The Economic Impact on San Joaquin County of Yield Decrement from Reduction in San Joaquin River Quality

Prepared for South Delta Water Agency et al.

By

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I. Introduction

This study provides a partial estimate of the economic impact of degraded water quality in the San Joaquin River. Building upon a previous study[1] by G.T. Orlob, this study analyzes the estimated crop decrement of six crop types in the South Delta resulting from increases in salinity of the San Joaquin River. The six crop types include: beans, corn, alfalfa, tomatoes, fruit and nuts and grapes. The estimated value of the lost crops is subsequently analyzed using an input-output model to estimate the overall economic impact from the loss of yields due to water degradation.

The study is an attempt to quantify the economic impact of higher salinity water flows in the San Joaquin River, the estimates presented herein must be interpreted with care. Some caveats regarding the results of this study:

- Additional crop types may also be affected by increased salinity but are not included in this analysis.
- Assumptions are necessarily made regarding soil conditions and distribution in the study area and the crops planted under each type of soil conditions that will differ from actual planting behavior and may somewhat distort the final estimates.
- It is unknown what the exact salinity of irrigation water will be at different points downstream of Vernalis. This study assumes for tractability, that a single salinity level prevails at all points downstream over the region of examined.

[1] Impact of San Joaquin River Quality on Crop Values in the South Delta

- Although we know that water qualities in the Central Delta will be better than those in the South Delta, salt impacts occur in that area at lower levels. For purposes of this analysis, I concluded that treating the whole study area the same was appropriate as indicating what results from incremental increases in salinity.

While all of these factors affect, to varying degrees, the precision of the estimates in this study, they do not change the qualitative or sign of the impacts nor do they have a great influence on the magnitude of the changes arising from increased salinity in the San Joaquin River.

II. Yield Decrement Due to Increased Salinity

This study does not involve primary research into the effects of salinity changes on crop yields nor does it investigate the ability of various soil types to leach properly. Instead it builds upon the research into the relationship between soil types, leaching and yield decrements conducted in the report by Dr. Orlob and referenced in section I.

Dr. Orlob's study investigates the relationship between the permeability of the soils in the South Delta and the leaching characteristics of these soils. Dr. Orlob details the percent of soil groups in the South Delta by permeability. The overwhelming share of soil groups fall in the slow to moderate permeability classification (91%).

Leaching characteristics were derived from the 1976 South Delta Salinity Status Study (as referenced in the Orlob study) 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) using the following relation:

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

$LF = Leaching\ Fraction$
$EC_W = electrical\ conductivity\ of\ applied\ water, mmhos/cm\ (dS/m)$
$(EC_e)_d = electrical\ conductivity\ of\ soil\ solution\ extract\ at\ drainage\ horizon$
$(assumed\ to\ be\ the\ maximum\ in\ the\ EC_e\ profiles)\ mmhos/cm\ (dS/m)$

Mean leaching fractions $(\overline{LF})$ and standard deviations (σ) were determined for each location. It was found that there was a large range for the standard deviation ranging from 25 to 65 percent of mean leaching fraction. Dr. Orlob adopted an average standard deviation equal to $(\overline{LF}/3)$ 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 from the Salinity Study (as referenced in the Orlob study) with permeability groups from a Soil Permeability Map (as referenced in the Orlob study). A consistent direct relationship between permeability and leaching fractions emerged with some variability that Dr. Orlob attributed to in-field variation.

From subsequent calculations he classifies soils in the South Delta into three groups; A, B, and C with mean leaching fractions equal to 0.053, 0.093 and 0.188 and standard deviations of 0.0177, 0.0310, and 0.0627 respectively. These parameters of the probability density function for LF are used in subsequent calculation of yield decrement by soil type and water quality that are subsequently calculated by Dr. Orlob.

The relationship between yield decrement, leaching fraction and applied water quality are given by the following equation (equation 2 in Orlob's study):

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

Where:
$\Delta Y =$ *yield decrement, percent*
$S =$ *unit decrement, percent / mmho / cm*
$B =$ *threshold* EC_e*, mmhos / cm.*

Values of S and B for various crops are taken from FAO Irrigation and Drainage Paper 29 (as referenced in the Orlob study) and supplemented by the Water Quality Advisory Panel for the South Delta Salinity Status Study (as referenced in the Orlob study).

Since the LF can vary over a given field, the yield decrement is determined by combining the above relationship with the probability density function for LF (assumed to be normal by Dr. Orlob) and integrating over a range from 0 to LF_c, a fraction above which there is no decrement in yield. The new equation for yield decrement thus becomes (equation 3 in Orlob's study):

$$\Delta Y = \int_0^{LF_c} S \left[EC_w \left\{ \frac{1+LF}{5LF} \right\} - B \right] \frac{1}{\sigma\sqrt{2\pi}} \left(\frac{1}{2} \frac{(LF - \overline{LF})}{\sigma^2} \right) dLF .$$

The yield decrement-water quality relationship for a given soil group is obtained by integrating over the range of EC_w that is of interest. For the South Delta he uses a range of 0.7 to 1.3 mmhos/cm. The characteristics of the soil are summarized by mean leaching fraction $(\overline{LF})$ and standard deviation (σ) and the susceptibility of the crop is parameterized by S and B. Orlob provides representative yield decrement-water quality relationships for the six crops and three soil types in Table 2 of his report. The yield decrements are summarized provided for three values of EC_w: 0.4, 0.7 and 1.0 dS/m. Since historically 0.7 has been maintained at Vernalis we use this salinity level as the baseline for this study.

Using Orlob's yield decrement table we examine crop decrement for increases of salinity levels equal to 0.8, 0.9 and 1.0 dS/m. This is accomplished by interpolating the crop decrement from salinity levels between the baseline 0.7 dS/m and 1.0 dS/m for increments of 0.1 dS/m. Results are displayed in Table A.

Table A; Yield Decrement (Percent), By Soil Group and Salinity Levels

Soil Group A
LF = 0.053, sigma = 0.0177

ECw	Beans	Corn	Alfalfa	Tomatoes	Fruit & Nuts	Grapes
0.7	0.00	0.00	0.00	0.00	0.00	0.00
0.8	8.67	5.33	3.33	4.33	9.00	4.33
0.9	17.33	10.67	6.67	8.67	18.00	8.67
1.0	26.00	16.00	10.00	13.00	27.00	13.00

Soil Group B
LF = 0.093, sigma = 0.0310

ECw	Beans	Corn	Alfalfa	Tomatoes	Fruit & Nuts	Grapes
0.7	0.00	0.00	0.00	0.00	0.00	0.00
0.8	5.00	2.67	1.33	0.67	4.67	2.67
0.9	10.00	5.33	2.67	1.33	9.33	5.33
1.0	15.00	8.00	4.00	2.00	14.00	8.00

Soil Group C **LF = 0.188, sigma = 0.0627**	**Beans**	**Corn**	**Alfalfa**	**Tomatoes**	**Fruit & Nuts**	**Grapes**
ECw						
0.7	0.00	0.00	0.00	0.00	0.00	0.00
0.8	2.00	0.33	0.33	0.33	0.67	0.67
0.9	4.00	0.67	0.67	0.67	1.33	1.33
1.0	6.00	1.00	1.00	1.00	2.00	2.00

Table A is read as follows. If the salinity level remains at 0.7, the current baseline, no additional yield decrement would occur. As salinity is increased, yield decrements increase for all crops. The decline is more pronounced for soil group A, less pronounced for soil group C.

In order to know precisely what the yield decrement would be for each crop requires knowledge of the soil type(s) in which each crop is planted. Since this data was not available a simplifying assumption that each crops acreage is planted uniformly and in the same proportion as the three types of soil in the South Delta.

Commodities and farmed acreages were extracted from the 2004 San Joaquin County Agricultural Commissioner's Office Pesticide Permitting Program Database and commodity valuation was obtained from the San Joaquin County 2004 Annual Crop Report, which is being offered as evidence in this proceeding. Using these data and distributing each crop over the three soil types as described above, yields the following distribution of the total value of the six crop yields by soil type.

Table B; South Delta Crop Value by Soil Grouping (Dollars)

	Beans	Corn	Alfalfa	Tomatoes	Fruit & Nuts	Grapes
Soil Group A	$3,916,938	$14,764,135	$17,271,999	$29,897,231	$17,155,066	$2,601,210
Soil Group B	$3,329,397	$12,549,515	$14,681,199	$25,412,646	$14,581,806	$2,211,029
Soil Group C	$2,546,010	$9,596,688	$11,226,799	$19,433,200	$11,150,793	$1,690,787

Multiplying the yield decrements derived from the Orlob Study (Table A) with the value of crops planted in each soil group (Table B) for each of the salinity levels yields the estimated value of lost yields for each crop, soil type and salinity level. These estimates are detailed in Table C and aggregated over soil type in Table D.

Table C; Dollar Value of Estimated Loss in Crop Yields by Soil Group and Salinity

Soil Group A

ECw	Beans	Corn	Alfalfa	Tomatoes	Fruit & Nuts	Grapes
0.7	$0	$0	$0	$0	$0	$0
0.8	$339,468	$787,421	$575,733	$1,295,547	$1,543,956	$112,719
0.9	$678,936	$1,574,841	$1,151,467	$2,591,093	$3,087,912	$225,438
1.0	$1,018,404	$2,362,262	$1,727,200	$3,886,640	$4,631,868	$338,157

Soil Group B	Beans	Corn	Alfalfa	Tomatoes	Fruit & Nuts	Grapes
ECw						
0.7	$0	$0	$0	$0	$0	$0
0.8	$166,470	$334,654	$195,749	$169,418	$680,484	$58,961
0.9	$332,940	$669,307	$391,499	$338,835	$1,360,969	$117,922
1.0	$499,410	$1,003,961	$587,248	$508,253	$2,041,453	$176,882

Soil Group C	Beans	Corn	Alfalfa	Tomatoes	Fruit & Nuts	Grapes
ECw						
0.7	$0	$0	$0	$0	$0	$0
0.8	$50,920	$31,989	$37,423	$64,777	$74,339	$11,272
0.9	$101,840	$63,978	$74,845	$129,555	$148,677	$22,544
1.0	$152,761	$95,967	$112,268	$194,332	$223,016	$33,816

Table D; Dollar Value of Estimated Crop Loss by Salinity Level

	Beans	Corn	Alfalfa	Tomatoes	Fruit & Nuts	Grapes
Ecw						
0.8	**$556,858**	**$1,154,063**	**$808,905**	**$1,529,742**	**$2,298,779**	**$182,952**

0.9	**$1,011,876**	**$2,244,149**	**$1,542,965**	**$2,929,929**	**$4,448,880**	**$343,360**
1.0	**$1,670,574**	**$3,462,190**	**$2,426,716**	**$4,589,225**	**$6,896,337**	**$548,855**

The impact on crop revenue stemming from increases in salinity of the water in the San Joaquin River is significant. These numbers are sobering; however it does not reflect the total economic impact of this reduction in crop yield on San Joaquin County.

III. The Economic Impact of a Reduction in Crop Yield

When economic activity is reduced (or increased) in one sector of the economy the repercussion of this decrease is not contained to the sector of origin. Because of interdependencies inherent in a region's economy, the change in activity in the original sector is propagated throughout the rest of the region's economy, contracting output (spending) in other sectors. In order to capture these effects, models that reflect this interdependency should be used to assess the total impact of the change in agricultural output caused by increased salinity in the San Joaquin River.

Input-Output models are commonly used to conduct economic impact analysis as they model the interdependencies between sectors of the economy. Input-Output models statistically quantify the relationship between businesses and between consumers and businesses. Once the structure of the economy of a region has been developed, economic activity in one sector of the economy can be traced as it is propagated throughout the rest of the economy. Thus, when activity changes in one sector the subsequent changes on the rest of the economy can be estimated.

The total economic impact of a change in economic activity in one (or more) sector(s) is comprised of three different effects. The direct effect, which is the change in originating sector(s) that starts the process, and in this case it is the reduction of output in the agricultural sectors caused by increased salinity. The secondary impact of this spending arises from inter-industry purchases triggered by the direct expenditures and is know as the indirect effect. The tertiary impact stems from the spending of employees in the affected primary and secondary industries. These consumer expenditures comprise the induced effect.

A commonly used metaphor for the different types of impacts is a stone tossed into a pond. The stone symbolizes the event or activity whose impact is being measured and the pond represents the economy of the region being analyzed. The initial splash, as the stone hits the pond, is analogous to the direct effect, while the waves and ripples that emanate out from that splash represent the indirect and induced effects on the economy.

In terms of the above metaphor the stone in this case is the reduction crop yields and the pond through which this is propagated is the economy of San Joaquin County (The Stockton-Lodi MSA).

IV. Economic Impact Results

In order to measure the economic impact we use one of three commonly employed input-output models. The results are generated using a version of the IMPLAN model which is widely used and was originally developed by the U.S. Department of

Agriculture. The results are presented in tables 1 through 9 below. The economic impact is estimated for each of the three salinity levels; 0.8, 0.9, and 1.0. Fore each salinity level three tables of results are presented depicting the economic impact of estimated crop decrements on economic output by industrial sector measured in 2005 dollars, on employment by industrial sector, and on tax revenues accruing to Federal, State/Local governments by revenue type and measured in 2005 dollars.

The economic impacts on San Joaquin County, like the yield decrements themselves, increase with the projected levels of salinity. The individual crop losses at each level of salinity may not seem as significant when examined individually. However, when the losses are pooled together and allowed to ripple throughout the region the numbers quickly become more noteworthy.

Examining the results of the impact study for the crop decrement caused by allowing salinity levels to rise to 1.0 dS/m can be found in tables 7, 8 and 9 demonstrates that significant damage is inflicted on the San Joaquin economy by this reduction in water quality. Loss of output in the economy reaches nearly 32 million dollars and 386 jobs are lost in the county. As a result of all this lost economic activity the tax revenues accruing to state and local governments decline by 1.4 million dollars.

In summary, the true economic impact of reduced salinity levels in the San Joaquin River cannot just be gauged by looking at the value of crop decrement resulting from higher salinity in irrigation water. While the estimates of the dollar loss of individual crop yields in the South Delta are not small, especially to the farmers who lose this revenue, the full impact of these losses is much higher than these crop by crop figures alone. When the total value of lost crops is aggregated and a full economic

impact study conducted, the potential damage inflicted by a reduction in river quality become readily apparent.

Water Quality EC_W = 0.8 MMHOS/CM
Employment Impact

Table 1

Industry	Direct	Indirect	Induced	**Total**
Ag, Forestry, Fish & Hunting	(75.1)	(21.5)	(0.2)	(96.7)
Mining	0.0	(0.0)	(0.0)	(0.0)
Utilities	0.0	(0.2)	(0.1)	(0.2)
Construction	0.0	(0.4)	(0.1)	(0.5)
Manufacturing	0.0	(1.7)	(0.5)	(2.2)
Wholesale Trade	0.0	(1.7)	(0.5)	(2.2)
Transportation & Warehousing	0.0	(1.5)	(0.6)	(2.1)
Retail Trade	0.0	(0.3)	(3.7)	(4.1)
Information	0.0	(0.1)	(0.3)	(0.4)
Finance & Insurance	0.0	(1.1)	(1.2)	(2.3)
Real Estate & Rental	0.0	(2.7)	(0.8)	(3.5)
Professional Scientific & Tech Services	0.0	(0.9)	(0.7)	(1.6)
Management of Companies	0.0	(0.1)	(0.2)	(0.3)
Administrative & Waste Services	0.0	(0.8)	(0.9)	(1.7)
Educational Services	0.0	(0.0)	(0.5)	(0.5)
Health & Social Services	0.0	(0.0)	(3.8)	(3.8)
Arts- Entertainment & Recreation	0.0	(0.1)	(0.6)	(0.7)
Accommodation & Food Services	0.0	(0.2)	(2.6)	(2.7)
Other Services	0.0	(0.9)	(1.9)	(2.7)
Government & Non NAICs	0.0	(0.2)	(0.2)	(0.4)
Total	(75.1)	(34.3)	(19.4)	(128.7)

Water Quality EC_W = 0.8 MMHOS/CM

Table 2

Output Impact

Industry	Direct	Indirect	Induced	**Total**
Ag, Forestry, Fish & Hunting	(6,837,314)	(807,905)	(19,886)	(7,665,105)
Mining	0	(6,476)	(1,758)	(8,235)
Utilities	0	(56,477)	(28,268)	(84,746)
Construction	0	(36,404)	(12,889)	(49,293)
Manufacturing	0	(258,091)	(97,680)	(355,771)
Wholesale Trade	0	(217,092)	(69,320)	(286,412)
Transportation & Warehousing	0	(149,173)	(51,809)	(200,983)
Retail trade	0	(18,242)	(216,251)	(234,493)
Information	0	(27,239)	(54,907)	(82,146)
Finance & Insurance	0	(166,688)	(175,565)	(342,253)
Real Estate & Rental	0	(375,451)	(103,826)	(479,277)
Professional- Scientific & Tech Services	0	(62,496)	(57,014)	(119,510)
Management of Companies	0	(10,256)	(15,451)	(25,707)
Administrative & Waste Services	0	(43,145)	(42,640)	(85,786)
Educational Services	0	(1,478)	(22,836)	(24,315)
Health & Social Services	0	(14)	(307,287)	(307,301)
Arts- Entertainment & Recreation	0	(3,992)	(19,892)	(23,884)
Accommodation & Food Services	0	(9,537)	(115,884)	(125,421)
Other Services	0	(93,778)	(123,701)	(217,479)
Government & Non NAICs	0	(34,066)	(245,475)	(279,540)
Total	(6,837,314)	(2,378,000)	(1,782,341)	(10,997,655)

Table 3

Water Quality EC_W = 0.8 MMHOS/CM

Tax Impact

	Employee Compensation	Proprietary Income	Household Expenditures	Enterprises (Corporations)	Indirect Business Tax	Total
Corporate Profits Tax				(136,314)		(136,314)
Indirect Bus Tax: Custom Duty					(7,429)	(7,429)
Indirect Bus Tax: Excise Taxes					(23,911)	(23,911)
Indirect Bus Tax: Fed Non-Taxes					(8,439)	(8,439)
Personal Tax: Estate and Gift Tax						0
Personal Tax: Income Tax			(372,727)			(372,727)
Personal Tax: Non-Taxes (Fines- Fees)			(3,147)			(3,147)
Social Ins Tax- Employee Contribution	(126,575)	(28,780)				(155,355)
Social Ins Tax- Employer Contribution	(131,075)					(131,075)
Federal Government Non-Defense Total	(257,650)	(28,780)	(375,874)	(136,314)	(39,780)	(838,399)
Corporate Profits Tax				(33,315)		(33,315)
Dividends				(396)		(396)
Indirect Bus Tax: Motor Vehicle License					(2,005)	(2,005)
Indirect Bus Tax: Other Taxes					(16,321)	(16,321)
Indirect Bus Tax: Property Tax					(102,048)	(102,048)
Indirect Bus Tax: S/L Non-Taxes					(18,147)	(18,147)
Indirect Bus Tax: Sales Tax					(150,744)	(150,744)
Indirect Bus Tax: Severance Tax					(77)	(77)
Personal Tax: Estate and Gift Tax						0
Personal Tax: Income Tax			(107,987)			(107,987)
Personal Tax: Motor Vehicle License			(3,378)			(3,378)
Personal Tax: Non-Taxes (Fines- Fees)			(28,401)			(28,401)
Personal Tax: Other Tax (Fish/Hunt)			(509)			(509)
Personal Tax: Property Taxes			(1,421)			(1,421)
Social Ins Tax- Employee Contribution	(1,558)					(1,558)
Social Ins Tax- Employer Contribution	(5,608)					(5,608)
State/Local Govt. Non-Education Total	(7,166)	0	(141,696)	(33,710)	(289,342)	(471,915)
Total	(264,816)	(28,780)	(517,570)	(170,025)	(329,122)	(1,310,313)

Water Quality EC_W = 0.9 MMHOS/CM

Employment Impact

Table 4

Industry	Direct	Indirect	Induced	**Total**
Ag, Forestry, Fish & Hunting	(144.0)	(41.2)	(0.4)	(185.6)
Mining	0.0	(0.1)	(0.0)	(0.1)
Utilities	0.0	(0.3)	(0.1)	(0.4)
Construction	0.0	(0.7)	(0.2)	(0.9)
Manufacturing	0.0	(3.3)	(0.9)	(4.2)
Wholesale Trade	0.0	(3.2)	(1.0)	(4.2)
Transportation & Warehousing	0.0	(2.8)	(1.2)	(4.0)
Retail Trade	0.0	(0.6)	(7.2)	(7.8)
Information	0.0	(0.3)	(0.5)	(0.8)
Finance & Insurance	0.0	(2.1)	(2.3)	(4.4)
Real Estate & Rental	0.0	(5.1)	(1.6)	(6.7)
Professional Scientific & Tech Services	0.0	(1.7)	(1.4)	(3.1)
Management of Companies	0.0	(0.2)	(0.3)	(0.5)
Administrative & Waste Services	0.0	(1.5)	(1.8)	(3.3)
Educational Services	0.0	(0.1)	(0.9)	(1.0)
Health & Social Services	0.0	(0.0)	(7.3)	(7.3)
Arts- Entertainment & Recreation	0.0	(0.2)	(1.2)	(1.4)
Accommodation & Food Services	0.0	(0.3)	(4.9)	(5.2)
Other Services	0.0	(1.6)	(3.6)	(5.2)
Government & Non NAICs	0.0	(0.4)	(0.3)	(0.7)
Total	(144.0)	(65.7)	(37.2)	(246.9)

Water Quality EC_W = 0.9 MMHOS/CM

Table 5

Output Impact

Industry	Direct	Indirect	Induced	**Total**
Ag, Forestry, Fish & Hunting	(13,107,820)	(1,549,612)	(38,164)	(14,695,596)
Mining	0	(12,405)	(3,374)	(15,780)
Utilities	0	(108,219)	(54,251)	(162,471)
Construction	0	(69,760)	(24,736)	(94,496)
Manufacturing	0	(494,596)	(187,463)	(682,058)
Wholesale Trade	0	(415,670)	(133,036)	(548,706)
Transportation & Warehousing	0	(285,611)	(99,430)	(385,041)
Retail trade	0	(34,955)	(415,018)	(449,972)
Information	0	(52,198)	(105,374)	(157,572)
Finance & Insurance	0	(319,823)	(336,935)	(656,758)
Real Estate & Rental	0	(719,179)	(199,258)	(918,437)
Professional- Scientific & Tech Services	0	(119,837)	(109,419)	(229,256)
Management of Companies	0	(19,646)	(29,652)	(49,298)
Administrative & Waste Services	0	(82,659)	(81,833)	(164,493)
Educational Services	0	(2,832)	(43,826)	(46,658)
Health & Social Services	0	(28)	(589,729)	(589,757)
Arts- Entertainment & Recreation	0	(7,657)	(38,176)	(45,833)
Accommodation & Food Services	0	(18,279)	(222,400)	(240,678)
Other Services	0	(179,731)	(237,401)	(417,132)
Government & Non NAICs	0	(65,271)	(471,102)	(536,374)
Total	(13,107,820)	(4,557,968)	(3,420,578)	(21,086,366)

Table 6

Water Quality EC_W = 0.9 MMHOS/CM

Tax Impact

	Employee Compensation	Proprietary Income	Household Expenditures	Enterprises (Corporations)	Indirect Business Tax	Total
Corporate Profits Tax				(261,141)		(261,141)
Indirect Bus Tax: Custom Duty					(14,255)	(14,255)
Indirect Bus Tax: Excise Taxes					(45,878)	(45,878)
Indirect Bus Tax: Fed Non-Taxes					(16,192)	(16,192)
Personal Tax: Estate and Gift Tax						0
Personal Tax: Income Tax			(715,318)			(715,318)
Personal Tax: Non-Taxes (Fines- Fees)			(6,041)			(6,041)
Social Ins Tax- Employee Contribution	(242,929)	(55,223)				(298,152)
Social Ins Tax- Employer Contribution	(251,566)					(251,566)
Federal Government Non-Defense Total	(494,495)	(55,223)	(721,358)	(261,141)	(76,324)	(1,608,542)
Corporate Profits Tax				(63,822)		(63,822)
Dividends				(758)		(758)
Indirect Bus Tax: Motor Vehicle License					(3,847)	(3,847)
Indirect Bus Tax: Other Taxes					(31,315)	(31,315)
Indirect Bus Tax: Property Tax					(195,798)	(195,798)
Indirect Bus Tax: S/L Non-Taxes					(34,818)	(34,818)
Indirect Bus Tax: Sales Tax					(289,230)	(289,230)
Indirect Bus Tax: Severance Tax					(148)	(148)
Personal Tax: Estate and Gift Tax						0
Personal Tax: Income Tax			(207,244)			(207,244)
Personal Tax: Motor Vehicle License			(6,483)			(6,483)
Personal Tax: Non-Taxes (Fines- Fees)			(54,505)			(54,505)
Personal Tax: Other Tax (Fish/Hunt)			(977)			(977)
Personal Tax: Property Taxes			(2,727)			(2,727)
Social Ins Tax- Employee Contribution	(2,990)					(2,990)
Social Ins Tax- Employer Contribution	(10,764)					(10,764)
State/Local Govt. Non-Education Total	(13,754)	0	(271,935)	(64,580)	(555,155)	(905,424)
Total	(508,249)	(55,223)	(993,293)	(325,721)	(631,479)	(2,513,965)

Water Quality EC_W = 1.0 MMHOS/CM

Employment Impact

Table 7

Industry	Direct	Indirect	Induced	**Total**
Ag, Forestry, Fish & Hunting	(225.2)	(64.4)	(0.6)	(290.2)
Mining	0.0	(0.1)	(0.0)	(0.1)
Utilities	0.0	(0.5)	(0.2)	(0.7)
Construction	0.0	(1.1)	(0.4)	(1.4)
Manufacturing	0.0	(5.2)	(1.4)	(6.6)
Wholesale Trade	0.0	(5.0)	(1.6)	(6.6)
Transportation & Warehousing	0.0	(4.4)	(1.8)	(6.2)
Retail Trade	0.0	(1.0)	(11.2)	(12.2)
Information	0.0	(0.4)	(0.8)	(1.2)
Finance & Insurance	0.0	(3.3)	(3.6)	(6.9)
Real Estate & Rental	0.0	(8.0)	(2.5)	(10.6)
Professional Scientific & Tech Services	0.0	(2.7)	(2.2)	(4.9)
Management of Companies	0.0	(0.3)	(0.5)	(0.8)
Administrative & Waste Services	0.0	(2.4)	(2.8)	(5.2)
Educational Services	0.0	(0.1)	(1.4)	(1.5)
Health & Social Services	0.0	(0.0)	(11.4)	(11.4)
Arts- Entertainment & Recreation	0.0	(0.3)	(1.8)	(2.1)
Accommodation & Food Services	0.0	(0.5)	(7.7)	(8.2)
Other Services	0.0	(2.6)	(5.6)	(8.2)
Government & Non NAICs	0.0	(0.6)	(0.5)	(1.1)
Total	(225.2)	(102.8)	(58.1)	(386.1)

Water Quality EC_W = 1.0 MMHOS/CM

Table 8

Output Impact

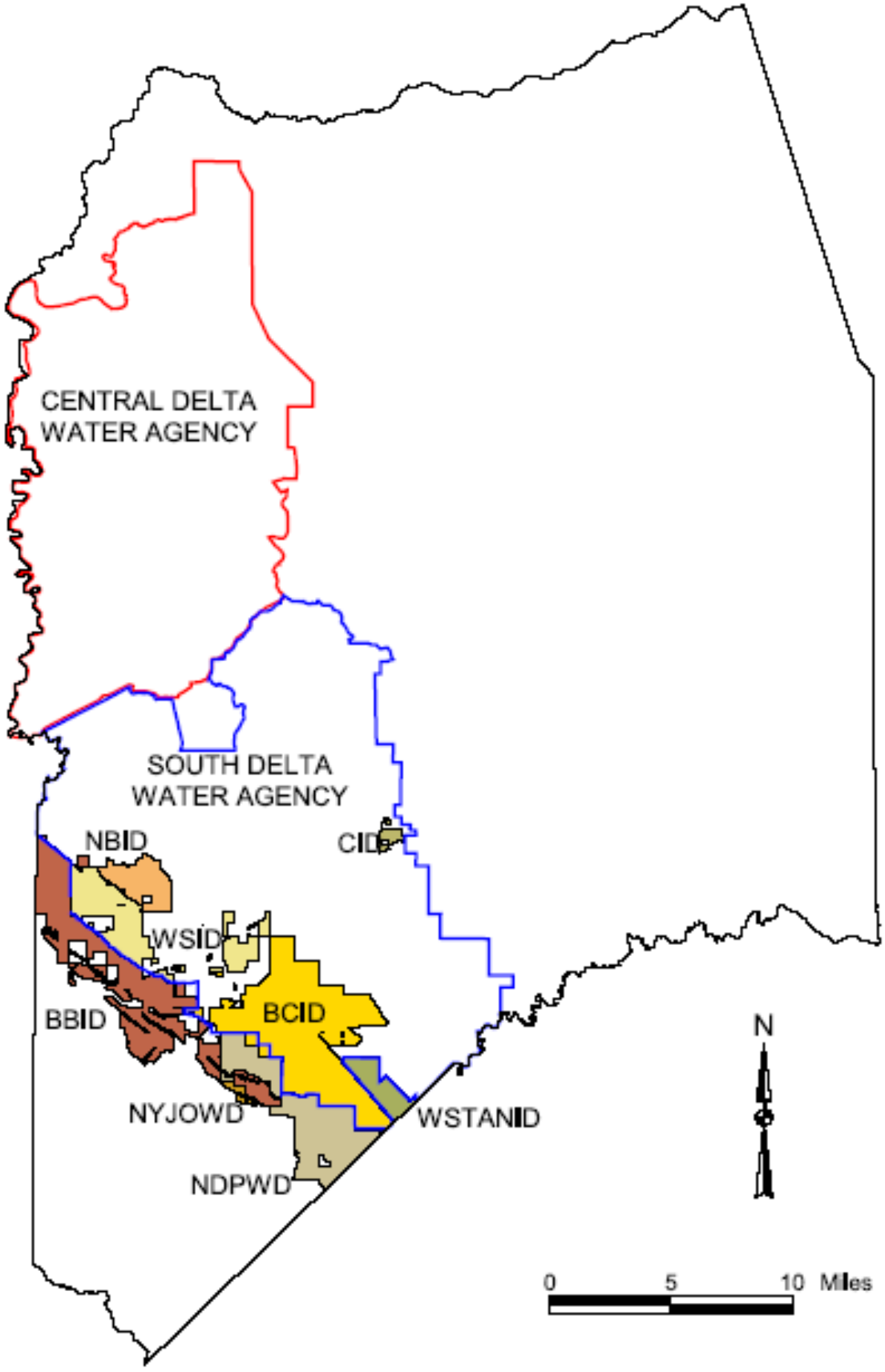
Industry	Direct	Indirect	Induced	**Total**
Ag, Forestry, Fish & Hunting	(20,511,940)	(2,423,715)	(59,658)	(22,995,312)
Mining	0	(19,429)	(5,275)	(24,704)
Utilities	0	(169,431)	(84,805)	(254,237)
Construction	0	(109,213)	(38,667)	(147,880)
Manufacturing	0	(774,272)	(293,040)	(1,067,313)
Wholesale Trade	0	(651,275)	(207,961)	(859,236)
Transportation & Warehousing	0	(447,520)	(155,428)	(602,948)
Retail trade	0	(54,727)	(648,752)	(703,479)
Information	0	(81,717)	(164,720)	(246,437)
Finance & Insurance	0	(500,064)	(526,695)	(1,026,759)
Real Estate & Rental	0	(1,126,353)	(311,479)	(1,437,832)
Professional- Scientific & Tech Services	0	(187,487)	(171,043)	(358,530)
Management of Companies	0	(30,768)	(46,352)	(77,120)
Administrative & Waste Services	0	(129,436)	(127,921)	(257,357)
Educational Services	0	(4,435)	(68,509)	(72,944)
Health & Social Services	0	(43)	(921,860)	(921,904)
Arts- Entertainment & Recreation	0	(11,975)	(59,677)	(71,652)
Accommodation & Food Services	0	(28,611)	(347,653)	(376,264)
Other Services	0	(281,333)	(371,103)	(652,436)
Government & Non NAICs	0	(102,197)	(736,424)	(838,621)
Total	(20,511,940)	(7,134,001)	(5,347,023)	(32,992,963)

Table 9

Water Quality EC_W = 1.0 MMHOS/CM

Tax Impact

	Employee Compensation	Proprietary Income	Household Expenditures	Enterprises (Corporations)	Indirect Business Tax	Total
Corporate Profits Tax				(408,943)		(408,943)
Indirect Bus Tax: Custom Duty					(22,288)	(22,288)
Indirect Bus Tax: Excise Taxes					(71,733)	(71,733)
Indirect Bus Tax: Fed Non-Taxes					(25,318)	(25,318)
Personal Tax: Estate and Gift Tax						0
Personal Tax: Income Tax			(1,118,180)			(1,118,180)
Personal Tax: Non-Taxes (Fines- Fees)			(9,442)			(9,442)
Social Ins Tax- Employee Contribution	(379,725)	(86,341)				(466,066)
Social Ins Tax- Employer Contribution	(393,226)					(393,226)
Federal Government Non-Defense Total	(772,951)	(86,341)	(1,127,622)	(408,943)	(119,339)	(2,515,196)
Corporate Profits Tax				(99,944)		(99,944)
Dividends				(1,187)		(1,187)
Indirect Bus Tax: Motor Vehicle License					(6,015)	(6,015)
Indirect Bus Tax: Other Taxes					(48,963)	(48,963)
Indirect Bus Tax: Property Tax					(306,144)	(306,144)
Indirect Bus Tax: S/L Non-Taxes					(54,440)	(54,440)
Indirect Bus Tax: Sales Tax					(452,233)	(452,233)
Indirect Bus Tax: Severance Tax					(231)	(231)
Personal Tax: Estate and Gift Tax						0
Personal Tax: Income Tax			(323,962)			(323,962)
Personal Tax: Motor Vehicle License			(10,134)			(10,134)
Personal Tax: Non-Taxes (Fines- Fees)			(85,202)			(85,202)
Personal Tax: Other Tax (Fish/Hunt)			(1,527)			(1,527)
Personal Tax: Property Taxes			(4,262)			(4,262)
Social Ins Tax- Employee Contribution	(4,674)					(4,674)
Social Ins Tax- Employer Contribution	(16,825)					(16,825)
State/Local Govt. Non-Education Total	(21,499)	0	(425,088)	(101,131)	(868,026)	(1,415,744)
Total	(794,449)	(86,341)	(1,552,710)	(510,074)	(987,365)	(3,930,940)


CENTRAL DELTA
WATER AGENCY
SOUTH DELTA
WATER AGENCY
NBID
CID
WSID
BBID
BCID
NYJOWD
WSTANID
NDPWD
N
0
5
10 Miles

STATEMENT OF QUALIFICATIONS
Sean M. Snaith, Ph.D.

B.S. Economics, with Honors, Allegheny College, 1989

M.A. Pennsylvania State University, 1994

Ph.D. Pennsylvania State University, 1996

Current position:

Director, Business Forecasting Center

Associate Professor of Business Economics

Eberhardt School of Business

University of the Pacific

ATTACHMENT "A"

TESTIMONY OF WILLIAM "CHIP" SALMON

My name is William Salmon. I reside at 7749 West Undine Road, Stockton, California. For the past five years I have been the manager of ABF Services, Inc. ("ABF") and I also own and lease other property in the South Delta which I farm separately.

As manager of ABF, I farm a piece of property at the east end of Grant Line Canal as indicated on Attachment "A." It is my understanding this property is riparian to both Grant Line Canal and Middle River. The crops on this property have included walnuts, grapes, beans, alfalfa, tomatoes and other row crops.

In the last few years, I have noticed an increasing and substantial damage to the crops resulting from salinity. This problem has been verified by representatives of the Ag Extension Service and by a laboratory analysis done by my fertilizer representative at John Taylor Fertilizer. Attachment "B" is a copy of the tissue analysis of the walnuts. It indicates acute chloride toxicity.

Attachments "C" and "D" are certain water quality sampling data from DWR for Middle River and Grant Line Canal, the two places from which I diverted water for this property. The Middle River data for 2002 shows EC levels in the 700 and 800 range for most of the year, especially in summer. The Grant Line Canal data (measured at Doughty Cut) shows EC in August was generally above 800 and sometimes 900. For the summer months in general, the level was most always above 700, though of course there were fluctuations. The EC objective at Vernalis for agriculture during the summer months is 700.

I have also attached some pictures as Attachment "E" which show some of the salt damage to the crops. Copies are difficult to view, but they do show the burned margins of the leaves and arrested growth associated with the salt damage.

The data for the damages in 2002 are as follows. The 105 acres of walnuts had a decrease in yield form 254,580 tons in 1999 to 105,380 in 2002 for the Payne variety and 85,420 tons in 1999 to 33,440 tons for the Westside variety. There was obvious leaf burn and stunted growth on the walnuts from the salts. Although the orchard would have to have been removed eventually due to a virus, it still should have had many more years of production left. However, I had to remove the orchard in 2002 because of the decrease in yield at a cost of $450 - $550 per acre which included tree removal, root removal and associated labor.

SDWA-3

The grapes are 47 acres of the Chardonnay variety. The sugar levels necessary to allow harvest for the contract I have were never reached, the grapes actually began to turn into raisins and the vines to defoliate. Although I did harvest some of them for juice, basically the entire crop was lost.

Beans were planted on 68 acres. The stunted growth of the plants was very obvious and the crop yield was one-half of other fields using the same seed and cultural practices. This acreage yielded 10 sacks per acre while the others were 20.

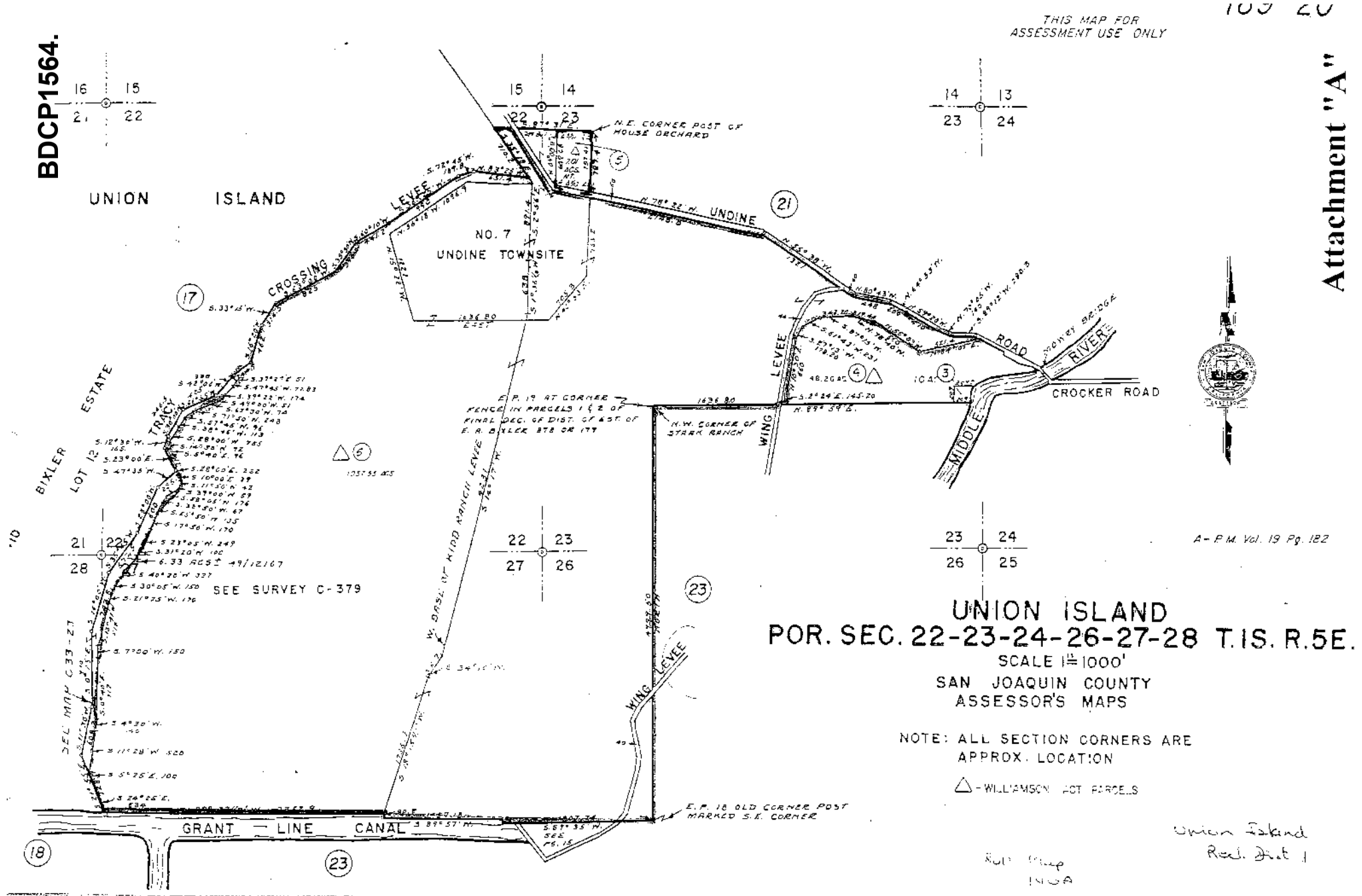
Although I have not calculated the current year's problems, the Chardonnay grapes are again stressed and will have a decreased yield and the young walnut tress I have planted which include the varieties of Tulare and Chandler are suffering from chloride stress.

To address this problem over the years I have applied soil amendments such as gypsum and have flooded the fields in winter to attempt to flush out the salts. However, the soil ph in combination with the salty water binds the chlorides and prevents leaching. The walnuts and grapes acreage are installed with tile drainage, but even that aid to drainage was inadequate.

If the water quality in the interior South Delta channels, including the Middle River near Old River compliance location was maintained at the 700 EC standard (April through August), the salt problems I am experiencing would certainly decrease and result in a direct economic benefit to ABF and associated parties. It is my personal belief that the State Water Resources Control Board should require DWR and USBR to comply with their respective permit conditions and meet the South Delta Water Quality Objectives.

BDCP1564.

Attachment "A"



LABORATORY ANALYSIS REPORT EVALUATION

JOHN TAYLOR FERTILIZERS

Fieldman: Albert Giannecchini **Customer: ABF**

Sample ID: 19

Sample Date: August 31, 2001

Soil: **Tissue:** X **Water:**

Crop: Walnut

As suspected by visual examination these young trees are suffering from acute chloride toxicity. The toxicity threshold for chloride in walnuts is 0.3%. At existing levels of 2.75% the source of chloride accumulation must be determined and aggressive corrective measures must be implemented or risk significant mortality. Steps should include periodic monitoring of irrigation water particularly if salt-water intrusion is suspected. Backhoe pits should be excavated this fall to observe the soil profile and collect soil samples at various depths to identify where in the profile Cl has accumulated. Some form of subsurface drainage systems may need to be installed to prevent this event from reoccurring in the future.

Attachment "B"

BDCP1564

REPORT NUMBER

01-248-016

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

Client No: 1420

SAMPLES SUBMITTED BY:

SEND TO:

JOHN TAYLOR FERTILIZERS
PO BOX 15289
SACRAMENTO, CA 95851-

GROWER: ABF

DATE OF REPORT 09/07/2001 PAGE 1

PLANT ANALYSIS

	REPORT OF ANALYSIS IN PERCENT								REPORT OF ANALYSIS PARTS PER MILLION							
SAMPLE NUMBER	N NITROGEN	S SULFUR	P PHOSPHORUS	K POTASSIUM	Mg MAGNESIUM	Ca CALCIUM	Na SODIUM	Cl CHLORIDE	Fe IRON	Al ALUMINUM	Mn MANGANESE	B BORON	Cu COPPER	Zn ZINC	NO_3-N NITRATE-NITROGEN	
19								2.75								

Sample # 19 | Date 08/31 | Lab # 47275 | Crop WALNUTS | Stage/Part

DEFINITION OF INTERPRETATION RATINGS

When interpretation of plant analysis results are given, they will be listed as follows:

D or Deficient	Plants should be showing visible symptoms of a nutritional deficiency. Plant growth would definitely be curtailed by an insufficient amount of this element.
L or Low	Plants may be normal in appearance but probably will be responsive to fertilization with this element.
S or Sufficient	Plants contain adequate amounts of this element for maximum yield and are normal in appearance.
H or High	Optimum yields can be expected and plants are normal in appearance. However, concentrations of this element are higher than normally anticipated.
E or Excessive	Plants probably show symptoms of a nutritional disorder or stunted growth. Yields may be reduced significantly by an excessive amount of this element.

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

A & L WESTERN AGRICULTURAL LABORATORIES

BY MIKE BUTTRESS, CPAg

Chloride Toxicity

The 2.0% Cl found in the most recent leaf sample clearly indicates a chloride toxicity. No chloride containing fertilizers have been applied so the source is either naturally in the soil or is carried in the irrigation water. The portable EC meter I used to test puddles formed below emitters revealed a water EC of approximately 1.0. This is higher than desired and it is possible that we are experiencing salt intrusion from the river. Complicating the problem is the deficit irrigations being practiced. As we dry down the soil the amount of salt remains static but the CONCENTRATION in the soil water increases, thus the accumulation in plant tissues. In arid climates where crops are grown using saline water, such as in Israel, they minimize salt damage by maintaining adequate soil moisture and avoiding dry down. This is a dilemma for ABF as they need to deliberately stress the vines for quality but by doing so they may be exaggerating salt injury. We may wish to excavate a few backhoe pits this fall-winter to explore the soil profile looking for layers that may be restricting leaching of salts as well as collect soil samples throughout the profile to determine where salts are accumulating.

TO: **Albert Giannecchini**

FROM: **Carl Bruice**

DATE: **September 6, 2001**

SUBJECT: **ABF Grape Issues**

TO: MR BILL SALMON

SUBJECT: SOUTH DELTA WATER QUALITY

Enclosed is a copy of the *South Delta Water Quality: 2001 Temporary Barriers Project* report. I also included some preliminary water quality data for Undine Road for 2002-03. Currently, the 2002 report is a work in progress. I will send you a copy as soon as it's completed. If you have any questions or would like any additional information, please call or email me.

Sincerely,

Shaun Philippart
Resource Assessment Branch
Department of Water Resources
(916) 227-2615
sphilipp@water.ca.gov

MIDDLE RIVER @ UNDINE ROAD (B9D75011230)
South Delta Temporary Barriers Project - 2002 Weekly Water Quality Sampling Data

	FIELD READINGS					BRYTE LAB RESULTS						
DATE & TIME (mm/dd/yy PST)	TEMP. (°C)	D.O. (mg/L)	E.C. (uS/cm)	TURB. (NTU)	GAGE HEIGHT (ft)	NH_3-N (mg/L)	NO_2+NO_3-N (mg/L)	ORG.-N (mg/L)	PO_4 (mg/L)	TURB. (NTU)	CHL.-A (ug/L)	PHEO.-A (ug/L)
3/26/02 7:23	13.2	7.5	946	10.8	5.02							
4/2/02 6:54	17.7	7.8	993		4.86	0.06	1.3	1.0	0.09	26.0	57.80	15.30
4/9/02 5:31	17.1	8.1	866	20.6	4.62							
4/16/02 6:21	16.0	9.2	653		4.53	0.03	1.3	1.2	0.09	13	36.7	10.9
4/23/02 5:35	16.5	8.0	393	10.3	4.60							
4/30/02 5:30	13.1	8.4	374		4.41	0.13	0.96	0.5	0.22	26.0	7.43	3.60
5/7/02 5:33	15.7	8.8	391	12.2	5.20							
5/14/02 5:50	15.8	7.9	419		5.30	0.05	0.97	0.3	0.08	11.0	7.75	3.37
5/21/02 5:31	16.8	7.6	548	8.9	5.43							
5/28/02 5:53	19.4	8.7	561		6.00	0.02	1.2	0.3	0.07	22.0	41.40	11.60
6/4/02 5:40	21.1	8.5	692	24.3	5.35							
6/11/02 5:40	19.6	10.4	764		5.44	0.04	0.90	0.7	0.06	43.0	57.10	28
6/18/02 5:55	21.0	7.2	801	24.8	5.60							
6/25/02 5:34	22.4	8.2	764		5.94	0.11	0.75	1.0	0.03	35.0	83.8	42.3
7/2/02 7:41	25.7	6.3	732	20.0	4.95							
7/9/02 6:30	23.9	7.7	750		5.30	0.06	1.20	0.6	0.09	28.0	90.8	32.2
7/16/02 8:10	23.5	6.6	767	22.2	4.40							
7/23/02 6:45	23.5	6.2	792		6.74	0.18	1.28	0.8	0.12	32.0	43.2	29.1
7/30/02 7:50	23.7	7.3	751	18.7	4.70							
8/6/02 6:40	21.9	7.6	770		6.06	0.1	1.4	1.1	0.14	32.0	39.7	22.1
8/13/02 5:45	25.0	7.6	853	34.8	4.75							
8/20/02 7:35	20.7	6.6	833		6.00	0.18	1.1	0.6	0.12	28.0	67.2	21.4
8/27/02 5:45	22.2	8.4	796	15.5	4.38							
9/3/02 6:03	23.8	6.6	793		5.78	0.2	1.5	0.6	0.1	38.0	69.1	42.8
9/10/02 5:55	20.6	10.0	799	15.9	4.64							
9/17/02 6:57	21.0	7.2	831		5.81	0.17	1.8	0.5	0.11	25.0	66.3	25.9
9/24/02 6:30	22.2	5.6	846	11.8	4.85							
10/1/02 6:05	19.1	6.6	767		5.64	0.14	2.1	0.9	0.12	17.0	13.2	9.22
10/8/02 5:50	19.4	8.6	747	19.0	4.80							
10/15/02 6:16	18.0	8.8	757		5.37	0.15	1.7	1.1	0.11	14.0	27.1	11.6
10/22/02 5:40	16.6	8.3	493	10.8	5.02							
10/29/02 7:34	14.5	7.8	718		5.04	0.14	1.47	0.4	0.11	10.0	8.81	3.91
11/5/02 7:10	12.2	8.2	701	6.3	5.10							
11/12/02 6:45	14.2	8.1	666		5.10	0.16	1.16	0.7	0.17	21.0	5.16	3.17
11/19/02 7:15	11.5	6.1	884	4.4	8.43							
11/26/02 6:40	11.4	7.7	922		3.30	0.25	1.60	1.1	0.14	8.0	7.04	2.31
12/3/02 6:25	10.1	9.3	924	33.7	4.35							

= Middle River barrier in place from 4/15/02 - 11/21/02.

	TEMP. (°C)	D.O. (mg/L)	E.C. (uS/cm)	TURB. (NTU)	GAGE HEIGHT (ft)	NH_3-N (mg/L)	NO_2+NO_3-N (mg/L)	ORG.-N (mg/L)	PO_4 (mg/L)	TURB. (NTU)	CHL.-A (ug/L)	PHEO.-A (ug/L)
MAXIMUM	25.70	10.40	884.00	34.80	8.43	0.20	2.10	1.20	0.22	43.00	90.80	42.80
MINIMUM	11.50	5.60	374.00	4.35	4.35	0.02	0.75	0.30	0.03	10.00	5.16	3.17
MEAN	19.39	7.80	700.19	16.24	5.33	0.12	1.28	0.71	0.11	24.69	41.55	18.82
Range	14.20	4.80	510.00	30.45	4.08	0.18	1.35	0.90	0.19	33.00	85.64	39.63
Standard Deviation	3.91	1.09	145.63	7.92	0.84	0.06	0.35	0.29	0.04	9.94	28.55	13.56
Sample Variance	15.26	1.19	21,206.74	62.78	0.70	0.00	0.13	0.08	0.00	98.90	815.13	183.97
Standard Error	3.94	1.07	138.65	7.65	0.88	0.06	0.34	0.29	0.05	10.17	22.24	6.15
Median	20.10	7.85	754.00	15.70	5.15	0.14	1.20	0.65	0.11	25.50	40.55	16.50
Mode	19.40	7.60	764.00	#N/A	6.00	0.18	1.20	0.60	0.12	28.00	#N/A	11.60
Kurtosis	-0.85	0.13	0.31	0.47	4.86	-1.29	0.61	-1.12	1.97	-0.87	-1.19	-0.98
Skewness	-0.37	0.17	-1.19	0.65	1.74	-0.38	0.86	0.23	0.84	0.11	0.21	0.45
Count	32	32	32	16	32	16	16	16	16	16	16	16
Confidence Level (95%)	1.35	0.38	50.46	3.88	0.29	0.03	0.17	0.14	0.02	4.87	13.99	6.65

* All descriptive statistics were calculated from data recorded while the Middle River barrier was in place.

Electrical Conductivity in MilliS for Doughty Cut Above Grant Line Canal
Period of Record 7/25/02 to Present
Provided by DWR by Mike Abiolui; Taken from CDEC

7/25/02 8:30	790	7/25/02 19:45	742	7/26/02 7:00	729
7/25/02 8:45	790	7/25/02 20:00	748	7/26/02 7:15	734
7/25/02 9:00	794	7/25/02 20:15	750	7/26/02 7:30	736
7/25/02 9:15	795	7/25/02 20:30	741	7/26/02 7:45	739
7/25/02 9:30	796	7/25/02 20:45	745	7/26/02 8:00	742
7/25/02 9:45	796	7/25/02 21:00	745	7/26/02 8:15	744
7/25/02 10:00	797	7/25/02 21:15	762	7/26/02 8:30	746
7/25/02 10:15	797	7/25/02 21:30	768	7/26/02 8:45	749
7/25/02 10:30	798	7/25/02 21:45	788	7/26/02 9:00	749
7/25/02 10:45	797	7/25/02 22:00	785	7/26/02 9:15	754
7/25/02 11:00	799	7/25/02 22:15	790	7/26/02 9:30	759
7/25/02 11:15	797	7/25/02 22:30	788	7/26/02 9:45	758
7/25/02 11:30	798	7/25/02 22:45	788	7/26/02 10:00	761
7/25/02 11:45	797	7/25/02 23:00	788	7/26/02 10:15	766
7/25/02 12:00	797	7/25/02 23:15	785	7/26/02 10:30	771
7/25/02 12:15	797	7/25/02 23:30	782	7/26/02 10:45	769
7/25/02 12:30	798	7/25/02 23:45	777	7/26/02 11:00	766
7/25/02 12:45	798	7/26/02 0:00	772	7/26/02 11:15	765
7/25/02 13:00	797	7/26/02 0:15	768	7/26/02 11:30	766
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Attachment "E"

TESTIMONY OF ALEX HILDEBRAND
HEARING ON PROPOSED CEASE AND DESIST ORDER TO DWR AND USBR

My name is Alex Hildebrand. I was a Director of the South Delta Water Agency (SDWA) for 30 years and am currently the engineer for that Agency. A copy of the Agency's boundaries is provided as Attachment "A." I have testified many times before this Board as well as other regulatory and legislative bodies and was qualified as an expert witness with regard to the water quality and flow issues affecting the South Delta.

A copy of my current statement of qualifications is attached hereto as Attachment "B." Briefly, I have a B.S. in physics with minors in chemistry and engineering, and worked for Chevron until I retired in engineering and technical capacities including Assistant Chief Engineer of the Richmond Refinery and Director of the La Habra Research Laboratory. Since that time I have farmed approximately 150 acres on the San Joaquin River about 12 miles by river downstream of Vernalis in the South Delta. For the past 30 years, I have been intimately involved in the discussions, negotiations, regulatory proceedings and litigation to protect its diverters from the adverse effects of SWP and CVP and to insure the area has an adequate supply of good quality water.

My testimony for this proceeding is divided into four parts following a discussion of background. The first part deals with how the DWR and USBR can meet current salinity standards while using temporary rock barriers. It has been argued that the 0.7 EC requirement in internal channels cannot be reasonably met even after implementation of the SDIP and that it is therefore unreasonable to require it now. That assertion is incorrect. The second deals with the numerous interrelated benefits which result from compliance with permit conditions. The third part explains how I and others are personally affected. And the last part addresses the reconsideration of the Water Quality Response Plan.

I. Background

1) Regulatory Background

As set forth in the 1991 and 1995 Water Quality Control Plans, the two San Joaquin River standards (at Brandt Bridge and Vernalis) were to be implemented promptly. The two Old River standards (Old River near Middle River and Old River at Tracy Road Bridge) were to be implemented no later than December 31, 1997 (see Attachment "C"). The 1995 Plan therefore recognized that the San Joaquin River standards would be addressed with good quality flows on the River, while the Old River standards required other actions such as barriers which could not be immediately implemented.

In D-1641, the Board acknowledged that, "Construction of permanent barriers alone is not expected to result in attainment of the water quality objectives." The Board went on to note that the "objectives can be met consistently only by providing more dilution or by treatment." (See Attachment "D" D-1641 at page 88.)

Hence, in 2000, this Board recognized that permanent barrier installation and operation ***and*** other actions, including additional dilution flows, were necessary to meet the standards.

Since 1995 at the earliest, and 2000 at the latest, DWR and USBR have known that in order to meet the 0.7/1.0EC standards, they had to undertake actions ***in addition to the proposed barrier program.*** To my knowledge, DWR and USBR have undertaken no actions other than the barrier program.

As I understand the issues before the Board in this proceeding, the questions are first, whether a Cease and Desist Order should issue, and second, if so, what terms should be in such an order.

The answer to the first question is certainly "yes." Since DWR and USBR do not believe their current operations, including temporary barriers, will result in compliance with their permit terms, especially at the three interior South Delta stations, they should be ordered to comply. There appears to be no logical or practical reason for not requiring compliance with existing Water Quality Objectives and permit terms. This is especially true given that the Board determined over five years ago in D-1641 that compliance would indeed require additional dilution flows (or treatment). The fact that DWR and USBR knew the permanent operable barriers would not be built in the short term and did not undertake the necessary and anticipated other actions to secure and provide additional flows or treatment does not change the need for the objectives or the benefits therefrom.

I note that HR 2828 requires the USBR to develop a plan by the end of this year under which it will meet its water quality obligations on the San Joaquin River (see Attachment "E"). Since the Congress believes the Bureau should meet the objectives, one would think the SWRCB would too.

2) <u>Historical Background</u>

The changes in San Joaquin River flows and water quality pre-CVP and post CVP are set forth in the June 1980 Report entitled "*Effects of the CVP Upon the Southern Delta Water Supply Sacramento - San Joaquin River Delta, California.*" This Report and numerous other studies and investigations (including D-1641) have identified the operation of the CVP as the principle cause of the salinity problem in the lower San Joaquin River and Delta. However, the SWP's effects on flows in Delta channels and its

joint efforts with the CVP in supplying export water to the San Joaquin Valley are significant contributory causes.

As a consequence of this problem, the SWRCB slowly adopted and even more slowly implemented water quality objectives to protect agricultural beneficial uses. Currently, only dilution water is used to meet the Vernalis standard. The delay in implementing the other three standards has allowed DWR and USBR to avoid taking other actions. [Although temporary barriers do trap some good quality export water which improves water quality in portions of Middle River and Tracy Old River compliance stations, the net flow is back (downstream) over the barriers and the water quality does not approach the 0.7 EC standard.

The dilution water needed to comply with the current Vernalis salinity objectives is required because the westside wetlands and farm lands receive Delta Mendota Canal (DMC) water which contains a large salt load. That salt load is then concentrated by crop and wetland evaporation. Most of the salt then drains to the river where it must be diluted.

II. Compliance with the 0.7/1.0EC internal South Delta salinity standard with Temporary barriers

The subject Water Quality Objectives can be met and the in-channel water supply in internal South Delta channels can be maintained at 0.7 EC from April through August with very little water cost to the CVP and SWP. This is the case both before and after permanent barriers are installed and other concurrent measures are provided. While using temporary barriers the following salinity control measures and others should be utilized.

1) Dilution Needs.

A) As water passes Vernalis, it slowly degrades due to evaporation, consumptive uses and urban discharges. This degradation is reflected in field data which DWR has collected and which is set forth in Attachment "F." The increase in salinity during low flows can be .1 EC or more from Vernalis to Brandt Bridge. The amount of dilution water needed to offset this rise in salinity at Brandt Bridge or elsewhere depends on the quality of the dilution water and the amount of the flow from Vernalis to Brandt Bridge. Dilution provided upstream of Vernalis can be used to lower salinity below 0.7 EC at Vernalis so that it will not rise above 0.7 EC at downstream locations. Dilution with Middle River water can be used to restore salinity to 0.7 EC at the point of dilution. To offset a 0.1 EC rise in salinity would take about 250 cfs of 0.4 EC dilution water when the Vernalis base flow is 1000 cfs. The 0.4 EC is representative of DMC water quality. If the dilution flow was provided from one of the tributaries, less of that better quality

water would be required.

2) Dilution Opportunities.

A) New Melones is currently the only reservoir used by the USBR to meet the Vernalis standard. Whatever additional measures are undertaken to meet the downstream South Delta standards, the New Melones releases that would be required in the absence of these measures to meet the Vernalis standard will continue to be required at least in the short term. Additional releases could also be made from this source to contribute to meeting the other South Delta standards. This year as of June, the Bureau has allocated 180,000 acre-feet of New Melones storage for water quality purposes, but has used none of this amount (see Attachment "G;" personal communication with USBR staff). Obviously, in the short term, water is available from New Melones.

B) Additional water from the tributaries to the San Joaquin River could be purchased for release during the April through August time frame. In the recent past, hundreds of thousands of acre-feet have been purchased from the tributaries for a variety of reasons. As stated above, it would take less of this high quality water to provide the needed dilution than is the case when DMC water is used.

C) Upstream exchanges could also be coordinated to provide dilution flows. Given the various connections of the SWP and CVP distribution systems, exchanges between water users could be made to provide additional flows on the San Joaquin River. For example, this year excess and flood flows from Friant were diverted at the Mendota Pool for delivery to Westlands Water District and others. Some of that water could have been allowed to flow downstream in exchange for other DMC, California Aqueduct, or San Luis Reservoir supplies.

D) Water can also be recirculated through the DMC using one of its wasteways to deliver the flows to the San Joaquin River. The Bureau conducted such a recirculation pilot project in 2004 using DMC water released from the Newman Wasteway. The releases during that project had a significant impact on San Joaquin River quality. (See Attachment "H"). The 250 CFS recirculation release from the Newman Wasteway decreased the EC in the River from 1,200 to 900 (or 1.2 to 0.9 using the same parameters as the 0.7 standard) at the Patterson Measurement Station and from 700 to 600 (or 0.7 to 0.6) at the Vernalis Station. [The differing changes are due to the differing amounts of flow in the River at the two locations.] I also note that D-1641 specifically required the Bureau to investigate the use of such recirculation to assist in meeting water quality standards. I believe the Bureau has failed to meet the deadlines required by D-1641.

E) Transfers for EWA or other purposes can be coordinated such that the transfer water could be released during the April - August time frame. The transfer water

would provide dilution but would not be lost as San Joaquin River and South Delta diversion needs do not change with flow fluctuations.

F) As the Board knows, CVP permits in addition to New Melones are burdened with the requirement of meeting the salinity objectives. Hence, releases from Friant, Shasta, Folsom, or San Luis could be used to supplement San Joaquin River flows. For example, the high flows this year from Friant re-charged (to some degree) the groundwater in the area at and above Gravelly Ford on the San Joaquin. The Bureau missed a perfect opportunity to test how much water would be lost from additional summer releases once that groundwater had been re-charged.

G) Temporary barrier operations result in net downstream flow back over the Middle River and Grant Line Canal barriers. Improved San Joaquin River water quality will also improve the Middle River and Grant Line quality. If this does not result in compliance at the Middle River and Old River Stations, other actions can be undertaken. The Middle River rock barrier can be improved to capture and retain more high tide water, and low lift pumps can be added at the barrier to increase the flow of high quality water up through Middle River and into Old River. This will maintain high quality water in Middle River, and the flow continuing into Old River will blend with the water flowing into the head of Old River. This will further reduce the salinity of the Old River water which is also reduced by the measures discussed above.

3) Recovery of Dilution Flows.

A) Any additional dilution flows added to the San Joaquin River are available for export as they pass through the South Delta. If the water cannot be currently pumped as additional exports, DWR and USBR could coordinate exchanges so that the water is pumped for such things as EWA purposes using the additional 500 CSF export authorization of the SWP or exchanged to replace or substitute for a transfer being accomplished under JPOD operations. Even if none of these authorizations were available, DWR and USBR could petition the Board for short term authorization to allow them to pump these additional dilution flows. One would assume the Board would look favorably upon such a request given that its underlying purpose is to meet existing Water Quality Objectives. Approval of such petition would be similar to D-1641's “no net loss” principle regarding fishery releases. In sum, all additional dilution flows would enter the South Delta and be available for export at the SWP and/or the CVP pumps. The losses should only be minimal. For example, the recirculation pilot program estimated the losses at less than 10%. I recall that carriage water losses for the DWR Dry Year Purchase Program were less than 5% in 2004.

It is important to note that the water deliveries of the CVP to its westside service area of the San Joaquin Valley, as assisted by the SWP, are the cause of the River’s

salinity problems. As I understand it, other parties are asserting that the CVP and SWP should not be required to meet the standards if it adversely affects their deliveries or costs. It would be illogical and unfair to allow the continued delivery of the water which causes the salt problem, and yet not require that some of that delivered water be used to mitigate the salt problem.

III. Benefits Resulting From Compliance With The Salinity Objectives

I will now give an overview of the benefits from meeting the Water Quality Objectives which also addresses the question of whether a Cease and Desist Order should issue.

A) As the Board knows, the 0.7/1.0 EC standards were developed to protect agricultural beneficial uses. The voluminous studies, investigations, and testimony previously used by the Board in setting these standards was referenced in SDWA's presentation at the Periodic Review process workshops. Generally, EC's above 0.7 have an incremental adverse effect on crop production, which translates into a monetary damage to farmers.

B) To get a broad estimate of the damage that occurs as the EC of the water rises, I refer the Board to the previously submitted report of Dr. G. T. Orlob attached hereto as Attachment "I," and entitled "Impacts of San Joaquin River Quality On Crop Yields In The South Delta." Therein, Mr. Orlob calculated the crop damage in dollars between actual crop yields and the yields which would result if a standard of 500 TDS had been met. Using 1976 figures and dollars, the crop loss for the South Delta area was (15.70 - 8.64) $7.06 million. In 2005 dollars, it is approximately $24 million (using a CPI calculation at http://woodrow.mpls.frb.fed.us/research/data/us/calc/). This gives the Board a good idea of the scope of the crop damage if the EC downstream of Vernalis were allowed to exceed the current standard during the April through August time frame. The specific impacts on diverters is exemplified by the testimony of the other SDWA and CDWA witnesses.

C) We also know that virtually all of the San Joaquin River water ends up at the State and Federal pumps (see Testimony of Thomas Zuckerman, Exhibit No. CDWA-10). This is due to the fact that even with temporary barriers, the net flow is downstream over the Grant Line and Middle River barriers, and, that the water which continues down the mainstem of the River also mostly ends up at the pumps. Hence, the quality of export water is partially dependent on the quality of the San Joaquin River. Improving the River water quality in order to meet the standards will benefit export interests, especially municipal water users. Although I do not have the calculations, I understand that the Bureau has done investigations which determined the benefit to municipal water treatment plants resulting from improvements and source water quality.

D) The Board is also well aware of the dissolved oxygen (DO) problem in both the mainstem of the River, specifically in the Stockton Deep Water Ship Channel, and also generally throughout the South Delta. Two Basin Plan Objectives for DO apply to these waters. Additional good quality water added to the system for purpose of meeting the salinity standards will also help improve DO levels both because of the quality of the flows, and the additional flow/circulation they will provide.

E) The additional flows would also provide benefits to the various fisheries. We know that out-migrating salmon smolts are traveling through the system even after the spring pulse flow has ended. These fish would be helped by the higher flows. Other species, such as steelhead and smelt may also be benefitted by the higher flows. Use of the additional flows for dilution would provide an opportunity for the fishery agencies to examine the effects.

IV. Effects On Farming Operations

As I referenced above, I am a farmer on the San Joaquin River. I divert under both appropriative rights (see Attachment "J") and under my riparian rights (my chain of title documents are being introduced by a CDWA witness as Exhibit No. CDWA-6). I have personally experienced the adverse impacts of the SWP and CVP, and other upstream projects. I have had reduced crop yields due to high salinity of the River water. I have been unable to divert from the River due to decreased upstream flows and the destruction of the high tide which previously extend to the portion of the River I abut. Requiring the DWR and USBR to meet the previously established Water Quality Objectives which are contained in their permits would not only protect me, but also numerous other beneficial users of water. Farmers further downstream have experienced more loss due to salinity because salinity rises above the Vernalis standard as water flows downstream as previously discussed.

Finally, for clarification, the draft Cease and Desist Order states the temporary barriers are installed to mitigate the adverse effects of the HOR fish barrier. This is misleading. Although the federal funding for the temporary barriers was previously linked in CVPIA to the funding for the HOR fish barrier as mitigation of that barrier, that does not accurately describe why the other three tidal barriers are installed. It is my understanding that DWR now shoulders all of the costs of the temporary barrier program, though there may be some arrangement whereby USBR will pay its share in some other way. The temporary tidal barriers are installed to partially mitigate the adverse effects on water levels, quality, and quantity resulting from the operations of the CVP and SWP. At this date, the SWRCB should not be trying to avoid describing the true state of affairs in the South Delta. There is no disagreement that the projects lower water levels, decrease flows, reverse channel flows, cause stagnant zones and worsen water quality. The temporary tidal barriers are one of the preliminary steps in correcting these problems.

V. Water Quality Response Plan

Finally, I will address this Board's reconsideration of the Chief of the Division of Water Rights approval of the current Water Quality Response Plan for Joint Point of Diversion. In approving the current Response Plan, the Division Chief waived compliance with the currently existing Water Quality Objectives for Agricultural Beneficial Uses at the Brandt Bridge, Old River near Middle River and Old River at Tracy Road (sic) Bridge. This would appear to be not only beyond the Division Chief's authority and contrary to D-1641, but also directly contrary to the purpose of the Water Quality Response Plan.

D-1641 requires as a condition to JPOD that the DWR and USBR "develop a response plan to ensure that the water quality in the southern and central Delta will not be significantly degraded through operations of the Joint Point of diversion to the injury of water users in the southern and central Delta" (see for example page 150-151 of D-1641). Approval of the plan was to come from the Division Chief.

The purpose of the plan is to ensure that the incremental affects on water quality resulting from JPOD do not injure other users. Inexplicably, the Division Chief decided that while she was protecting the Delta users from the incremental effects of JPOD on water quality, she would relax the existing Water Quality Objectives. In other words, she allowed a greater impact to water quality than she was protecting through the plan.

This bizarre decision by the Division Chief cannot stand and should be forthwith revoked. No further evidence is necessary to undo such an act which is not only beyond her authority but directly contrary to the explicit and implicit purposes of the Water Quality Response Plan. This Board will consider changes to the 1995 Water Quality Control Plan through the Periodic Review process and perhaps through the process resulting from DWR and USBR's Petition to delay implementation of their permit terms. The Response Plan process did not give any party notice that such a significant change was pending and so it would be unfair and wrong to allow it. Similarly, we belief a change in the standards would require new environmental evaluation.

SDWA requests that the Water Quality Response Plan not include the Division Chief's wrongful waiver of existing standards.

BDCP1564.

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. S1.) 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.

BDCP1564.

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"

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.

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

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

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

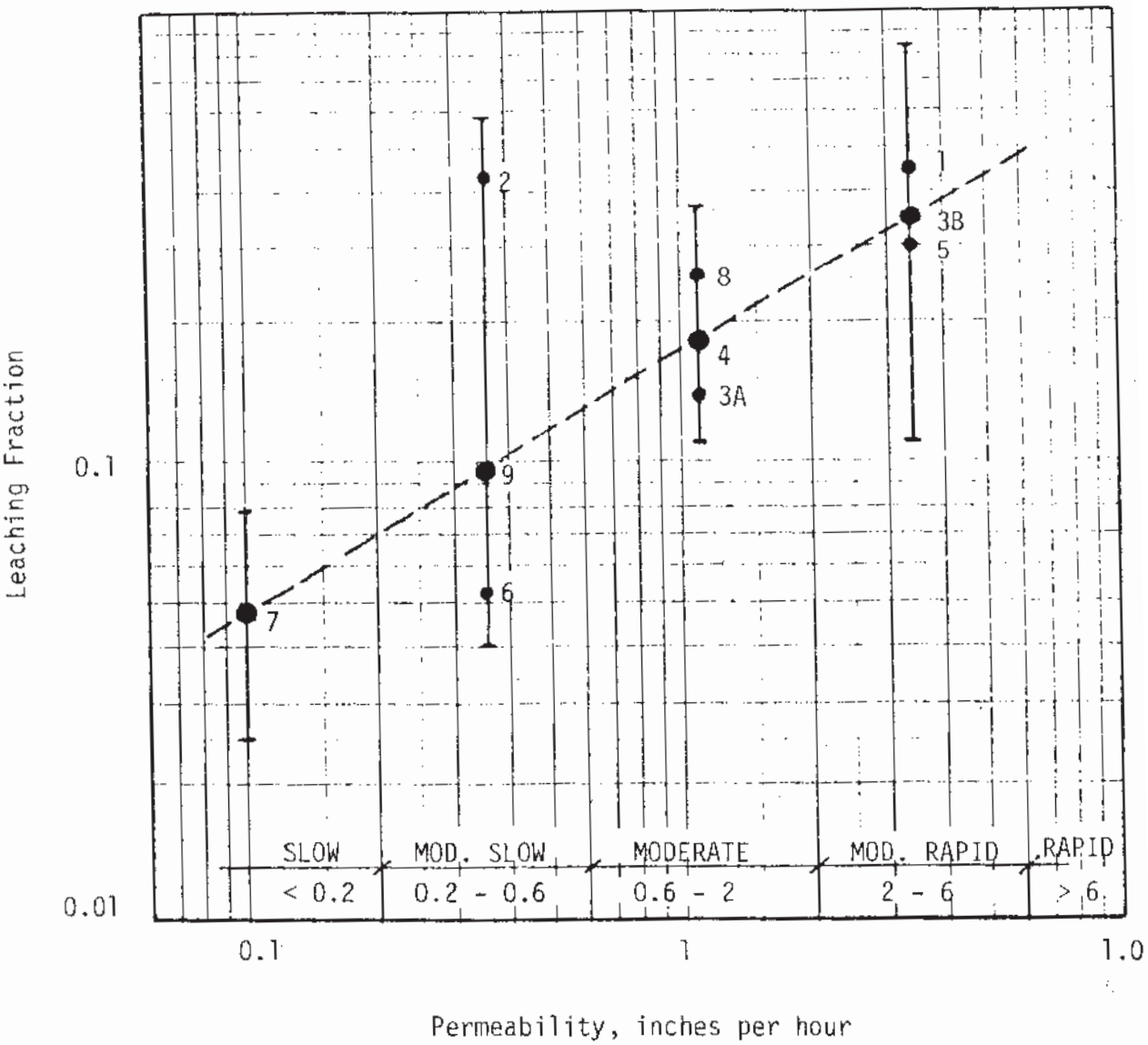

Figure 1. RELATIONSHIP BETWEEN LEACHING FRACTION AND FIELD PERMEABILITY, SOUTH DELTA SOILS

CROP YIELD VS WATER QUALITY

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

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

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.

$$\Delta Y = \int_0^{LF_c} S \left[EC_w \{\frac{1 + LF}{5\ LF}\} - B \right] \frac{\exp}{\sigma\sqrt{2\pi}} \left(- \frac{1}{2} \frac{(LF-\overline{LF})^2}{\sigma^2} \right) dLF \quad (3)$$

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

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

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.

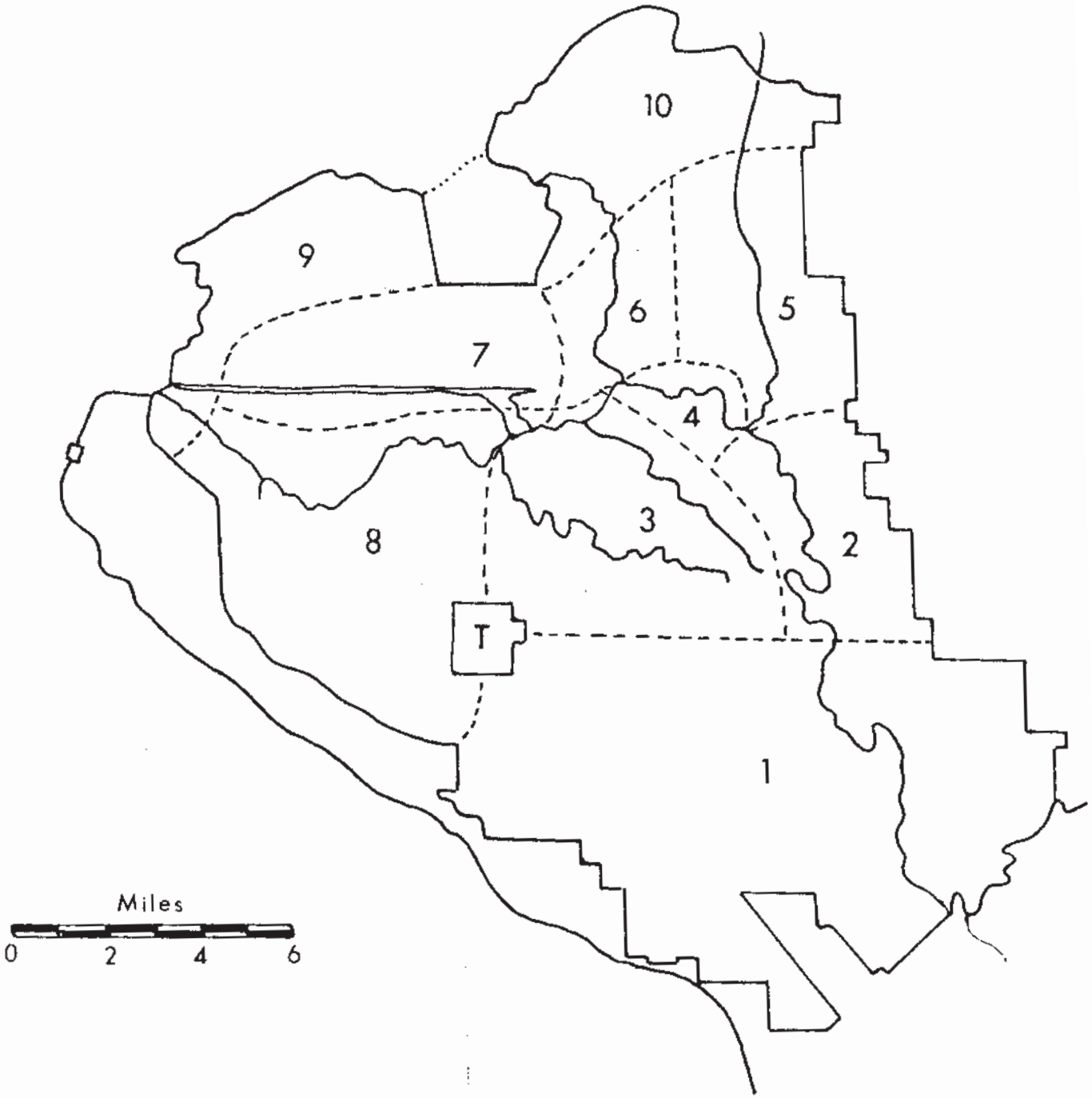

Figure 2. AGRICULTURAL SUBAREAS, SOUTH DELTA WATER AGENCY

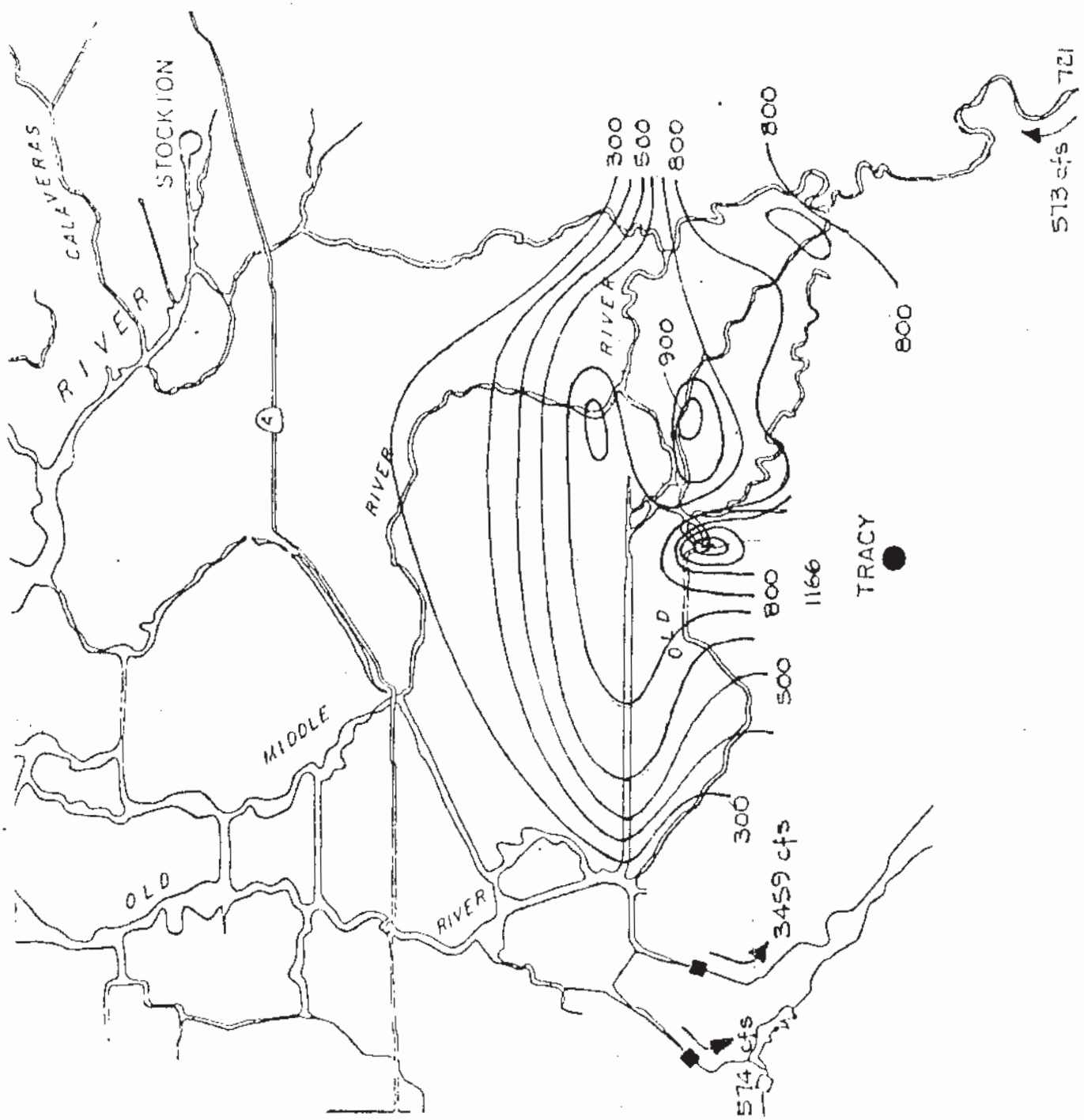

Figure 3. SIMULATED WATER QUALITY IN SOUTH DELTA CHANNELS, MID-JULY 1976, ACTUAL HYDROLOGY
(Contours are of equal TDS, mg/L)

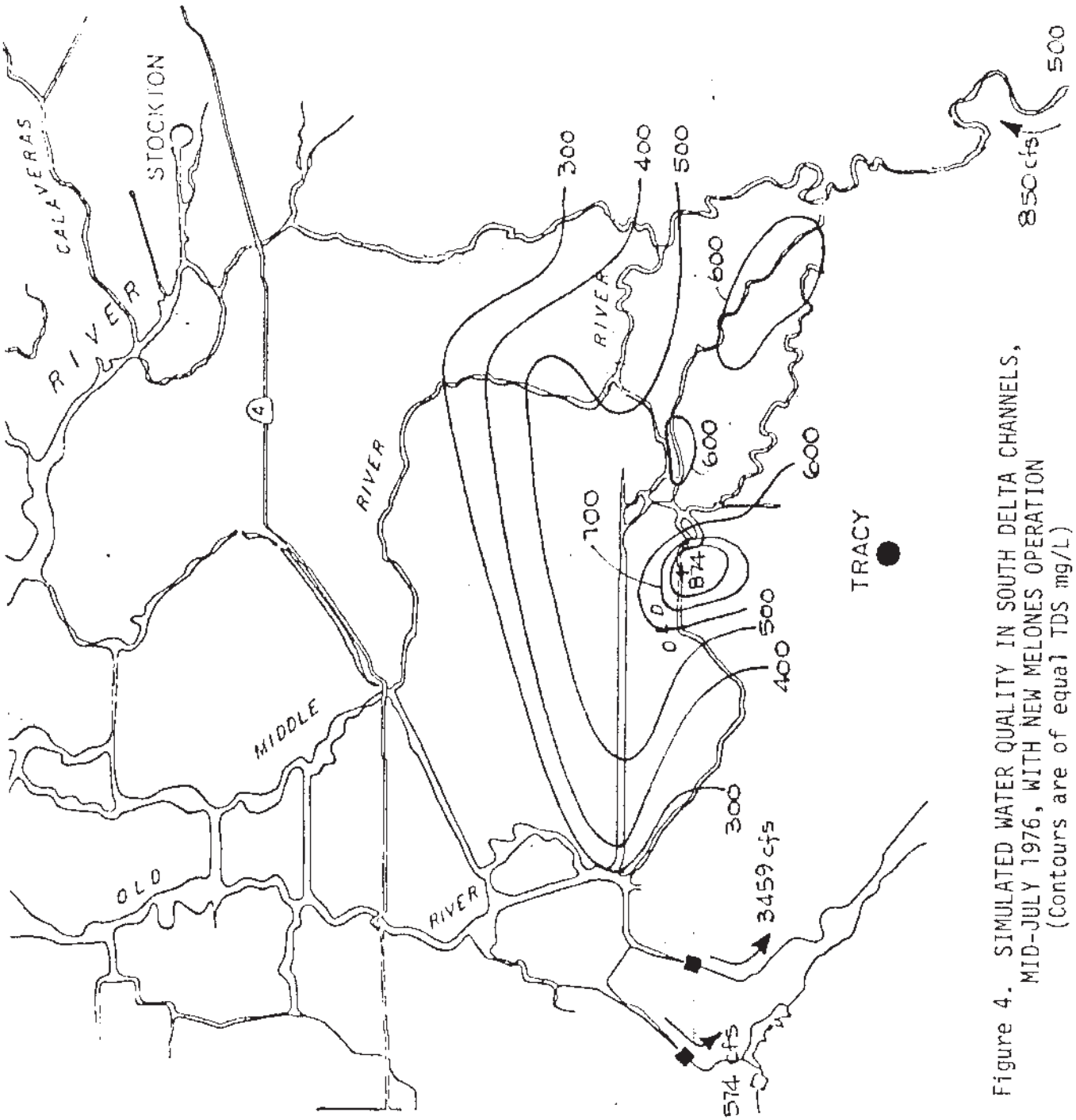

Figure 4. SIMULATED WATER QUALITY IN SOUTH DELTA CHANNELS, MID-JULY 1976, WITH NEW MELONES OPERATION (Contours are of equal TDS mg/L)

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		1976 w/N.Melones	
				ΔY/100	ΔC	ΔY/100	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.