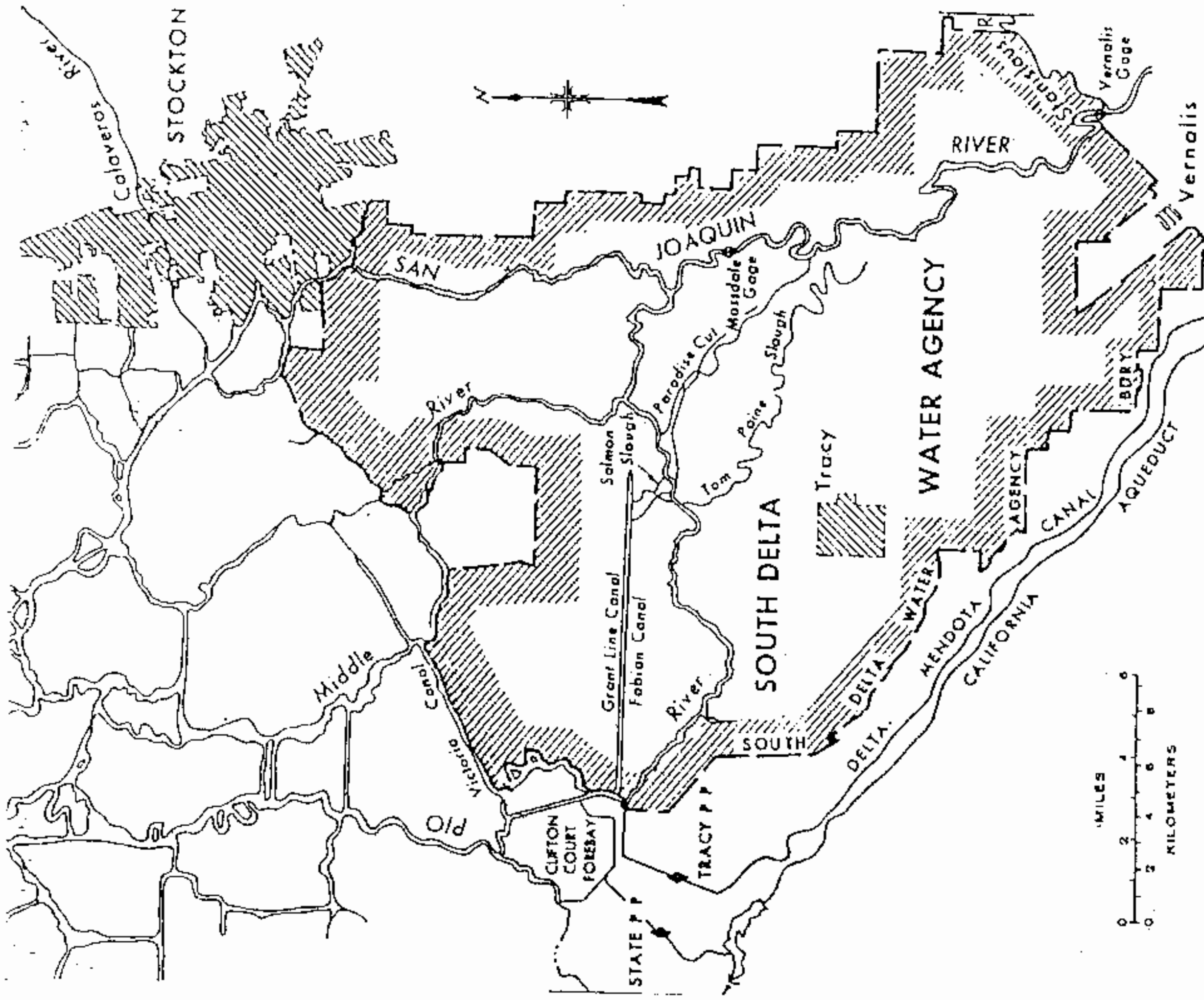


NOTE: Minor sloughs and oxbows are not shown on this Figure.

SOUTH DELTA WATER AGENCY

Attachment "A"

STATEMENT OF QUALIFICATIONS OF
ALEX HILDEBRAND

Agriculturally Related Qualifications

° Past Director and Secretary of South Delta Water Agency for 30 years

° President of Delta Water Users Association

° President of McMullin Reclamation District No. 2075

° President of San Joaquin River Water Users Company (non-profit water distributor within District #2075)

° Director of California Central Valley Flood Control Association

° President of San Joaquin River Flood Control Association

° Director (and member of Water Committee) of San Joaquin County Farm Bureau

° Member of California Farm Bureau Water Advisory Committee

° Owner (since 1944) and resident operator (since 1963) of 150-acre farm (in District #2075). Have made observations for several years of the depth of water percolation in two of my fields by use of Tensiometers, and have observed over many years the dramatic effect of variation in applied water salinity on the production and quality of produce from our family produce plot.

° Participated in development of South Delta Barrier Program

° Active participant in San Joaquin River Management Plan

° Expert witness in numerous hearings before the State Water Resources Control Board

° Member CalFed Bay/Delta Advisory Council

Professional Qualifications

° Honors Degree in Physics from U.C. Berkeley

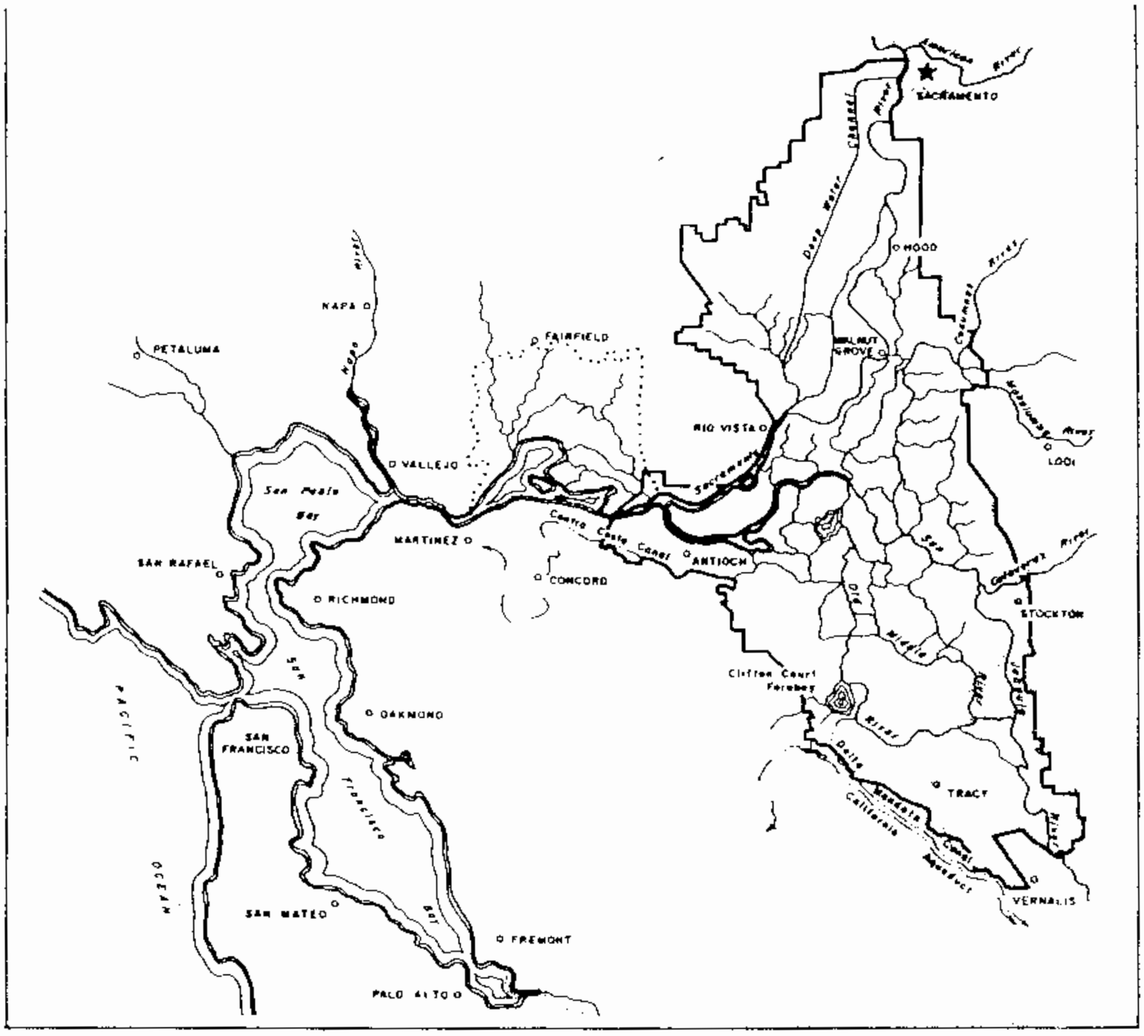
° Registered Professional Engineer

° Former Assistant Chief Engineer of Chevron's Richmond Refinery

° Retired Director of Chevron's Oil Field Research Laboratory. The research in that laboratory covered a broad spectrum of science and engineering, including substantial research on the flow of

Attachment "B"

fluids through permeable earth materials (both in laboratory and field tests) together with the movement of dissolved materials. This work required an understanding of the mechanisms of fluid flow, the physical chemistry involved, and the consequences of non-uniform permeability. Also responsible for analyzing and determining the applicability of these research results to commercial operations.



DRAFT

WATER QUALITY CONTROL PLAN

for the

San Francisco Bay/ Sacramento-San Joaquin Delta Estuary

MAY 1995

STATE WATER RESOURCES CONTROL BOARD

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

Attachment "C"

4. **Southern Delta agricultural salinity objectives.** Elevated salinity in the southern Delta is caused by low flows, salts imported in irrigation water by the State and federal water projects, and discharges of land-derived salts, primarily from agricultural drainage. Implementation of the objectives will be accomplished through the release of adequate flows to the San Joaquin River and control of saline agricultural drainage to the San Joaquin River and its tributaries. Implementation of the agricultural salinity objectives for the two Old River sites shall be phased in so that compliance with the objectives is achieved by December 31, 1997.

REVISED
Water Right Decision 1641

In the Matter of:

Implementation of Water Quality Objectives for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary;

A Petition to Change Points of Diversion of the Central Valley Project and the State Water Project in the Southern Delta; and

A Petition to Change Places of Use and Purposes of Use of the Central Valley Project

Adopted December 29, 1999

Revised March 15, 2000
in accordance with Order WR 2000-02

STATE WATER RESOURCES CONTROL BOARD
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

Attachment "D"

DWR, SDWA, Stockton, and the USDI presented evidence regarding the barriers. The main benefit of the barriers is improved water levels in the southern Delta. (SWRCB 87, p. 51.) The barriers also benefit water quality by improving circulation in the southern Delta. (R.T. p. 7525.) The barriers generally improve water quality in the southern Delta because salts otherwise trapped in the channels are transported out of the area due to the enhanced circulation. (DWR 37, pp. 12-13.) The barriers reduce the amount of salt imported by way of the Delta-Mendota Canal, which should result in some long-term improvement in the quality of the San Joaquin River. (R.T. p. 3905.) The improved quality of water delivered through the Delta-Mendota Canal should result in improvements to the salinity of drainage water that returns to the river. (R.T. p. 3731.)

The construction of permanent barriers alone is not expected to result in attainment of the water quality objectives. (R.T. pp. 3672, 3710, 3787-3788; DWR 37, p. 15; SWRCB 1e, pp. [IX 30]-[IX-41].) The objectives can be met consistently only by providing more dilution or by treatment. (R.T. p. 3737.) The modeling studies indicate that even when the barriers do not result in attainment of the standards, water quality generally improves as a result of the permanent barriers. The exception is at Brandt Bridge where water quality may worsen slightly at times due to barrier operation. (R.T. p. 3677; DWR 37, p. 18; SWRCB 1e, Figures [IX-19]-[IX-26].) Barriers may result in slightly worse water quality in the mainstem of the San Joaquin River in the Delta, but the more saline water is quickly diluted. (DWR 37.) Modeling shows that construction and operation of the temporary barriers should achieve water quality of 1.0 mmhos/cm at the interior stations under most hydrologic conditions.

The DWR and the USBR are partially responsible for salinity problems in the southern Delta because of hydrologic changes that are caused by export pumping. Therefore, this order amends the export permits of the DWR and of the USBR to require the projects to take actions that will achieve the benefits of the permanent barriers in the southern Delta to help meet the 1995 Bay-Delta Plan's interior Delta salinity objectives by April 1, 2005. Until then, the DWR and the USBR will be required to meet a salinity requirement of 1.0 mmhos/cm. If, after actions are taken to achieve the benefits of barriers, it is determined that it is not feasible to fully implement the objectives, the SWRCB will consider revising the interior Delta salinity objectives when it reviews the 1995 Bay-Delta Plan. The USBR and the DWR will be responsible to take any actions required by CEQA, NEPA, and the federal and State ESA prior to constructing the barriers.

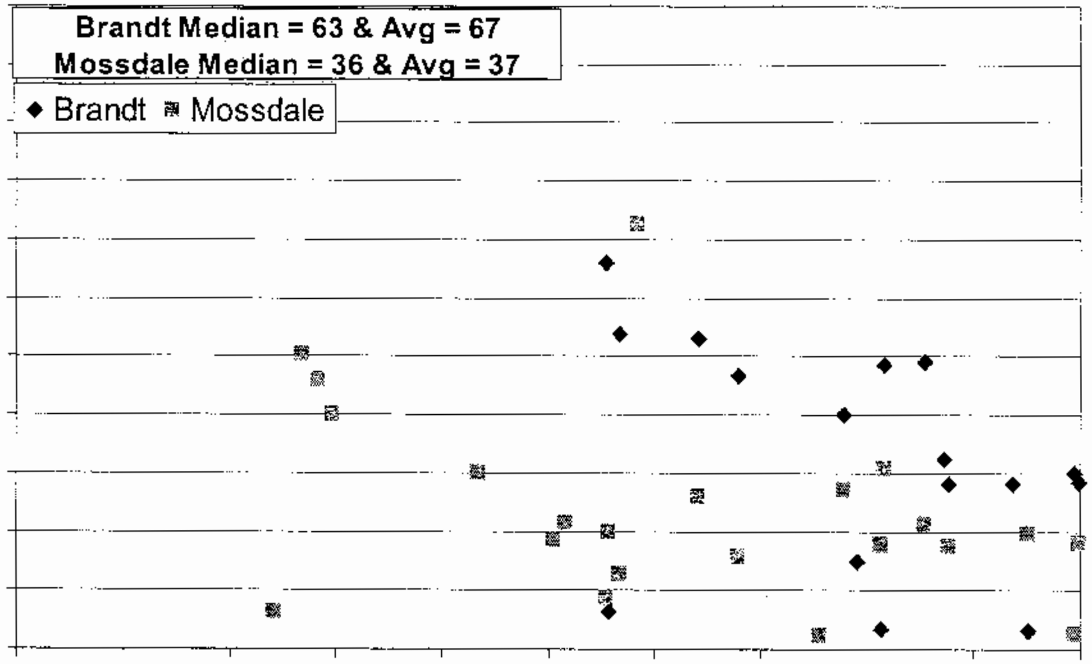
Public Law 108-361

Sec. 103 (d) (2)

(D) PROGRAM TO MEET STANDARDS.-- (i) IN GENERAL.--Prior to increasing export limits from the Delta for the purposes of conveying water to south-of-Delta Central Valley Project contractors or increasing deliveries through an intertie, the Secretary shall, not later than 1 year after the date of enactment of this Act, in consultation with the Governor, develop and initiate implementation of a program to meet all existing water quality standards and objectives for which the Central Valley Project has responsibility. (ii) MEASURES.--In developing and implementing the program, the Secretary shall include, to the max- imum extent feasible, the measures described in clauses (iii) through (vii). (iii) RECIRCULATION PROGRAM.--The Secretary shall incorporate into the program a recirculation pro- gram to provide flow, reduce salinity concentrations in the San Joaquin River, and reduce the reliance on the New Melones Reservoir for meeting water quality and fishery flow objectives through the use of excess capacity in export pumping and conveyance facilities.

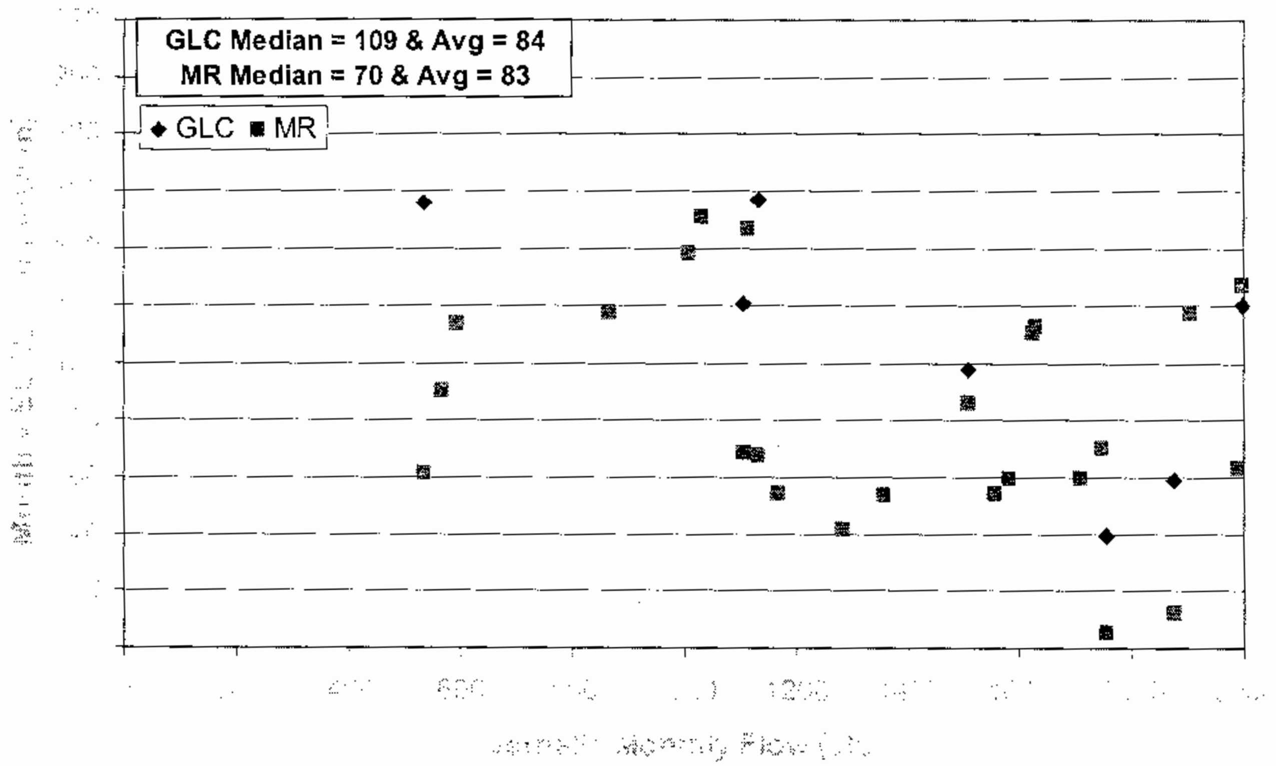
Attachment "E"

Monthly EC Diff (Brandt/Mossdale – Vernalis) When Vernalis Flow < 2000 cfs During 1987-1997 (June-August)

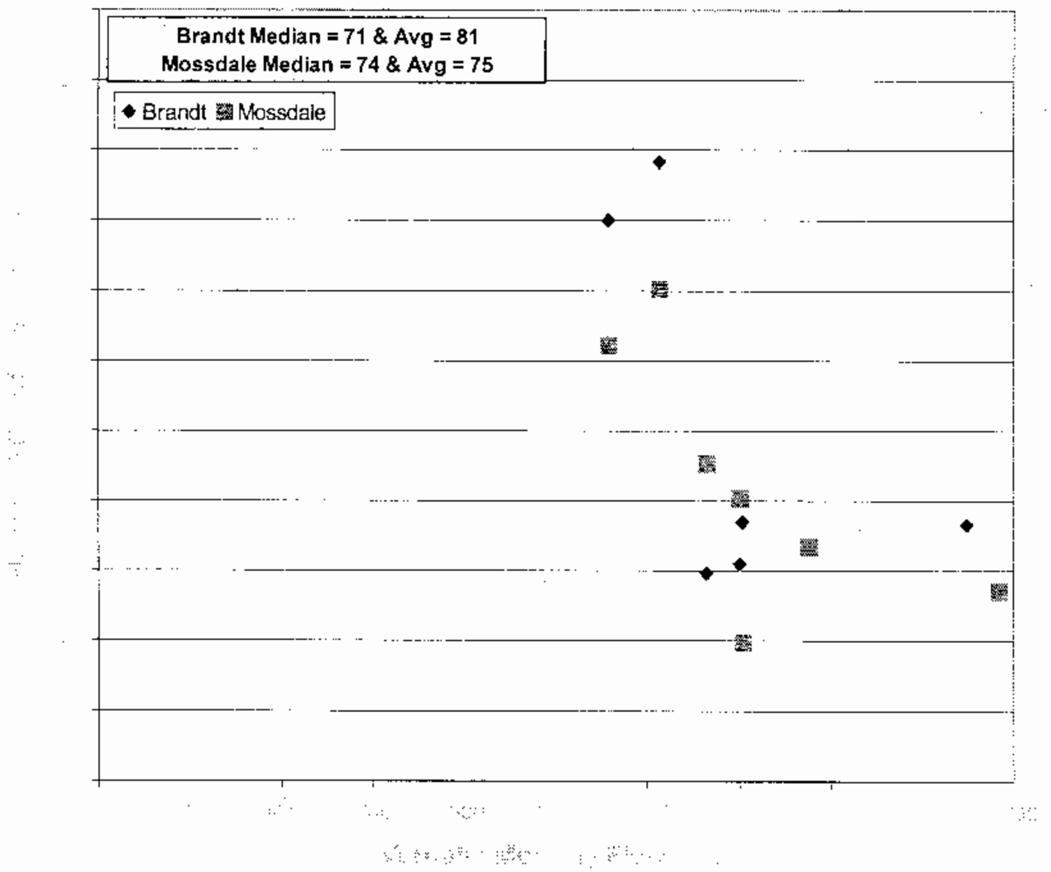


Attachment "F"

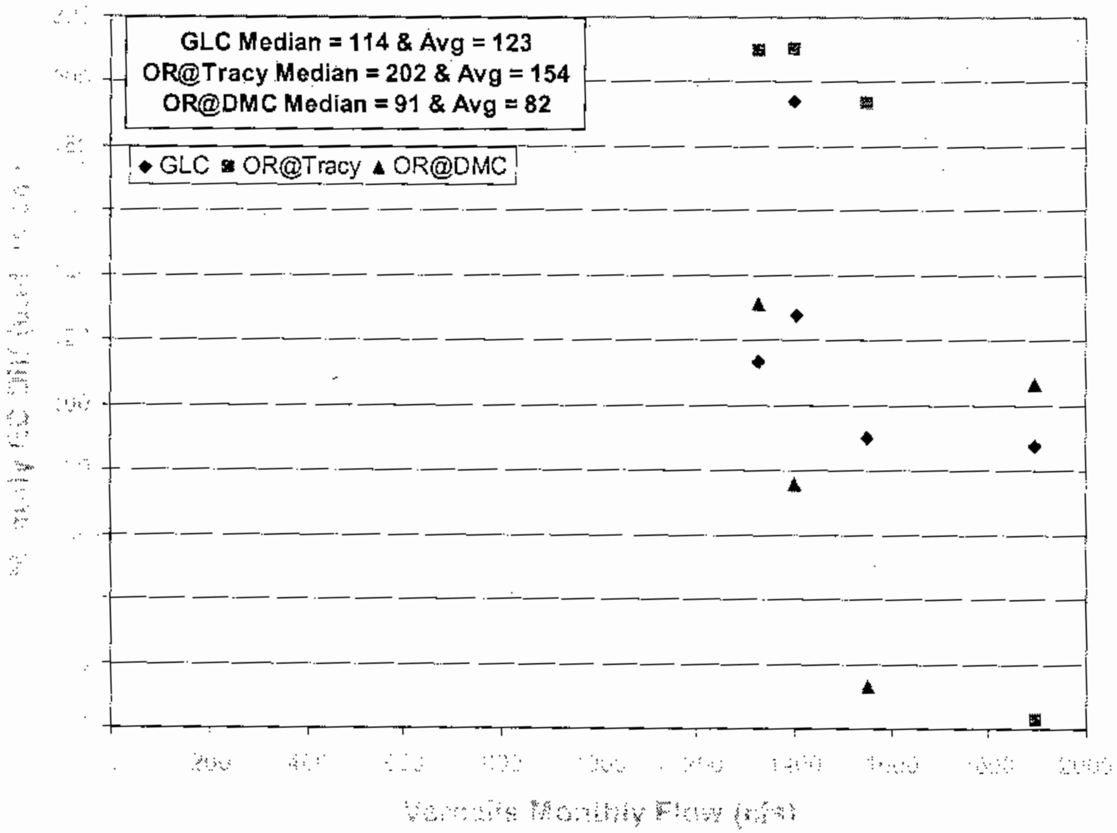
Monthly EC Diff (GLC/MR – Vernalis) When Vernalis Flow < 2000 cfs During 1987-1997 (June-August)



Monthly EC Diff (Brandt/Mossdale – Vernalis) When Vernalis Flow < 2000 cfs During 1999-2002 (June-August)



Monthly EC Diff (GLC/OR@Tracy/OR@DMC – Vernalis) When Vernalis Flow < 2000 cfs During 1999-2002 (June-August)



Subj: **Re: New Melones**
Date: 9/22/2005 8:24:50 A.M. Pacific Standard Time
From: EKITECK@mp.usbr.gov
To: Jherrlaw@aol.com

Hello John,

The final allocation for Vernalis water quality (in June) according to the IOP was 180,000 ac-ft. Thus far there have been no releases this year for salinity.

Elizabeth

>>> <Jherrlaw@aol.com> 9/21/2005 3:49:02 PM >>>
Dear Elizabeth:

Can you give me the current figures for amounts of water allocated for
water quality (salinity) and the amounts actually used this year from/in Mew
Melones? Thanks, JOHN

John Herrick, Esq.
4255 Pacific Avenue, Suite 2
Stockton, CA 95207
(209) 956-0150
(209) 956-0154 Fax

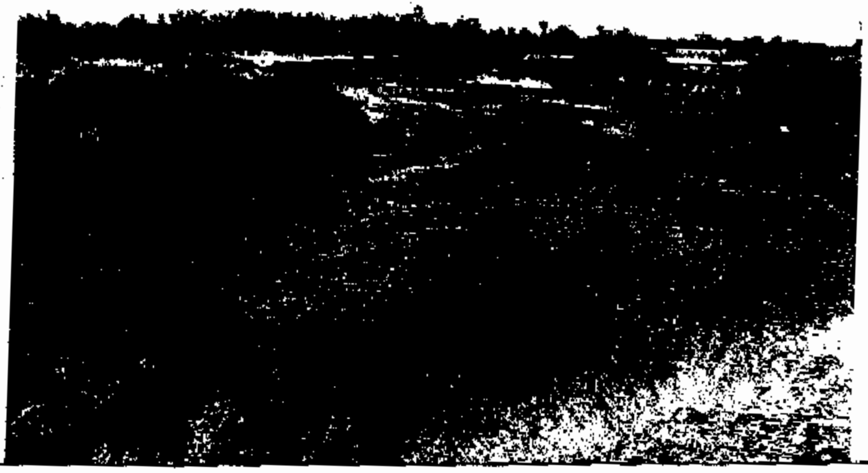
Attachment "G"

RECLAMATION

Managing Water in the West

Recirculation Pilot Study Final Report

Stanislaus County, California
Mid-Pacific Region



Recirculation Pilot Study Attachment "H"

Final Report

Stanislaus County, California
Mid-Pacific Region

prepared by

Division of Planning
Delta and Integrated Resource Planning Branch
Sharon McHale, AICP, Project Manager
Erika Kegel, P.E., Civil Engineer

Decision Analysis Branch
Gene Lee, Water Quality Specialist

Central Valley Operations Office
Water Operations Division
Paul Fujitani, Chief
Peggy Manza, P.E., Hydraulic Engineer

South-Central California Area Office
M. Chris Eacock, Natural Resource Specialist

As with TSS, it is unknown from the study if the turbidity level exiting the Wasteway would have decreased to the level of the upstream site given a longer period of time for the sediment to flush out. Methods should be considered that reduce sediment mobilization in the Wasteway, and therefore turbidity impacts to the River, if recirculation is going to be evaluated further.

Dissolved Oxygen

The CVRWQCB basin plan lists 5.0 mg/L as the most stringent objective for dissolved oxygen (DO). DO concentration of the DMC water entering the Wasteway hovered around 8 mg/L. Water exiting the Wasteway during the initial flush dropped below 5 mg/L, and then rose to a concentration around 7 mg/L. Levels in the lower River did not drop below the 5 mg/L water quality goal, but the addition of the recirculated water from the Wasteway decreased the average DO concentration in the River from 8.3 mg/L at the upstream site to 7.7 mg/L at the downstream site.

Water Quality Monitoring Summary

Analysis of the data shows that implementation of the recirculation pilot study impacted the River water quality for the following parameters: aluminum, metolachlor, TKN, total phosphorus, ammonia as nitrogen, TOC, TSS, DO, and turbidity. In assessing the data for the above parameters, a declining trend in concentration over the course of the pilot study was noted with the exception of aluminum, TSS, and turbidity. The initial elevated levels shown for these chemical constituents were the result of the first flush effect caused by the mobilization of accumulated agricultural drainage, channel bottom sediments, and vegetation in the Newman Wasteway.

For the three parameters that were elevated due to the discharge of CVP water, none exceeded the most stringent water quality standards. TSS and turbidity effects attributable to recirculation were expected and could be reduced through design and structural improvements and/or operation of the Wasteway. The elevated aluminum levels may be the result of analytical matrix problems and will be investigated further.

Flow and Salinity Data

In addition to the data collected by the study team in the vicinity of the Newman Wasteway, flow and salinity data from existing gauges along the River were also downloaded from the CDEC website. This data was analyzed to quantify the impact of the study on the River at the Wasteway, as well as determine if the impacts were measurable at downstream monitoring stations.

Analysis of flow data

The flow data plotted in Figure 11 shows an abrupt increase in flow in the River at Newman (NEW) about 12 hours into the study, and about 24 hours at the Patterson (SJP) gauge. Both stations show an abrupt spike in flow which peaked at a little over 600 cfs at both stations (located about 14 miles apart). The 250 cfs flow introduced from the Wasteway was diminished in amplitude to about 200 cfs when the pulse reached the Newman gauging station then increased to the full 250 cfs about 48 hours into the study. The pulse was only 150 cfs when it reached the Patterson gauging station about 12 hours later, then increased to 200 cfs about 72 hours into the study. Since the Fremont Ford and Mud Slough gauges showed stable flows for the first week of the pilot study, the increased flow in the River can be attributed to the discharge from the Newman Wasteway.

Mud Slough (MSG) and San Joaquin River at Fremont Ford (FFB) are the main sources of water upstream of the Wasteway. Fremont Ford diminished from 150 cfs to about 100 cfs after the first week (160 hours) of the pilot study. Newman flows were reduced from 600 cfs to 500 cfs at about the same time – the Patterson gauge showed flow diminishing by the same amount, although starting at about day 4 (100 hours) after onset of the pilot study. The greater flow decrease at Patterson as compared to flow at Fremont Ford can be attributed to the decreased tributary inflow from the Merced River (see Figure 12). The Merced River diminished from 100 cfs to about 50 cfs after the first week (144 hours) of the pilot study.

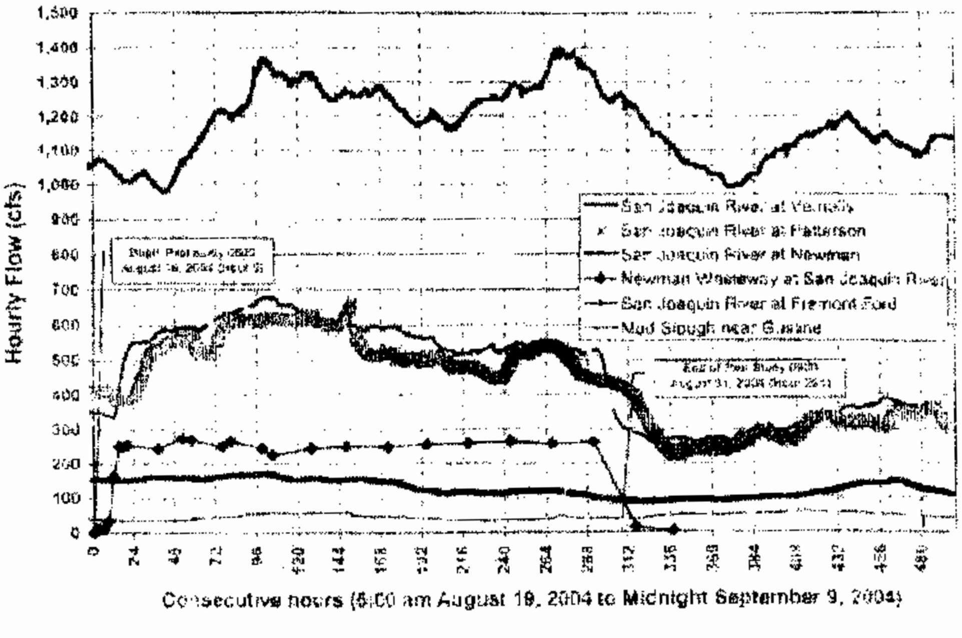


Figure 11. Analysis of San Joaquin River and main tributary flow data.

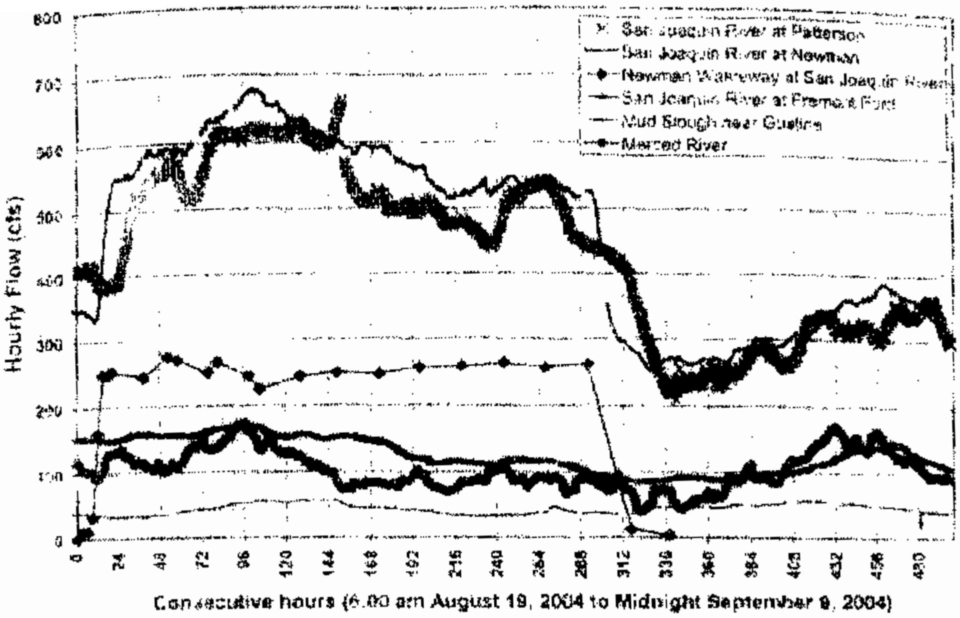


Figure 12. San Joaquin River tributary flow data.

Because there are no major tributaries between the Newman and Patterson gauges, the flow records should be very similar. However, the Patterson gauge data does not document as high of an initial increase from recirculation flow as that recorded at the Newman gauge. That muted response coincided with an increase in diversion by West Stanislaus Irrigation District commencing 20 hours into the pilot study. In contrast, diversion by the Patterson Irrigation District remained quite static at about 125 cfs throughout the pilot study (see Figure 13). Other variations in the Patterson gauge data can be attributed to ungauged surface drain inflows, seepage losses, and late season riparian diversions along the reach between the Newman and Patterson gauges. Because the recirculation pilot study was not designed to monitor all inflows to and diversions from the River, quantification of these flows was not possible.

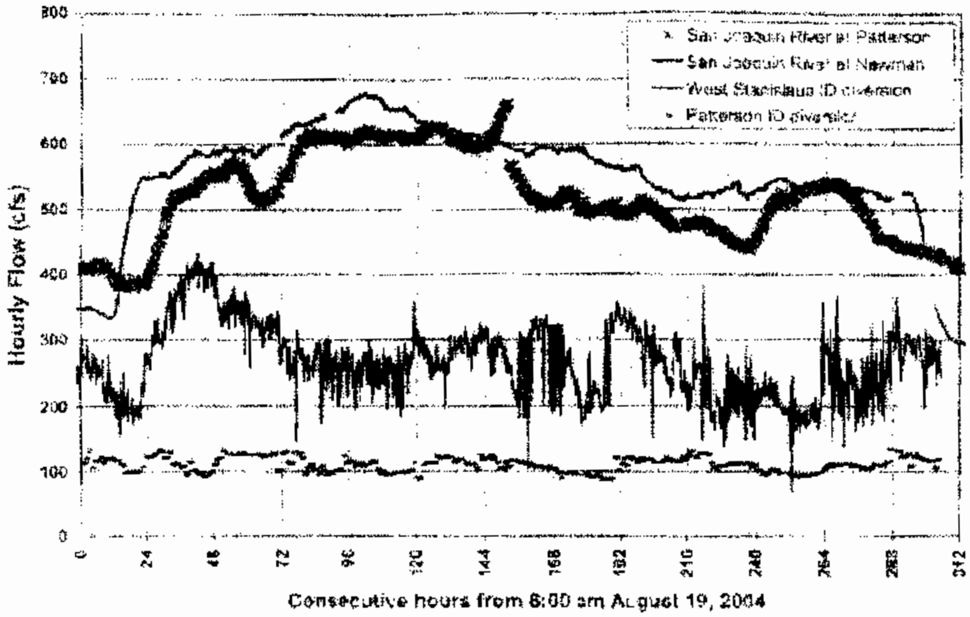


Figure 13. Effect of riparian diversion at Patterson ID and West Stanislaus ID on flow at San Joaquin River at Patterson.

Analysis of electrical conductivity data

D-1641 established a San Joaquin River agricultural salinity objective of 1000 μS/cm between April and August and 700 μS/cm between September and March to be met at Vernalis. Evaluation of the impact of recirculation on salinity, as measured by electrical conductivity (EC), was an objective of the pilot study.

In Figure 14 the displacement of salt in the Wasteway begins about 17:30, eleven and a half hours after the initial release of water into the Wasteway, and continues until about 7:00 the next morning after which time the Wasteway EC takes the characteristic signal of the diverted DMC water.

Interpretation of the EC data is more complex than the flow data on the San Joaquin River. Upon initial observation, the data does not exhibit the inverse relationship between flow and salt concentration expected at the San Joaquin River stations. In the case of the Patterson monitoring site, about 36 hours into the study the EC dropped from approximately 1200 μS/cm to less than 900 μS/cm until the seventh day of the pilot study after which the EC steadily climbed (see Figure 15). The EC increase can be attributed to upstream salinity changes. As shown in Figure 15, the EC concentration upstream of the Wasteway at Fremont Ford was stable near 1150 μS/cm for the first three days of the pilot study, then increased to 1600 μS/cm between day 6 and end of the study (after 290 hours). This 50% EC increase correlated with an approximate 50% reduction in flow during the same period, thus the salt load remained about the same.

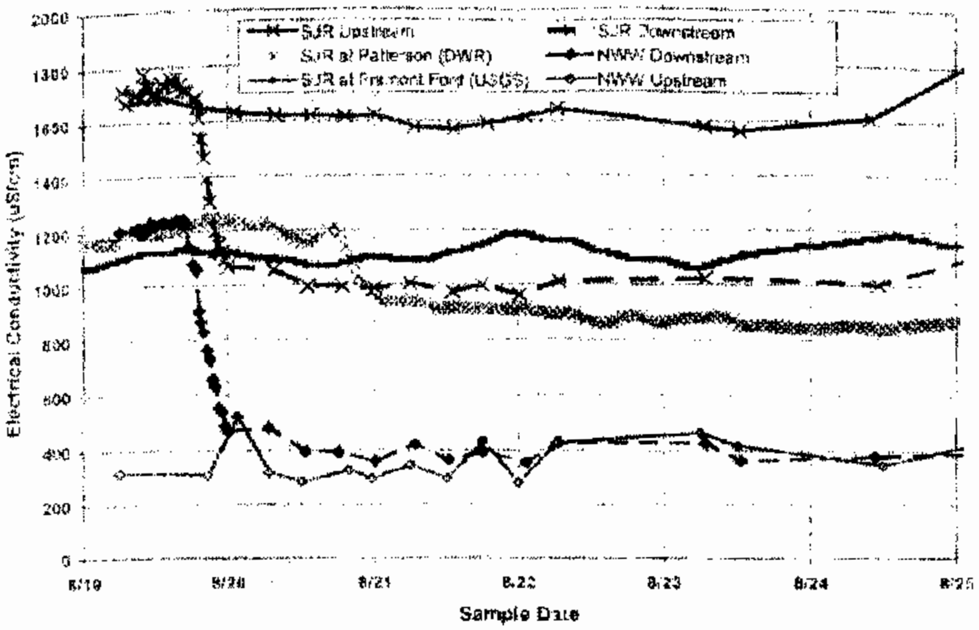


Figure 14. Effect of Recirculation on EC after 6 days (144 hours) at various main stem river sites as well as upstream and downstream sites along the Newman Wasteway

The Vernalis EC data showed a lagged response to the recirculated flow. The reduction in EC from about 700 μS/cm to 600 μS/cm occurred approximately 48 hours after the flow pulse was first evident at the Patterson gauging station. Similar to the trend at Patterson, after the initial drop around hour 72 the EC at Vernalis slowly increased during the 291 hour study period and was about 650 μS/cm at the end of the pilot study.

Initially it was thought that the drop in EC at Vernalis was not as great as might be expected given the reduction at Patterson. After analyzing the EC response with respect to the relative flow contribution from recirculation, the observed drop in Vernalis EC was found to be consistent. The flow at Patterson was only 400 cfs prior to arrival of the 200 cfs recirculation pulse, which provided a 50% increase in flow. The recirculated flow only increased the flow at Vernalis by 20%, from 1000 to 1200 cfs. From such a small increase in the flow at Vernalis one would expect the observed modest reduction in EC.

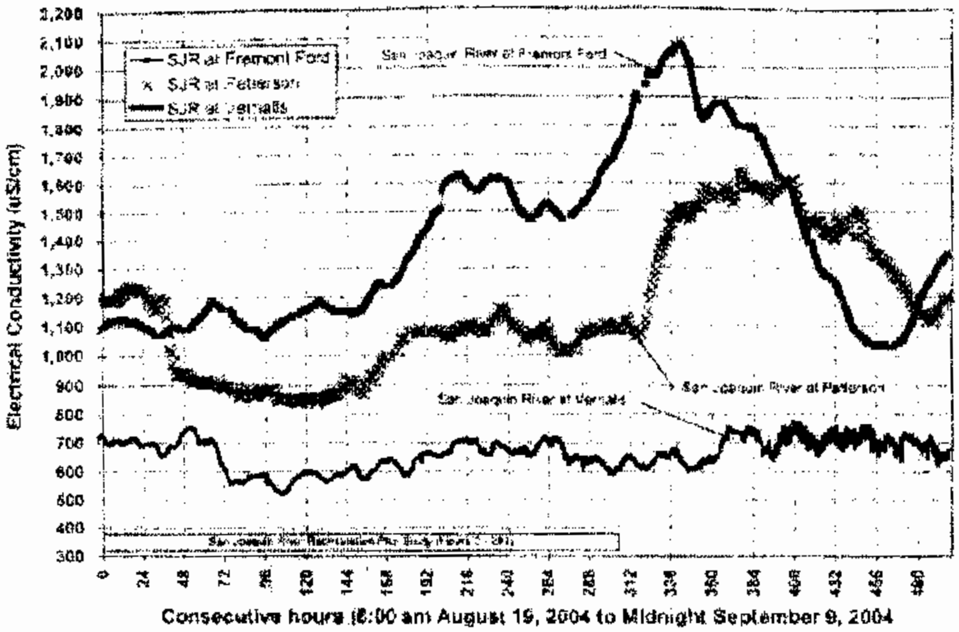


Figure 15. Effect of recirculation on EC after 21 days at various main stem San Joaquin River sites.

Figure 10 shows steady flows in Mud Slough and in the River passing Fremont Ford during the pilot study. These sites represent upstream or baseline conditions in the River and Grasslands Basin. Figure 14 shows an abrupt rise in salinity at Fremont Ford during the study that may have been caused by flushing out the refuges in preparation for the new season. The rise in salinity was diminished by the pilot study flow (reduced 500 uS/cm @ hour 240). This data shows a clear benefit of recirculation.

Findings and Conclusions

Water Quality Assessment

The pilot study showed clearly that recirculated flow through the Newman Wasteway was effective in increasing flow and reducing the EC concentration at Vernalis. The pilot study also demonstrated agency coordination at its best; data collection was well coordinated and a complete water quality characterization of the first flush flow from the Wasteway was obtained. The analysis does suggest, however, that real-time water quality monitoring and management will be essential if recirculation is to realize savings in New Melones water quality releases. A short-term increase in riparian diversion by the West Stanislaus Irrigation District resulted in a much lower response at Vernalis than was expected during the first two days of the pilot study. It was later determined that West Stanislaus Irrigation District had increased diversions for two days and then cutback again to the conditions that existed when the pilot study was initiated. A decision to increase recirculation flows in response to the less than expected Vernalis EC would have resulted in excess dilution and water wastage as West Stanislaus Irrigation District reduced its river diversion. Therefore, real-time flow and EC monitoring data from mainstem River stations, including the major Westside tributaries and the diversions, will be essential for full implementation of any future recirculation program.

Water Supply Assessment

There were no water supply impacts to CVP contractors as a result of the pilot study. It was difficult to accurately measure the losses due to insufficient data and controls during the recirculation operation. There are several irrigation districts which have tailwater flow into the San Joaquin River which are in the process of being calibrated, and monitoring data was not available during the pilot study. In addition, data on the quantities of water diverted from the San Joaquin River by the water districts is limited beyond the data available for West Stanislaus Irrigation District and Patterson Irrigation District. Without a higher level of detail, it is difficult to determine exactly how much of the water released through the Newman Wasteway was lost to the system between the release point and Vernalis. Therefore, monitoring of recirculation water will be an essential component of any future study when, and if, another test of recirculation is performed or a full-scale recirculation program is implemented.

IMPACT OF SAN JOAQUIN RIVER QUALITY
ON CROP YIELDS IN THE SOUTH DELTA

G. T. Orlob

INTRODUCTION

The agricultural productivity of lands within the South Delta Water Agency is dependent upon both the quantity of water that enters the Delta at Vernalis and its quality. It is also determined in part by the nature of soils, i.e. their permeabilities and leaching requirements to avoid excessive accumulation of salinity during the growing season. In general, fine textured soils such as those that comprise the major part of South Delta lands have lower permeabilities, and thus require higher quality of applied water to assure optimal crop growth without loss of yield.

To demonstrate the nature and dependence of agricultural productivity in the South Delta on San Joaquin River quality, it is necessary to consider the following factors:

1. Soil characteristics, i.e. permeabilities and field leaching fractions, and variability of these over the lands of the South Delta,

2. Crop yields in relation to water quality, soil characteristics, and crop type,

3. Quality of water available in South Delta channels during the growing season, and

4. Cropping pattern and crop value for the South Delta.

Attachment "I"

Combining these factors in a quantitative framework results in estimates of the sensitivity of the South Delta area to water quality at Vernalis.

SOIL CHARACTERISTICS

Soils of the South Delta, identified in the most recent soil survey of the area, have been organized into five groups according to field permeabilities. These are depicted on the general soil map for the South Delta area (SDWA Exhibit 106), and for a smaller representative area in the vicinity of Old River between the San Joaquin River and Salmon Slough (SDWA Exhibit 107). Characteristics of these soil groups, which are considered indicative of *between-field* variability in the South Delta, are given in Table 1.

Table 1. Soil Groups in the South Delta

Group	Map Color Code	Percent of area	Permeability description in/hr
A	brown	40	slow < 0.2
B	blue	34	mod. slow 0.2 - 0.6
C	yellow	17	moderate 0.6 - 2
D	green	6	mod. rapid 2 - 6
E	red	3	rapid > 6

Leaching characteristics of South Delta soils were derived from the 1976 South Delta Salinity Status Study (SDWA Exhibit 104), using observed EC_es and applied water EC_ws for 51 sites at 10 different locations. Leaching fractions (LF) were calculated for both spring and fall EC_e profiles at all sites (102 determinations) according to the relation

$$LF = \frac{EC_w}{2(EC_e)_d} \qquad (1)$$

where

EC_w = electrical conductivity of applied water, mmhos/cm (dS/m)

$(EC_e)_d$ = electrical conductivity of soil solution extract at drainage horizon (assumed to be the maximum in the EC_e profiles) mmhos/cm (dS/m)

Mean leaching fractions ($\overline{LF}$) and standard deviations from the mean (σ) were determined for each location (up to 15 observations in some cases). It was found that σ ranged widely, from about 25 to 65 percent of $\overline{LF}$. An average of about one-third, i.e. $\sigma = \overline{LF}/3$, was adopted as representative of *in-field* variation in leaching during the growing season.

Soil permeabilities and leaching fractions were related to one another by identifying specific locations (Salinity Study, SDWA Exhibit 104) with permeability groups (Soil Permeability Map, SDWA Exhibit 106). Calculated LFs were plotted against permeabilities as shown in Figure 1. While some scatter is apparent, owing largely to in-field variation, there appears to be a fairly consistent relationship between permeability and leaching fraction.

In subsequent calculations, values of $\overline{LF}$ and standard deviations of the distributions shown in Figure 1 are identified with the various soils as they are actually classified for the South Delta (SDWA Exhibit 106). These values for the moderate to slow permeability soils are:

Group	$\overline{LF}$	σ
A	0.053	0.0177
B	0.093	0.0310
C	0.188	0.0627

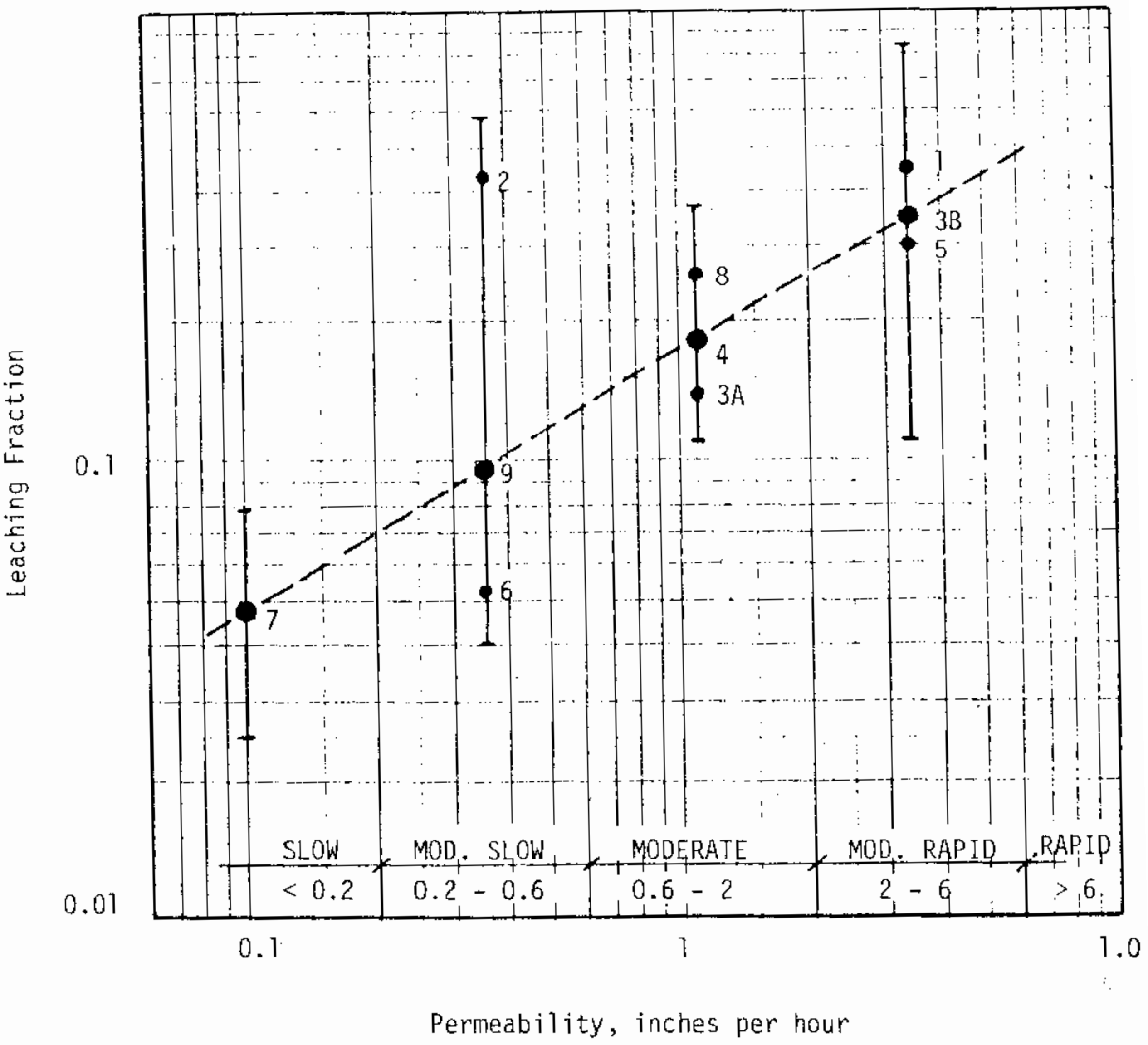


Figure 1. RELATIONSHIP BETWEEN LEACHING FRACTION AND FIELD PERMEABILITY, SOUTH DELTA SOILS

CROP YIELD VS WATER QUALITY

The relationship between yield decrement, leaching fraction, and applied water quality is given by

$$\Delta Y = S(EC_w \{ \frac{1 + LF}{5LF} \} - B) \qquad (2)$$

where

ΔY = yield decrement, percent

S = unit decrement, percent/mmho/cm

B = threshold EC_e, mmhos/cm

and other terms are as previously defined. Values of S and B for various crops are found in FAO Irrigation and Drainage Paper 29 as revised (SDWA Exhibit 105) and were supplemented by the Water Quality Advisory Panel for the South Delta Salinity Status Study (SDWA Exhibit 103).

The yield decrement for a field with variable LF is determined by combining equation (2) with the probability density function for LF and integrating from 0 to LF_c, a fraction above which no decrement in yield occurs.

$$\Delta Y = \int_{0}^{LF_c} S \left[EC_w \{\frac{1 + LF}{5\ LF}\} - B \right] \frac{\exp}{\sigma\sqrt{2\pi}} \left(- \frac{1}{2} \frac{(LF-\overline{LF})^2}{\sigma^2} \right) dLF \qquad (3)$$

where all terms are as previously defined.

A yield decrement--quality relationship for a particular soil, e.g. Group A, is obtained by carrying out the integration of equation (3) over the range of EC_w that is of interest. In the case of the South Delta, this was 0.7 to 1.3 mmhos/cm, corresponding to a range of TDS of roughly 450 to 825 mg/L. The properties of the soil are given by $\overline{LF}$ and σ and the susceptibility of the crop by S and B. Representative yield decrement--quality relationships used in this study are summarized for the six most sensitive crops and the three soil groups in Table 2.

Table 2. Yield Decrement at Function of
Water Quality, Soil Type, and Crop

EC_w, dS/m	Yield Decrement, Δy, percent					
	Beans	Corn	Alfalfa	Tomatoes	Fruit & Nuts	Grapes
			Soil Group A, $\overline{LF}$ = 0.053, σ = 0.0177			
0.4	19	4	-	-	10	3
0.7	42	18	9	8	34	16
1.0	68	34	19	21	61	29
			Soil Group B, $\overline{LF}$ = 0.093, σ = 0.0310			
0.4	6	-	-	-	2	-
0.7	18	4	2	2	10	4
1.0	33	12	6	4	24	12
			Soil Group C, $\overline{LF}$ = 0.188, σ = 0.0627			
0.4	-	-	-	-	-	-
0.7	3	1	-	-	2	-
1.0	9	2	1	1	4	2

REVENUE LOSS DUE TO QUALITY DEGRADATION

The dollar value of potential crop losses for a given water quality and soil is estimated from the known acreage of specific crops, the market value per acre, and the decrement calculated by equation (3), and is given by

$$C_T = \frac{1}{100} \sum_{i=1}^{n} \sum_{j=1}^{m} A_{ij} \, c_{ij} \Delta Y_{ij} \tag{4}$$

where

C_T = total potential loss, $

A = area, acres

c = value of crop, $/acre

ΔY = yield decrement, percent

i = crop, 1 to n

j = soil group, 1 to m

A representative cropping pattern for the South Delta Water Agency, i.e. values of A_{ij}, is derived from a survey of the San Joaquin County Agricultural Department for the period 1971-1975. Typical unit values of crops, i.e. values of C_{ij}, were derived from the 1980 San Joaquin Agricultural Report. These data are summarized in Table 3.

Table 3. Cropping Pattern for the South Delta Water Agency

Crop	Percent of total area	Area acres	Crop Value $/acre[1]
Beans	8	9,840	656
Corn	9	11,070	563
Alfalfa	26	31,980	732
Tomatoes	14	17,220	2110
Fruit and Nuts	5	6,150	2154[2]
Grapes	0.8	1,000	1358
Grains	16	19,680	426
Asparagus	7	8,610	1434
Sugar beets	10	12,300	1235
Other	4.2	5,150	-
Total	100	123,000	

Source: San Joaquin County Agricultural Department survey data within the SDWA for the 1971-75 period

[1]1980 values

[2]average of peaches and walnuts

CASE STUDY EXAMPLE

To illustrate the application of the procedure for estimation of potential crop losses due to water quality degradation, two scenarios are considered.

1. Actual conditions of water quality prevailing in the South Delta during 1976, and

2. 1976 conditions modified by the assumption of New Melones Project operation to maintain 500 mg/L TDS at Vernalis.

The procedure entails the following steps:

a. Simulation of hydrodynamics and water quality for the South Delta for the agricultural season, using the mathematical models of the estuarial system (SDWA Exhibit 82),

b. Estimation of the average quality of water supplied to each of 10 subareas of the South Delta, as identified in Figure 2,

c. Calculation of the yield decrement ΔY expected for each soil type (3), crop (6), and subarea(10) by application of Equation 3.

d. Summation of incremental costs due to loss of yield, by application of Equation 4,

e. Comparison of cost differences attributed to water quality control by New Melones.

Results of water quality simulations are presented in Figures 3 and 4. Conditions shown are for mid-July, considered to be representative of the quality of water available at the peak of the irrigation season. From the results of the two simulations, the average quality of water available to the 10 subareas may be estimated as that of the most accessible channel serving the area. These are summarized in Table 4.

Yield decrements were estimated from the relationships summarized in Table 2. These were then weighted by subarea and soil group in relation to the entire SDWA area, and summed to obtain the aggregate decrement for each crop type. These were then applied to the total value of the crop to obtain the decrement in revenue. Table 5 summarizes the calculations.

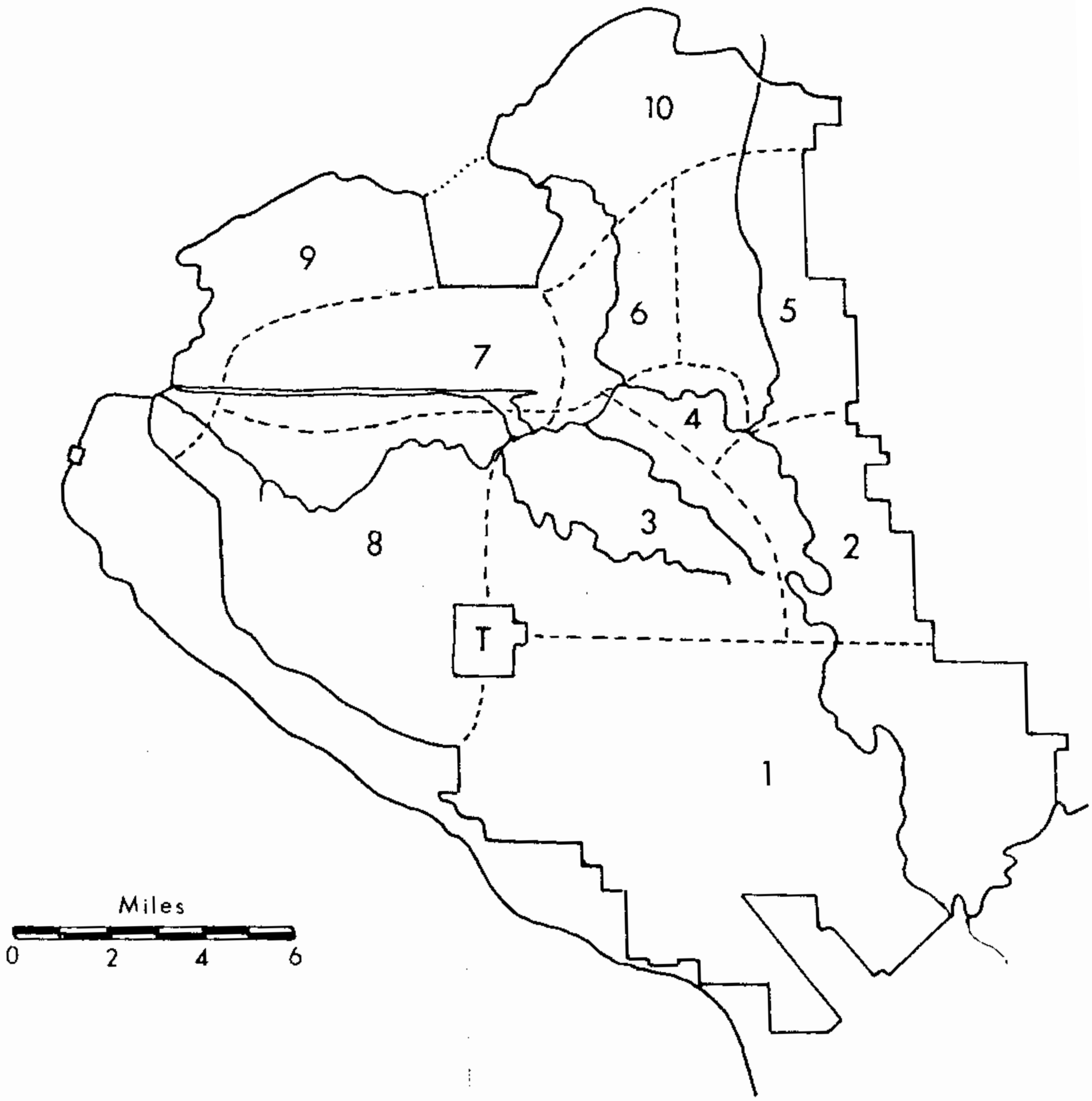


Figure 2. AGRICULTURAL SUBAREAS, SOUTH DELTA WATER AGENCY

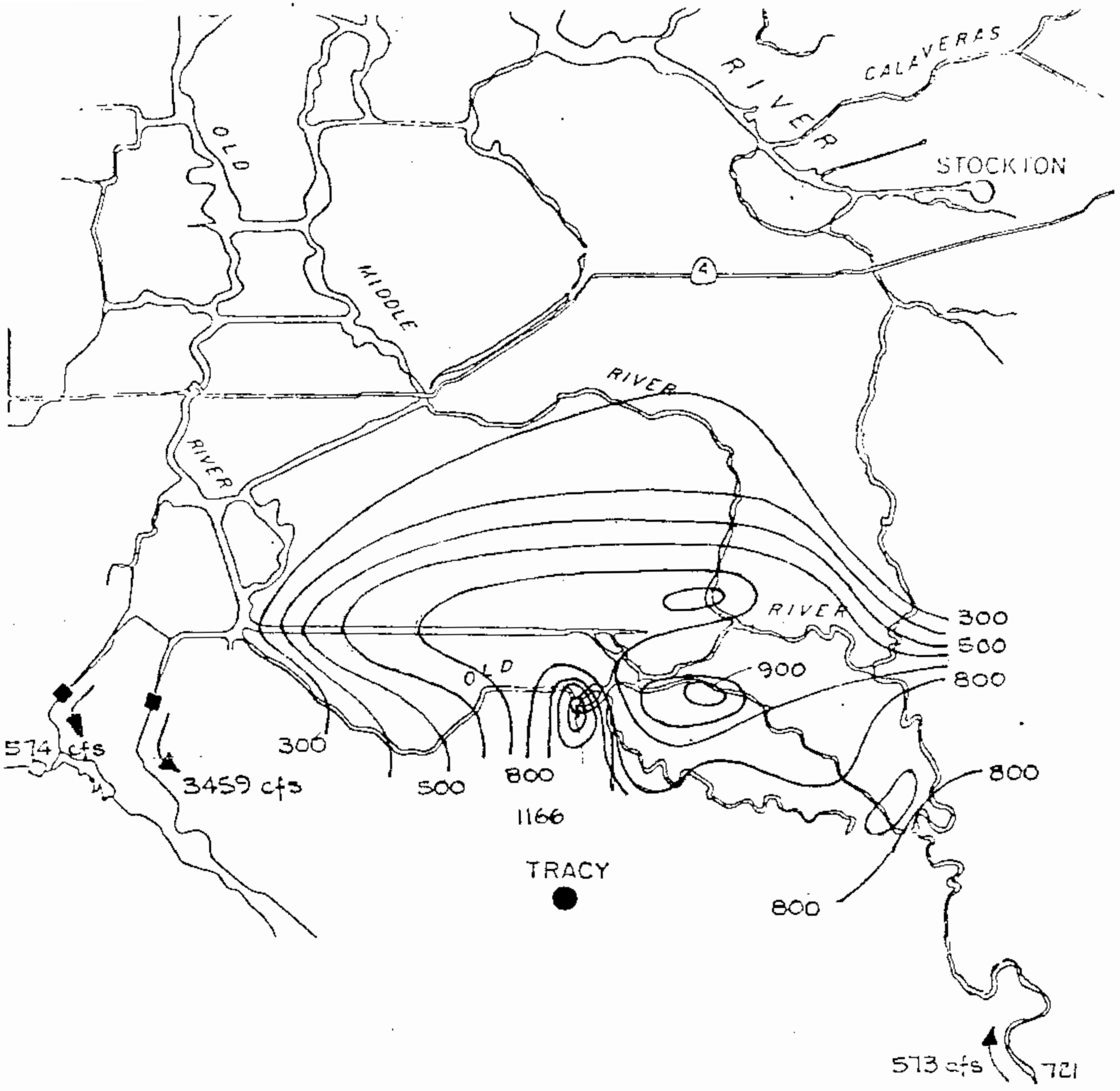


Figure 3. SIMULATED WATER QUALITY IN SOUTH DELTA CHANNELS, MID-JULY 1976, ACTUAL HYDROLOGY
(Contours are of equal TDS, mg/L)

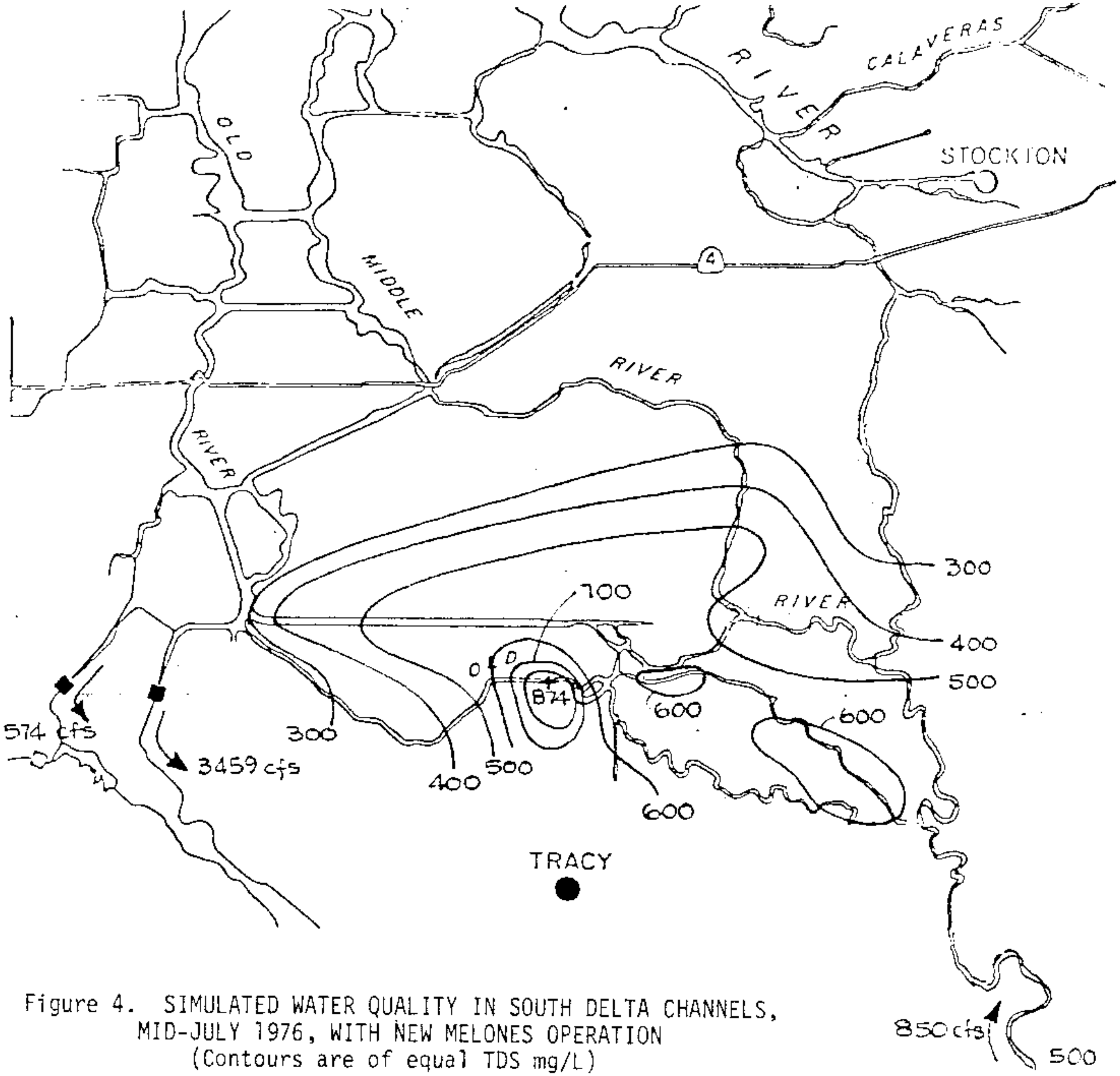


Figure 4. SIMULATED WATER QUALITY IN SOUTH DELTA CHANNELS, MID-JULY 1976, WITH NEW MELONES OPERATION
(Contours are of equal TDS mg/L)

Table 4. Comparison of Crop Loss for 1976 Conditions in South Delta With and Without New Melones Water Quality, Mid-July (Day 195)

Subarea	1976		1976 w/N.M.	
	TDS	EC*	TDS	EC*
1	753	1.19	496	0.77
2	812	1.28	492	0.76
3	777	1.22	559	0.87
4	675	1.06	487	0.77
5	244	0.36	264	0.40
6	684	1.07	486	0.75
7	710	1.12	521	0.81
8	673	1.06	575	0.90
9	227	0.34	226	0.34
10	297	0.45	282	0.43

* EC = (TDS - 18)/620, mmhos/cm

DISCUSSION

Results of this case study illustrate the potential impacts of water quality degradation on the agricultural productivity of lands within the South Delta Water Agency. These impacts are likely to be most severe in areas served by channels in which circulation is not sufficient for unidirectional transport of salt loads entering the Delta at Vernalis. Such was the case in 1976, the case investigated. It is noted that while the area is estimated to have suffered a substantial loss of productivity in this period--as much as 18 percent of the value of salt sensitive crops--this loss could be diminished by improving quality and flow at the upstream boundary at Vernalis. The apparent loss with New Melones operation, i.e. with a maximum TDS of 500 mg/L maintained by releases from the reservoir, would have been reduced by about one half, to roughly 10 percent of the total value of salt sensitive crops.

Table 5. Estimated Loss of Crop Revenue Due to Water Quality Degradation, Case Study: 1976 and 1976 With New Melones Operation

Crop	Area[1]	Unit Value[2]	Mkt.Value	Loss of Crop Revenue, 10^6 $ Actual 1976 $\Delta Y/100$	Actual 1976 ΔC	1976 w/N.Melones $\Delta Y/100$	1976 w/N.Melones ΔC
	acres	$/acre	10^6 $		$		$
Beans	9,840	656	6.46	0.406	2.62	0.331	2.14
Corn	11,070	563	6.23	0.201	1.25	0.105	0.65
Alfalfa	31,980	732	23.41	0.102	2.81	0.051	1.19
Tomatoes	17,220	2110	36.33	0.111	4.03	0.052	1.89
Fruit & Nuts	6,150	2154	13.25	0.359	4.76	0.199	2.64
Grapes	1,000	1358	1.36	0.169	0.23	0.093	0.13
TOTALS	72,260[3]		87.04		15.70		8.64

[1] 1971-75 average

[2] 1980 San Joaquin County Agriculture Department

[3] Does not include 50,740 acres of salt tolerant crops

It should be noted, however, that the presumption that the target quality could be assured by New Melones releases is conditioned by the availability of water in storage for quality control. In some years, the entire volume allocated for this purpose may be released before the critical period of crop growth, as early as mid-April in the case of 1987. With the expectation of increased yield of salinity from the San Joaquin Basin, it will be increasingly difficult to achieve quality control at Vernalis, and in the South Delta, under the present mode of operation and with the current limitations imposed on storage for water quality control.

Another important factor which is illuminated by this example is the increased sensitivity of crops to damage when they are grown in soils of only moderate permeability, less than necessary to achieve optimum leaching during irrigation. A high proportion of South Delta soils are of this type; more than a third are classified as having "slow" permeabilities, less than 0.2 inches per hour. These soils have inherently poor leaching characteristics, with leaching fractions averaging 10 percent or less. Moreover, the wide variability in permeabilities in South Delta soils, over the entire area and even within the same field, exacerbates the leaching problem. Significant fractions of an irrigated area may be comparatively less permeable than the average, requiring higher quality water to avoid potential crop damage due to salinization in sensitive zones.

In summary, soils of the South Delta are found to be more sensitive than normal because of their lower average permeabilities and natural heterogeneity. Crops normally grown in the area are impacted adversely when water quality is not sufficient to preclude buildup of salinity in the soil profile during the irrigation season. Obvious solutions to this problem lie in enhanced water quality in South Delta channels and reductions in the salt load carried into the estuary by the San Joaquin River.

State Water Resources Control Board
DIVISION OF WATER RIGHTS
P.O. Box 2000 SACRAMENTO, CA 95812-2000
901 P STREET, SACRAMENTO, CA
(916) 657-1364 FAX: (916) 657-1485

REPORT OF LICENSEE FOR

A 0 1 9 1 9 4

1994, 1995, 1996

OWNER OF RECORD: BARBARA F. HILDEBRAND, ALEXANDER HILDEBRAND

APPLICATION: A019194

LICENSE: 007144

ALEXANDER HILDEBRAND
23443 SOUTH HAYS ROAD
MANTECA, CA 95336

TELEPHONE NUMBER:
(209) 823-4166

IF OWNER'S NAME/ADDRESS/PHONE NO. IS WRONG OR MISSING, PLEASE CORRECT.

SOURCE:		COUNTY:
SAN JOAQUIN RIVER		SAN JOAQUIN
PURPOSE:	**DIVERSION/STORAGE SEASON:**	**ACRES/HP:**
IRRIGATION	MAY 01 TO NOV 01 /	40 AC
STOCKWATERING	MAY 01 TO NOV 01 /	0 AC

AMOUNT: 0.5 CFS 0 AC-FT

THIS REPORT IS REQUIRED BY THE TERMS AND CONDITIONS OF YOUR LICENSE

IMPORTANT: EVERY license is subject to the conditions therein. I have currently reviewed my license: YES [✓] NO [ ]. I am complying with the conditions of my license: YES [✓] NO [ ]. Identify any noncompliance by license term number under "Remarks" on reverse side. This report is important in providing the record of use needed in maintaining your water right. It should be filled out carefully and returned promptly to the above-listed address.

THE PROJECT HAS BEEN ABANDONED, AND I REQUEST REVOCATION OF THE LICENSE: YES [ ].

COMPLETE FOR DIRECT DIVERSION PROJECTS

1. Have you used the full licensed amount of water each year? YES [✓] NO [ ].
2. State the quantity of water used each month in gallons or acre-feet (if not known, check months water was used).

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual
1994			✓		✓	✓	✓		✓				
1995			Flood		✓	✓	✓	✓	✓	✓			
1996				✓	✓	✓	✓	✓					

COMPLETE FOR STORAGE PROJECTS

	1994	1995	1996
3. Did your reservoir spill this year?			
4. If not, how many feet below spillway vertically was the water level at maximum storage?			
5. Have you emptied the reservoir?			
6. How many feet below spillway vertically was it drawn down at end of season?			

(Continued on reverse side)

1996

State Water Resources Control Board
Bay-Delta Hearings Application No. 5626
PARTICIPANT:
EXHIBIT: SDWA 041
INTRODUCED: 6/24/99
ACCEPTED IN EVIDENCE (YES) NO
DATE 6/24/99

Attachment "J"

State Water Resources Control Board
DIVISION OF WATER RIGHTS
P.O. Box 2000 SACRAMENTO, CA 95812-2000
901 P STREET, SACRAMENTO, CA
(916) 657-1384 FAX: (916) 657-1485

A 0 1 7 9 5 0

REPORT OF LICENSEE FOR 1994, 1995, 1996

OWNER OF RECORD: BARBARA F HILDEBRAND, ALEXANDER HILDEBRAND

APPLICATION: A017950

ALEXANDER HILDEBRAND
23443 SOUTH HAYS ROAD
MANTECA, CA 95336

LICENSE: 007143

TELEPHONE NUMBER:
(209) 823-4166

IF OWNER'S NAME/ADDRESS/PHONE NO. IS WRONG OR MISSING, PLEASE CORRECT.

SOURCE: SAN JOAQUIN RIVER

COUNTY: SAN JOAQUIN

PURPOSE:	DIVERSION/STORAGE SEASON:	ACRES/HP:
STOCKWATERING	APR 01 TO NOV 01 /	0 AC
IRRIGATION	APR 01 TO NOV 01 /	24 AC

AMOUNT: 0.3 CFS 0 AC FT

THIS REPORT IS REQUIRED BY THE TERMS AND CONDITIONS OF YOUR LICENSE

IMPORTANT! EVERY license is subject to the conditions therein. I have currently reviewed my license: YES [ ] NO [ ]. I am complying with the conditions of my license: YES [ ] NO [ ]. Identify any noncompliance by license term number under "Remarks" on reverse side. This report is important in providing the record of use needed in maintaining your water right. It should be filled out carefully and returned promptly to the above-listed address.

THE PROJECT HAS BEEN ABANDONED, AND I REQUEST REVOCATION OF THE LICENSE: YES [ ]

COMPLETE FOR DIRECT DIVERSION PROJECTS

1. Have you used the full licensed amount of water each year? YES [✓] NO [ ]
2. State the quantity of water used each month in gallons or acre-feet (If not known, check months water was used)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual
1994			✓		✓	✓	✓	✓	✓	✓			
1995			[illegible]			✓	✓	✓	✓	✓			
1996				✓	✓	✓	✓	✓	✓				

COMPLETE FOR STORAGE PROJECTS

	1994	1995	1996
3. Did your reservoir spill this year?			
4. If yes, how many feet below spillway vertically was the water level at maximum storage?			
5. Have you emptied the reservoir?			
6. How many feet below spillway vertically was it drawn down at end of season?			

(Continued on reverse side)

1996