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Evalution of Drainage Tile to Alleviate Salt Building in Heavy Soils Irrigated with Brackish Water and Cropped with Rice and Soybeans

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EVALUATION OF DRAINAGE TILE TO ALLEVIATE SALT BUILDING IN HEAVY SOILS IRRIGATED WITH BRACKISH WATER AND CROPPED WITH RICE AND SOYBEANS

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Technical Completion Report Research Project G-829-07

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Arkansas Water Resources Research Center

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ABSTRACT

EVALUATION OF DRAINAGE TILE TO ALLEVIATE SALT BUILDING IN HEAVY SOILS IRRIGATED WITH BRACKISH WATER AND CROPPED WITH RICE AND SOYBEANS

The use of tile drains for alleviating soluble salt accumulation on silt loam soil was investigated during 1984. Although the chemical analyses of the floodwater and tile drainage water were very similar suggesting that the floodwater was moving to the tile drain, the overall results so far indicate that this is not a feasible solution owing to lack of significant drainage. Application of DRAINMOD utilizing soil and weather data from Arkansas showed no significant effluent from the tile drains for our experimental site during rice production. This was attributed to the extremely slow saturated hydraulic conductivity values for this particular soil. However, more observations (concerning the operation of the tile field) are needed before it can be concluded that tile drain fields are not a viable solution to the problem.

T. C. Keisling, J. T. Gilmour, H. D. Scott, A. M. Sadeghi and R. E. Baser

Completion Report to the U.S. Department of the Interior, Washington, D.C., August, 1984.

KEYWORDS -- Drainage / salinity / mathematical modelling / rice / soybeans.

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ACKNOWLEDGEMENTS

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INTRODUCTION

Salt-bearing waters used in the production of rice and soybeans have resulted in soil accumulations of salt that are detrimental to crop production (1,2,3). In certain areas of eastern Arkansas the groundwater salt content is sufficiently high that irrigation wells have not been developed. If the accumulated soluble salts could be removed from soil and if future accumulations of soluble salt in soil could be avoided, the salt-bearing waters could safely be used for rice, soybean, and cotton irrigation.

The principal reason that the soluble salt is not leached from soils found in eastern Arkansas is the extremely low overall hydraulic conductivity found in the soil profile. Many of these soils have hydraulic conductivities in the surface 0.37 m that are not too restrictive to water movement. More recent data indicate that a significant reduction occurs in the surface horizon hydraulic conductivity under flooded rice culture (1). However, the hydraulic conductivities of horizons immediately below 0.37 m usually are very low resulting in restricted water movement through the soil profile. Therefore, the placement of tile drains above the restrictive layer in temporary water tables could possibly remove soluble salts at a rate rapid enough to prevent excessive soluble salt accumulations, thus permitting normal, irrigated crop production.

Almost all previous research for saline water management and soluble salt reduction in the root zone has been undertaken in arid and semi-arid climates and on soils that allow substantial leaching of water (3,6,8). This previous work does not necessarily apply to Arkansas' climate (humid) or soils (extremely low leaching rate). Under humid climates sufficient rainfall occurs to leach the excess soluble salts if the soils are permeable to water.

A. Purpose and Objectives

The objective of this study was to assess the use of tile drains in alleviating salt accumulation in selected Arkansas soils irrigated with salt-bearing waters during the production of rice and soybeans.

METHODS AND PROCEDURES

A site on McGehee silt loam (Table 1) in Desha County, Arkansas was selected as the location for the study. The McGehee soil has a slope of less than 1 percent and is considered to be poorly drained. Its permeability is very slow, except where the soil is cracked. Selected soil chemical characteristics of the particular site chosen for the study are presented in Table 2. Three 5 cm x 30 m plastic tile drains spaced at 15 m (Figure 1) were installed in late January, 1984. Care was exercised during installation to place the tile immediately above the restrictive clay horizon (IIB31) of the soil profile. The study site was further instrumented with aluminum piezometers having an O.D. of 5 cm. They were installed to the 76 cm depth and placed at logarithmic distances in a line perpendicular to the direction of the tile drain (Figure 2). Three lines of piezometer tubes were used.

The center tile drain was instrumented to measure drainage. Drainage water flowed into a stilling well fitted with a v-notch weir. A water stage recorder was used to measure water height in the v-notch weir.

On April 25 the area was disked and harrowed. "Lebonnet" rice was drill seeded in 15 cm rows at the rate of 135 kg/ha. On May 31, a broadcast application of 4.5 and 0.84 kg per ha of propanil and basagran, respectively, was performed. Water management to date consists of a June 4 flush, a June 6 drain, and a June 11 establishment of a permanent flood averaging 8 cm deep. Floodwater and tile drainage water were collected at 0, 7, 14 and 21 days after flooding. One tile drainage water sample was collected prior to flood.

The electrical conductivity of the drainage water was measured with YSI model 31 conductivity meter. The chloride concentration was measured using a Buchler-Cotlove chloridometer.

Rainfall was measured using a recording rain gauge.

Fertility management of the rice consisted of June 11 application of 67 kg/ha N, a July 9 application of the first midseason N of 34 kg/ha, and a July 23 application of the second midseason N application of 34 kg/ha N. Other general management criteria are shown in Table 3.

DRAINMOD, a computer program which was developed by Dr. R. W. Skaggs at North Carolina State University (7), was utilized to predict discharge of water from the tile lines. The inputs required to utilize DRAINMOD were the climatological and the soil water retention and transport characteristics. For the climatological data, the amount of daily precipitation and the maximum and minimum daily temperatures were needed. For the soil properties parameters such as unsaturated hydraulic conductivity, saturated hydraulic conductivity and soil moisture retention had to be measured directly or approximated. DRAINMOD then was tested using 1973 (a wet year) and 1983 (a dry year) weather data from the Rice Research and Extension Center (RREC) near Stuttgart, Arkansas and the soil properties of the Crowley silt loam which are similar to those at the experimental site. RREC is within 50 km of the study site. In this manner the experimental results could be extended to other similar soils by using a few easily measurable weather and soil parameters.

PRINCIPAL FINDINGS AND THEIR SIGNIFICANCE

After the tile was installed, the area was allowed to settle until about the first of May. Soil-water flow characteristics and spring rains should have resulted in a continuous discharge from the tile lines. The piezometer tube readings indicated a sufficiently high water table (Fig. 3) for ample water to be in a temporary or "perched" water table above the clay horizon. However, no measurable outflow was obtained. Since no discharge was obtained, we decided to seed rice and flood the area with a surface pool of water. This surface pool was established on June 11. Some discharge occurred form the tile lines (estimated at < 0.14 cm per day through the soil profile).

Ten weeks prior to establishing the flood, extensive rainfall had saturated the soil and resulted in drainage from the tile. A tile drainage water sample collected at that time had an electrical conductivity (EC) of 235 μmhos/cm and a concentration of 0.2 meq/l chloride (Table 4). Figure 4 presents EC and chloride data obtained after flooding, the EC and chloride data for floodwater and tile drainage water were very similar suggesting that floodwater was moving to the tile drain. The EC and chloride followed similar patterns with a decrease in tile drainage water values at 21 days after flood. This decrease was attributed to runoff from a 7.5 cm rainfall at 19 days after flooding which diluted drainage water. No other rainfall sufficient to cause dilution occurred during this period.

If no channeling of water through the soil was occurring, then Figure 5 would depict a flow envelope and the slowest and fastest rates of water flow through soil could be calculated. These calculations are presented below.

Calculation of the drainage Rate for Slowest Flow path

We will assume that the lateral and vertical hydraulic conductivities are equal and steady state flow conditions occur. The value of K_p can be calculated from

$$\frac{L_p}{K_p} = \frac{L_{Ap}}{K_{Ap}} + \frac{L_{AB}}{K_{AB}} \qquad [1]$$

where

L_p = distance water travels through soil profile (cm)

K_p = Saturated conductivity for the total path through the soil profile (m/day)

L_{Ap}, L_{AB} = distance water travels in the Ap and AB soil horizons (cm)

K_{Ap},K_{AB} = saturated hydraulic conductivity of the Ap and AB soil horizons (cm/day) as estimated from references 1 and 5.

For our example and the slowest flow path, the saturated hydraulic conductivity is

$$\frac{817}{K_s} = \frac{15\ \text{cm}}{0.0432\ \text{cm/day}} + \frac{802\ \text{cm}}{5.490\ \text{cm/day}}$$

where the subscript s indicates the slow case. The value of the saturated hydraulic conductivity is

$$K_s = 1.656\ \text{cm/day}$$

Now to calculate flow rate Q_s

$$Q_s = \left(\frac{1.656\ \text{cm}}{\text{day}}\right)\left(\frac{55\ \text{cm}}{817\ \text{cm}}\right)$$

or

$$Q_s = 0.1115\ \text{cm/day}$$

Calculation of the Drainage Rate for the Fast Flow Path

For the fast flow path the saturated hydraulic conductivity is

$$\frac{55\ \text{cm}}{K_f} = \frac{15\ \text{cm}}{0.996\ \frac{\text{cm}}{\text{day}}} + \frac{40\ \text{cm}}{6.5\ \text{cm/day}}$$

where the subscript f indicates fast flow. The value of the saturated hydraulic conductivity is

$$K_f = 2.593 \text{ cm/day}$$

The flow rate for the fast path Q_f is

$$Q_f = 2.593 \text{ cm/day}$$

The flow rate measured in the field should be a value between Q_s and Q_f. A majority of the time flow was too slow in the field to measure. However, the depth of water in the V flume was measured on June 9 (early after flood) and the drainage rate was calculated as follows:

Quantity of water through flume (QWF) is given by the equation

$$QWF = (1.305 \times 10^9)\ (g\frac{L}{H})^{1/2}\ (DW)^{5/2} \qquad [3]$$

where QWF has units of cm/day and

g = gravitational constant in ft/sec^2

$\frac{L}{H}$ = dimensionless ratio from Figure 6.

DW = Depth of water flowing over the flume in feet.

In our example QWF = 654,912 cm/day for an estimate depth of water (DW) of 0.6 cm occurring early after flood.

$$Q_{\text{Field estimate}} = \frac{654912 \text{ cm/day}}{(100 \times 12 \times 2.54)(50 \times 12 \times 2.54)}$$

$$Q_{\text{Field estimate}} = 0.1410 \text{ cm/day}$$

which was between Q_s and Q_f.

DRAINMOD Predictions

The use of DRAINMOD predicted no significant effluent would be obtained from the tiles for these soils utilizing soil flow parameters that were available (1,5). The soil water parameters needed as input for DRAINMOD were chosen properly (Appendix A DRAINMOD TRIAL FORMS). DRAINMOD then was run for several times by changing the magnitude of soil water transport parameters (procedures to run DRAINMOD are given in Appendix B). Results from these simulations indicated that a very low hydraulic conductivity exists in Arkansas soils such as the McGehee. As a result, the model predicted nearly the same low values for daily drainage rate (about 0.3 cm/day) regardless of the value of the available saturated hydraulic conductivity. However, increases in predicted values of daily drainage rates were observed when the magnitude of the soil hydraulic conductivities were increased to approximately 100 times higher than the actual values for the soil in our study (an example of the output of DRAINMOD for month of July, 1983, is given in Appendix B). There is some question of whether or not the computer model is accurate at the low hydraulic conductivities that exist in silty and clayey Arkansas soils. The hydraulic conductivities for which the model has been used in the past were 100 to 1000 fold larger than those found in Arkansas soils.

SUMMARY AND CONCLUSIONS

It was the objective of this study to determine whether or not tile drains could be used to promote internal drainage of agricultural soils in the Mississippi delta of Arkansas. If drainage from the tiles could be established, then water from wells containing a high soluble salt content could be used for irrigation, and with proper management, no detrimental soluble salt buildup would occur in soil. The results of this study indicate that tile drainage does not remove sufficient water to provide a useful tool in salt management. However, there needs to be two additional observations made (which the early report due date precluded): (1) Are the tile lines stopped up in the field? and (2) has a thin layer of soil been puddled immediately surrounding the tile drain that is restricting flow to the drain.

These last two observations should be completed before the final assessment of this study can be made. In addition, it appears that the effective hydraulic conductivity of the soil may decrease during the flooding period.

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Table 1. Typical profile of McGehee silt loam, in a moist cultivated field in the SE1/4SW1/4SW1/4 sec. 14, T. 13 S., R. 3W.

Ap - 0 to 7 inches, brown (10YR 5/3) silt loam; weak, fine, granular structure; friable; many fine roots; few fine pores; strongly acid; clear, smooth boundary.

B21t - 7 to 11 inches, grayish-brown (10YR 5/2) silty clay loam; common, medium, faint, brown (10YR 5/3) and gray (10YR 5/1) mottles; moderate, medium, subangular blocky structure; firm; common, thick clay films; silt coatings on most ped faces; many fine roots; many fine pores; few fine, black concretions; strongly acid; clear, smooth boundary.

B22t - 11 to 16 inches, variegated reddish-brown (5YR 5/4), grayish-brown (10YR 5/2), and brownish-yellow (10YR 6/8) silty clay loam; moderate, medium, subangular blocky structure; firm; common, thick clay films; silt coatings on most vertical ped faces; few fine roots and pores; few fine, black concretions; medium acid; abrupt, wavy boundary.

IIB31 - 16 to 28 inches, reddish-brown (5YR 4/4) silty clay; few fine, faint, yellowish-red mottles; moderate, medium, subangular blocky structure; very firm; few fine roots and pores; few fine, black concretions; neutral; gradual, smooth boundary.

IIB32 - 28 to 41 inches, dark reddish-brown (5YR 3/4) clay; common, medium, distinct, yellowish-red (5YR 4/6) mottles; moderate, medium, subangular blocky structure; very firm; few fine roots and pores; many calcium carbonate nodules ranging from 1/16 to 1/2 inch in diameter; mildly alkaline; gradual, smooth boundary.

IIC1 - 41 to 65 inches, dark reddish-brown (5YR 3/4) clay; many fine, faint, strong-brown mottles; massive; very firm; few fine roots and pores; many calcium carbonate nodules up to 1/2 inch in diameter; moderately alkaline; clear, smooth boundary.

IIC2 - 65 to 72 inches, dark grayish-brown (10YR 4/2) clay; many fine, distinct, strong-brown and yellowish-red mottles; very firm; many fine, black concretions; moderately alkaline.

Table 2. Selected soil chemical characteristics at the beginning of the study.

Depth cm	pH	EC umhos/cm	Cl	HCO_3	SO_4
			mg/kg*		
0 - 15	7.7	180	29.6	109.2	558.4
15 - 30	6.9	170	45.6	62.0	620.0
30 - 45	6.6	235	59.0	64.4	40.0
45 - 60	6.3	280	78.0	37.2	60.0

* Soil concentrations were determined utilizing a 2:1 water:soil ratio and subsequent chemical analysis of the extract.

Table 3. General management guidelines for rice production over the experimental tile drain field.

FIELD NAME:	1
VARIETY:	LEBONNET
EMERGENCE DATE:	5/21
TILLERING BEGINS - APPLY EARLY TOP DRESS BY:	6/14
RICE WATER WEEVIL ALERT:	6/14 - 6/21
MODERATE RISK OF INFESTATION, AT FLOOD SCOUT FIRST 7 DAYS.	
STRAIGHTHEAD CONTROL	
DRY SOIL BETWEEN:	6/23 - 7/3
HERBICIDE APPLICATION	
APPLY PHENOXY BETWEEN:	7/1 - 7/8
PROPANIL CUT-OFF	
PREFERRED:	7/8
ABSOLUTE:	7/13
ORDRAM CUT-OFF	
PREFERRED:	7/8
ABSOLUTE	7/24
APPLY BLAZER BETWEEN:	6/26 - 7/21
APPLY COLLEGO BETWEEN:	
WHEN FB. NO FUNGICIDE:	6/26 - 7/21
AFTER DRYING FOR STRATI HEAD, FB. NO FUNGICIDE:	7/8 - 7/21
BEGINNING INTERNODE ELONGATION:	7/1
SCOUT FOR SHEATH SLIGHT SYMPTOMS BETWEEN:	7/10 - 8/1
APPLY 1ST MID-SEASON N:	7/10
HEADING:	8/3
DRAINING ALERT FOR HARVEST:	8/28
HARVEST:	9/7

Table 4. Water analyses for selected dates.

Sample date	source	EC umhos/cm	Cl	HCO_3	SO_4
			--------mg/kg--------		
June 6	Tile effluent	380	65	124	67
June 11	Tile effluent	1350	320	364	437
	Well	1400	280	458	133
June 18	Tile effluent	1600	305	443	370
	Well	1675	280	525	304
June 25	Tile effluent	1700	313	440	330
	Well	1525	288	408	260
July 2	Tile effluent	1050	182	299	190
	Well	1560	312	372	280

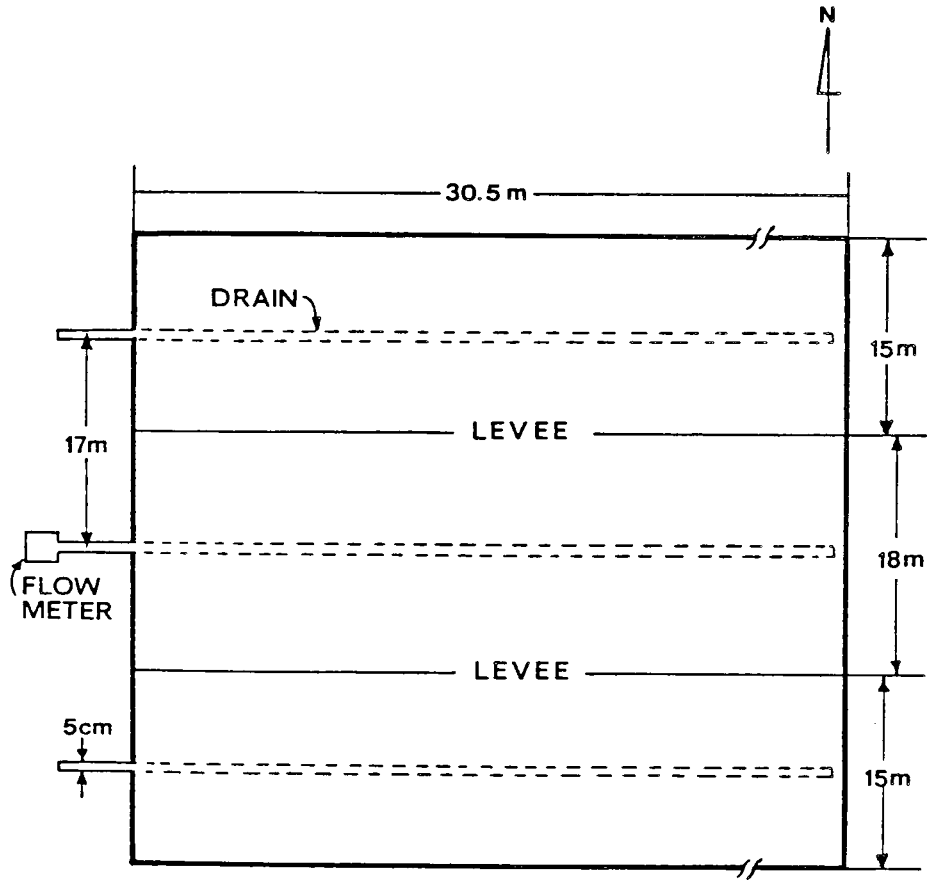

Figure 1
Field layout of tile drain field at the experimental site

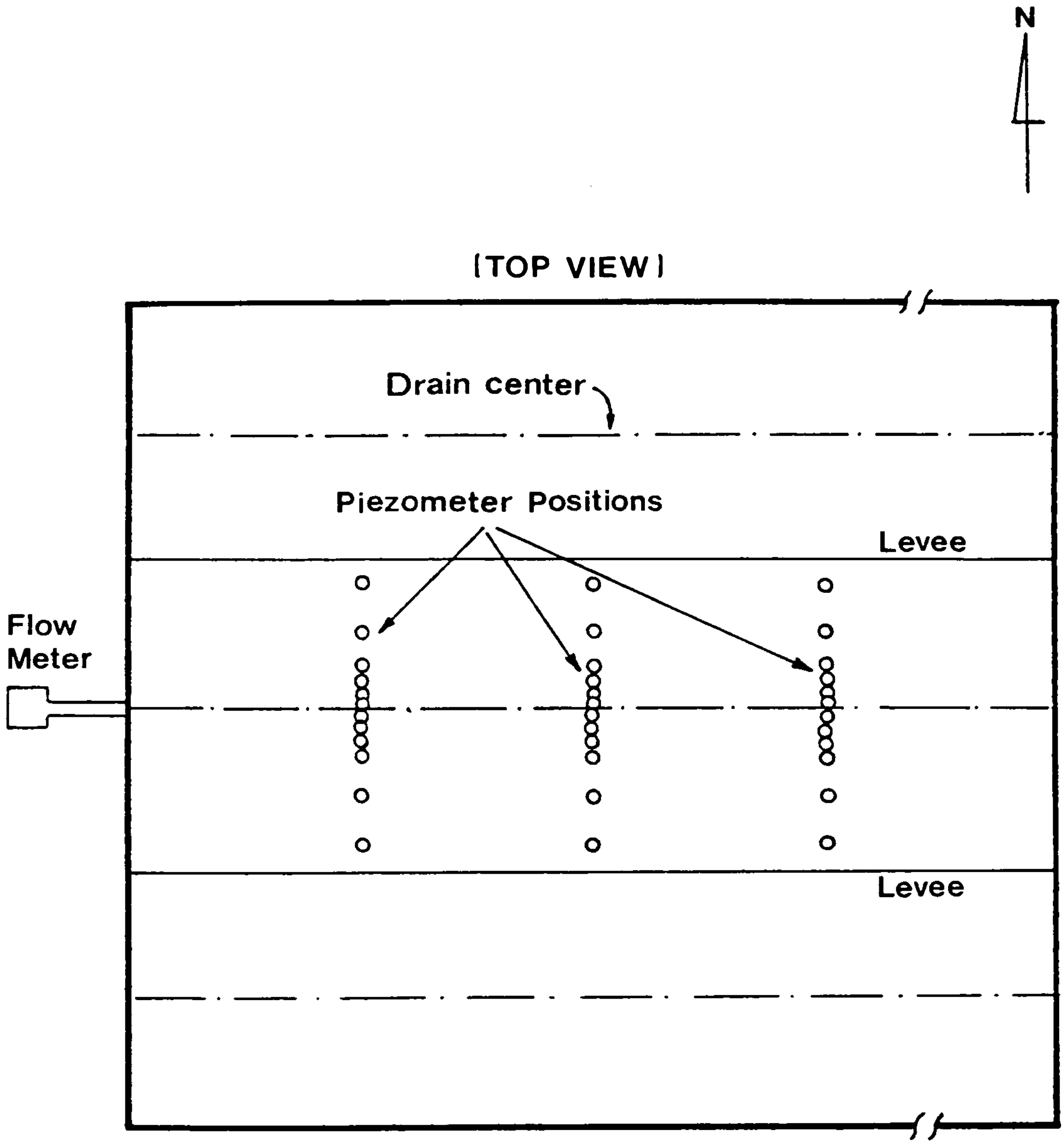

Figure 2. Piezometer tube locations in the tile drain field.

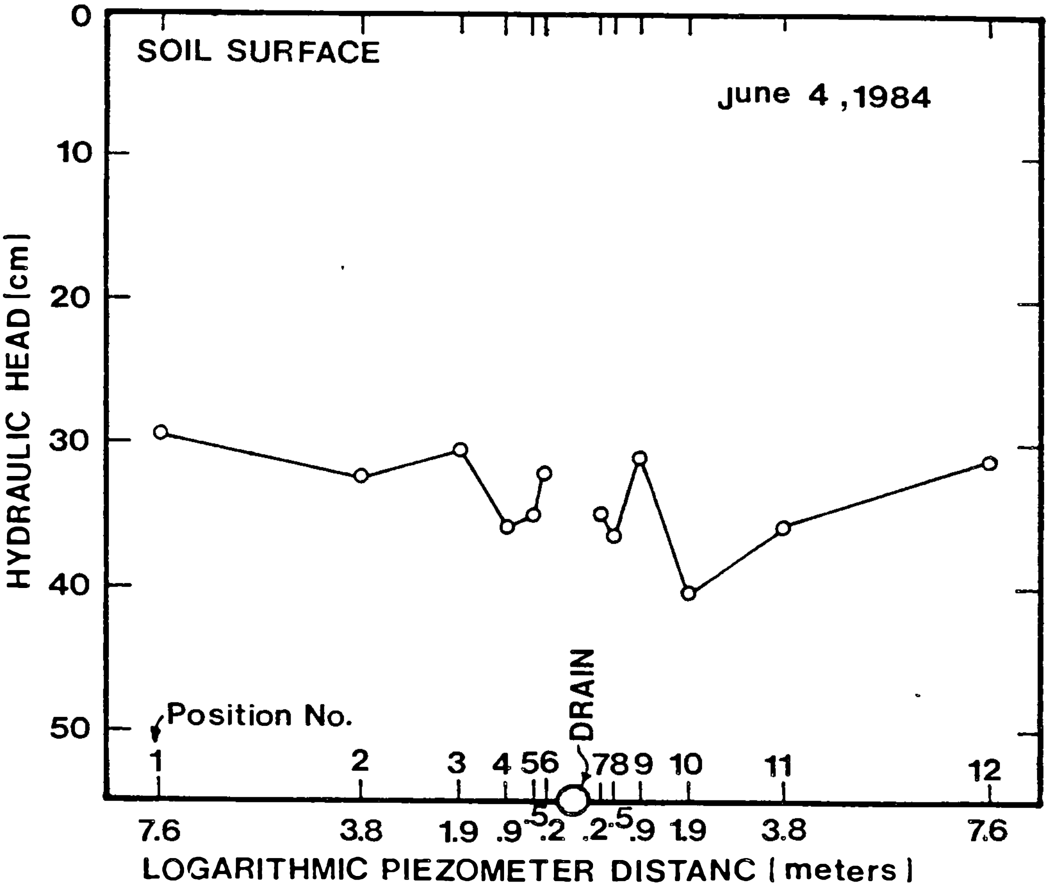

Figure 3. Hydraulic head in relation to the reference of the soil surface and with distance from the tile drain lines.

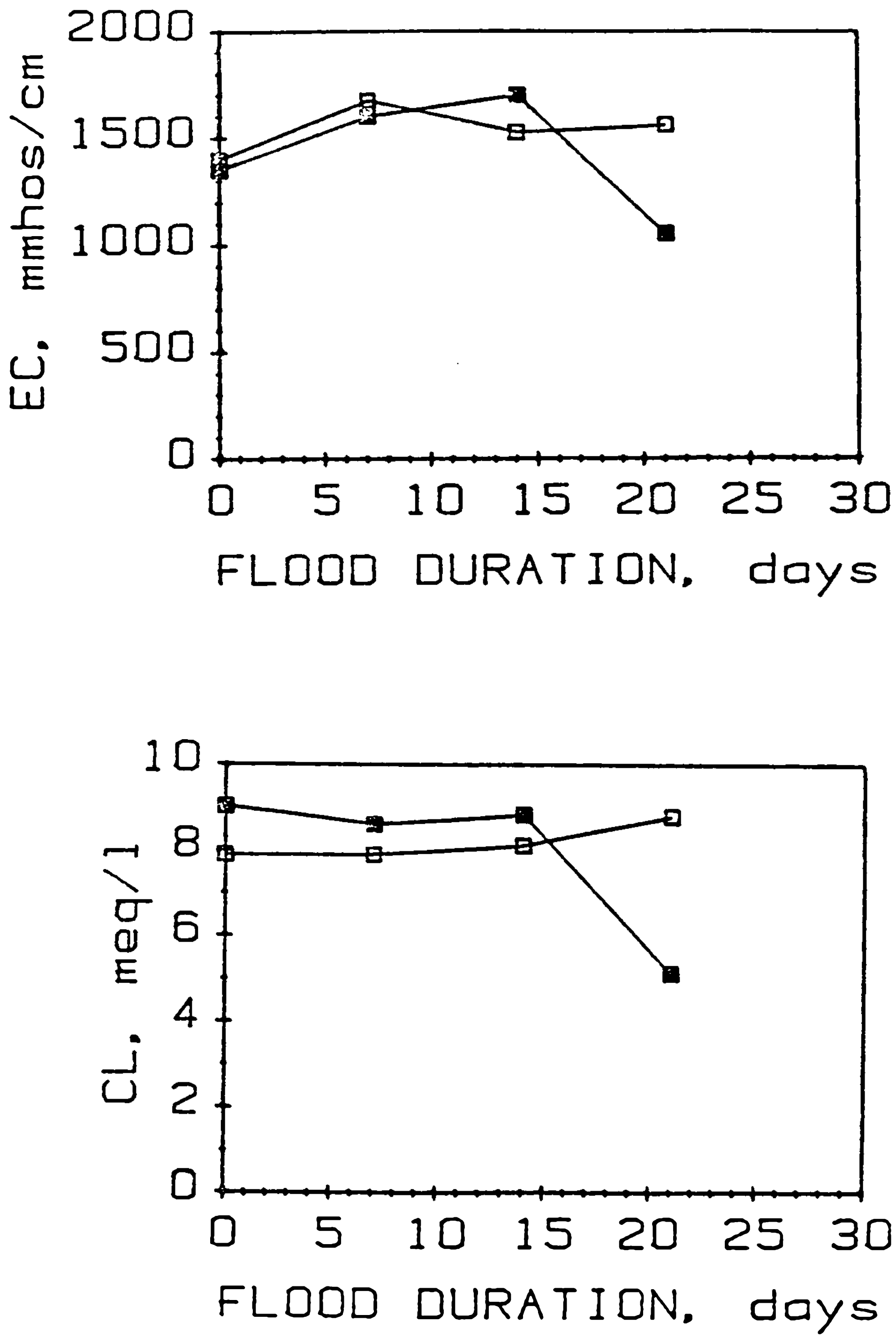

Figure 4. Electrical conductivity and chloride concentration in floodwater (open box) and the tile drainage water (solid box).

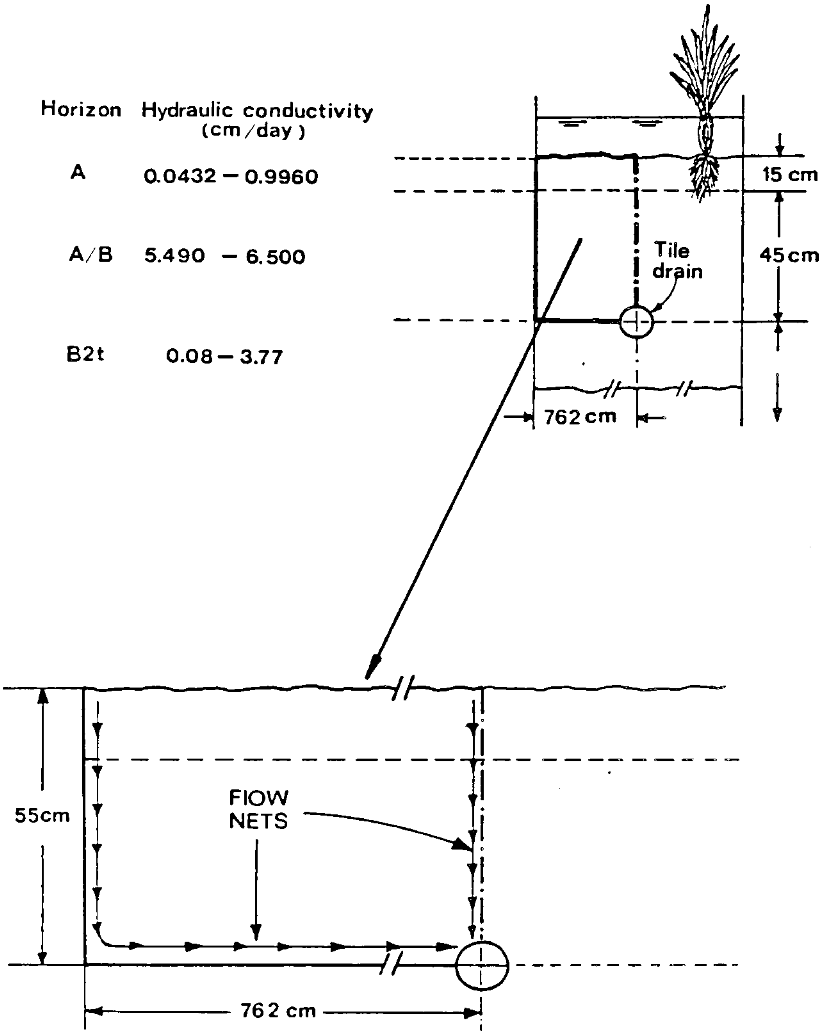

Figure 5

Flow net to a tile drain showing the slowest and fastest water flow paths through soil to tile.

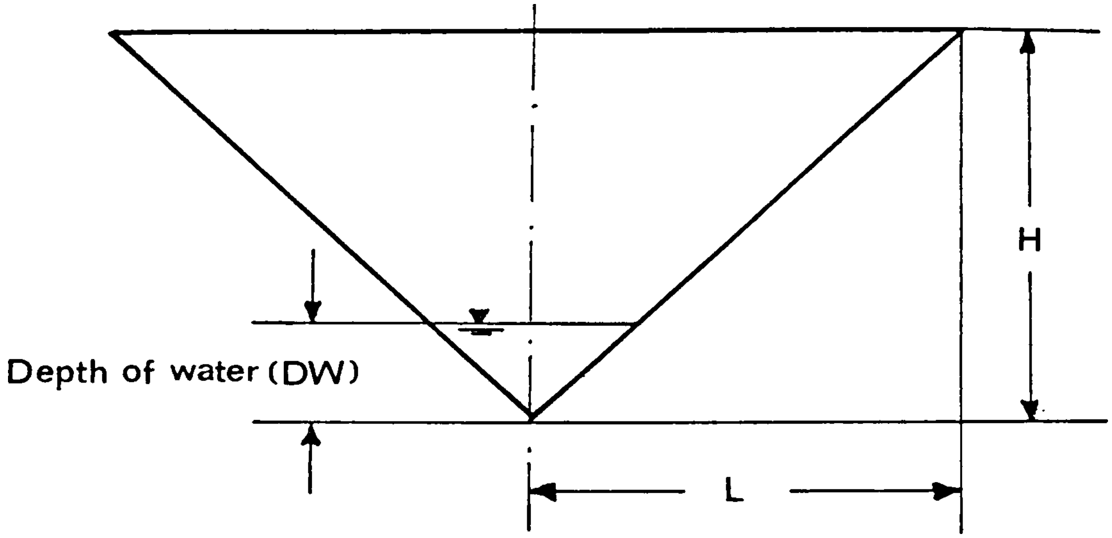

Figure 6. Deth of water(DW) outflow for V flume showing all variables utilized for flow calculations.

Appendix A

PROCEDURE TO RUN DRAINMOD

In MUSIC: Account Number T F283
Password Number T 8677

There are four files or programs:

a) Main model call DRAIN 2.FORTRAN
b) Soil data file called SOILD.DATA
c) Weather data file called WEATH.DATA
d) Program which combine the a, b, and c and run it. This is called DRAIN.GO

Since the required input soil data are relatively small, we follow the format needed for each record to type the soil data. There are, however, 24 records and the format for each record is specified and is described on Drainmod User's Manual (7). In order to change the soil data, simply edit the SOILD.DATA and go line by line (be sure that the numbers are in the right column).

For the weather data, since we normally have a lot of data, we decided to have a SAS program to take care of the format needed for this file. Therefore, to run this SAS program we should start with the CMS and do the following:

a) Get on CMS
   ACC. T DS27058
   Password T SCODO
b) XEDIT ALI/SAS/A
c) Go to the cards; line
d) Type the weather data as follows:
   1) For the rainfall data you need to type the day and the amount of rainfall in hundreds of an inch. If there is a day with no rain, do not type that day. At the end of the month type two zeros.
   2) For the maximum and minimum temperatures, you simply type max and min and continue until the end of the month and then type two capital X.
e) Execute ALI, the output will be called PUNCH
f) You need to transfer PUNCH to the Music account #F283 (you need BPW, which is 677)
g) In Music you can change the name PUNCH to the WEATH.DATA.

In order to run DRAINMOD we type DRAIN.GO and the model will be run on the screen. If you want to get the printout from Remote 14 we should type SUBMIT then two lines will be printed out. You need to fill the blanks as follows:

```
SUBMIT
*IN PROGRESS

MUSIC SUBMIT FACILITY

FILE=//, CODE=/F283000/, SU=60, PAGES=10, CARDS=0, CLASS=
/A0/, ROUTE=//, FORMS=//, SYSID=/MUSICB/, NODE=//
ENTER FILE NAME AND ANY OTHER CHANGES
?

FILE=/DRAIN.GO/, PAGES=999, ROUTE=/REMOTE 14/, FORMS=/STD./
ENTER MUSIC BATCH PASSWORD FOR CODE F283000
BPW=677
JOB/DRAIN.GO/SUBMITTED AT 08.50.14 03AUG84 CLASS=/A0/
*END

*GO
```

Appendix B

DRAINMOD TRIAL FORM

1/ **1**

TITLE

2/ **2**

RAINID	TEMPID	START YEAR	ST MO	END YEAR	E MO	TEMP LAT	HID
331786	331786	1983	01	1983	12	3457	080

3/ **3**

PET
1.0

2/ **4**

INSIRR	FDAYSI	INTDAY	IHRSTA	IHREND	NOIRR1	NOIRR2	NOIRR3	NOIRR4
1.0	164	1.0	1.0	24	1.0	163	243	365

3/ 4/ **5**

REQDAR	AMTRN	AMTSIM											
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
0.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1/ (Alpha-numeric) use letters or numbers.
2/ (Integer) use numbers without a decimal.
3/ (Real) use numbers with a decimal.
4/ This record must be maintained in the data sequence even if it is blank.

DRAINMOD TRIAL FORM

3/ 6

6	DDRAIN	HDRAIN	SDRAIN	STMAX	DEPTH	XNI	DC	ADEPTH
	54.0	1.0	1,524.0	2.0	55.0	1.0	0.78	55.0

3/ 7

7	STORRO	GEE
	2.0	7.33

3/ 8

8	DZ (1)	CONK (1)	DZ (2)	CONK (2)	DZ (3)	CONK (3)	DZ (4)	CONK (4)	DZ (5)	CONK (5)
	5.0	77.24	15.0	28.74	46.0	6.50	55.0	6.0	56.0	0.08

	3/	2/	2/
9	AMINC	NOPORT	NMONTH
	1.0	5	5

2/ 10

10	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
	DACHNG	DWIER		DWIER		DWIER		DWIER		DWIER		DWIER		DWIER		DWIER		DWIER		DWIER		DWIER		DWIER
	00	55.0	00	55.0	00	55.0	00	55.0	00	550	00	550	00	550	00	550	00	550	00	550	00	550	00	550

1/ (Alpha-numeric) use letters or numbers.
2/ (Integer) use numbers without a decimal.
3/ (Real) use numbers with a decimal.

DRAINMOD TRIAL FORM

11

2/	2/	2/	2/	3/	3/	3/
BWKDY1	EWKDY1	SWKHR1	EWKHR1	AMIN1	ROUTA1	ROUTT1
060	135	08	20	3.0	2.5	4.0

12

2/	2/	2/	2/	3/	3/	3/
BWKDY2	EWKDY2	SWKHR2	EWKHR2	AMIN2	ROUTA2	ROUTT2
303	365	08	20	2.0	0.5	1.0

3/
13

DITCHB	DITCHS	ROOTD	CRITD	WP	DTWT
1.0	1.0	0.0	0.0	0.084	0.0

14

2/	2/	2/	2/		3/
ISEWMS	ISEWDS	ISEWME	ISEWDE	[illegible]	SEWX
05	01	09	15		30.0

2/
15

IDRYMS	IDRYDS	IDRYME	IDRYDE
05	01	09	15

1/ (Alpha-numeric) use letters or numbers.
2/ (Integer) use numbers without a decimal.
3/ (Real) use numbers with a decimal.

DRAINMOD TRIAL FORM

16 2/

INDET	INWIER
00	00

17 2/

NUM	IVREAD
09	01

18 3/

THETA		HEAD
0.450		0.0
0.420		-50.0
0.382		-200.0
0.294		-300.0
0.265		-500.0
0.185		-1000.0
0.115		-2000.0
0.104		-5000.0
0.084		-15000.0

19 3/ 4/

X	XVOL	FLUX
0.0	0.0	0.0
5.00.0	50.0	0.0

1/ (Alpha-numeric) use letters or numbers.

2/ (Integer) use numbers without a decimal.

3/ (Real) use numbers with a decimal.

4/ This record must be maintained in the data sequence even if it is blank.

DRAINMOD TRIAL FORM

20

NUMA 2/
06

21

D 3/	A 3/	B 3/
0.0	0.0	0.37
54.0	0.0	0.20
55.0	0.0	0.001
56.0	0.0	0.0001

22

NO 2/
15

23

INDAY 2/	ROOTIN 3/	INDAY 2/	ROOTIN 3/	INDAY 2/	ROOTIN 3/	INDAY 2/	ROOTIN 3/	INDAY 2/	ROOTIN 3/	INDAY 2/	ROOTIN 3/	INDAY 2/	ROOTIN 3/	INDAY 2/	ROOTIN 3/
001	3.0	122	3.0	132	4.0	142	8.0	152	16.0	162	21.0	172	23.0	182	30.0

1/ (Alpha-numeric) use letters or numbers.

2/ (Integer) use numbers without a decimal.

3/ (Real) use numbers with a decimal.

DRAINMOD

OUTPUT EXAMPLE

(all data in cm)

```
   1983        6
DAY   RAIN   INFIL     ET    DRAIN   AIR VOL   TVOL    DDZ     WETZ    DTWT    STOR RUNOFF  WLOSS   YC   DRNSTO  SEW   DMTSI
  1    0.0    0.0     0.27   0.03     3.68     3.68    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0    0.0     0.0
  2    0.0    0.0     0.40   0.03     4.10     4.10    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0    0.0     0.0
  3    1.12   0.00    0.48   0.03     4.61     4.61    0.0     0.0     0.0     1.12  0.00   0.03   0.0    0.0    0.0     0.0
  4    0.0    0.47    0.45   0.03     4.51     4.61    0.0     0.0     0.0     0.64  0.00   0.03   0.0    0.0    0.0     0.0
  5    0.0    0.45    0.43   0.03     4.61     4.61    0.0     0.0     0.0     0.19  0.00   0.03   0.0    0.0    0.0     0.0
  6    0.0    0.19    0.49   0.03     4.92     4.92    0.0     0.0     0.0     0.0   0.00   0.03   0.0    0.0    0.0     0.0
  7    0.0    0.0     0.34   0.03     5.28     5.28    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0    0.0     0.0
  8    0.0    0.0     0.30   0.03     5.61     5.61    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0    0.0     0.0
  9    0.0    0.0     0.36   0.03     6.00     6.00    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0   30.00    0.0
 10    0.0    0.0     0.43   0.03     6.45     6.45    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0   30.00    0.0
 11    0.0    0.0     0.51   0.03     6.98     6.98    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0   30.00    0.0
 12    0.0    0.0     0.50   0.03     7.51     7.51    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0   30.00    0.0
 13    0.0    0.0     0.53   0.03     8.06     8.06    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0   30.00    0.0
 14    0.69   0.00    0.57   0.03     8.65     8.65    0.0     0.0     0.0     0.68  0.00   0.03   0.0    0.0   30.00    0.0
 15    0.0    0.53    0.51   0.03     8.65     8.65    0.0     0.0     0.0     0.15  0.00   0.03   0.0    0.0   30.00    0.0
 16    0.0    0.15    0.43   0.03     8.96     8.96    0.0     0.0     0.0     0.0   0.00   0.03   0.0    0.0   30.00    0.0
 17    0.0    0.0     0.50   0.03     9.48     9.48    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0   30.00    0.0
 18    0.18   0.00    0.53   0.03    10.03    10.03    0.0     0.0     0.0     0.18  0.00   0.03   0.0    0.0   30.00    0.0
 19    0.0    0.18    0.47   0.03    10.35    10.35    0.0     0.0     0.0     0.0   0.00   0.03   0.0    0.0   30.00    0.0
 20    0.0    0.0     0.51   0.03    10.88    10.88    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0   30.00    0.0
 21    1.12   0.00    0.54   0.03    11.45    11.45    0.0     0.0     0.0     1.12  0.00   0.03   0.0    0.0   30.00    0.0
 22    0.0    0.57    0.55   0.03    11.45    11.45    0.0     0.0     0.0     0.54  0.00   0.03   0.0    0.0   30.00    0.0
 23    0.23   0.54    0.55   0.03    11.48    11.48    0.0     0.0     0.0     0.23  0.00   0.03   0.0    0.0   30.00    0.0
 24    0.66   0.23    0.54   0.03    11.81    11.81    0.0     0.0     0.0     0.66  0.00   0.03   0.0    0.0   30.00    0.0
 25    0.0    0.53    0.51   0.03    11.81    11.81    0.0     0.0     0.0     0.13  0.00   0.03   0.0    0.0   30.00    0.0
 26    0.0    0.13    0.54   0.03    12.25    12.25    0.0     0.0     0.0     0.0   0.00   0.03   0.0    0.0   30.00    0.0
 27    0.0    0.0     0.56   0.03    12.83    12.83    0.0     0.0     0.0     0.0   0.0    0.03   0.0    0.0   30.00    0.0
 28    1.17   0.00    0.57   0.03    13.42    13.42    0.0     0.0     0.0     1.17  0.00   0.03   0.0    0.0   30.00    0.0
 29    0.0    0.51    0.49   0.03    13.42    13.42    0.0     0.0     0.0     0.65  0.00   0.03   0.0    0.0   30.00    0.0
 30    0.0    0.51    0.49   0.03    13.42    13.42    0.0     0.0     0.0     0.14  0.00   0.03   0.0    0.0   30.00    0.0
```