DISTRICT EXAMPLE - INLAND SURFACE WATER PLAN

BROADVIEW WATER DISTRICT

This report has been prepared as an example of a typical water district in the Central Valley of California. The information on the district is laid out following the "informational needs" outline in our 16 March 1992 letter and is intended to give the user an idea of the detail and format expected in reports submitted to the Central Valley Regional Water Quality Control Board.

This report has been prepared as an example and does not necessarily represent current field conditions within the district.

Most of the information for the report is contained in the following tables and figures.

Tables

Figures

Prepared by the Central Valley Regional Water Quality Control Board
Agricultural Unit

March 1992

I GENERAL

1. Broadview Water District
   6939 N. Fairfax Avenue
   P.O. Box 95
   Firebaugh, CA 93622

2. Dave Cone, Manager

3. 9,515 Acres

4. Attached (Map #1)

5. Federal Water Contract - Delta Mendota Canal imported freshwater through a Federal contract, Delta-Mendota Canal, beginning in 1957. Freshwater replaced deep well water for irrigation. Wells have been abandoned.

II WATER SUPPLY SOURCES

1(a) Attached (Map #2)

1(b) No deep wells

1(c) Attached (Map #2)

1(d) Attached (Map #2)
Attached Table #1

2. Average Annual Inflow, Delta Mendota Canal:

January	1,278 Acre Feet
February	1,324
March	1,697
April	1,884
May	3,119
June	3,915
July	3,998
August	2,553
September	745
October	1,796
November	1,884
December	1,176
Total	25,369

3. Attached (Table #1)

III LAYOUT OF SURFACE DRAINAGE SYSTEM

1. Tailwater from farms was collected by the district in open drains flowing to the north. Water was lifted back up at Nees Pump Station into Broadview's Main Canal to be 100% recirculated. Tailwater from lands south of the district also enter the district at various locations.

   (a) Attached (Map #3)

   (b) Attached (Map #3)

   (c) Attached Table 2

   (d) Attached (Map #3)

   (e) Not Available

   (f) None

   (g) Attached (Map #3)

2. Tiling began in early 60s and continued throughout until 1988. Almost all lands in the district have now been tiled to some degree. This tile water is pumped from on-farm sumps into the open drains and commingled with the tailwater. No tilewater from outside the district is permitted to enter the district.

   As more and more lands were tiled within the district, the quality of the drainage water deteriorated making the mandatory recirculation unfeasible. Crop yields, crop diversity, and land quality were all effected.

   Broadview completed over two years of negotiations with Firebaugh Canal Co., Central California Irrigation District, and the Grasslands Water district in mid 1982. The negotiations enabled Broadview to release up to 35 cfs of drainage water of a specified quality to and through Firebaugh Canal W.D. and CCID existing drainage facilities to Grasslands. The discharge was on a fifteen year license. (Thought of as a temporary solution until a long term solution to the west San Joaquin Valley drainage problem was found).

   In return, Broadview improved Grassland distribution and drainage facilities using a "1968 Grassland Master Plan" (which was never implemented) as its guide. At a cost to Broadview of around $300,000, Broadview implemented the Plan providing better drainage, flood control and a complete renovation of distribution facilities within Grasslands. Broadview also pays Grassland a $5.00/acre/year assessment ($47,575.00/year), to enable Grassland to maintain, monitor, or mitigate in any way it feels necessary the 35 cfs (maximum) of drainage from Broadview.

Broadview also was obligated to improve some of the drainage facilities within Firebaugh CWD and CCID, as well as build some internal facilities for monitoring, dilution, and regulation. Total cost to Broadview for the entire project was just under $1,000,000.00.

On January 17, 1983, Broadview opened its outlet with capabilities of releasing a maximum 25 cfs of drainage water and potential of dilution up to an additional 10 cfs when necessary.

(a) Attached (Map #4)

(b) Attached (Map #4; Table 2)

(c) Attached (Map #3)

(d) None. Only tailwater enters the district (Map #3).

IV OPERATION OF THE SURFACE DRAINAGE SYSTEM

1(a) Attached (Table #2)

(b) Attached (Table #2)

(c) There are no estimates by drain for water entering the district. The total inflow volume is estimated to be

Average Annual Inflow, Surface Drainage Water (Ag Tail Water Only):

January	350	Acre Feet
February	400	
March	250	
April	275	
May	400	
June	700	
July	1,000	
August	850	
September	100	
October	100	
November	25	
December	250	
Total	4,700	Estimation

The discharge from the district is estimated and is listed by month and by crop year in Table 3.

(d) All the surface drains carry a mixture of agricultural tail water and subsurface tile drainage water. The system does not receive municipal, industrial, or dairy wastewater.

(e) Flow in the drains is primarily restricted to periods of irrigation. Pre-irrigation begins at the end of January with the final irrigation occurring in October. The drains remain dry during November and December unless a major storm event causes natural runoff.

(f) The lateral drains are cleared of silt every other year. The Main Drain is cleaned more frequently, usually on an annual basis.

(g) Attached (Table 2)

V. WATER QUALITY MONITORING PROGRAMS

1. Attached (Map #2, 3, and 4)

2. Attached (Table 4)

   Data is tabulated and stored in a LOTUS 1,2,3 data base system by district personnel. Collected information is reported to the Central Valley Regional Water Quality Control Board on an annual basis via the district's Drainage Operation Plan.

3. The current monitoring program presented in Table 4 is the most comprehensive undertaken by the district. Flow and salinity measurements have been conducted by the district at major diversion points since the 1960's. Additional monitoring has been conducted by the University of California and the San Joaquin Valley Drainage Program to study relationships between irrigation management and salt loads. Some of the information developed by these studies can be found in the reports listed in the Appendix.

4. The California Department of Water Resources has provided funding through ARS (Agriculture Resource Stabilization) to continue the current monitoring program until 1994. The current program is designed, in part to measure groundwater movement through the district. After funding ceases, the district will statistically review the collected data and develop a new program.

5. No aquatic life surveys have been conducted in this district.

6. Since the 1960's, BVWD has experienced a high groundwater table which has reduced crop yields, crop diversity, and land quality. Installing tile drainage systems, effectively lowered the water table but also substantially increased the salt load in the district's drainage. By the early 1980's, BVWD could no longer recycle 100% of its drainage and still maintain viable cropland.

As discussed in Section III, Part 2, in January 1983, BVWD opened its outlet to the Crooked Drain which eventually feeds the Main Drain which becomes a tributary of the San Joaquin River. The outlet has the capacity to release up to 25 cfs of drainage water with additional dilution of 10 cfs when necessary.

Water quality problems within the district boundaries include:

1) Excess sediment in tailwater

2) Elevated TDS concentrations

3) Elevated Boron Concentrations

4) Elevated Selenium Concentrations

5) Elevated Molybdenum Concentrations

With the exception of excess sediment in tailwater, most of the district's elevated trace element concentrations are due to the discharge of subsurface drainage. BVWD has instigated a number of programs to improve irrigation efficiency and thereby decrease drainage discharge and the subsequent loading of salts and trace elements. The programs include:

- tiered water pricing
- economic studies
- recycling drain water
- irrigation management workshops
- load, flow, and concentration studies
- gravity irrigation systems
- pre-irrigation improvements
- reducing cropped acreage
- improving water delivery systems
- involvement in selenium removal projects
    - Harza
    - Pilot Plant

District goals for 1992 (assuming a full water supply available) include decreasing water deliveries by 15%, decreasing subsurface drain water 25%, and reducing drain water releases by 50%.

VI. COST OF DRAINAGE WATER MANAGEMENT PROGRAM

1. Unknown

2. The present monitoring program costs $500 per month for the analyses and requires a minimum of 2 staff days.

3. The current monitoring program will continue until 1994, at which time the program may be altered based on statistical review of the data.

Table 1. Broadview Water District Water Supply System*

Name	Type	Construction	Length (miles)	Water Type	Water Quality Concerns†
BVWD Main Canal‡	constructed	earthlined	5.9	DMC	-
33 Lateral	constructed	earthlined	0.5	DMC, ag tail	2, 3, 4
Chuck Lateral	constructed	earthlined	2.3	DMC, ag tail	2, 3, 4
4-1 Lateral	constructed	earthlined	2	DMC, ag tail	2, 3, 4
4-3 Lateral	constructed	earthlined	2	DMC, ag tail	2, 3, 4
9-1 Lateral	constructed	earthlined	3	DMC, ag tail	2, 3, 4
Section 8 Lateral	constructed	earthlined	1.9	DMC, ag tail	2, 3, 4
8-A Lateral	constructed	earthlined	0.5	DMC, ag tail	2, 3, 4
8-B Lateral	constructed	earthlined	0.5	DMC, ag tail	2, 3, 4
9-3 Lateral	constructed	earthlined	4	DMC, ag tail	2, 3, 4
16-1 Lateral	constructed	earthlined	4	DMC, ag tail	2, 3, 4
16-3 Lateral	constructed	earthlined	4	DMC, ag tail	2, 3, 4

* supply canals are depicted on Map 2

‡ 1.8 miles of the Main Canal is a 60 inch cement pipe that runs underground from the Delta Mendota Canal to the District Boundary

† water quality concerns for the supply lines are primarily due to the recycling of the tailwater and subsurface drainage

1 = excess sediment in tailwater
2 = elevated TDS concentrations
3 = elevated boron concentrations
4 = elevated selenium concentrations
5 = elevated molybdenum concentrations

Table 2. Broadview Water District Drainage System (as depicted on Map 3).

Name	Type	Length (miles)	Construction	Drained Acreage	Water Type	Flow Period	Maintenance	Water Quality Concerns†
BVWD Main Drain	Main	8	earthenlined	9515	Ag tail & tile	Jan. - Oct.	annual	1,2,3,4,5
Hudson Drain	Lateral	4	earthenlined	3200	Ag tail & tile	Jan. - Oct.	bi-annual	1,2,3,4,5
Jerrold Drain	Lateral	3.4	earthenlined	2420	Ag tail & tile	Jan. - Oct.	bi-annual	1,2,3,4,5
Newcomb Drain	Lateral	2.5	earthenlined	1900	Ag tail & tile	Jan. - Oct.	bi-annual	1,2,3,4,5
Douglas Drain	Lateral	2.7	earthenlined	1280	Ag tail & tile	Jan. - Oct.	bi-annual	1,2,3,4,5

† 1 = excess sediment in tailwater
2 = elevated TDS concentrations
3 = elevated boron concentrations
4 = elevated selenium concentrations
5 = elevated molybdenum concentrations

Table 3. Monthly discharge of drain water (drainage outlet) by crop year, Broadview Water District

Month	1983	1984	1985	1986	1987	1988	86-88 Average	1989	1990	1991
October	0	1080	1106	369	643	652	555	303	87	0
November	0	899	953	711	1166	338	738	232	506	10
December	0	1048	1258	1153	1080	12	748	108	398	11
January	233	1558	788	562	1031	95	563	476	562	7
February	1218	1432	1468	1634	1142	808	1195	1373	926	215
March	930	1356	1969	2212	1717	1304	1744	1005	615	634
April	757	1603	3007	1517	1298	1131	1315	782	488	326
May	1475	1265	2137	1354	1946	1365	1555	1013	416	265
June	1198	1481	1441	1468	1823	442	1244	1079	247	29
July	1323	1663	1672	1181	1370	695	1082	1114	293	0
August	1356	1476	1416	1433	1468	954	1285	1215	326	18
September	154	913	689	822	532	361	572	362	23	10
Total:	8644	15774	17904	14416	15216	8157	12596	9062	4887	1524

(Combination: Tile, Tail, and Fresh Water)

Monthly collected subsurface Drain water by crop year within Broadview Water District

Month	1986	1987	1988	86-88 Average	1989	1990	1991
October	114.4	143.7	81	113	44.6	34.1	153.6
November	177.2	174.9	123.7	158.6	62.6	189	176
December	292.3	281.5	61.3	211.7	66.4	409.9	61.1
January	334	315.5	75.6	241.7	181.8	330.5	68.4
February	603.3	366.6	449.7	473.2	411.6	418.6	158.6
March	553.6	371.5	357.6	427.6	448.8	358	135.7
April	442.8	459.6	350.4	417.6	463.2	351.1	146.6
May	453.9	367.1	427.5	416.2	529.6	256.5	155.3
June	452.3	433.7	586.2	490.7	533.4	347.4	191.8
July	724.8	459.2	558	580.7	494.3	443.8	383.9
August	363	227.4	412.7	334.4	388.5	274.4	177.2
September	114.6	103.1	144	120.6	111.6	51	51.5
Total:	4626.2	3703.8	3627.7	3986	3736.4	3464.3	1859.7

Table 4.

Broadview Water District

Water Monitoring (Quality and Quantity)

WATER QUALITY

	Sampling Location	Frequency	Tested For	Testing Method
D-1	Delta-Mendota Canal @ Pump Sta. #1	daily	TDS	hand meter
		monthly	EC, Se, Bo & Mo	lab
R-1	Drain Water @ Outlet (surface & subsurface)	daily	TDS	hand meter
		weekly	EC, Se, Bo & Mo	lab
		* monthly	EC, Se, Bo & Mo	lab
		continuous	EC	recording meter
R-1	Drain Water @ Nees Sta. (surface & subsurface)	daily	TDS	hand meter
		monthly	EC, Se, Bo & Mo	lab
R-1	Delivered Irrigation Water @ Pond 3 (with recycled drain water)	daily	TDS	hand meter
		monthly	EC, Se, Bo & Mo	lab
	Tile Drainage Sumps (25)	weekly	TDS	hand meter
		monthly	EC, Se, Bo & Mo	lab
SD1 SD2 SD3 SD4	Misc. Drains @ South District Boundary	daily (if flow)	TDS	hand meter

WATER QUANTITY

	Measuring Location	Frequency	Measured For
	Delivery Turnouts	every other day	volume & flow
		1st of month	volume
D1	Delta-Mendota Canal Delivery Meters	every other day	volume
		1st of month	volume
		continuous	flow (USBR)
R-1	Nees Pump Sta. Meters (recycled water)	every other day	volume
		weekly	volume
		1st of month	volume
R-1	Drain Water @ Outlet (surface & subsurface)	every other day	volume
		weekly	volume
		* 1st of month	volume
		continuous	flow
	Tile Drainage Sumps (25)	weekly	volume
		Oct. 1st	volume

Table 4 continued:

GROUND WATER

Measuring Location	Frequency	Measured For
Various Locations	6 times a year	depth from ground surface

* Required by the CRWQCB.

Broadview Water District

Irrigation Management Monitoring

Irrigation deliveries recorded by field and by crop (AF & AF/Ac)

Pre-emergent irrigation deliveries (AF & AF/Ac)

Post-emergent irrigation deliveries (AF & AF/Ac)

Irrigation events by field and by crop (AF & AF/Ac)

Total deliveries for crop year by field and by crop (AF & AF/Ac)

Irrigation methods (type)

Length of irrigation runs (distance)

Irrigation patterns (every furrow vs every other furrow)

Misc. field cultural practices

Table 5. Ranges in Water Quality Concentrations, Broadview Water District.

Site*	EC umhos/cm	TDS mg/L	Boron mg/L	Se ug/L	Mo ug/L
D-1	450 - 780	300 - 500	.25 - .40	<1 - 5	30
R-1	2300 - 5500	1500 - 3500	5.0 - 10	50 - 400	30 - 50
SD-1	-	500 - 650	-	-	-
SD-2	-	500 - 650	-	-	-
SD-3	-	500 - 650	-	-	-
SD-4	-	500 - 650	-	-	-
				-	-
Tile Sumps	4800 - 15000	3000 - 9600	2.5 - 33	22 - 1400	30 - 80

* From Table 4.

APPENDIX

Reports and Papers Concerning
Drainage in Broadview Water District

Wichelns, D., 1986. Economic Impacts of Salinity: Farm-Level Effects and Regional Analysis. Unpublished Ph.D. Dissertation. University of California, Davis.

Wichelns, D., R. Howitt, G. Horner, and D. Nelson, 1988b. The Economic Effects of Salinity and Drainage Problems. California Agriculture. 42(1). January-February.

Wichelns, D., and D. Nelson, 1987a. Estimating the Relationship Between Agricultural Drainage Flows and Salt and Selenium Loadings. Staff Work Paper. Department of Resource Economics, University of Rhode Island. September.

Wichelns, D., and D. Nelson, 1987b. Estimating the Relationship Between Applied Irrigation Water and Subsurface Drainage Flows. Presented at the U.S. Committee on Irrigation and Drainage 1987 Regional Meetings on Water Management. Sacramento, California. November 11-13.

Wichelns, D. and S. Nelson, 1987c. Empirical Analysis of Salt and Selenium Concentrations in Subsurface Drainage Flows. In Toxic Substances in Agricultural Water Supply and Drainage. Proceedings of the U.S. Committee on Irrigation and Drainage, 1987 National Meetings. Las Vegas, Nevada. December 2-4.

Wichelns, D. and D. Nelson, 1988a. Empirical Analysis of Spatial Variation in Subsurface Drainage Flows. Staff Work Paper. Department of Resource Economics, University of Rhode Island. March.

Wichelns, D. and D. Nelson, 1988b. Using Observed Irrigation and Drainage Relations to Select Optimal Management Policies. Presented at the U.S. Committee on Irrigation and Drainage, 11th Technical Conference on Irrigation, Drainage, and Flood Control. San Diego, California. September.

Wichelns, D., D. Nelson, and T. Weaver, 1988a. Farm-level Analysis of Irrigated Crop Production in Areas with Salinity and Drainage Problems. Report to the San Joaquin Valley Drainage Program, United States Bureau of Reclamation. January.

Wichelns, D., 1989. Economic Analysis and Farm-Level Implications of Regional Drainage Policies. Report to the San Joaquin Valley Drainage Program, United States Bureau of Reclamation. June.

Wichelns, D., and D. Cone, 1989. An Increasing Block-Rate Pricing Program to Motivate Water Conservation and Drain Water Reduction. Second Pan-American Regional Conference on Irrigation and Drainage, U.S. Committee on Irrigation and Drainage. June.

Wichelns, D. and D. Cone, 1990. An Increasing Block-Rate Pricing Program to Motivate Water Conservation and Reduce Subsurface Drain Water (Preparing for the 90's Drainage Reduction through Water Conservation). California Plant and Soil Conference, American Society of Agronomy. January.

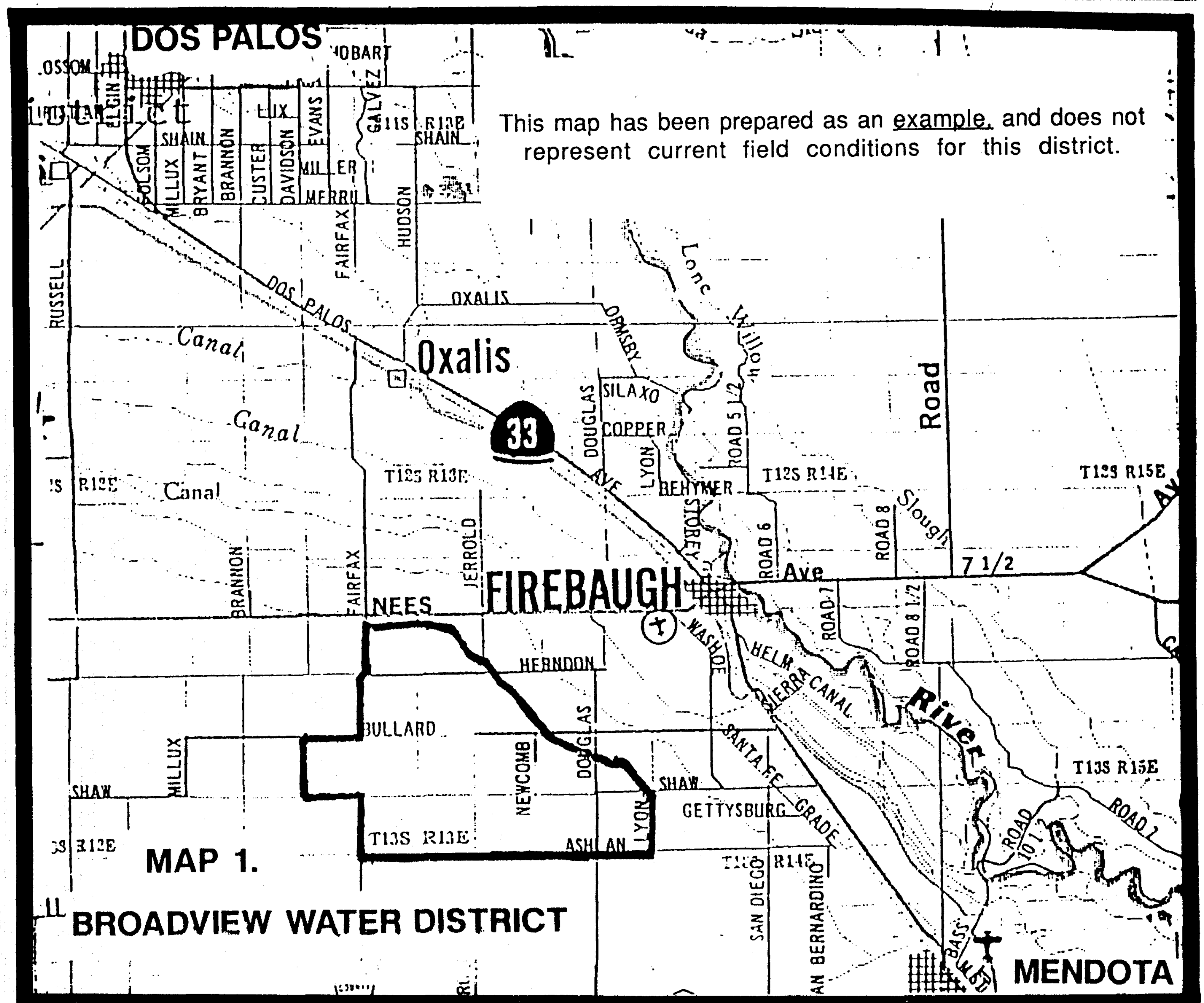
Wichelns, D. and J.D. Oster, 1990. Potential Economic Returns to Improved Irrigation Infiltration Uniformity. "Agricultural Water Management", in press.

Wichelns, D. and D. Nelson, 1989. An Empirical Model of the Relationship Between Irrigation & the Volume of Water Collected in Subsurface Drains. "Agricultural Water Management, 16:293-308.

Wichelns, D., R. Howitt, G. Horner, and D. Nelson, 1990. Economic Effects of Long-Term Restrictions on Drainage Water Disposal. "Applied Agricultural Research", 5(1):48-55.

Wichelns, D. and D. Cone, 1990. Our Experience With Increasing Block-Rate Prices for Agricultural Water. Proceedings of CONSERV 90, The National Conference and Exposition Offering Water Supply Solutions for the 1990's. Phoenix, Arizona, August 1990.

Wichelns, D. and M. Weinberg, 1990. Economics of Agricultural Drainage Policy. "California Agriculture". 44(4). July-August.


DOS PALOS
This map has been prepared as an example, and does not represent current field conditions for this district.
Oxalis
FIREBAUGH
MENDOTA
33
RUSSELL
DOS PALOS AVE
Canal
Canal
Canal
OXALIS
ORMSBY
SILAXO
COPPER
DOUGLAS
LYON
BEHYMER
STOREY
ROAD 5 1/2
ROAD 6
ROAD 7
ROAD 8
ROAD 8 1/2
7 1/2 Ave
Road
Slough
Lone Willow
T12S R13E
T12S R14E
T12S R15E
T13S R13E
T13S R15E
NEES
FAIRFAX
BRANNON
JERROLD
HERNDON
BULLARD
NEWCOMB
DOUGLAS
SHAW
MILLUX
ASHLAN
LYON
GETTYSBURG
SAN DIEGO
SAN BERNARDINO
WASHOE
HELM CANAL
SIERRA
SANTA FE GRADE
River
ROAD 10 1/2
ROAD 7
BASS
HOBART
GALVEZ
ELGIN
FOLSOM
SHAIN
BRYANT
CUSTER
DAVIDSON
LUX
EVANS
MILLER
MERRILL
HUDSON
MAP 1.
BROADVIEW WATER DISTRICT