PROBLEMS OF THE LOWER SAN JOAQUIN RIVER INFLUENCING THE 1963 SALMON RUN

THE RESOURCES AGENCY OF CALIFORNIA

Department of Fish and Game

Department of Water Resources

Central Valley Regional Water
Pollution Control Board

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This report was prepared cooperatively by the following Resources Agency units:

California Department of Fish and Game

California Department of Water Resources

Central Valley Regional Water Pollution Control Board

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U. S. Bureau of Reclamation

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U. S. Corps of Engineers

U. S. Fish and Wildlife Service

State Lands Commission

State Reclamation Board

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City of Stockton, California

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THE PROBLEM

Studies conducted by the Delta Fish and Wildlife Protection Study defined a problem relating to the upstream migration of adult salmon caused by flow reversal and pollution in the lower San Joaquin River area. Further studies are now under way to solve this problem in the future with the construction of Delta water facilities.

An immediate problem, however, "was :found to exist. These studies indicated that during 1961 and 1962 flow reversal and pollution did exist in the San Joaquin River during the September-October period when adult salmon are normally migrating. The salmon runs in all of the tributaries of the San Joaquin River were drastically reduced for each of these two years, decreasing from approximately 50,000 fish to under 3,000. It is felt that flow reversal or pollution may have been key factors accounting for the 1961-62 decline.

The salmon in the San Joaquin River have been faced with many problems over the past years. These include highway construction, siltation of spawning gravels, pollution, loss of spawning grounds due to dam construction, diversions, etc. The Department of Fish and Game has been involved in many actions to solve each of these problems. The long-term future for salmon looks good, however, in spite of the present status of the San Joaquin salmon run. Water development projects, which are perhaps the principal reasons for past declines, may well become the means for restoration of the salmon.

It was decided that action was required during the fall of 1963 to permit safe passage of salmon, particularly since the 1961 and 1962 salmon runs were practically nonexistent. Since salmon runs operate on a three or four-year cycle, the chances were good that a failure during the fall of 1963 could result in the loss of most if not all the San Joaquin salmon run.

Flow reversal is caused both by pumping at the U. S. Bureau of Reclamation pumps at Tracy and other diversions in the Delta area as well as upstream development and diversion in the entire San Joaquin River system. It has existed in both Old and Middle River during summer and fall months since 1951 when the Tracy pumping plant started operation. It has also existed in the lower San Joaquin River and during past years has continued into the fall months.

Dissolved oxygen sags in the lower San Joaquin River area are historically caused primarily by waste discharges — cannery wastes are suspected as the key problem during the fall period. This problem is made more acute by the limited downstream flow in the San Joaquin River past Stockton.

SUMMARY OF ACTIONS TAKEN

The problem was brought to the attention of Resources Agency Administrator Fisher on July 26, 1963 by Director Shannon, Department of Fish and Game. A meeting of Resources Agency units was held August 15 to explore the problem. There appeared to be two immediate actions which could be taken to permit safe passage of salmon during the 1963 fall run period.

The first action was to request the U. S. Bureau of Reclamation to pump additional waters at their Tracy pumping plant for diversions into the San Joaquin River to increase the San Joaquin River flows.

The second action was to construct a partial closure of the head of Old River which would divert additional amounts of San Joaquin water past Stockton, rather than into Old River to the pumps. Both the pumping and partial closure would assist in preventing flow reversal and pollution in the Stockton area.

Administrator Fisher following an August 29 meeting with the U. S. Bureau of Reclamation requested them to pump additional water at Tracy for release into the San Joaquin River. Administrator Fisher requested the Department of Water Resources and the Department of Fish and Game to determine if a partial closure at the head of Old River was possible.

Administrator Fisher also requested the Department of Water Resources, the Department of Fish and Game, and the Central Valley Regional Water Pollution Control Board to conduct whatever sampling was necessary to gain more information and measure the results of the pumping and the partial closure of Old River. The Department of Water Resources was given responsibility for hydraulics studies necessary to determine water flows and measure flow reversal. The Department of Water Resources, the Central Valley Regional Water Pollution Control Board, and the Department of Fish and Game cooperated in conducting water quality studies.

A system of weekly meetings was established to review each week's results by the Department of Fish and Game, Department of Water Resources, the U. S. Bureau of Reclamation and the U. S. Fish and Wildlife Service. On the basis of these meetings, decisions were then made by the Bureau of Reclamation regarding the following week's pumping schedule.

Pumping by the Bureau of Reclamation was commenced on September 15 and continued until November 1. The pumping schedule varied from week to week, depending upon sampling results obtained.

The Department of Water Resources made analyses of the history of flows in the lower San Joaquin River and devised a method to predict the magnitude and duration of flow reversal which might be expected in the fall of 1963. Tidal flow measurements were made on September 18 and 19 to check actual flows.

The Department of Water Resources investigated alternatives which could be used to make a partial closure of Old River, The decision was made to place a 130-foot barge on a rock blanket in Old River to effect a partial closure.

The Department of Fish and Game obtained the loan of the barge from the Oakland Army Terminal, The Department of Fish and Game also obtained a $10,000 deficiency appropriation to buy the rock and pay for outside services and equipment required for the barge installation and removal.

Required permits for partial closure of Old River were obtained from the State Reclamation Board, State Lands Commission and U. S. Corps of Engineers by joint efforts of the Department of Water Resources and the Department of Fish and Game.

The barge was installed on October 10 under the supervision of Department of Water Resources engineers. The barge was removed on November 14 and returned to the Oakland Army Terminal. Tidal flow measurements were made by the Department of Water Resources on October 14 to determine the effects of the barge installation on flows.

Water quality studies were initiated by the Department of Water Resources on September 11 and continued weekly through the end of October. The Regional Water Pollution Control Board also conducted water quality studies as did the City of Stockton. The Department of Fish and Game and U. S. Fish and Wildlife Service personnel provided assistance to these studies.

The Department of Fish and Game carried out salmon gill netting operations seven different times in several Delta channels between September 25 and November 6. Observations on the several San Joaquin tributaries to observe and count salmon were started in early November and continued to January 10.

RESULTS

Flow computations by the Department of Water Resources (based upon historic measurements at the Old River-San Joaquin confluence) indicated that average monthly flows from September-November 1963 would remain positive past Stockton and that no flow reversal would exist during this period. Actual flow measurements conducted during the survey indicated that flows past Stockton were less than predicted; thus the Department of Water Resources concluded that borderline flow reversal conditions would exist.

Dissolved oxygen observations were made throughout the area of investigation from a point about five miles upstream from the San Joaquin River's confluence with the Stockton harbor to a point approximately eight miles downstream from the City of Stockton.

During the survey, dissolved oxygen levels at the uppermost station above Stockton varied between 10.3 and 5.2 parts per million (ppm). Values of dissolved oxygen less than 3.0 ppm. were observed throughout 5.3 miles of the river in the vicinity of Stockton during the most adverse oxygen condition when the absolute: minimum values observed were 0.4 ppm. At this same station the lowest 24-hour average of 0.9 ppm. was obtained. The lowest point of the dissolved oxygen sag was observed in the deep water channel below the confluence of the San Joaquin River.

Additional pumping by the U. S. Bureau of Reclamation provided additional water in the San Joaquin River, However, prior to placement of the barge, tidal flow measurements showed that 77 percent of the water flowing down the San Joaquin River continued to be diverted into Old River and only 23 percent traveled downstream in the San Joaquin River past Stockton. Therefore, additional pumping alone did not materially enhance the flow past Stockton.

The partial closure of Old River changed the flow distribution. Tidal flow measurements with the barrier in place showed that 52 percent of the San Joaquin River flow proceeded downstream past Stockton, and only 48 percent flowed into Old River toward the pumps.

Studies showed, therefore, that a combination of a partial Old River closure plus additional Bureau of Reclamation pumping can be combined to provide significant increases in flow of the San Joaquin River at Stockton.

Net flows over 1,400 cfs. past the Stockton area did result in improved dissolved oxygen levels so that water quality conditions were suitable for salmon migration throughout the lower San Joaquin River.

Although flow is recognized as having considerable influence on dissolved oxygen values in a body of water, it was found that other strong influences on dissolved oxygen overshadowed any positive benefits of flows in the low ranges (up to 500 cfs.). Water quality studies demonstrated there are many factors which influence dissolved oxygen levels in the San Joaquin River near Stockton. It was not possible from the 1963 studies to identify the relative influence of every factor upon dissolved oxygen levels.

Gill net sampling in the San Joaquin River below Stockton consistently yielded salmon. This demonstrated that salmon were in the reach below the pollution block throughout the study period. The density of salmon in the area, however, was relatively low. Subsequent surveys of the salmon spawning grounds showed that salmon spawned in the Tuolumne and Stanislaus Rivers in 1963, although the spawning was about as poor as it was in 1962. Other evidence pointed to the poor spring flows, from 1959 on, in the San Joaquin as a possible cause of the serious decline in adult spawners some 3 and 4 years later (1961 and 1962). This may also have been partly responsible for the poor 1963 season.

Past studies show that oxygen levels as low as those found and flow reversals are detrimental to the migration of salmon. However, it is also clear that other factors, including low spring flows, are involved in the serious condition existing at the present time.

CONCLUSIONS

The 1963 studies showed that upstream water users and waste dischargers, large exports of water from the southern Delta, and waste discharges in the Stockton area contribute significantly to water quality problems in the lower San Joaquin River, Low dissolved oxygen conditions can be improved by proper remedial measures such as increased flows in the San Joaquin River, water distribution controls within the Delta, and reduction of waste discharges.

Poor water quality conditions are likely to occur in 1964 and future years unless positive measures are taken for their correction.

RECOMMENDATIONS

It is recommended a Resources Agency committee be established with membership from the Central Valley Regional Water Pollution Control Board, the Department of Fish and Game, and the Department *of* Water Resources,

The responsibility of this committee should be to outline plans for improving water quality and water flow conditions to the extent necessary to fully protect the salmon resources and other beneficial uses in the lower San Joaquin River area.

The committee should:

(1) Prepare by April 1, 1964 an emergency plan to permit safe passage of salmon during the 1964 fall run period.

(2) Outline a plan for studies required to pinpoint sources of pollution, and action necessary to upgrade water quality conditions in the lower San Joaquin River by July 1, 1966 to protect beneficial uses of water.

(3) Outline a plan for studies required to further define migration problems faced by salmon in the Delta in relation to water quality and water flows.

APPENDIX A

HYDRAULICS

General

Introduction

Hydraulic consideration for this report will be, confined to the Delta channels south of the Stockton Deep Water Channel during September, October, and November. It is in this area that pronounced changes have taken place in flow pattern and distribution which have become of concern to the Department of Fish and Game in relation to salmon migration.

History

Several physical changes have been made in the area during the past few years that could alter the flow pattern and distribution. However, it is difficult to attribute changes in the flows to any one of these physical changes. It can only be pointed out what these physical changes have been and then attempt to evaluate the effects of each.

Prior to 1950, the most noticeable change taking place in the system was the decreased inflow into the Delta caused by upstream development and control. This decrease in inflow coupled with increased diversions from Delta channels produced more tranquil flows and created a more stable environment. The flow pattern for southern Delta channels at this time is shown on Plate 1. During this period and continuing to the present time, work was being carried on to enlarge and improve some channels while others became less useful for carrying flows. This factor tended to affect the distribution of flow in several interior Delta channels, but did not materially change the natural flow pattern as shown on Plate 1.

In 1951, a major change occurred in the hydraulic environment when the Bureau of Reclamation began pumping operations at the Tracy pumping plant. Pumping was begun in June, and the normal flow patterns and distributions were affected during this first summer of operation. The result was a flow reversal in Old River north of Grant Line Canal, in Middle River north of Victoria Canal and in Victoria Canal. The influence of the export pumps also began drawing greater flows from the San Joaquin River into Old River. The resulting flow pattern is shown oh Plate 2.

In the period since 1951, increased pumping at the Tracy pumping plant coupled with low flows in the San Joaquin River have produced flow reversals in not only Middle and Old Rivers, but in the San Joaquin River as well. (See Plate 3), This reversal has occurred in the San Joaquin River nearly every year since 1958. A more comprehensive report on flow reversal magnitudes and locations is contained in the report, "The Effect of Flow Reversal on Salmon," by D, W. Kelley and D. Ganssle, August 1963. Data for this report was provided by the Department of Water Resources.

Old River Closure

Problem

Evidence of past flow reversals on the San Joaquin River and their undesirable effect on migrating salmon resulted in an investigation to determine if a reversal would occur in 1963. This investigation was started in August and was designed to predict the magnitude and duration of flow reversal.

Method of Solution

Data from previous years were gathered on Tracy pumping plant pumping rates, flow in the Sari Joaquin River at Vernalis, water use from channels between Vernalis and Old River head, water use between Old River head and Stockton.

Average monthly values of these parameters were determined for the months of July to December, for each year since 1958. The values were plotted and trends were established for each parameter (see Plates 4, 5, 6, 7), On the basis of these trends, values for each parameter were predicted for 1963. The average monthly flow in the San Joaquin River at Stockton was then predicted by the following method,

Flow in the San Joaquin River at Mossdale is the average flow at Vernalis less the diversions from Vernalis to Old River head. Plate 8 was then used to determine the amount of flow into Old River for the average Tracy pumping rate. The flow in the San Joaquin River at Stockton was then computed as Mossdale flow, less flow into Old River, less water diverted from the channel between Old River head and Stockton. These results provided the following values for predicted average monthly flows:

September	190 cfs
October	320 cfs
November	580 cfs

These results show that average monthly flows were predicted to remain positive.

Tidal flow measurements were made on September 18 and 19, 1963, in an attempt to. verify the results. These measurements showed that our predicted flows might be higher than actual flows. It was concluded that a borderline condition would exist as far as flow reversal is concerned.

Future Uses of the Method

Future predictions made using this method should not use 1963 trends in Vernalis flows or Tracy pumping, since the normal trends were upset by abnormal pumping and the Old River closure. The tidal flow measurement of September 18 and 19, 1963 indicated that changes in channel size and levee improvements may have altered the flow distribution at the head of Old River, This would indicate that the curve of Plate 8 should be revised. This would require a series of tidal flow measurements during different flow conditions and pumping rates.

Results of Old River Investigation

Based on the prediction of a borderline condition for flow reversal and the fact that a pollution problem existed in the San Joaquin River, the decision was made to institute remedial measures to correct these conditions. The Bureau of Reclamation agreed to pump extra water at the Tracy pumping plant for release into the upper San Joaquin, Releasing began in mid September and continued through October as shown on Plate 11, When this method of operation failed to correct the pollution problem, the decision was made to install a partial closure in Old River, This installation coupled with continued pumping by the Bureau of Reclamation provided the desired results. The relative effect of each method is shown on Plate 9, Flows on Plate 9 are not actual 1963 flows and only serve to illustrate the relative benefit of each corrective procedure. Actual flows in the San Joaquin River are shown on Plate 10. These flows are calculated and are based on rated Vernalis flows and the curve of Plate 8. Flows during the time the closure was in place are based on a tidal flow measurement taken October 14 and 15, 1963, which showed a division of flow at Old River head of 52 percent in San Joaquin, 48 percent in Old River.

Prior to the closure the tidal flow measurement of September 18 and 19, 1963, showed a division of 77 percent Old River, 23 percent San Joaquin River. The September measurement and the October measurement cannot be directly compared, however, since the pumping rates during the two measurements were materially different (October = 2,800 cfs, September = 1,900 cfs). Actual flows for 1963. were computed based on the October tidal flow measurement and Plate 8. The flow past Stockton with the closure contribution and Bureau pumping contribution is shown on Plate 12.

Conclusions

It appears from an evaluation of the tidal flow measurements before and during the closure and all other pertinent hydraulic data collected relative to this project that the combination of a partial Old River closure and Bureau of Reclamation pumping can be combined to provide significant increases in flow in the San Joaquin River at Stockton. As indicated on Plate 9, the relative effect of the closure alone or Bureau of Reclamation pumping alone produce nearly the same effect. A combination of the two, however, produce the increased effect that appears to be necessary to sufficiently correct flow reversal during the low natural flow periods of the San Joaquin River.

APPENDIX B

PARTIAL CLOSURE OF OLD RIVER

Placement of Barge in Old River

This discussion generally sets down the parameters which affected the physical installation of a barge in Old River and describes the actual placement of the barge.

Site Parameters

The closure was limited to the reach of Old River between its head at the San Joaquin arid a point upstream of the U. S. Army Corps of Engineers riprap work under "contract to Basalt Rock Company. This limited the site location to approximately 3 miles of waterway. Soundings and cross sections were subsequently taken at various sections in the 3-mile reach, and an optimum section was selected. Factors affecting the selection of the optimum section were: that the section be uniform; that the section fit generally the shape of the barge; that the section minimize the amount of rock necessary to be placed for "bed" protection and hence minimize costs; and that the section be accessible to heavy equipment and personnel. The section selected for the barge closure is located approximately 4,000 feet downstream from the mouth of Old River (consult Exhibit A). A cross section from tag line sounding is also shown on Exhibit A. Cross sections 50 feet upstream and 50 feet downstream of the section indicated relative uniformity in. channel section.

Hydraulic Parameters

The hydraulic parameters affecting installation of a barge in Old River are as follows:

(1) No tide reversal.

(2) Maximum natural stream velocities of 1.5 feet per second.

(3) Mean half tide (USC & GS) = 2.3 feet.

(4) Mean higher high water (USC & GS) = 3,2 feet.

(5) Estimated highest water (USC & GS) = 4.7 feet.

(6) Mean lower low water (USC & GS) = 1.4 feet.

(7) Top width cross section at mean half tide = 185 feet.

(8) Cross section shape trapizoidal.

(9) Mean cross section depth at mean half tide = 10 feet.

(10) Flow in San Joaquin River before installation was approximately 550 cfs.

(11) Flow in San Joaquin after barge installation was approximately 1,000 cfs.

(12) Flow split between Old River and the San Joaquin River prior to barge installation = 77 percent Old River, 23 percent San Joaquin River.

(13) Channel characteristics:

(a) Left bank levee - 18-inch riprap protection.

(b) Right bank levee - natural silty sand.

(c) Bottom of channel - natural silty sand.

(14) Estimated head loss due to barge closure = 1.5 feet.

With the above site and hydraulic parameters, design of closure utilizing a 130-foot long by 30-foot wide by 11-foot deep type BC army barge was begun. The barge was provided by the U. S, Army facility located in Oakland, at no cost to the Department of Fish and Game, with the provision that the barge would be returned in like condition as borrowed and that the interior spaces would be re-oiled if needed to protect them from rust,

Selection of Method

Two proposals were investigated as regards placement of the barge in the channel. Proposal A, placing the barge on a sloping wedge of rock (the purpose being to increase the coefficient of static friction) and Proposal B, placing the barge level in the section. Total weight of the barge was determined to be 180 tons, or 360,000 pounds. The following assumptions were used in computing the coefficient of friction (that is, the tangent of the friction angle equal to the sum of the horizontal forces divided by the sum of the normal forces).

(1) Upstream head = 13 feet.

(2) Downstream head = 11-1/2 feet,

(3) Head loss = 1-1/2 feet.

(4) Maximum velocities hitting side of barge = 3 feet per second.

(5) Barge could be completely filled with water.

(6) That a safe coefficient of friction would be equal to or less than 0.25 (i.e., at which no lateral movement of the sunken barge would occur).

It might be noted here that for design the maximum expected head differential was combined with the highest tide which in actuality is not the case. This was considered an additional factor of safety.

Investigation of the channel characteristics of Old River indicated that the right bank and channel bottom were basically silty sand. Therefore, to insure that excessive scour due to increased velocities and/or turbulent eddies be prevented, it was decided that a blanket of angular rock be placed on the channel bottom and side slopes. It was assumed that the barge would have no surcharge, that is, no deck load, and that all weight calculations would assume that any surcharge which could be" applied to the normal force, would come from water entrapped in the hull in a prism above upstream and downstream channel water levels.

In comparison of two proposals (A - placing the barge on a sloping blanket, and B - placing the barge on a horizontal blanket with the assumption that a 2-foot layer of rock would be laid on the bottom of the channel), it was found that proposal A required 328 yards of rock and would yield a coefficient of friction equal to 0,25 and that proposal B would require a volume of 310 yards of rock and would yield the same coefficient of friction. It was, however, felt that it would be harder to place the rock in the shape of a sloping wedge than it would be to place it level on the channel bottom. For the latter reason and because of the smaller required yardage, it was decided to place the barge in a horizontal attitude. To further increase the factor of safety of sliding, it was decided that a minimum surcharge sand load of 250 tons would be placed on the barge. In addition, because of physical installation requirements and for additional safety, an anchor would restrict the barge on one end, and cables tied to a shore-located pier would restrict the barge on the other end. It was felt that the anchor and shore cable were necessary only on the upstream side of the barge, inasmuch as there was "no flow reversal.

Outside Contracts

Pre-installation planning indicated that $5,000 worth of riprap-type rock (i.e., angular rock) would suffice for the bed lining and side slope protection blankets. It was further estimated that $4,000 contracted for the purpose of loading the sand surcharge, round-trip towing of the barge to the site, and other contingencies regarding barge installation and removal would be required. An additional $1,000 was anticipated necessary for purchase of materials, such as plywood, to protect the barge hull, half-inch wire cable for anchoring the barge, gasoline for operating pumps, rental of pumps for filling the barge bulkheads, and oil for the reapplication of the oil protection code. Total outside contract and materials costs for installation and removal were estimated at $10,000,

Three bids were solicited for the rock blanket installation. Bids were obtained from:

(1) Fisher Brothers, Inc.
P. 0, Box 478
Rid Vista, California

(2) Dutra Dredging Company
219 Montezuma Street
Rio Vista, California

(3) Basalt Rock Company, Inc.
P. 0. Box 540
Napa, California

Basalt Rock Company, Inc., was the low bidder with a price of $4.90 per ton (rock in place). A contract was subsequently drawn up for the purchase of 1,020 tons of rock fill.

As extreme versatility was believed necessary in the final positioning of the barge at right angles to the stream and since a tug type boat was necessary for this portion of the work, it was decided that the only boat suitable was a modified LCM (350 horsepower) owned by Ed Dutra of Dutra Dredging Company, 219 Montezuma Street, Rio Vista, California. As it would be uneconomical, as well as provide redundancy in having the project engineer consult with a multitude of contractors, it was also decided that Dutra would tow the Army barge from the Oakland Army Terminal to the site, return it to same and perform necessary clam-shell work as in surcharging the barge with 250 tons of sand.

Pumps were obtained from the Department of Water Resources, Chris Lauritzen of Antioch, and Nomellini Tool Rental of Stockton, California. A total pumping capacity of 2,000 gallons per minute was available with this battery of pumps,

Pre-installation planning indicated that the job could be performed and completed in about three days, providing efficient preparation was undertaken ahead of time.

Chronology of Barge Installation

On Monday, October 7, a three-man crew arrived at the Old River site and installed the necessary piers for anchoring the barge and cleared bank areas for the work which was to ensue. Piers were set as shown in Exhibit B. The piers consisted of 15-foot long telephone poles (8 to 10 inches in diameter at the base) placed 10 feet deep into silty sand soil. As there was some doubt as to the ability of one pier placed in this type of soil in sustaining the load, three piers in a line were installed as shown in Inset 1 on Exhibit B, and laced together in such a way that strength was developed in all three piers. Two separate lines, 1/2-inch 9 by 16 steel core wire rope were used in anchoring the bow of the barge to these piers.

Plans called for the sand barge to be tied upstream of the closure section during preparation of the blanket area. The barge would then be moved downstream and pivoted about the half-inch cables until a 7/8-inch anchor line secured to a 2,500 pound soft bottom anchor became "set", thus holding the barge in a cross-channel attitude. In addition, the LCM would be pushing from the downstream side of the barge helping to maintain this position. It was planned that clearance between the bottom of the barge and the top of the rock bed would be no more than one foot and that with the battery of pumps at hand, the bow of the barge would be setting on the bottom in a matter of 40 minutes. It was during this critical 40-minute period that anchor ropes, 1/2-inch cables and LCM would have to maintain the position of the barge against the currents in Old River. As there is no tide reversal in Old River, and hence no slack tide, the best time to perform this work was when velocities were minimum. In Old River this occurs at the same time that the peaks of the high tides occur. Since high high tide did not occur at a convenient time, the installation was scheduled to proceed at low high tide,

At 1400 hours Monday, Chris Lauritzen left Oakland with the BC type barge and 20 hours later arrived at the Old River site. Basalt Rock Company, under the direction of Floyd Nicolson, moved their crane and barge into location Monday evening. At approximately 1000 hours Tuesday morning, they began placing rock on the natural slope of the right bank. Shortly thereafter the LCM arrived with the Army barge. It was tied upstream and the LCM then proceeded back to Rio Vista to pick up a 30 by 50-foot barge. It subsequently proceeded to Antioch where a 22B Bucyress Erie Crane was loaded onto this barge. A 4-inch Department of Water Resources pump and a 4-inch pump belonging to Chris Lauritzen were also loaded at this time. At approximately noon on Wednesday, the LCM arrived back at the Old River site and the sand surcharge operations were begun. Basalt operations were continued through all of Tuesday and started again at 0700 on Wednesday, concluding at dusk Wednesday night.

Original plans called for charging the barge with 250 tons of sand and then filling all tanks until 1 foot of clearance could be obtained between the bottom of the barge hull and the top of the rock pad. When this was attempted, it was found that the barge was not designed for flooding the tanks. It, in fact, has no fore and aft bulkheads (that is, longitude bulkheads), and it was discovered that as little as 4 inches of water in the holds, combined with any undistributed load in excess of 10 tons on the deck, would "list" the barge drastically to port or starboard. Therefore, all tanks were subsequently pumped dry or as dry as possible. It cannot be stressed too strongly that in future installations of this kind in Old River, that sand barges, or like type barge which have no fore and aft bulkheads must be surcharged with all tanks completely dry in order to insure that capsizing of the barge will not occur. Since a normal load could not be obtained by charging the tanks of the barge with water, it was necessary to surcharge the surface of the barge with an additional amount of sand so that the 1-foot clearance requirement could be met. It was felt that anything greater than 1-foot clearance between the bottom of the barge and the top of the rock pad would result in increasing the critical period of time when the barge must hover over the pad with nothing more to hold it against the streamflow but anchor cable, 1/2-inch wire ropes, and LCM. It was further decided that with 1-foot clearance and two anchor points that water charging of the barge tanks would be accomplished without undue danger of capsizing.

On Thursday morning the crane was again utilized in surcharging the barge until a 6-1/2 foot draft was obtained. The surcharge load was relatively uniformly distributed. Anchors were then "set" and cable marked at the proper length. It was first thought that 500-pound anchors could be used to anchor the barge, but these were found to drag so a 2,500-pound anchor was rented from Basalt for the job. Flow velocities in mid-channel were recorded on Wednesday and it was found that minimum velocities would occur on Thursday at 1630 hours, It was decided that at 1430 hours the barge would be slid back into position and that pivoting into the final resting place would begin at approximately 1530 hours. It was estimated that enough water could be pumped into the hull of the barge so that the bow would be resting on the bottom by no later than 1630 hours. Pumping would begin from the right bank and proceed to the left bank. Mid-channel velocity during the installation time would be approximately 9/10 foot per second.

On schedule at 1430 hours, the barge was moved parallel to the streamflow back into a position where it was ready to be pivoted into its cross-channel attitude. At this time the barge again took a bad list. This was due entirely to no more than 4 inches of water left in the holds; this water had not been pumped out because the suction inlets of the 4-inch pumps were not submerged at this depth. The Bucyress crane was brought alongside the sand barge and the surcharge was changed to level the barge. The barge-mounted crane was then moved downstream of the section by the LCM. The LCM returned to the site and pushed on the barge near the stern (the bow was to be faced into the right bank). At 1545 hours howser lines holding the barge parallel to the streamflow were cut and the upstream end of the barge was allowed to drift out into the channel, catching the current and hence pivoting about the 1/2-inch wire ropes into position. The half-inch wire ropes were of a predetermined length such that the pivot point was so located that the upstream edge of the barge came to rest on the upstream edge of the rock pad. As the barge reached its horizontal attitude, the 7/8-inch anchor rope connected to the 2,500 pound soft mud anchor came taunt and the barge held. All pumps were immediately started and water was pumped into the tank nearest the right bank, the plan being to lower one end of the barge first and then proceed to the next tank, thence the next, and the next, until the entire barge had reached the bottom. Pumping enough water for the hull of the barge to reach the bottom would take 40 minutes. Subsequent pumping of water to fill all the tanks of the barge to the ultimate capacity would take between 6 and 7 hours. At approximately 1700 hours, it was estimated that the barge hull hit bottom. Pumping proceeded at a fast rate and at about 2200 hours all tanks were full and anchor lines slack. Observation of flow patterns around the ends of the barge indicated that more than enough riprap had been laid down to protect the natural banks against scour. It was also evident that water was going underneath the barge as boils were evident on the downstream side of the barge. No sand material, however, was evident in these boils.

Results

The final attitude of the barge was such that the Stewart Tract end of the barge was lower than the bow located on the Roberts Island site. The slope was approximately 1-1/2 feet per hundred; this was basically due to irregularities in the bed. This slope was predicted prior to the barge installation by inspection of the rock, blanket profiles. Observations of flow through the large gap on the left bank side which was about 30 feet wide, indicated that the head loss approached 1-1/2 feet. The velocities exceeded 10 feet per second at low water, yet soundings showed that the rock layer in this opening was maintaining its original position. Soundings along the side of the barge on the rock blanket and cross-sections along the side of the barge through boil areas indicated that no change in the rock bottom was evident. Soundings upstream of the barge and downstream of the barge outside of the rock blanket area also indicated that no channel digging or scouring was occurring. To date all checks and investigations indicate that the barge closure is a feasible method of reducing the flow in Old River; however, certain safeguards, such as warning to mariners, etc., must be adopted due to the very high velocities experienced in the 30-foot gap which is left open for the use of the boating public.

Proposed Alternatives to the Use of a Barge For Closure of Old River

Upon notice that a closure was to be designed to block Old River, work was initiated to determine the type of structure to be built and the efficiency to be expected from the structure. The Hydraulic Unit of the Delta Studies Section supplied the necessary data concerning the maximum differential head that could be expected across the proposed structure, and the size of opening which would be used and still obtain an effective closure. These initial computations were done on the basis of a closure at the head of Old River approximately 200 feet downstream from the left bank of the San Joaquin River.

Three alternative types of structure were proposed: (1) sand fill, (2) metal construction cubes, and (3) stone fill or combination of stone and submerged barge,

Sand Fill

For the placement of the sand fill, the reach of Old River in question was investigated for available borrow sites. As no available borrow sites were found, it was then necessary to remove borrow from the channel bottom. The local dredging companies in the Delta that were contacted were Dutra Dredging Company, Olympian Dredging Company, and Utah Construction Company. It was found that the above companies had prior commitments and for the most part could not easily change their schedule, Mr. Cantrella of Dutra Dredging Company, Rio Vista, visited the site of the proposed closure with a staff member and suggested that if sand fill was to be used, that possibly they (Dutra) could do the job between Army contracts on Bear Creek. He also suggested that in lieu of a sand fill, *a* simple solution to the problem would be to construct a stone fill using the Basalt Rock Company as a contractor. The computations for sand fill volumes amounted to approximately 10,000 cubic yards. These volumes were computed on the basis of a 16-foot high fill with a 10-foot top width and 5 on 1 side slopes. The opening in the sand fill would have a 10-foot bottom width with its invert at elevation -3 feet USGS datum. Mean low low water and flood plain in this area are 1.0 feet and 20,2 feet respectively, USGS datum. The opening would be rocked with 1-1/2 feet of quarry rock overlaying 6 inches of filter blanket. The total cost of installing this closure was estimated to be approximately $10,000. This cost would include construction of the sand fill, importing filter blanket and quarry rock, construction of an access ramp on the right bank of Old River, and move-in and out costs of the dredge. As the Reclamation Board would require the removal of this fill and the material replaced to its original position, the above costs would be considered to be duplicate for the removal or a total cost of $20,000 for the installation and removal of the closure.

Metal Construction Cubes

Another possibility for construction of a closure was the use of 7-foot by 7-foot prefabricated metal cubes which were used during war time by the Army Engineers and the Navy Construction Battalion. It was thought that a closure could be made by assembling and filling with water approximately 170 of these cubes. Upon inquiry of the Army Transportation Corps, Rio Vista, and Sharpe's Army Depot at Stockton, only seven of these cubes could be located.

As a result of this lack of material, the plan was discarded.

Stone Fill

A bid price of $4.90 per ton was obtained from Mr. E. F. Bravelli of Basalt Rock Company for placement of a stone fill at the site in Old River. This construction could be accomplished during a slack period in their Army Corps of Engineers' contract for revetment of the left bank levee of Old River, approximately two miles downstream from the San Joaquin River. The $4.90 price would place the rock in the fill and give ownership of the rock to the State, The 16-foot high fill would require approximately 2,870 tons of stone assuming 1.3 on one side slope and allowing for 10-percent spillage.and settlement or a cost of approximately $14,000. The above price would include a small boat navigation opening with a bottom width of 10 feet and side slopes of 1.5 on 1,

A problem was encountered in disposing of the rock material after the usefullness of the fill was ended. Two storage sites on the San Joaquin River were investigated, both downstream of the head of Old River and were found to be priced out of suitability for stockpiling purposes. The cost of removal of the stone fill and placement in a stockpile would be approximately $2 per ton of material recovered---assuming that approximately 77 percent of the fill placed would be recovered.

Necessary Permits for the Old River Closure

Reclamation Board Permit

Application was made to the Reclamation Board for the closure at the head of Old River. The application blanks were filed with an application for each of the two reclamation districts involved, Reclamation District 544 and Reclamation District 2062, Mr. Julius Muhs, President of Reclamation District 544, was contacted by Glenn Twitchell of the Department of Water Resources and Tim Farley of the Department of Fish and Game. A meeting was set up for review of the application at the office of John A. Wilson, attorney for the reclamation district. As a result of this meeting, the application was endorsed by this district. It was found that their concern involved any legal liability for damages as a result of this endorsement.

Mr. Douglas Cohen of Reclamation District 2062 was contacted for endorsement of the application by Glenn Twitchell of the Department of Water Resources and Don Kelley of the Department of Fish and Game. Mr, H. N. Kuechler, president of the reclamation district, was on vacation in Europe at the time, Mr. Cohen took the application under advisement and consulted with the attorney and available district trustees. There was some question as to the ownership of the Old River channel bottom.

The Reclamation Board, at its meeting in Firebaugh on October 3, 1963, approved the application subject to obtaining Mr. Cohen's endorsement.

Navigation Permit

Mr. Coleman, Corps of Engineers, Sacramento District, was contacted concerning the navigation requirements for the closure. He supplied the Department of Water Resources representatives with the proper manuals and advised them as to the proper completion of the permit. There was a question of the required warning signs on either side of the closure. After a telephone conversation with Mr. Oliver de Graf, U. S. Coast Guard, Aids to Navigation Section, San Francisco, it was decided that a warning sign up and downstream of the structure, staff gages on either side of the opening, and flasher lites (four minimum) would be sufficient to properly mark the closure.

Under ordinary navigation permit procedure, a 30-day advertising period is allowed* Under the conditions for which this particular permit was obtained, the Department of Army mailed notices to concerned parties in lieu of standard public notice. We thereby obtained the navigation permit in about two weeks.

The warning signs were obtained from Dosch Company, 1704 Kathleen Avenue, North Sacramento.

State Lands Permit

As Old River in this area lies within the boundaries of the El Pescadero land grant, the State Lands Division has never laid claim to the ownership of the channel bottom. The levees on either side of the Old River channel are within the Sacramento-San Joaquin Flood Control Project. The Reclamation Board's right-of-way staff has the metes and bounds description of the adjacent ownerships. Upon investigation of these descriptions, it was learned that the ownership boundary along the right bank of Old River, Mary Mohr Brown, was at the right bank high water line. The left bank property line was not as well defined. It is the opinion of the Reclamation Board staff that the ownership line is at the left bank high water line but could not be positively proved without survey, as the property description has no mention of the San Joaquin River or Old River channels.

Mr. Bob Nady of the Division of State Lands in Sacramento, and Mr. H. E. Pahner of the Los Angeles office, Division of State Lands, were contacted for advice on this problem. Formal application was made to State Lands Commission for this closure even though it was to be constructed outside their jurisdiction.

APPENDIX C

WATER QUALITY EVALUATION
STOCKTON AREA STUDY
SEPTEMBER- arid OCTOBER 1963

Introduction

The principal objective of the water quality field survey was to describe an oxygen deficient body of water in the San Joaquin River near Stockton and the effects of increased flows past the City of Stockton on dissolved oxygen concentrations.

Observations were made during eight field surveys from September 11 through October 31, 1963.

Problem Description

It has been apparent that a problem of low dissolved oxygen (DO) concentrations has existed in the San Joaquin River near Stockton during the late summer months, of various years, since 1935.

Factors Influencing Dissolved Oxygen

Factors contributing to the low dissolved oxygen values observed in the area of investigation are the quantities of flow, waste discharges, temperature, sunlight, nature and extent of bio community, mineral concentrations, water transparency, channel characteristics and benthal deposits.

Location and Magnitude of DO Sag

Dissolved oxygen observations were made throughout the area of investigation from a point about five miles upstream from the San Joaquin River's confluence with the Stockton harbor to a point approximately eight miles downstream from the City of Stockton.

During the survey, DO levels at the upper most station above Stockton varied between 10.3 and 5.2 parts per million (ppm.). Values of DO less than 3.0 ppm, were observed throughout 5.3 miles of the river in the vicinity of Stockton during the most adverse oxygen condition when the absolute minimum values observed were 0.4 ppm. At this same station the lowest 24-hour average of 0,9 ppm. was obtained. The lowest point of the DO sag was observed in the deep water channel below the confluence of the San Joaquin River. From observation of the conditions in the Stockton harbor, a minimum DO of 0.1 ppm. was obtained. Minimum 24-hour average DO was 1.2 ppm.

Oxygen Relationships

Throughout the period of observation practically every factor affecting oxygen concentrations varied to some extent. Those factors previously mentioned as influencing oxygen levels caused considerable variation in DO between study periods and throughout the area of investigation. As an example during study 3, September 25-26, cloud cover was absent and due to clear skys, sunlight caused extreme biological productivity. In contrast weather conditions during study 2, September 18-20, were such that very little sunlight was provided for phyto-plankton activity.

Although these variations in factors influencing oxygen concentrations occurred, it is felt that the quantity of flow was the dominant influence above a flow of 1,400 cubic feet per second (cfs.). It was found that other strong influences on DO overshadowed any positive benefits of flows in low ranges (up to 500 cfs.). Table 1 presents data collected in the upper reach of the San Joaquin River above the confluence of the San Joaquin River with the deep water channel.

Table 1
Dissolved Oxygen Relationships

Study	Date	Dissolved Station I	Oxygen Station 7	ppm Loss	BOD discharged lb/day	River Flow, cfs
1	9/11-12	8.7	4.9	3.6	3600	175
2	9/18-20	5.6	2.8	2.8	4700	390
3	9/25-26	8.0	6.9	1.1	3500	485
4	10/2-3	6.2	3.3	2.9	2900	250
5	10/9-10	8.4	6.8	1.6	1900	530
6	10/16-17	6.9	6.6	0.3	2600	1720
7	10/23-24	7.8	7.7	0.1	1000	1980
8	10/30-31	8.2	7.9	0.3	700	1500

Due to the nature of this study, i.e., determine conditions of water quality affecting fish migration in the San Joaquin River, only partial DO data were collected from harbor waters. Sufficient data were obtained, however, to show that:

(A) Dissolved oxygen varied significantly within the harbor area,

(B) This large body of oxygen deficient water causes a reduction in DO in waters near the confluence of the San Joaquin River.

Data show that the location of the DO sag was displaced more than four miles downstream when flows increased from 530 cfs. to 1655 cfs. Environmental conditions changed significantly in the San Joaquin River at Turner Cut. The body of oxygen deficit water seemed to break up when approaching areas influenced by flow from the Sacramento River,

Summary and Recommendations

It was observed that during the study period while flows are low, the DO's are highly variable but at high flow rates, DO's were good. This, in part, can be explained by re-emphasizing the fact that such influencing factors as temperature, algal populations, nutrient concentrations, BOD waste loadings, weather conditions, and recreation factors were also changing; sometimes to aid the oxygen resources of the receiving water, sometimes to deplete them.

Due to the lack of observed data at flows between 600 and 1,400 cfs., it is problematical at what flow a healthy fishery (oxygen) environment could be maintained. A number of factors must be considered when one estimates required flows of dilution water. First, a higher initial flow is probably required if an oxygen deficit exists before more dilution is added; second, initial oxygen concentrations in the dilution water change, thereby changing the allowable DO drop; third, a minimum level of DO must be established as the lowest allowed and this level adhered to. These three facets of characterizing oxygen relationships should be foremost in one's mind when computing the amount of river flow necessary to maintain a specific DO concentration.

From observations made during this study, it can be stated that if conditions exist next year similar to those found this year, from September 11 through October 31, a flow of at least 1,400 cfs. past Stockton could possibly maintain DO concentrations at a level sufficient for salmon migration.

CROSS SECTION – OLD RIVER CLOSURE

THE RESOURCES AGENCY OP CALIFORNIA

DEPARTMENT OF WATER RESOURCES

SCALE:
HORIZONTAL : 1" = 30'
VERTICAL : 1" = 10'

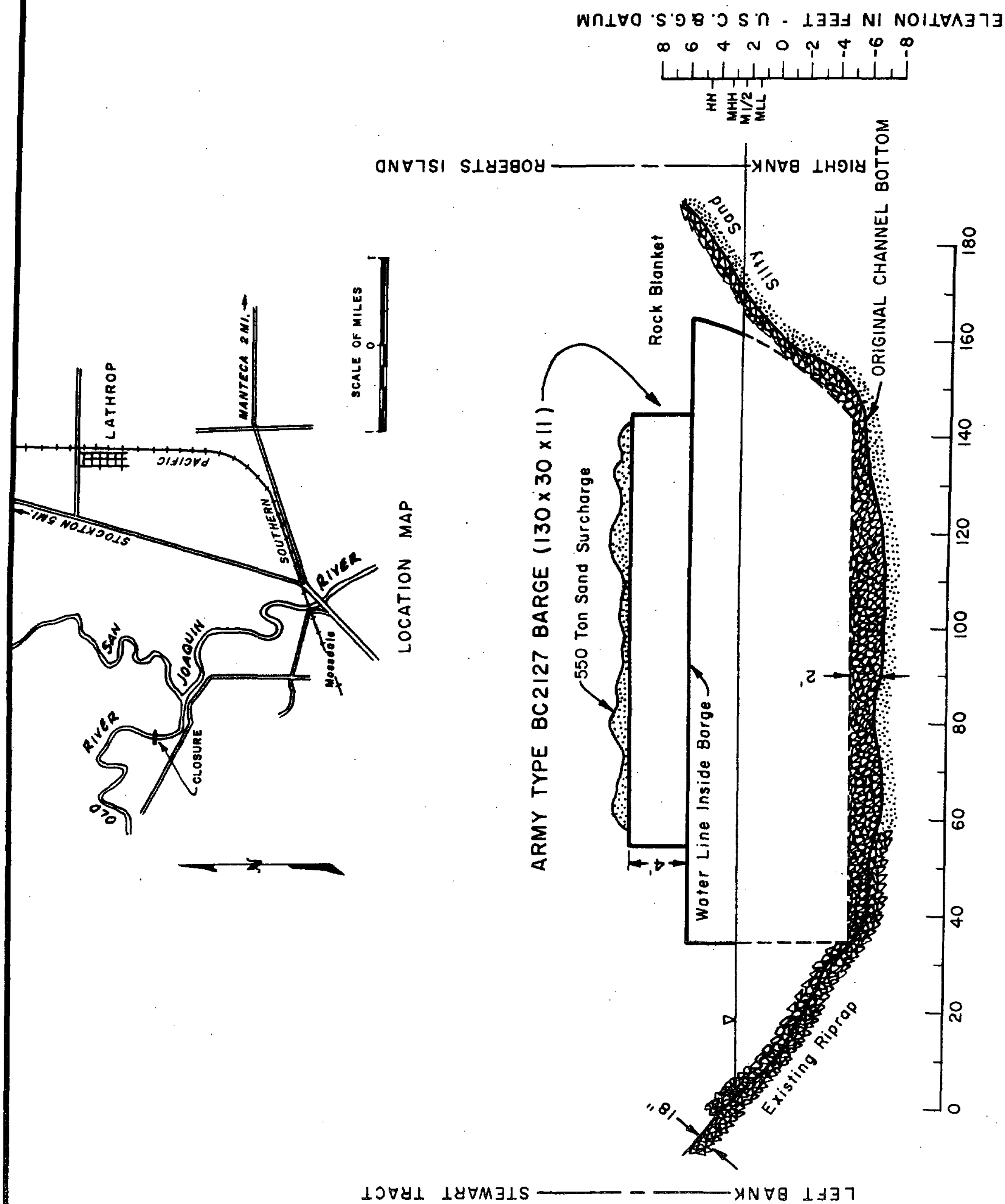
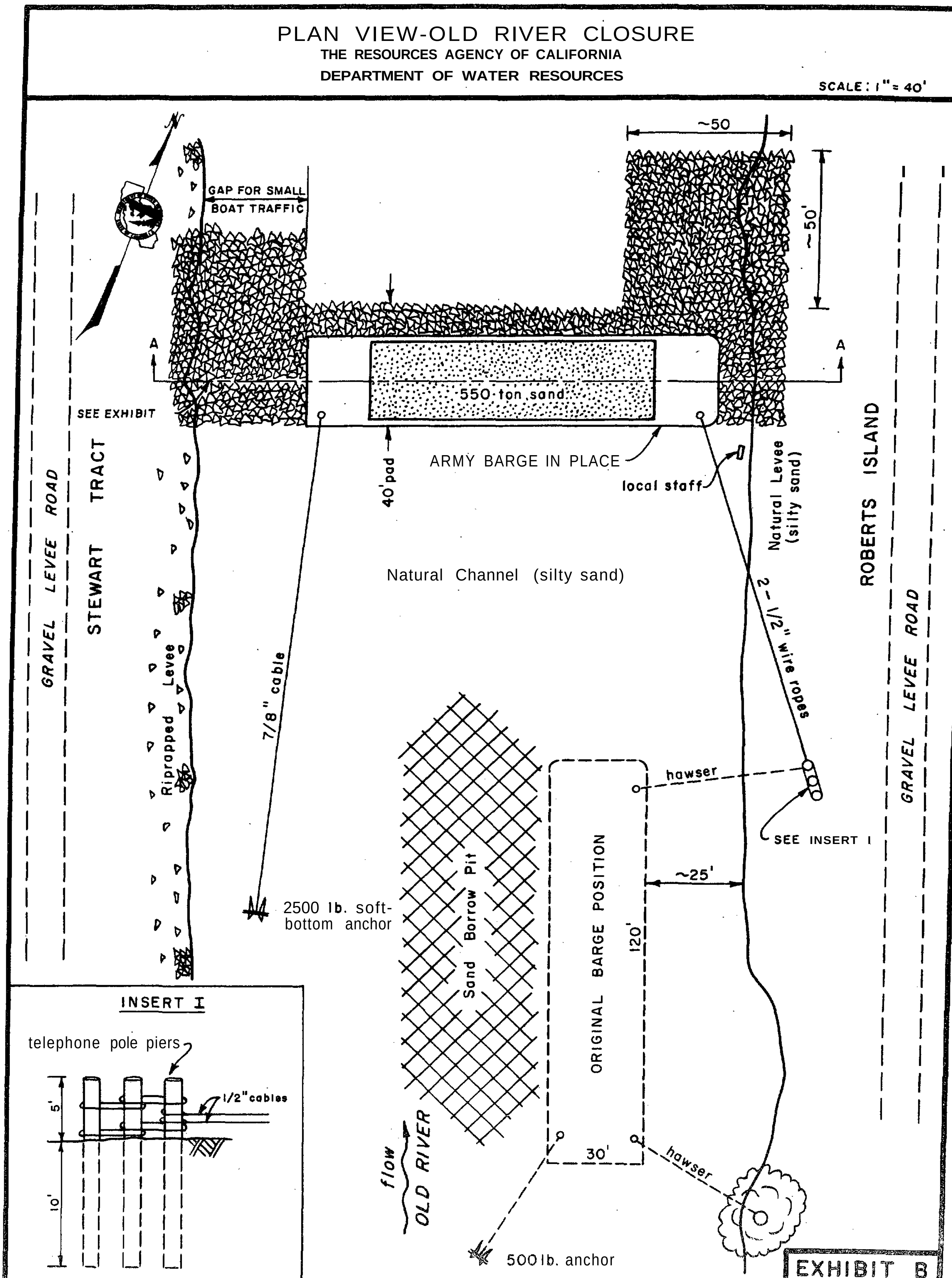
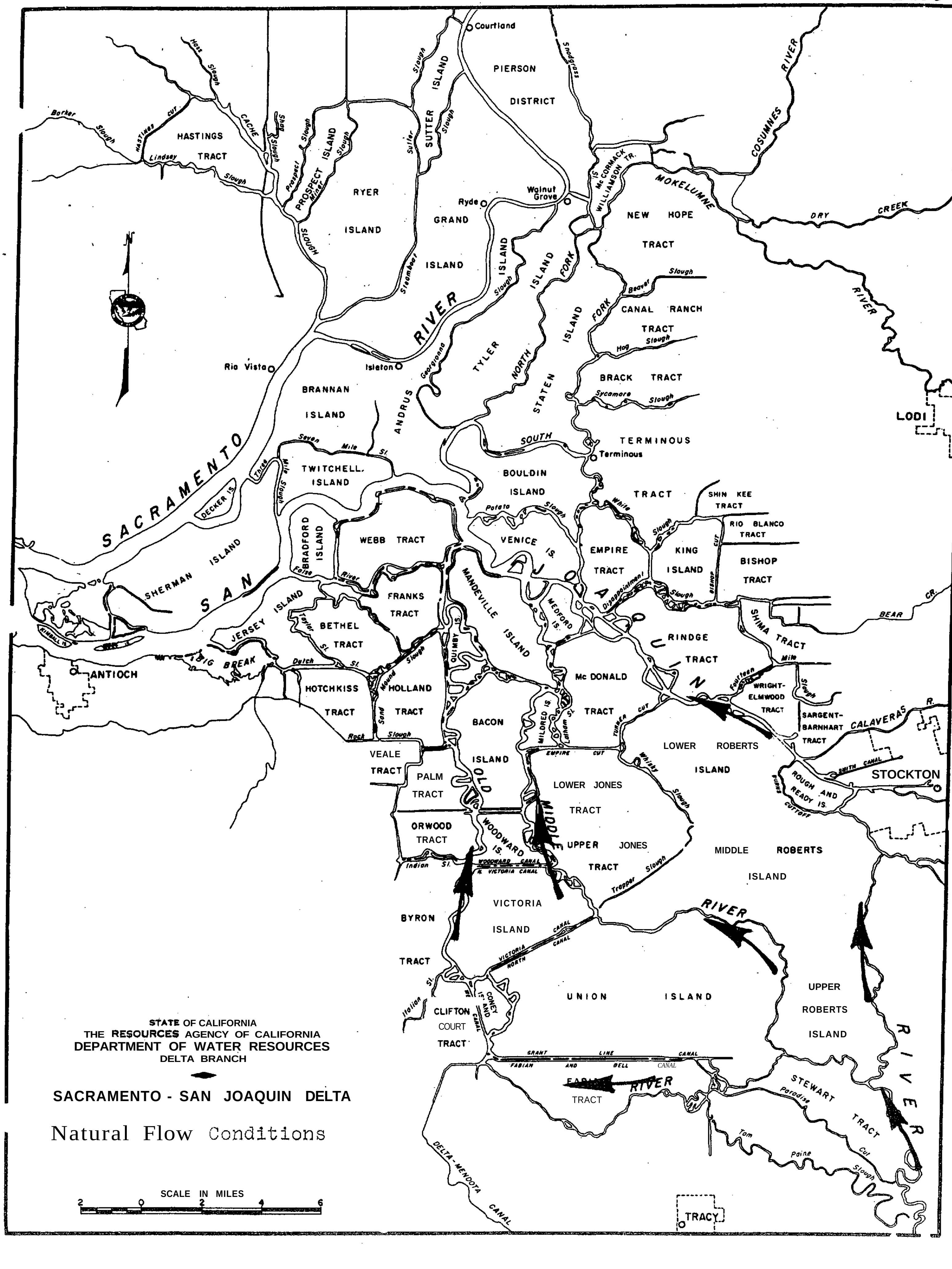


EXHIBIT A


PLAN VIEW-OLD RIVER CLOSURE
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SCALE: 1" = 40'
~50
~50'
GAP FOR SMALL BOAT TRAFFIC
A
A
550 ton sand
SEE EXHIBIT
ARMY BARGE IN PLACE
40' pad
local staff
Natural Levee (silty sand)
GRAVEL LEVEE ROAD
STEWART TRACT
ROBERTS ISLAND
GRAVEL LEVEE ROAD
Natural Channel (silty sand)
Riprapped Levee
7/8" cable
2 - 1/2" wire ropes
hawser
SEE INSERT I
Sand Borrow Pit
ORIGINAL BARGE POSITION
120'
~25'
2500 lb. soft-bottom anchor
INSERT I
telephone pole piers
1/2" cables
5'
10'
flow
OLD RIVER
30'
hawser
500 lb. anchor
EXHIBIT B

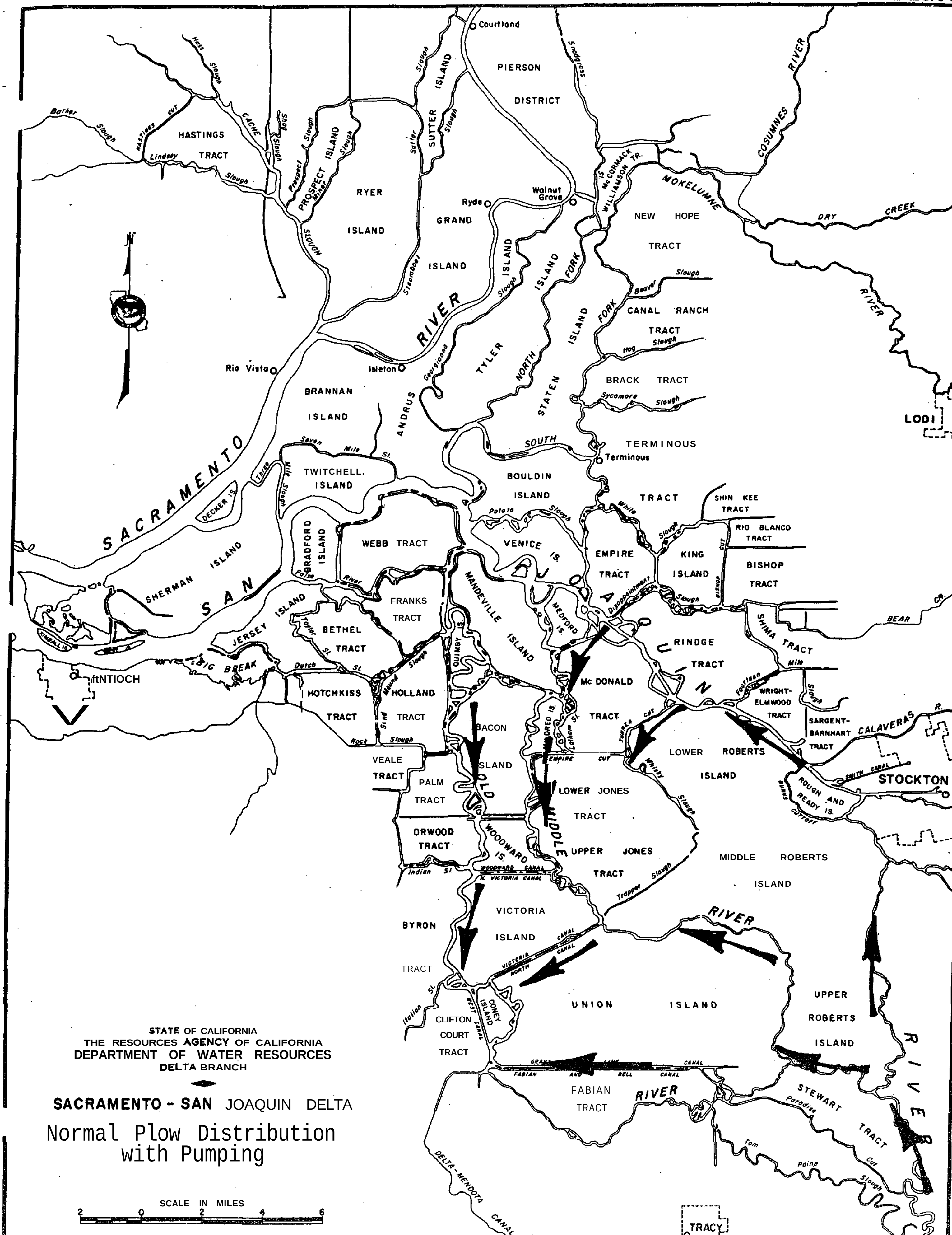


STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

SACRAMENTO - SAN JOAQUIN DELTA

Natural Flow Conditions

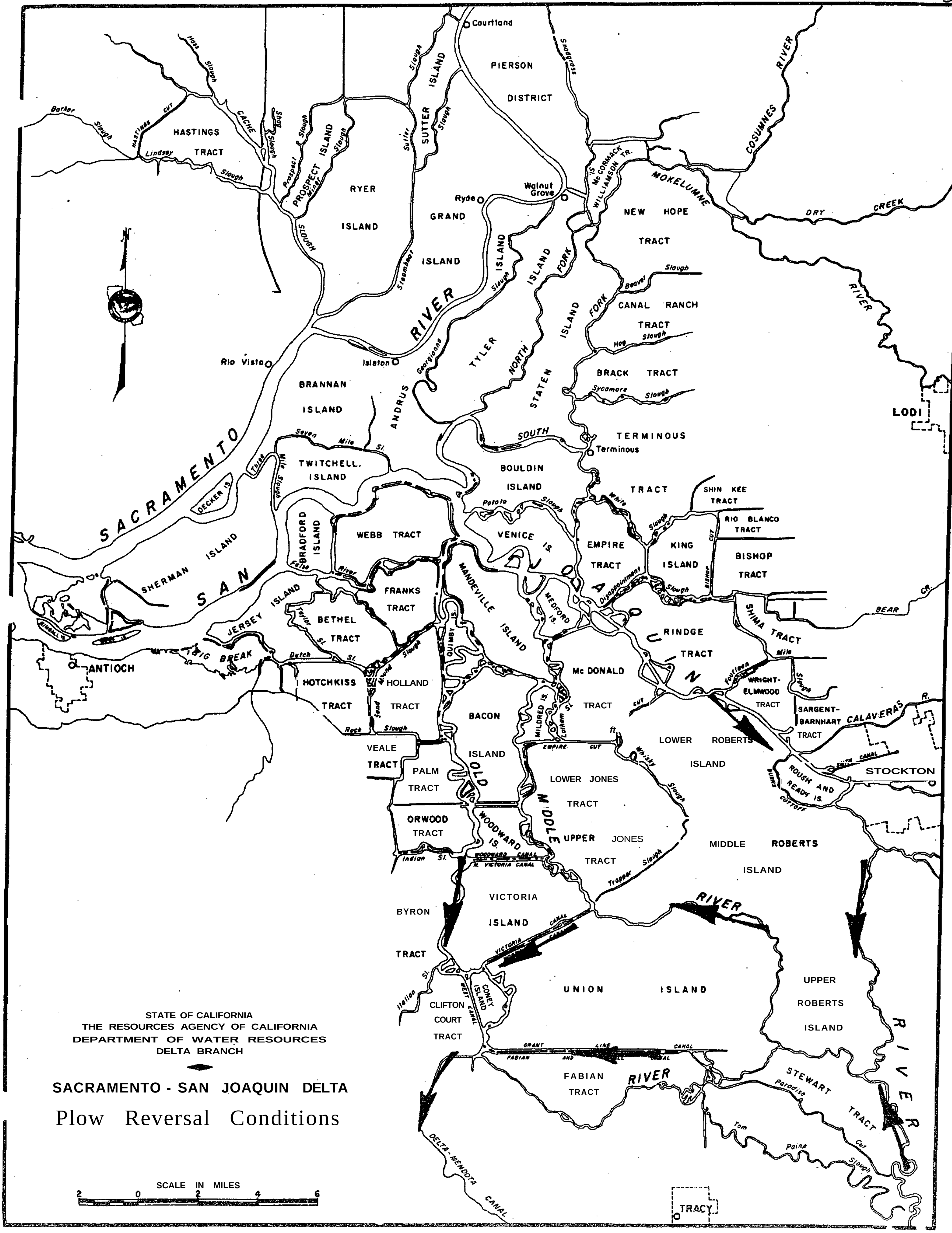
SCALE IN MILES
2 0 2 4 6



STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

SACRAMENTO - SAN JOAQUIN DELTA

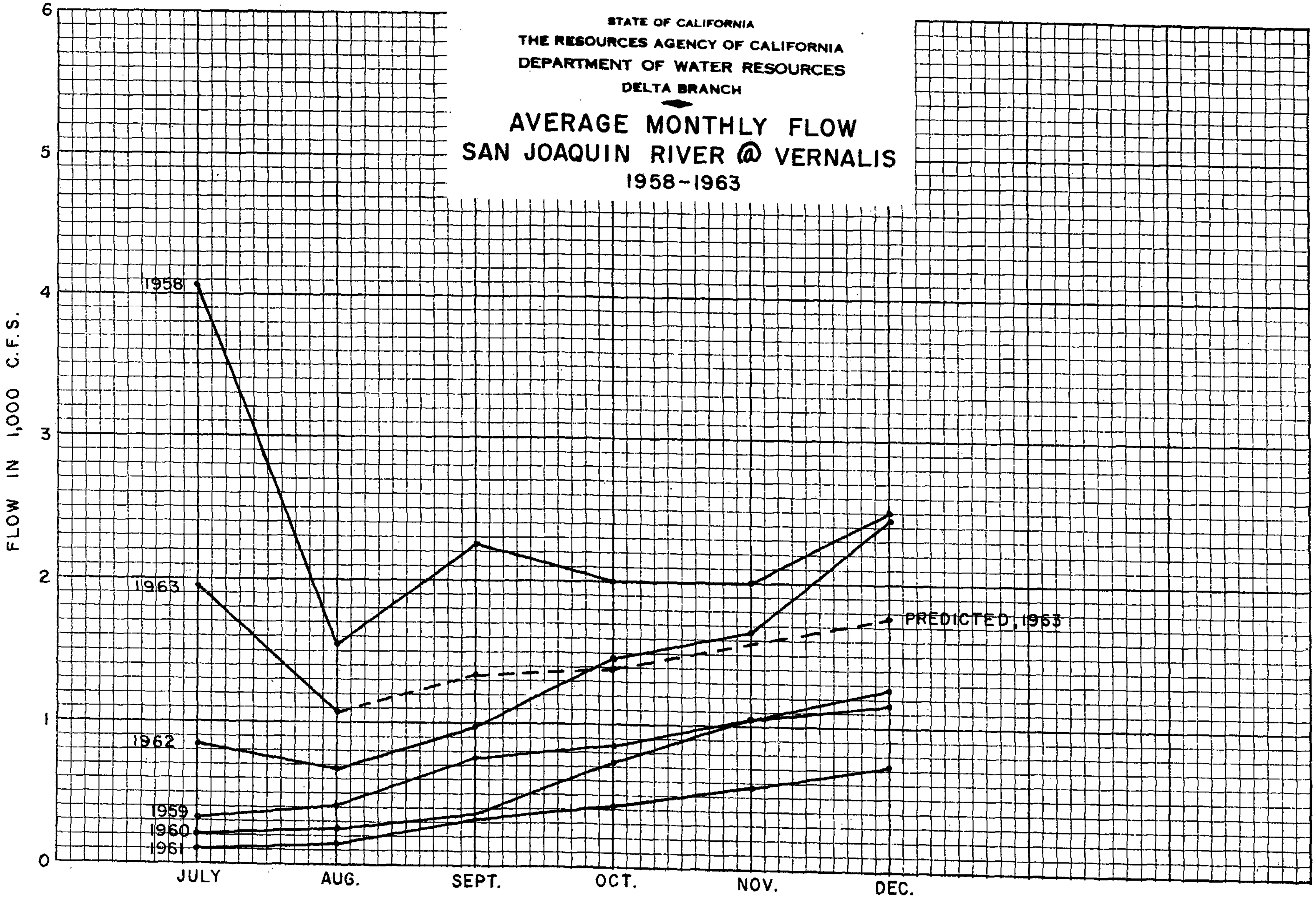
Normal Plow Distribution
with Pumping



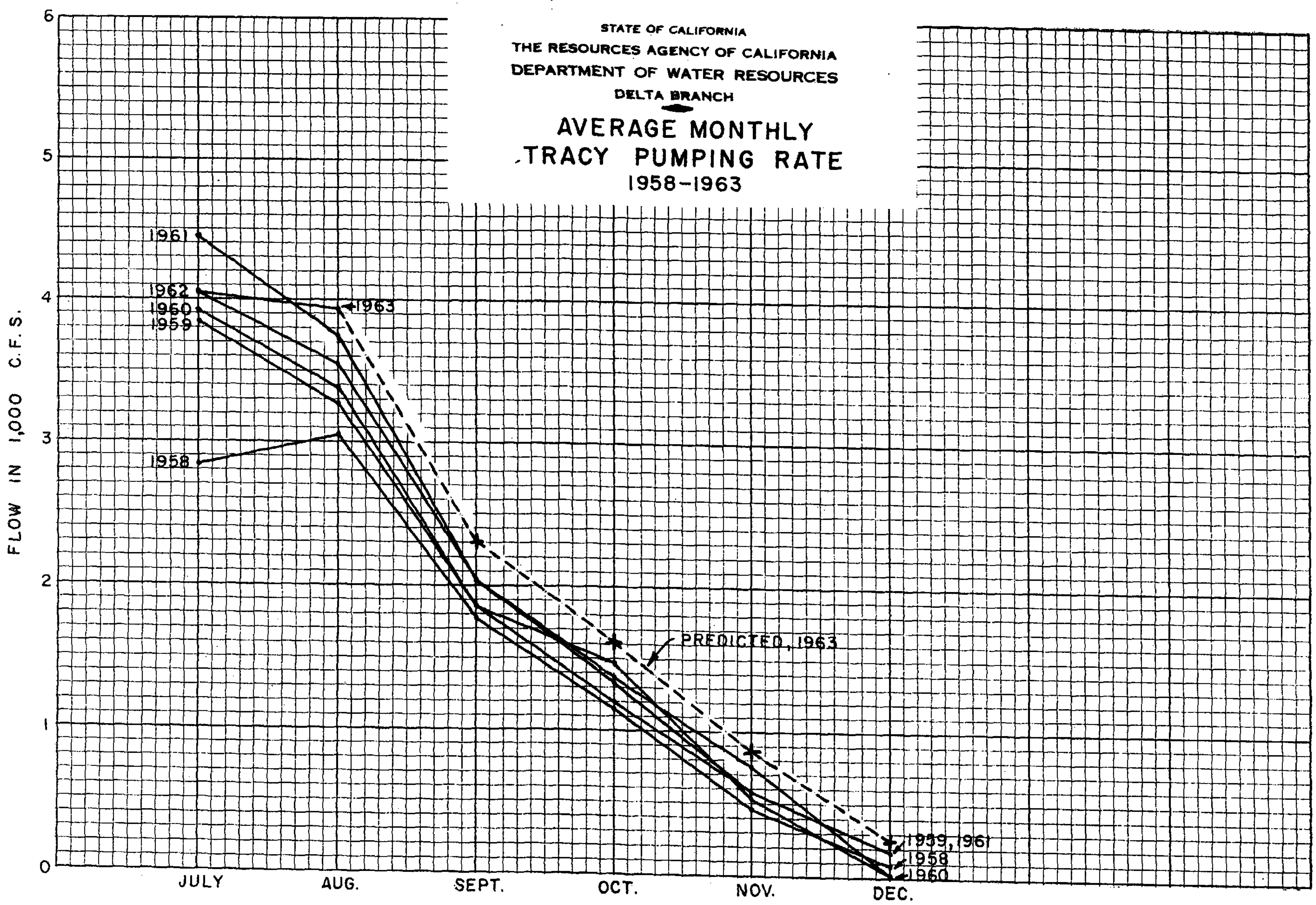
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

SACRAMENTO - SAN JOAQUIN DELTA

Plow Reversal Conditions


STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
AVERAGE MONTHLY FLOW
SAN JOAQUIN RIVER @ VERNALIS
1958-1963
FLOW IN 1,000 C.F.S.
0
1
2
3
4
5
6
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
1958
1963
1962
1959
1960
1961
PREDICTED, 1963

DEO 1963

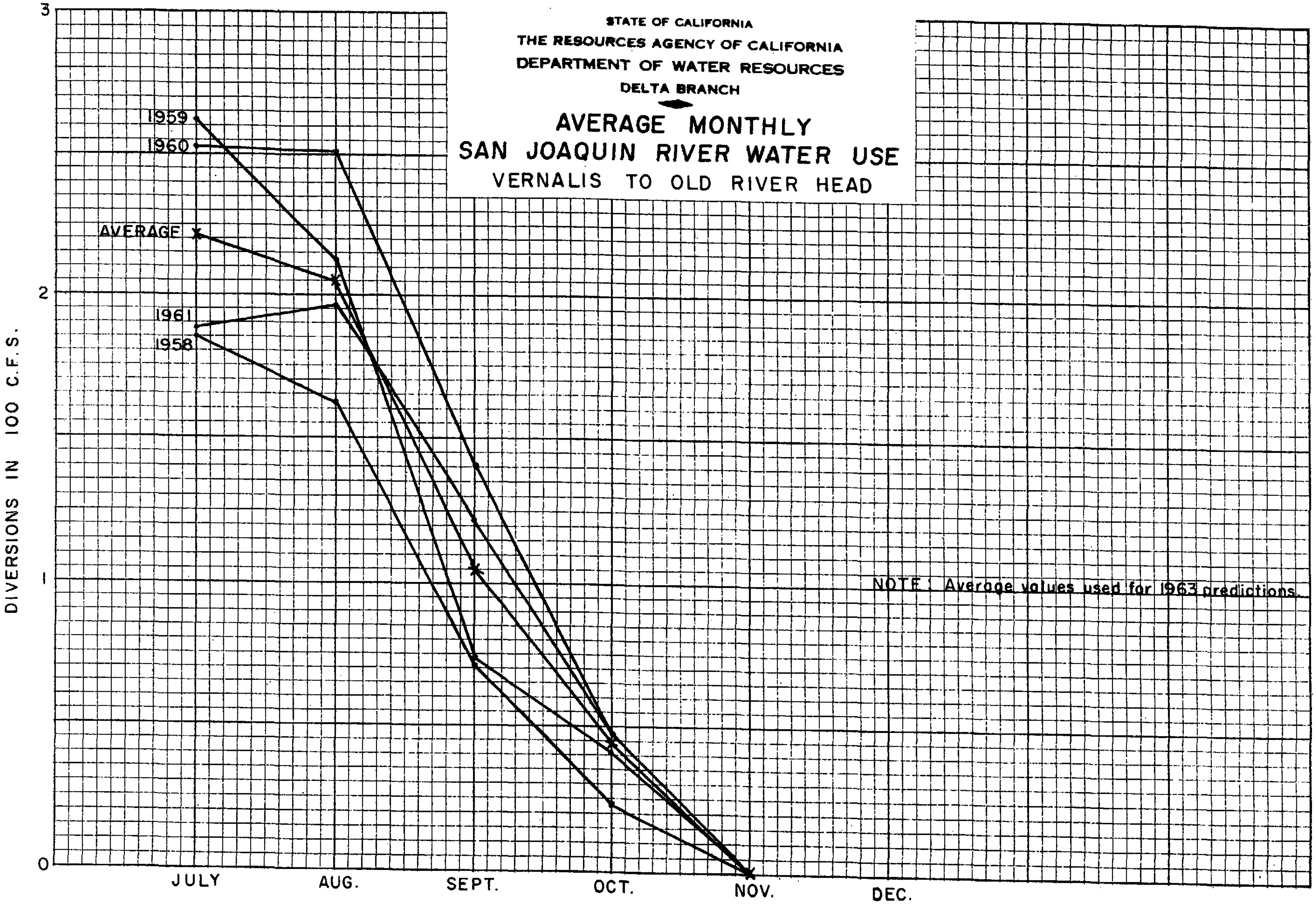

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
AVERAGE MONTHLY
TRACY PUMPING RATE
1958-1963
FLOW IN 1,000 C.F.S.
0
1
2
3
4
5
6
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
1961
1962
1960
1959
1958
1963
PREDICTED, 1963
1959, 1961
1958
1960

DEC. 1963

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

AVERAGE MONTHLY SAN JOAQUIN RIVER WATER USE

VERNALIS TO OLD RIVER HEAD

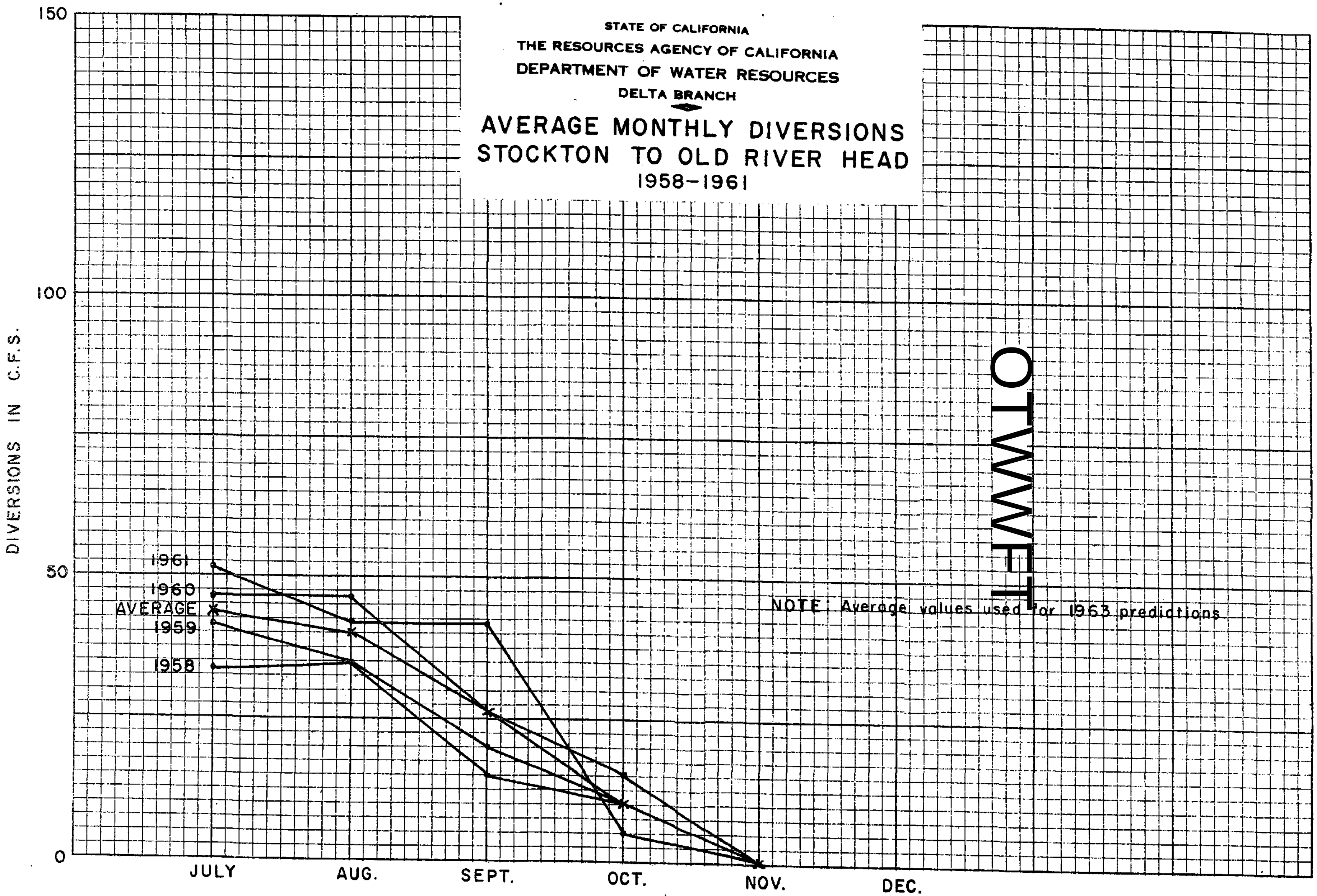


NOTE: Average values used for 1963 predictions.

DEC. 1963

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

AVERAGE MONTHLY DIVERSIONS STOCKTON TO OLD RIVER HEAD 1958–1961

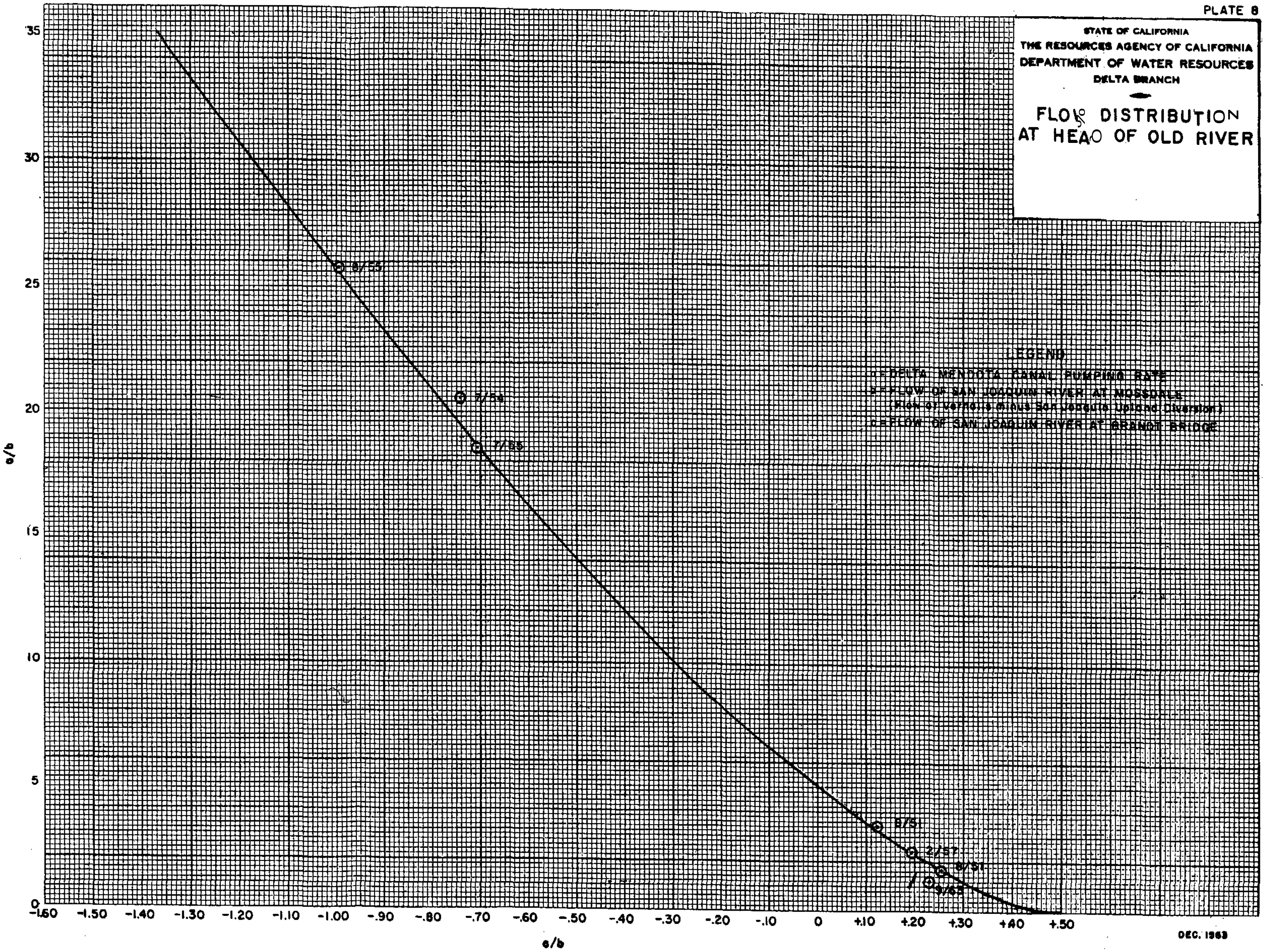


DEC. 1963

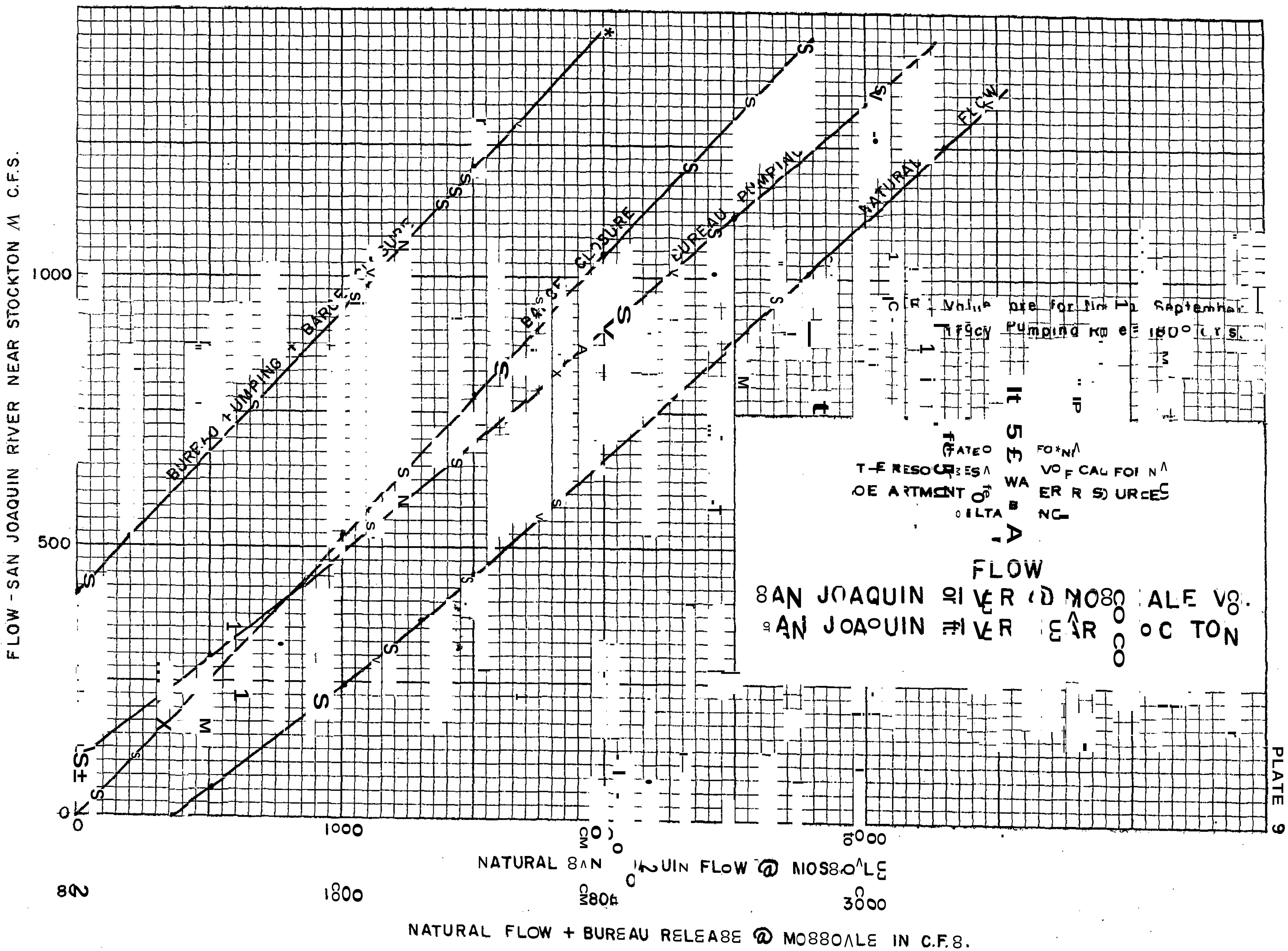
PLATE 8

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

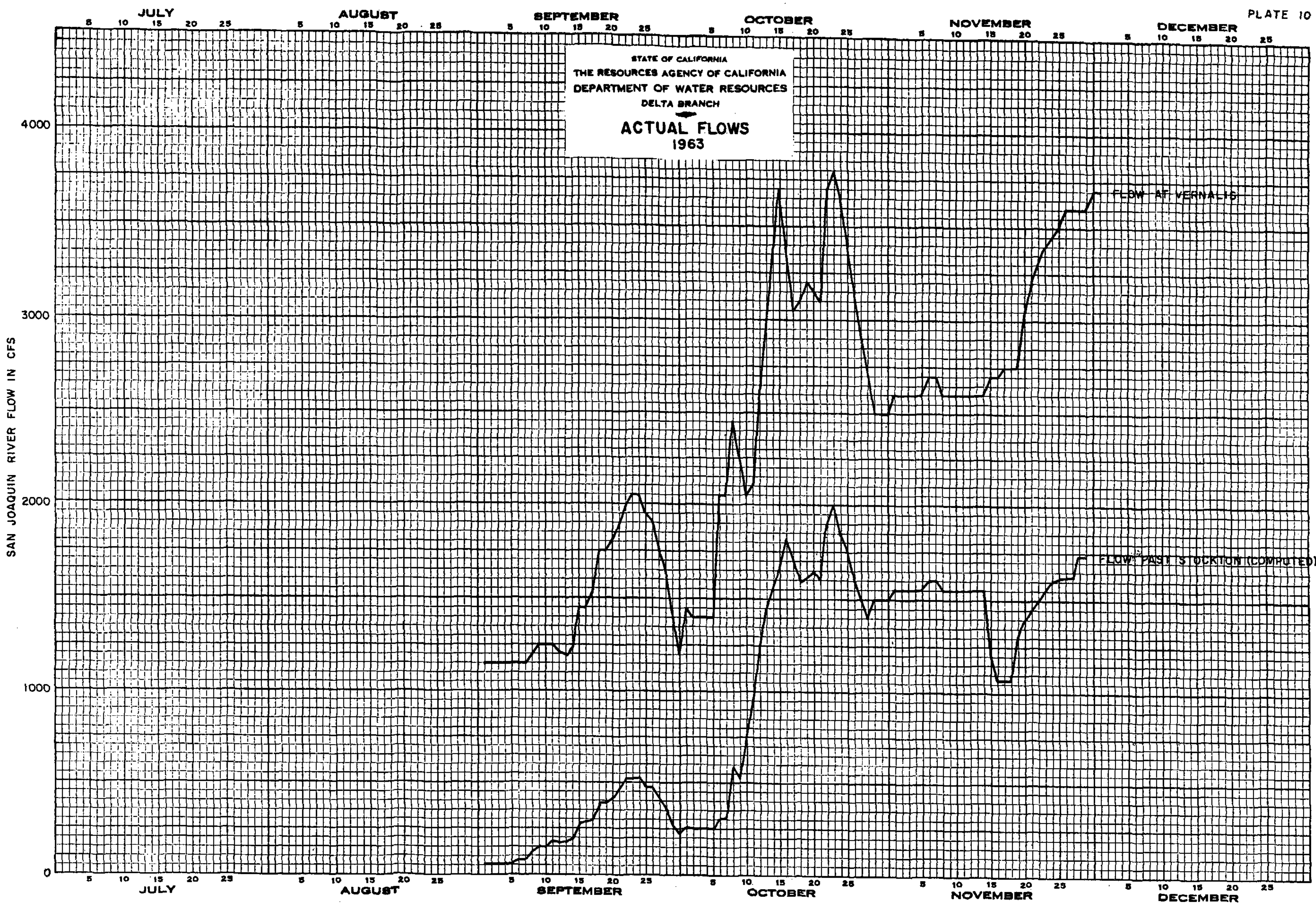
FLOW DISTRIBUTION AT HEAD OF OLD RIVER



DEC. 1963

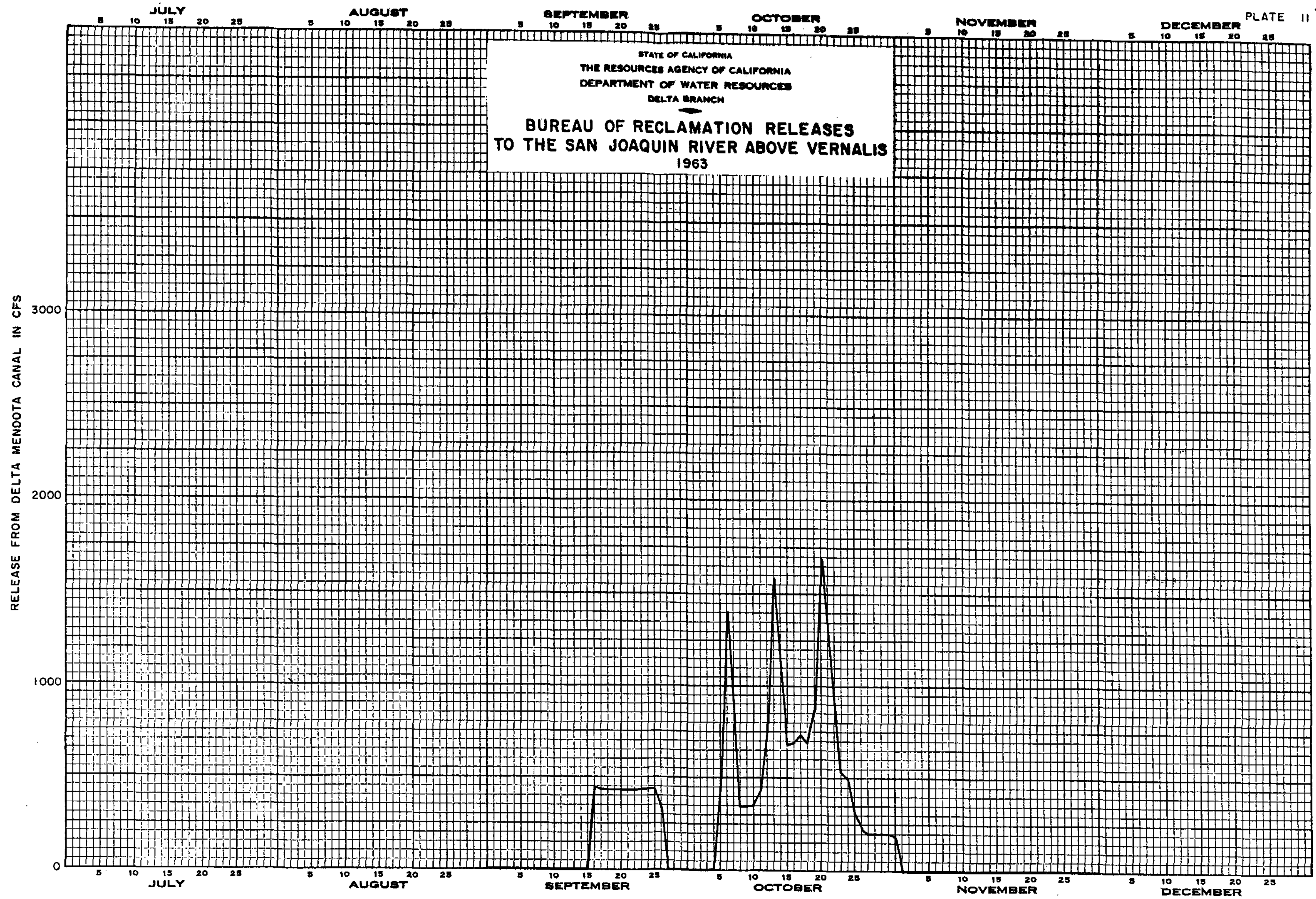

FLOW - SAN JOAQUIN RIVER NEAR STOCKTON IN C.F.S.
1000
500
0
NATURAL FLOW
BUREAU PUMPING
BARS CLOSURE
BUREAU PUMPING + BARS
1000
2000
3000
NATURAL SAN JOAQUIN FLOW @ MOSSDALE
NATURAL FLOW + BUREAU RELEASE @ MOSSDALE IN C.F.S.
FLOW
SAN JOAQUIN RIVER @ MOSSDALE VS.
SAN JOAQUIN RIVER NEAR STOCKTON

DEC. 1963


STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
ACTUAL FLOWS
1963
FLOW AT VERNALIS
FLOW PAST STOCKTON (COMPUTED)
SAN JOAQUIN RIVER FLOW IN CFS
0
1000
2000
3000
4000
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
5
10
15
20
25

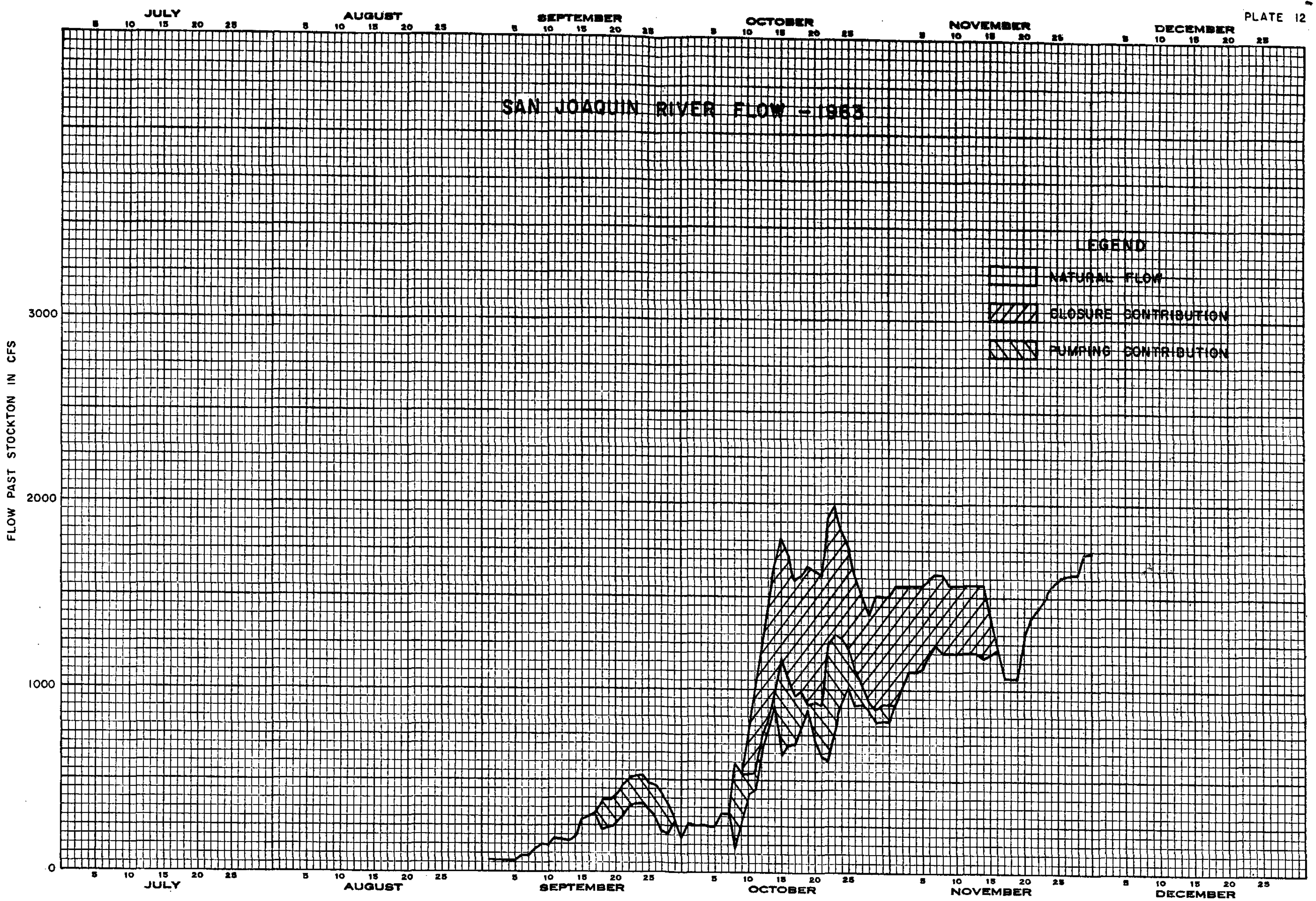
DEC. 1963

PLATE 11



DEC. 1963

PLATE 12



SAN JOAQUIN RIVER FLOW - 1963
LEGEND
NATURAL FLOW
CLOSURE CONTRIBUTION
PUMPING CONTRIBUTION
FLOW PAST STOCKTON IN CFS
0
1000
2000
3000
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
5 10 15 20 25