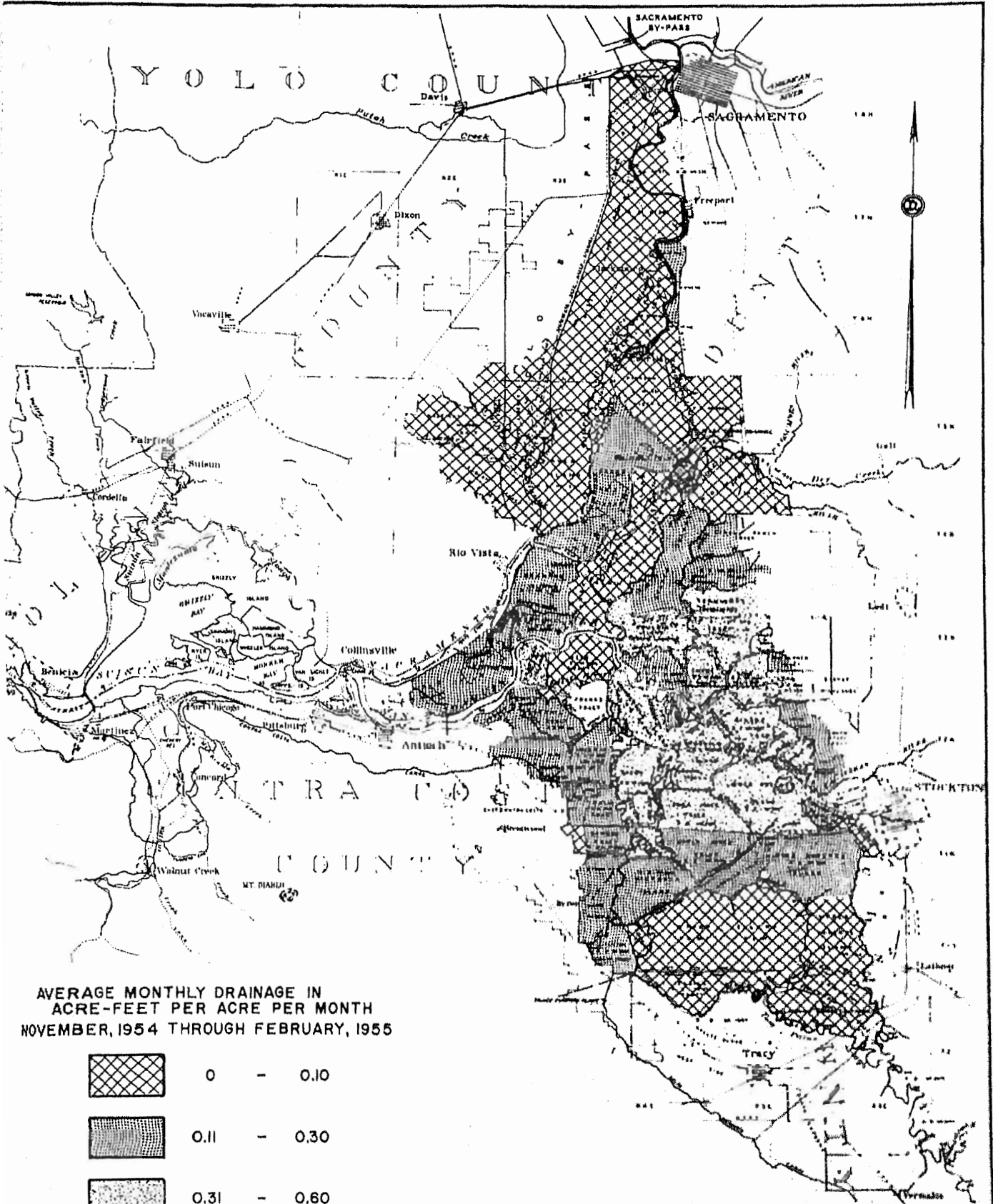


AVERAGE MONTHLY DRAINAGE IN
ACRE-FEET PER ACRE PER MONTH
MAY THROUGH OCTOBER, 1954


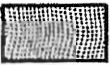

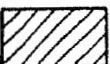
| | | | |
|---|------|---|------|
|  | 0 | - | 0.10 |
|  | 0.11 | - | 0.30 |
|  | 0.31 | - | 0.60 |
|  | 0.60 | - | 1.00 |

LOWLANDS DRAINAGE RATES
SACRAMENTO-SAN JOAQUIN DELTA

Scale of miles



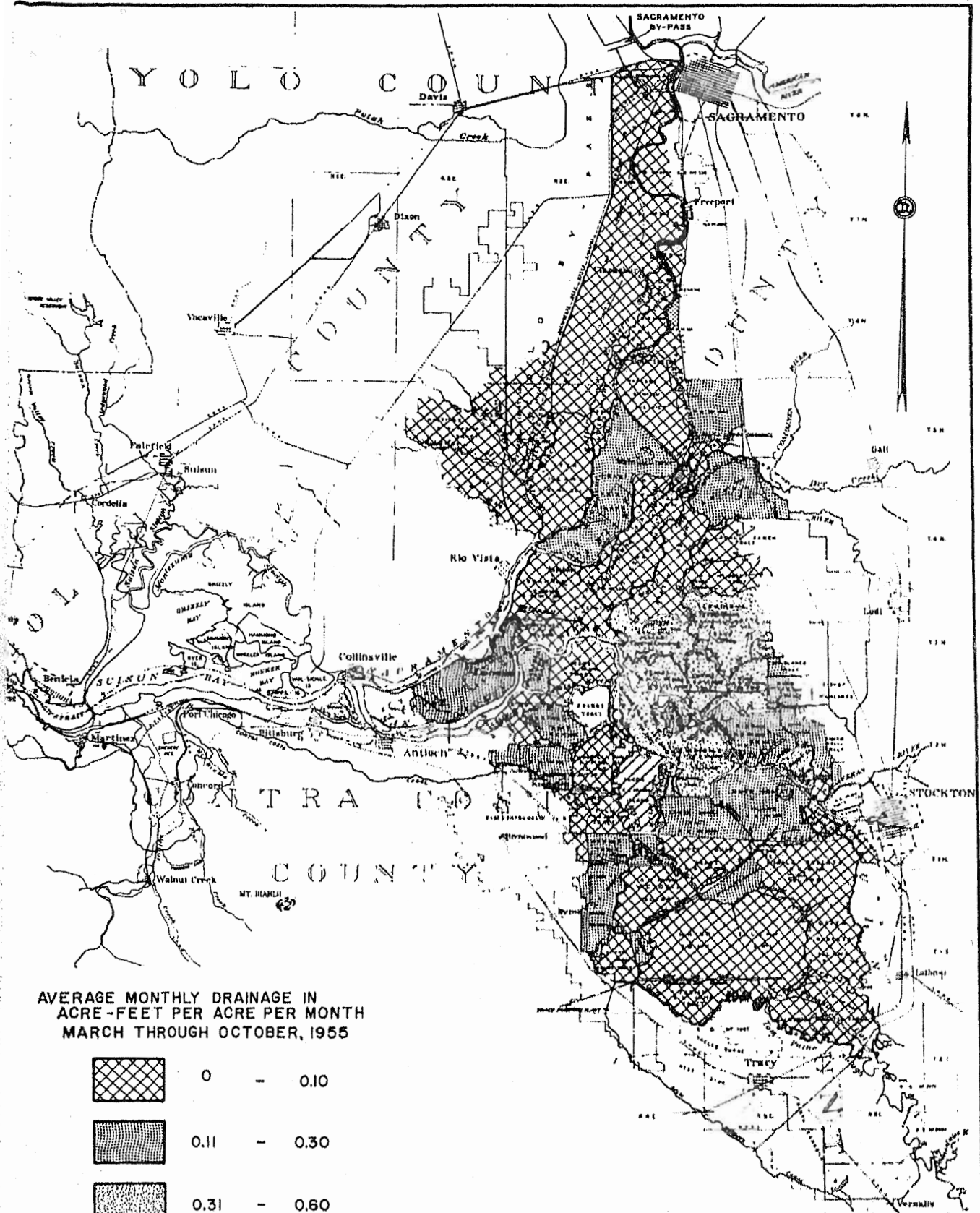
AVERAGE MONTHLY DRAINAGE IN
ACRE-FEET PER ACRE PER MONTH
NOVEMBER, 1954 THROUGH FEBRUARY, 1955

| | |
|---|-------------|
|  | 0 - 0.10 |
|  | 0.11 - 0.30 |
|  | 0.31 - 0.60 |
|  | 0.60 - 1.00 |





LOWLANDS DRAINAGE RATES

SACRAMENTO-SAN JOAQUIN DELTA

Scale of miles

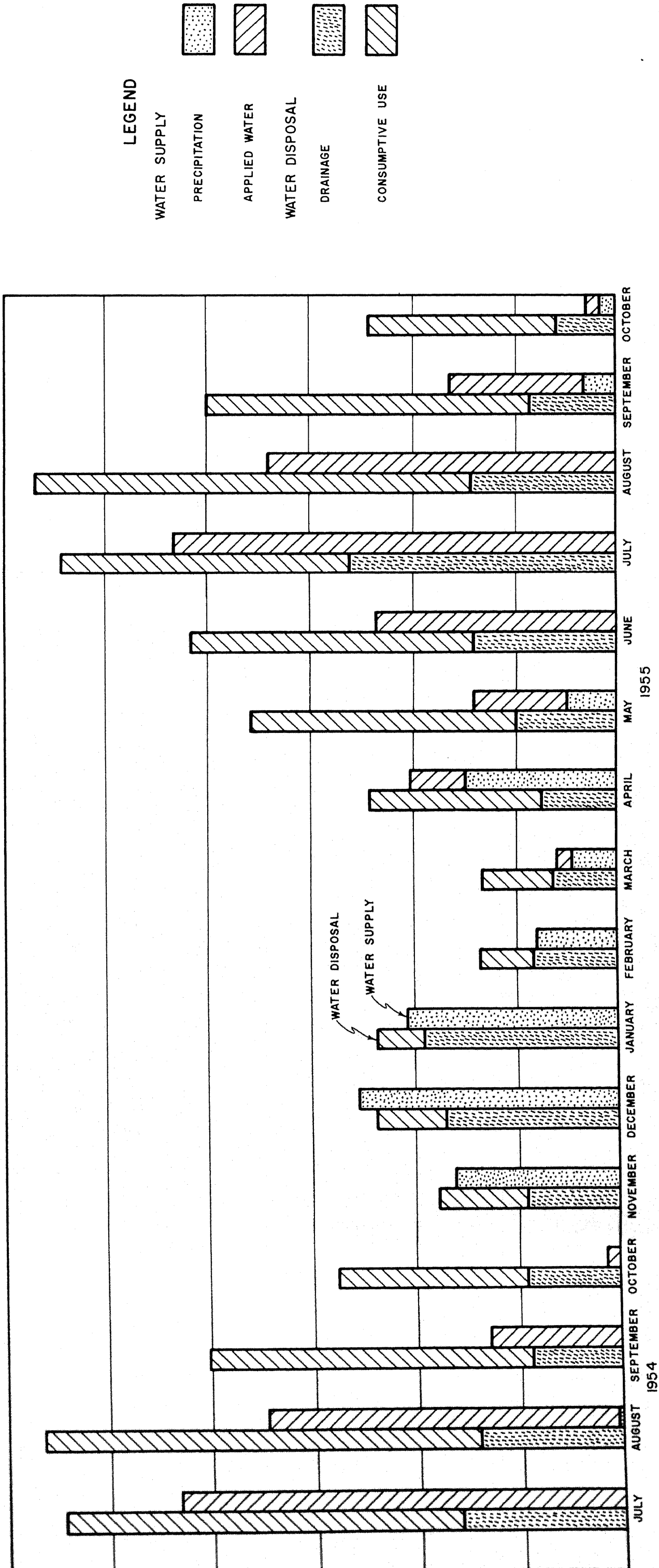


AVERAGE MONTHLY DRAINAGE IN
ACRE-FEET PER ACRE PER MONTH
MARCH THROUGH OCTOBER, 1955

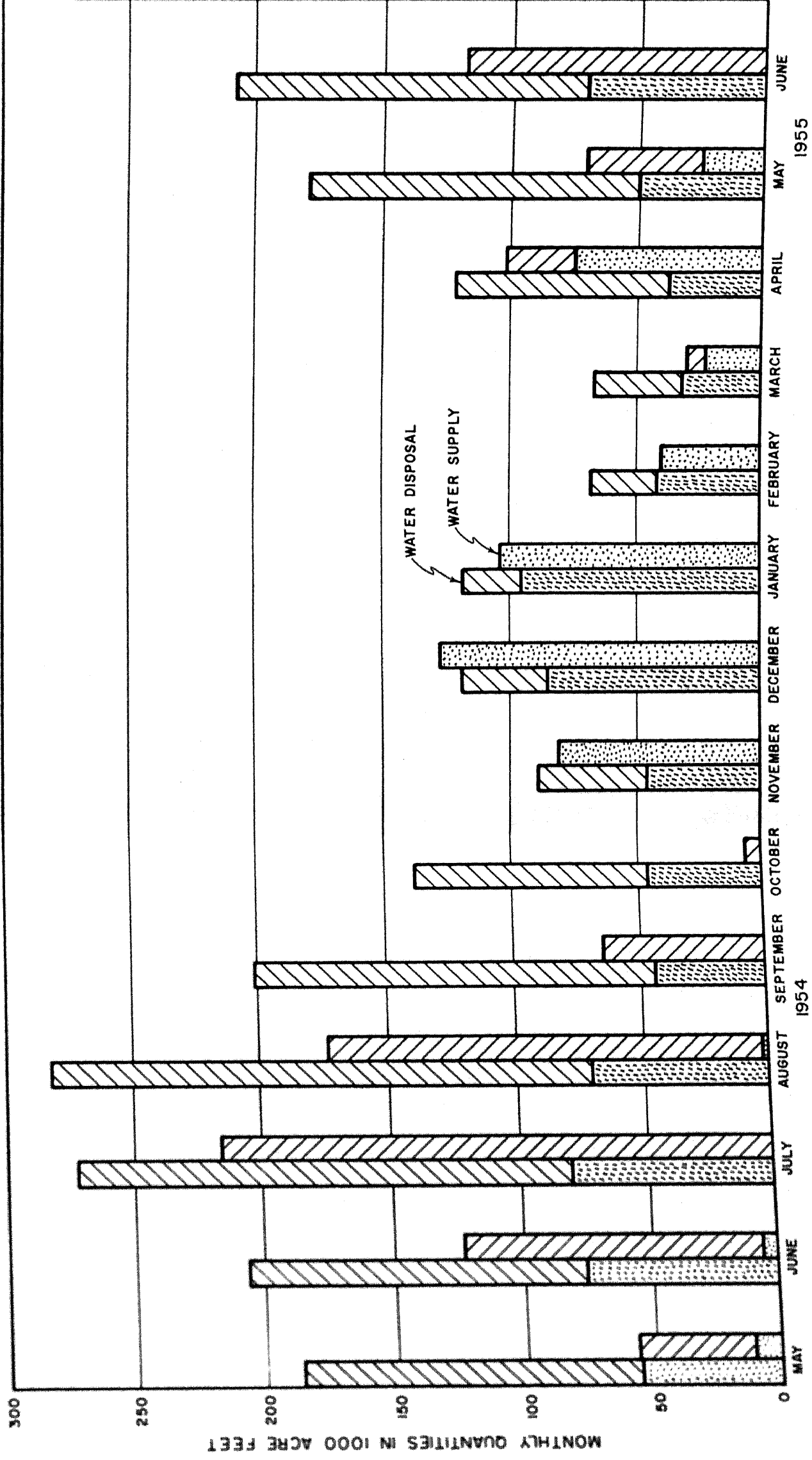
| | |
|---|-------------|
|  | 0 - 0.10 |
|  | 0.11 - 0.30 |
|  | 0.31 - 0.60 |
|  | 0.60 - 1.00 |

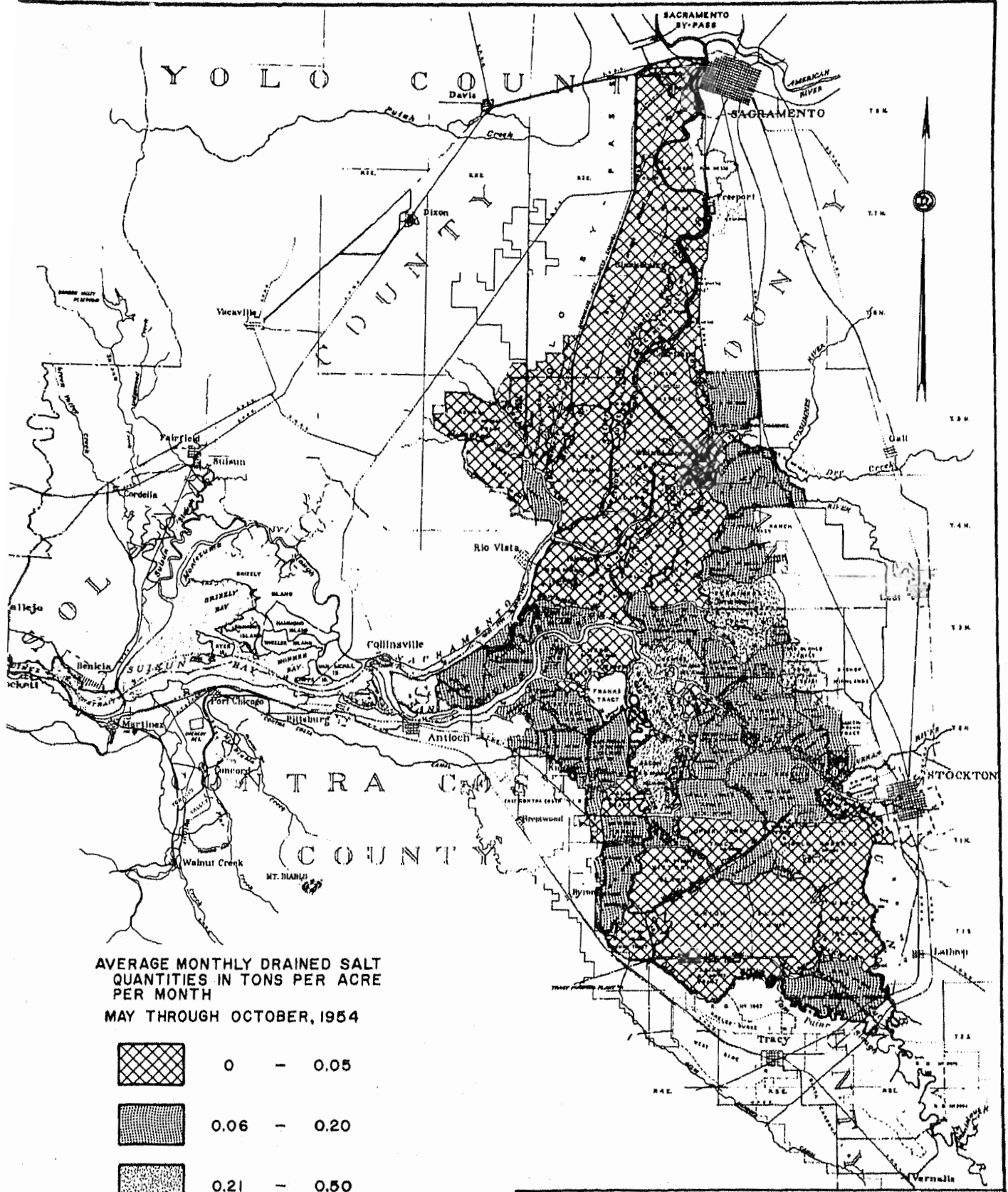
LOWLANDS DRAINAGE RATES
SACRAMENTO-SAN JOAQUIN DELTA

Scale of Miles

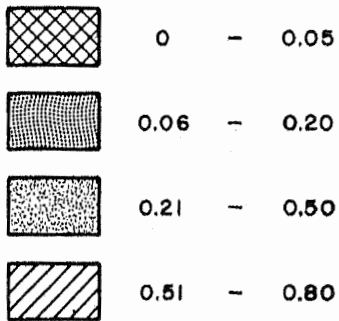


COMPARISON OF WATER SUPPLY AND DISPOSAL
DELTA LOWLANDS
1954-55



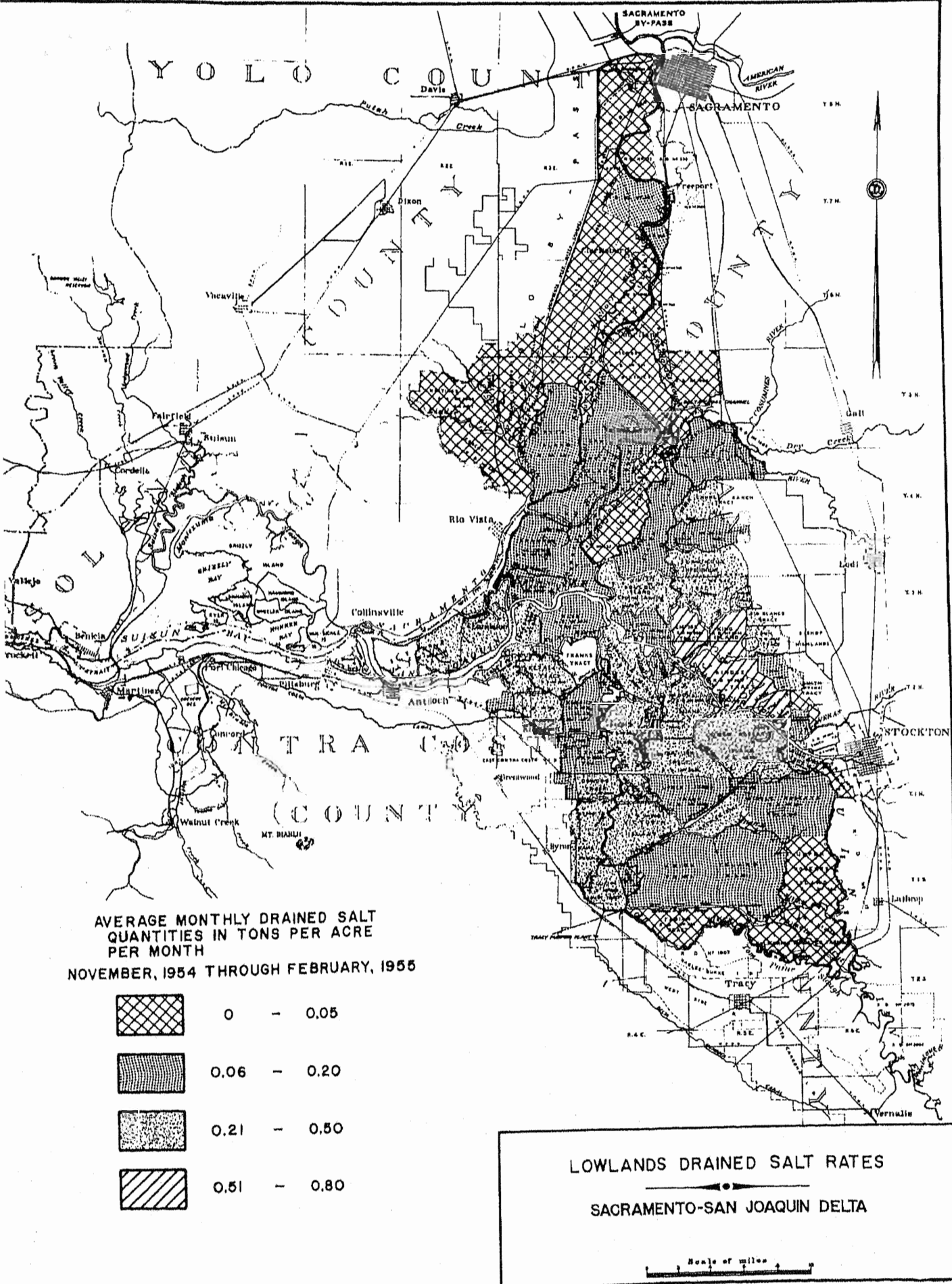


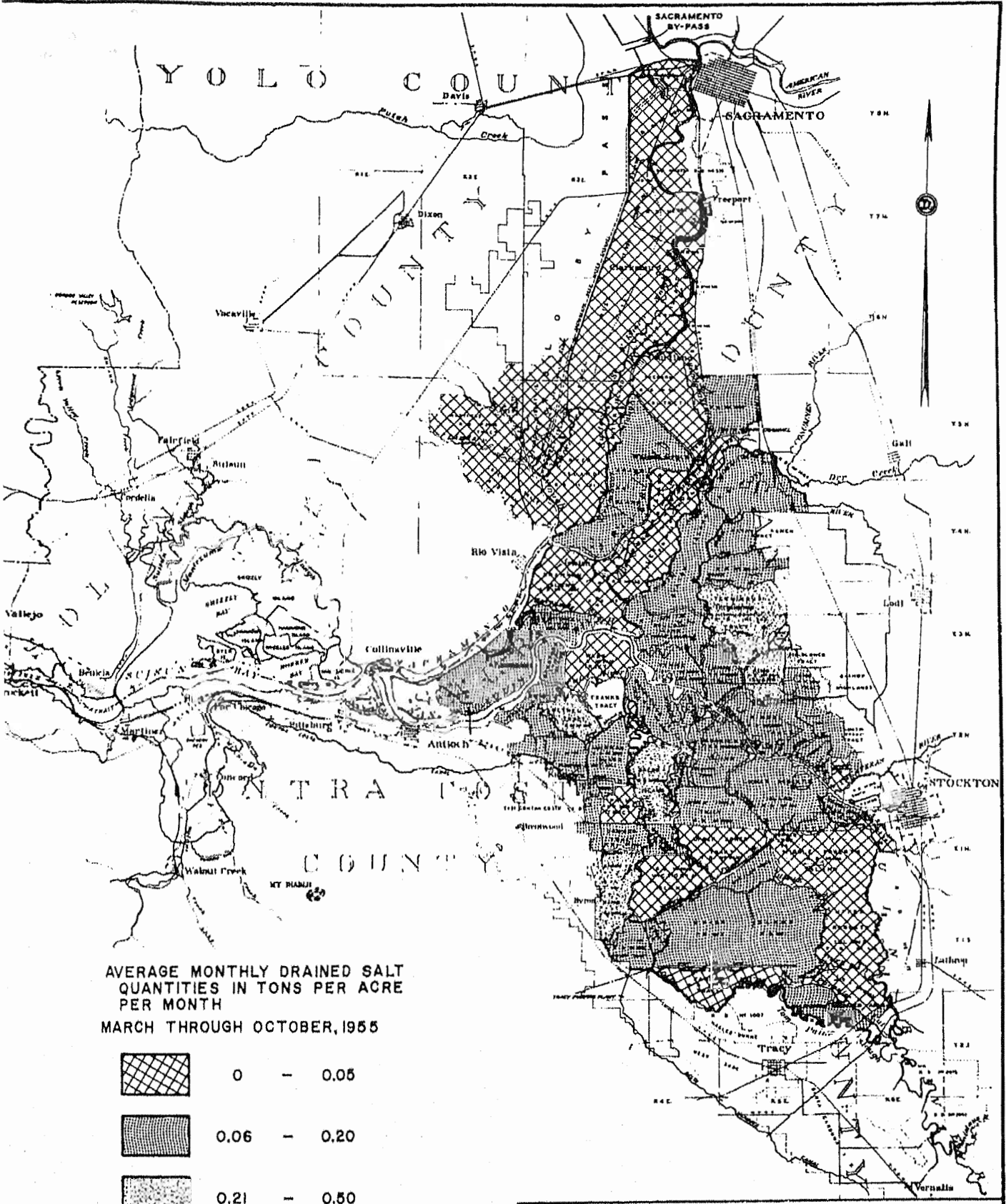
AVERAGE MONTHLY DRAINED SALT QUANTITIES IN TONS PER ACRE PER MONTH
MAY THROUGH OCTOBER, 1954



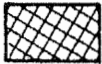
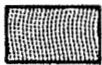


LOWLANDS DRAINED SALT RATES
 SACRAMENTO-SAN JOAQUIN DELTA

Scale of miles





AVERAGE MONTHLY DRAINED SALT QUANTITIES IN TONS PER ACRE PER MONTH
MARCH THROUGH OCTOBER, 1955

| | |
|---|-------------|
|  | 0 - 0.05 |
|  | 0.06 - 0.20 |
|  | 0.21 - 0.50 |
|  | 0.51 - 0.80 |

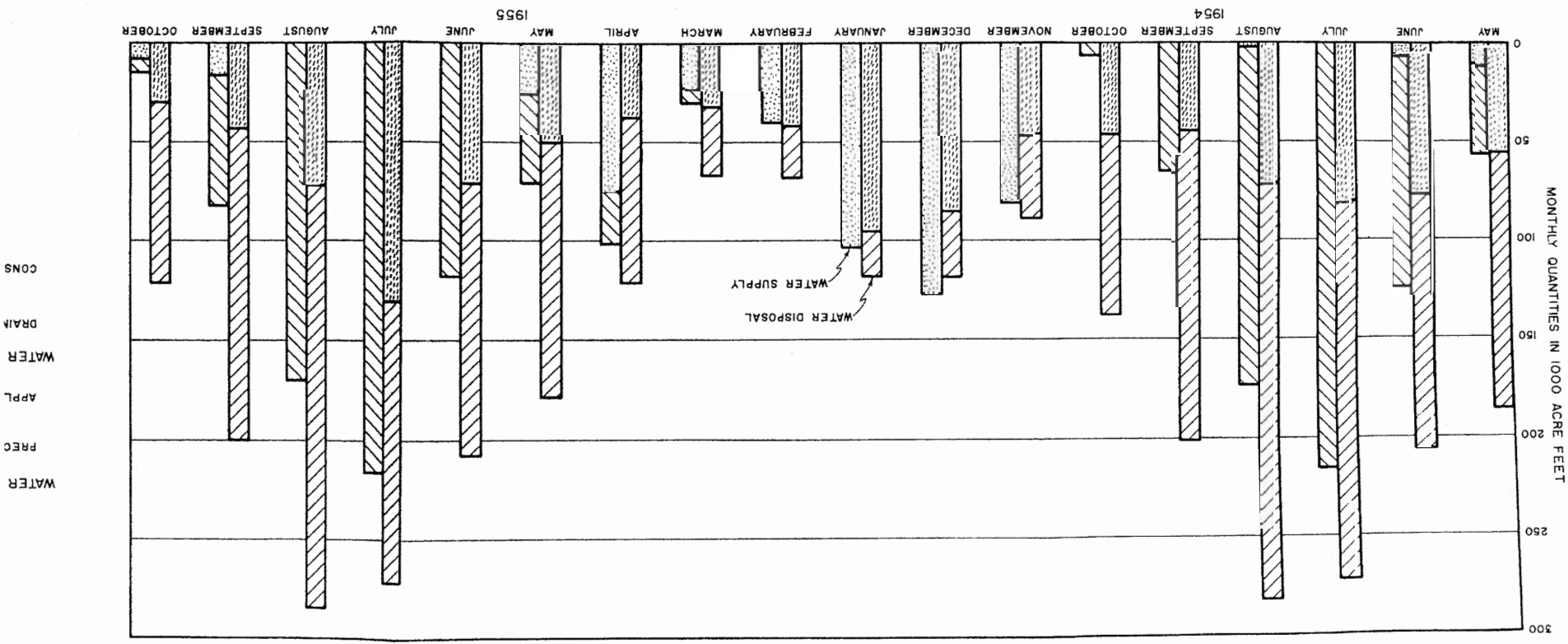
LOWLANDS DRAINED SALT RATES

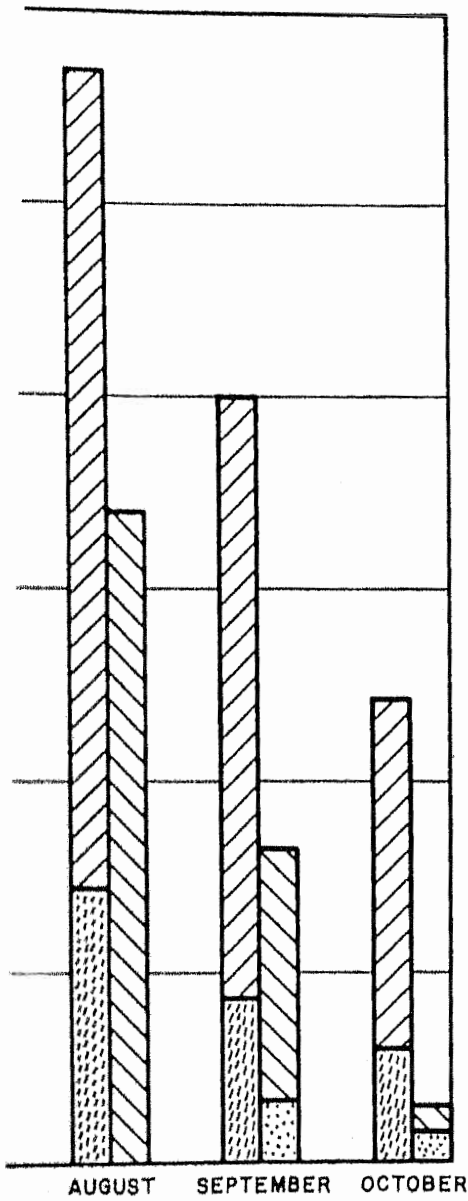
SACRAMENTO-SAN JOAQUIN DELTA

Scale of Miles

COMPARISON OF WATER SUPPLY
DELTA LOWLAND
1954-55

Legend attached





LEGEND

To previous page

WATER SUPPLY

PRECIPITATION

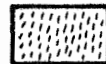


APPLIED WATER



WATER DISPOSAL

DRAINAGE



CONSUMPTIVE USE

