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### Responding to Water Quality Problems Through Improved Management of Agricultural Water

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**Responding to Water Quality Problems  
through Improved Management  
of Agricultural Water**

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**Water Organizations in a Changing West**

**Natural Resources Law Center  
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## **I. Introduction**

### **A. Summary**

The land within the Broadview Water District, near Firebaugh, California has a subsurface drainage problem. In order to manage this problem, drainage water is collected in buried tile drains, pumped from the drains, and then discharged to the San Joaquin River. The drainage water contains several elements found naturally in local soils, such as boron, molybdenum, and selenium. These elements degrade water quality when discharged into the sloughs and the river.

California water quality authorities have directed that boron, molybdenum, and selenium levels in agricultural drainage water entering the San Joaquin River be reduced to achieve water quality objectives. The District has developed a program to improve the management of agricultural water to reduce drainage water in order to meet the water quality objectives. The program has been successful and continues to evolve as opportunities for improvement are identified.

### **B. References**

Cone D. 1992. Responding to water quality problems through improved water management. A.C.W.A. Water Quality Monitor, Volume 4, Number 5, p. 7.

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Wichelns D. & Cone D. 1993 (forthcoming) Water agency programs improve water management. International Commission on Irrigation and Drainage, 15th Congress, The Hague, The Netherlands.

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## **II. Background Information**

### **A. Description of District**

**1. District background:**

California Water District supplying irrigation water.

Due to decreasing ground water quality, in 1955 the District was formed to deliver agricultural water from the U. S. Bureau of Reclamation's Delta-Mendota Canal.

Located about 40 miles northwest of Fresno, California, on the west side of the San Joaquin Valley.

**2. 9,500 acres with average farm size 500 acres.**

**3. Highly productive soils - Panoche silty clay loam, Panoche silty clay, and Panoche clay loam. These are relatively heavy soils.**

**4. Major crops: cotton, processing tomatoes, alfalfa seed, cantaloupes, wheat, and barley.**

**5. No usable groundwater in the District: relatively high levels of salinity and boron.**

**6. All irrigation and drinking water are imported.**

### **B. Description of the District's Drainage Problem**

**1. Clay layers in the soil cause excess irrigation water to accumulate in the soil, creating a saline shallow water table (4 to 10 feet below the land surface).**

**2. Farmers have installed 25 subsurface tile drainage systems to maintain the shallow water at an acceptable depth to continue agriculture production. About 3/4 of the District land is considered tilled.**

**3. All surface runoff and subsurface drainage water is collected by the District through a series of surface drainage channels.**

**4. District has 3 options to manage the collected drainage water:**

**a. Discharge to the San Joaquin River, subject to water quality criteria.**

**b. Recycle for re-delivery to farmland through the irrigation system.**

**c. Combination of a and b.**

**5. Major constituents in the subsurface drain water are: selenium, boron, molybdenum, and salt.**

**C. Water Quality Objective Levels Set by the California Regional Water Quality Control Board.**

**1. Description of discharge route.**

Drain water (a mixture of surface and subsurface drain water) is discharged through the District's outlet to a drain operated by the Firebaugh Canal Water District (FCWD). The drain water is mixed with FCWD's drain water (also a mixture of surface and subsurface water) and flows about 1 1/2 miles to a drain operated by the Central California Irrigation District (CCID). The drain water is mixed with CCID's drain water and flows about 8 miles to the Grassland Water District (GWD). At that point, GWD then directs the flow into one of several channels (eventually to Mud Slough and/or Salt Slough) to transport the drain water to the San Joaquin River.

Prior to the identification of the problems caused by selenium discharged by Westlands Water District (WWD) into the Kesterson National Wildlife Refuge, the Grassland Water District used the drain water from the Grassland Basin water districts (WWD is not a Grassland Basin water district) to provide water to private hunting club land. All unused drain water and drainage from the hunting clubs, were discharged to the San Joaquin River through Mud and Salt Sloughs.

None of the drain water from the Grassland Basin water districts ever was discharged to the Kesterson National Wildlife Refuge.

**2. San Joaquin River Objective Levels at Hills Ferry and downstream:**

selenium: 5 ppb (maximum mean monthly level)  
26 ppb (instantaneous maximum)

**3. Mud and Salt Sloughs Objective Level (effective October 1993):**

selenium: 10 ppb (monthly mean)  
boron: 19 ppb (monthly mean)  
molybdenum: 2.0 ppm (monthly mean)

### III. Water Management Program

- A. Collection of field-specific and crop-specific data describing water deliveries, irrigation events, and other cultural practices. This information is made available to the farmers within days of actual irrigation events.**

Example of field-specific irrigation data prepared for all fields in BWD:

Farmer: Jones			Seasonal Irrigations					
Field No.	Crop	Acres	Pre-irrigation	1st	2nd	3rd	4th	Total
-----acre-feet per acre-----								
6-2	cotton	138	0.90	0.68	0.63	0.57	0.34	3.12
6-3	tomatoes	150	0.78	0.65	0.72	0.63	0.45	3.23

- B. Tiered water pricing.**

The volume of subsurface drain water produced is primarily related to the over application of irrigation water. In order to reduce subsurface drain water, in 1989 the District initiated a tiered water pricing program to charge farmers the cost of drainage when they over irrigate. The program involved the establishment of tier levels for each crop grown within the District. Whenever the delivery of water exceeds the tier level for a specific crop on a specific field, an additional \$24 per acre-foot is charged on any additional water delivered.

The tier value set for each specific crop was based on a 10% reduction from the average water delivered to specific crops during the period 1986 through 1988.

**Crop-specific average irrigation depths and selected tiering levels:**

Crop	1986-1988	Tier Level (AF/Ac)
	Average Delivered Water (AF/Ac)	
cotton	3.20	2.9
tomatoes	3.22	2.9
cantaloupes	2.11	1.9
wheat	2.30	2.1
sugarbeets	4.58	3.9
alfalfa seed	2.06	1.9
rice	5.65	5.1

While we believe the tiered water pricing program has assisted the District in improving water management among its farmers, it is only one item in our water management program. Tiered water pricing should not be considered applicable to all agricultural water districts. It is a self-imposed water rate increase and must have a basis other than increasing revenue or modifying the types of crops grown within a district. A district's water pricing policy should be reviewed to determine if it is in conflict with other programs or goals.

**C. Timely exchange of information among District farmers.**

In September or October of each year, the District has a meeting with the farmers to go over the irrigation delivery and drainage results for the past irrigation season. The farmers share with each other what worked and what didn't work.

**D. Flexibility in scheduling water delivery turn ons, turn offs and changes.**

The official policy of the District is that all irrigation deliveries require a 24-hour notice to the District and all changes are to take place between 5 a.m. and 3 p.m. In order to assist the farmers in improving irrigation water management, the District will allow a much shorter notice providing it can meet all of its other requirements. In addition, the District has shut water off at all hours of the day and night. This requires the cooperation of the entire District's staff.

**E. Low interest loans for the purchase of sprinkler and gated pipe irrigation systems to encourage farmers to improve irrigation effectiveness.**

The District has acquired a \$1.5 million low-interest loan through the California State Water Resources Control Board for the purchase of irrigation systems. These systems will allow the farmers to make greater improvements in water management and greater reductions in subsurface drainage (non-point source pollution). To date, the District has spent about \$1.1 million of the loan for the following listed equipment:

57 miles of sprinkler lateral pipe  
10 miles of sprinkler mainline  
15 miles of gated pipe  
7 booster pumps

Twelve of the District's 20 farmers have participated in the loan program.

**F. Water transfers and purchases to help farmers manage water.**

Since several of the Broadview farmers also farm in other districts, Broadview has assisted them in transferring their water supply into and out of the District in order for them to operate more economically. The District has also purchased ground water from other sources in order to increase their water supplies during drought and reduce water allocation periods.

**G. Participation in demonstration projects to improve water management.**

The District has participated in several demonstration projects within the District, such as:

Improved Furrow Irrigation Demonstration (5-year project)  
California Department of Water Resources  
Dellavalle Laboratory, Fresno, California  
Lay-Flat Tubing Demonstration  
U.S.D.A., Agricultural Research Service, Kimberly, Idaho  
1990 in cotton  
1991 in onion seed

## IV. Results

### A. Irrigation improvements.

#### 1. Average Water Deliveries by Crop Year (acre-feet/acre):

Crop Type	1989	1990	1991	1992
all crops	2.88	2.52	2.34	2.03
cotton	3.34	2.84	2.46	2.25
alfalfa seed	1.84	1.88	1.36	0.91

#### 2. District-wide Estimated Field Application Efficiencies by Crop Year:

1986	1987	1988	1989	1990	1991
0.66	0.68	0.65	0.73	0.77	0.81

#### 3. Crop Yields (selected crops):

Crop Type	Units	1989	1990	1991	1992
cotton	bales/ac	3.10	3.16	3.10	3.37
tomatoes	ton/ac	37.9	30.8	30.9	35.2
alfalfa seed	lbs/ac	684	926	1,345	1,154

### B. Drainage improvements.

#### 1. Collected Subsurface Drain Water by Crop Year (acre-feet):

1986	1987	1988	1989	1990	1991	1992
4,626	3,704	3,628	3,736	3,464	1,857	854

#### 2. Discharge of Commingled Surface Runoff and Subsurface Drain Water to the San Joaquin River (acre-feet):

1986	1987	1988	1989	1990	1991	1992
14,416	15,216	8,157	9,062	4,887	1,553	667

**3. Salt Load Collected in Subsurface Drainage Systems (tons):**

1988	1989	1990	1991	1992
26,254	27,086	28,497	17,379	6,385

**4. Estimated Salt Load in Drain Water Discharged through the District's Outlet:**

1988	1989	1990	1991	1992
22,346	25,054	17,726	5,792	2,496