January 1973 WRRI Report No. 012

13030 GLM

Quarterly Progress Report

QUALITY AND QUANTITY OF RETURN FLOW AS INFLUENCED BY TRICKLE AND SURFACE IRRIGATION

October, November and December - 1972

PROGRESS REPORT

WRRI-308, PROJECT 13030 GLM

October, November, December

1972

Accomplishments this past quarter are discussed in the sequence they appear in the Task Description and Time Table for the second project year, included herein as Figure 1.

1. Grow and Harvest Cotton Crop

Cotton was harvested by handpicking three center rows in each surface irrigated plot (a total of 60 feet), and four center rows in each trickle irrigated plot. The first harvest was on October 18, 1972 and the second, and last, harvest on November 1, 1972. After harvesting the cotton, the remaining stalks and the non-harvested plants were pulled out of the soil and removed from the plots. The plots were then raked, and all plant material was removed to minimize transfer of diseases for next year's crop. The yield data for the first and second pick and the total yield are presented in Table 1 for the surface irrigated plots and in Table 2 for the trickle plots. The amount of irrigation water applied to each plot is also presented.

The irrigation treatments are listed below:

L_1 = 25% depletion

L_2 = 50% depletion

L_3 = 75% depletion

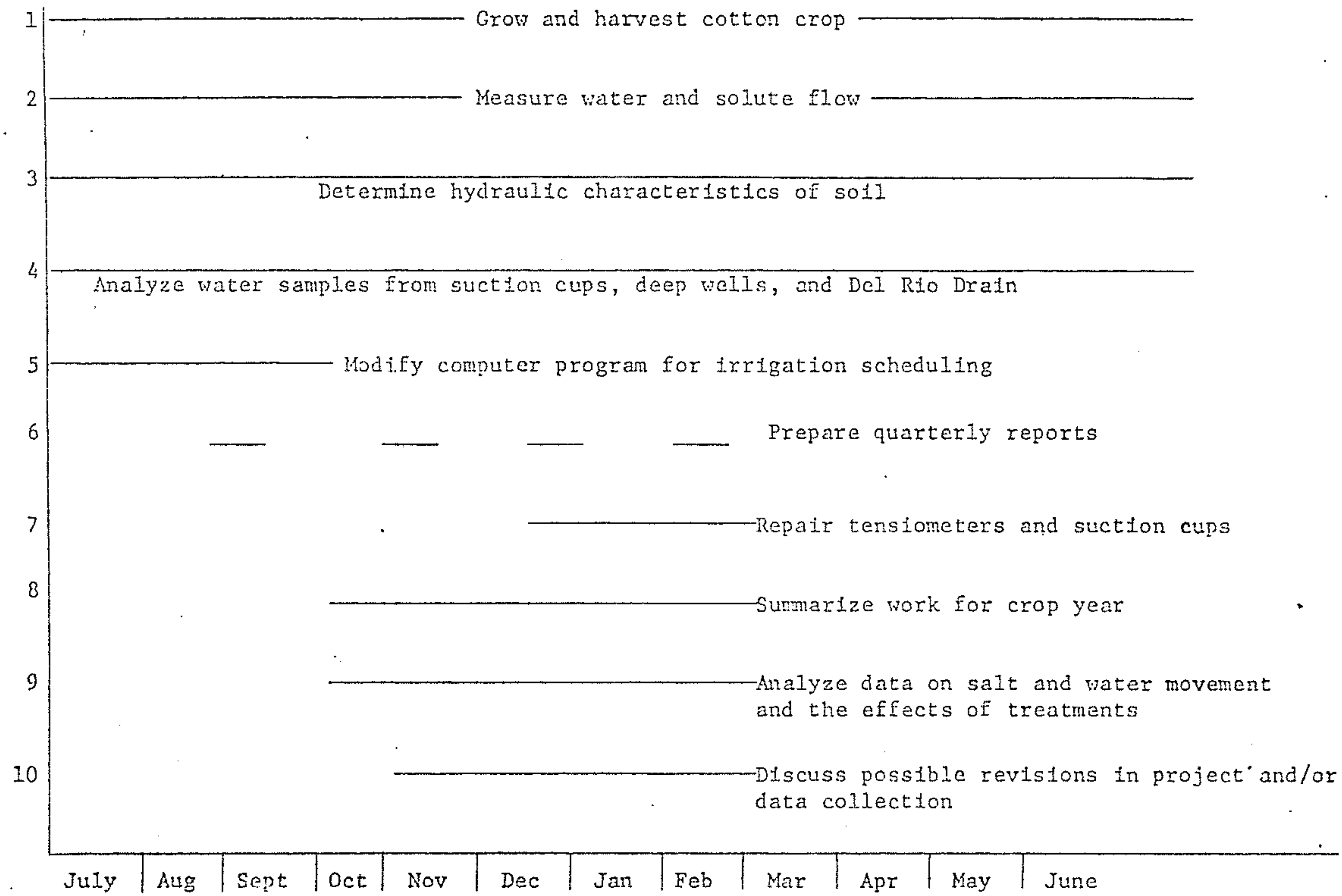

Fig. 1. Task description and time table for second year of study

Table 1. Cotton yields (bales per acre) of surface irrigated plots of the the first and second harvest. Combined yields and total amounts of irrigation water applied are given in the last two columns. The numbers between brackets are the standard deviations.

	1st harvest 10/18/72	2nd harvest 11/1/72	Total	Irrigation water, incl. 8" preirr.
		bales/acre		inches
T_1, $L_1 \times E_1$	.96	.58	1.54	36.6
	.77	1.04	1.81	36.5
	.83	.80	1.63	36.2
Average	.85 (.09)	.80 (.23)	1.66 (.14)	36.4
T_2, $L_2 \times E_1$	.99	1.27	2.26	37.7
	.53	.43	.96	35.5
	.72	.57	1.29	37.1
Average	.75 (.23)	.75 (.45)	1.50 (.68)	36.7
T_3, $L_3 \times E_1$	1.10	1.09	2.19	34.8
	.95	.92	1.87	35.7
	.93	.72	1.65	34.3
Average	.99 (.09)	.91 (.19)	1.90 (.27)	34.9
T_4, $L_1 \times E_2$	.45	.73	1.18	28.2
	.61	.76	1.37	28.2
	.91	.57	1.48	28.3
Average	.66 (.23)	.69 (.10)	1.34 (.15)	28.2
T_5, $L_2 \times E_2$	.96	.26	1.22	29.3
	1.28	.92	2.20	29.8
	.93	.80	1.73	29.1
Average	1.05 (.19)	.66 (.35)	1.71 (.49)	29.4
T_6, $L_3 \times E_2$	.98	.84	1.82	27.2
	.90	.75	1.65	27.1
	.80	.96	1.76	27.3
Average	.89 (.09)	.85 (.11)	1.74 (.109)	27.2
T_7, $L_1 \times E_3$	.66	.67	1.33	24.6
	.62	.99	1.65	26.1
	.79	.57	1.36	24.0
Average	.69 (.109)	.74 (.22)	1.43 (.15)	24.9
T_8, $L_2 \times E_3$	.89	.95	1.84	24.7
	.85	.91	1.76	24.7
	1.07	.69	1.76	24.6
Average	.94 (.12)	.85 (.14)	1.78 (.05)	24.7

Table 1. Continued

	1st harvest 10/18/72	2nd harvest 11/1/72	Total	Irrigation water, incl. 8" preirr.
	bales/acre			inches
T_9, L_3 x E_3	1.06	.65	1.71	23.6
	.80	.62	1.42	23.8
	.76	.86	1.62	23.4
Average	.87 (.16)	.71 (.13)	1.58 (.15)	23.6

Average yield for all surface plots 1.63 (± .31) bales/acre

Table 2. Cotton yields (bales/acre) of trickle irrigated plots after the first and second harvest. Combined yields and total amounts of irrigation water are given in the last two columns. The numbers between the brackets are the standard deviations.

	1st harvest 10/18/72	2nd harvest 11/1/72	Total	Irrigation water, incl. 8" preirr.
		bales per acre		inches
T_{02}	1.01	1.19	2.20	26.8
	.97	1.37	2.34	31.3
	.90	1.27	2.17	25.4
Average	.96 (.05)	1.28 (.09)	2.24 (.09)	27.8
T_{06}	2.02	.48	2.50	16.2
	1.50	.42	1.92	16.2
	1.32	.25	1.57	16.3
Average	1.61 (.36)	.38 (.12)	2.00 (.46)	16.2

Average yield for all trickle plots 2.12 (± .33) bales/acre

E_1 = 50% efficiency

E_2 = 75% efficiency

E_3 = 100% efficiency

T_{02} = Irrigated (trickle) when tension at 6" reached 0.2 atm

T_{06} = Irrigated(trickle) when tension at 6" reached 0.6 atm

A statistical analysis of the yield data was made by the Department of Experimental Statitistics. From the analysis it was found that there were no significant differences at the 5% level between treatments due to either % depletion, or % efficiency in the surface irrigated plots. Although the average yield in the low efficiency plots (1.68 bales/acre) was somewhat higher than the average yield in the high efficiency plots (1.60 bales/acre), the difference was much too small to be significant. Thus irrigation with 36" of water gave about the same yield as irrigation with 24" of water.

The amounts of water added to the 100% efficiency plots were based on U. S. Weather Bureau pan evaporation data. It is possible that the factor used for converting pan data to actual consumptive use data was overestimated, and that the 100% efficiency plots were irrigated at an efficiency less than 100%, causing relative small differences in plant-water stress between the high and low efficiency treatments.

The average yields from the trickle plots (Table 2) were considerably higher than from the surface irrigated plots, while the amounts of water added were about the same, or less than for the surface irrigated plots. With 28 inches of water an average yield of 2.24 bales/acre was obtained from the wet (0.2 bars) trickle plots, and with 16 inches of water an average yield of 2.0 bales/acre was obtained from the dry (0.6 bars) trickle plots. These data seem to indicate that possibly less water could have been added to the surface plots, without much decrease in yield.

Due to the considerable variation in yield within treatments, the difference between the yield of the dry and of the wet trickle treatments was not significant. However, in contrast with the surface plots, harvest x treatment was highly significant for the trickle plots. The dry trickle plots matured earlier, and the first harvest had the highest yield, whereas for the wet trickle plots the second harvest yielded highest.

Cotton samples were taken from each plot for quality analysis in the laboratory. The data are not yet complete at this time, but will be reported in the next quarterly report.

The cotton yields reported in Tables 1 and 2 were negatively affected by the date of planting and difficulties during germination. Planting on May 15, 1972, was between two and three weeks late, due to unexpected difficulties encountered with the installation of tensiometers and neutron access tubes within the plots. Earlier planting would have had a positive effect on yields, especially for the second harvest. Because of the small size of the surface plots (24 x 24') and because of the plastic covered borders around these plots, no furrows were made inside the plots. Instead, the cotton was planted on level soil which resulted in nonuniform and late germination due to formation of a surface crust.

2. Measure Water and Solute Flow

Daily monitoring of the tensiometers at two levels below the soil surface in each plot were continued until the end of November. The data will be used to calculate deep percolation losses from each plot, once the hydraulic conductivity functions of the subsoil have been established. The calculated deep percolation losses, in combination with salinity data from the suction cups and from saturation extracts made from soil samples taken in each plot before and after the irrigation season, will yield estimates of the return flow quality and quantity under each of the different treatments.

During the last two weeks of November and the first week of December soil samples were taken at two locations within each of the 33 plots. The samples were taken at 20 cm intervals down to the level of the suction cups in each plot. The samples were air dried and are now being analyzed for total salt content.

In Figures 2, 3, 4 and 5, the electrical conductivities (mmhos/cm at 25°C) are given of the saturation extracts of soil samples from the 0-20, 20-40, 40-60 and 60-80 cm soil depths. The samples were collected before planting in April 1972, partly during installation of the neutron access tubes. The approximate location from where the samples were taken is indicated by the location of the data in Figures 2-5. The data in Figures 2-5 show a large spatial variation in salt content over the plot area. The salt content increases with depth, but decreases with decreasing distance to the Del Rio Drain. The large variation in salt content of the samples removed from any one

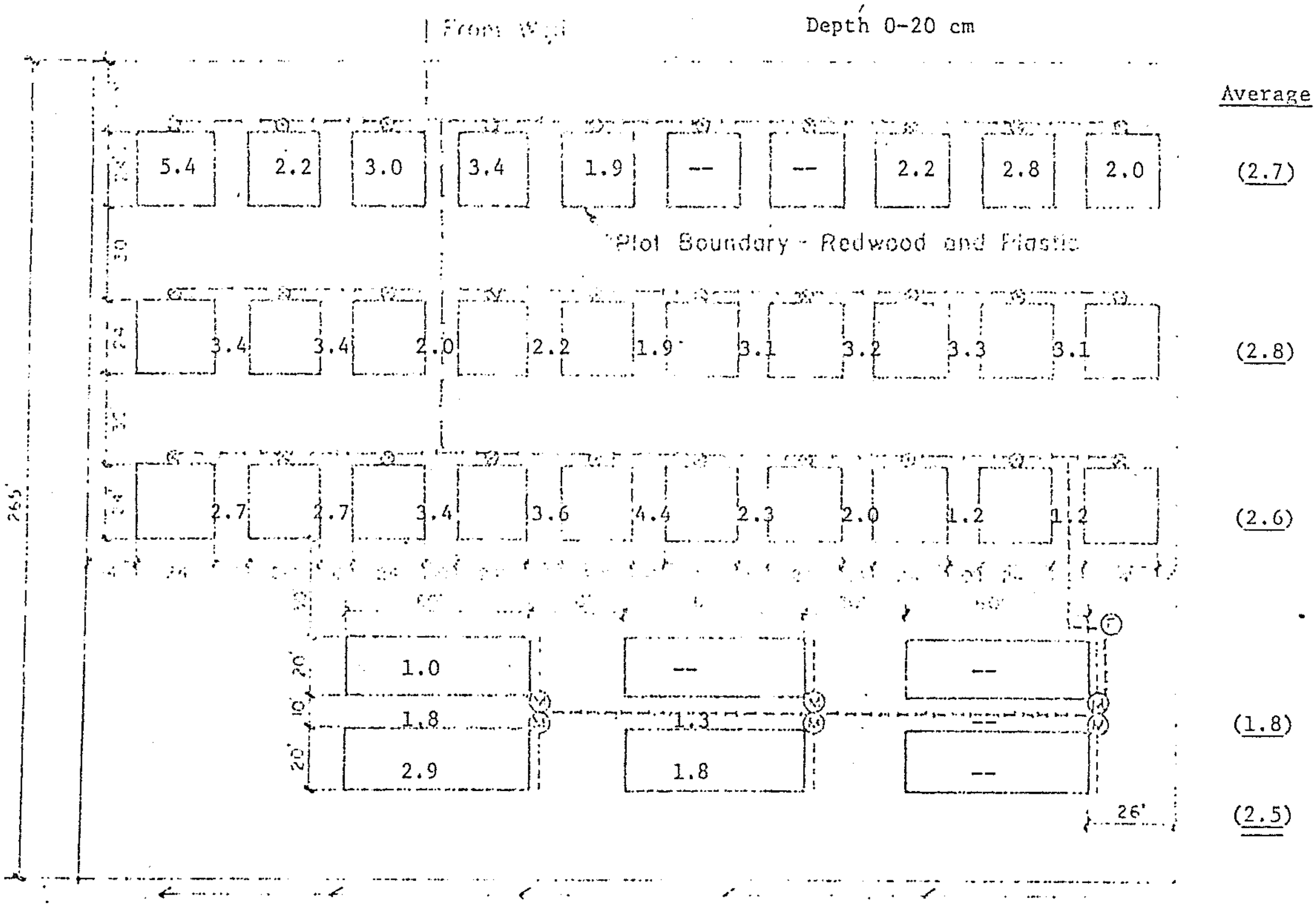

Fig. 2. Electrical conductivities (mmhos/cm at 25°C) of saturation extracts of soil samples from the 0-20 cm depth; before planting; Spring 1972.

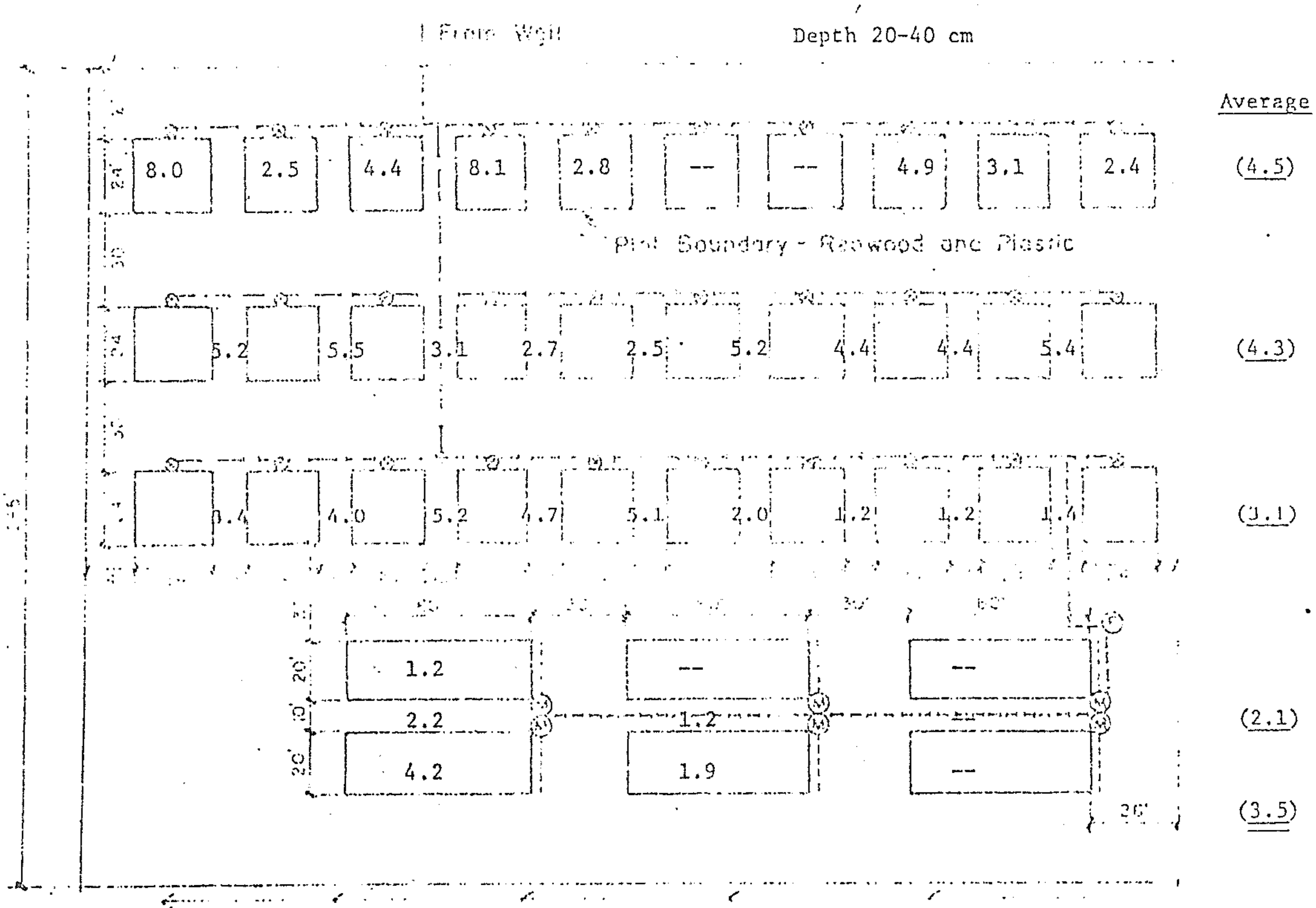

Fig. 3. Electrical conductivities (mmhos/cm at 25°C) of saturation extracts of soil samples from the 20-40 cm depth; before planting; Spring 1972.

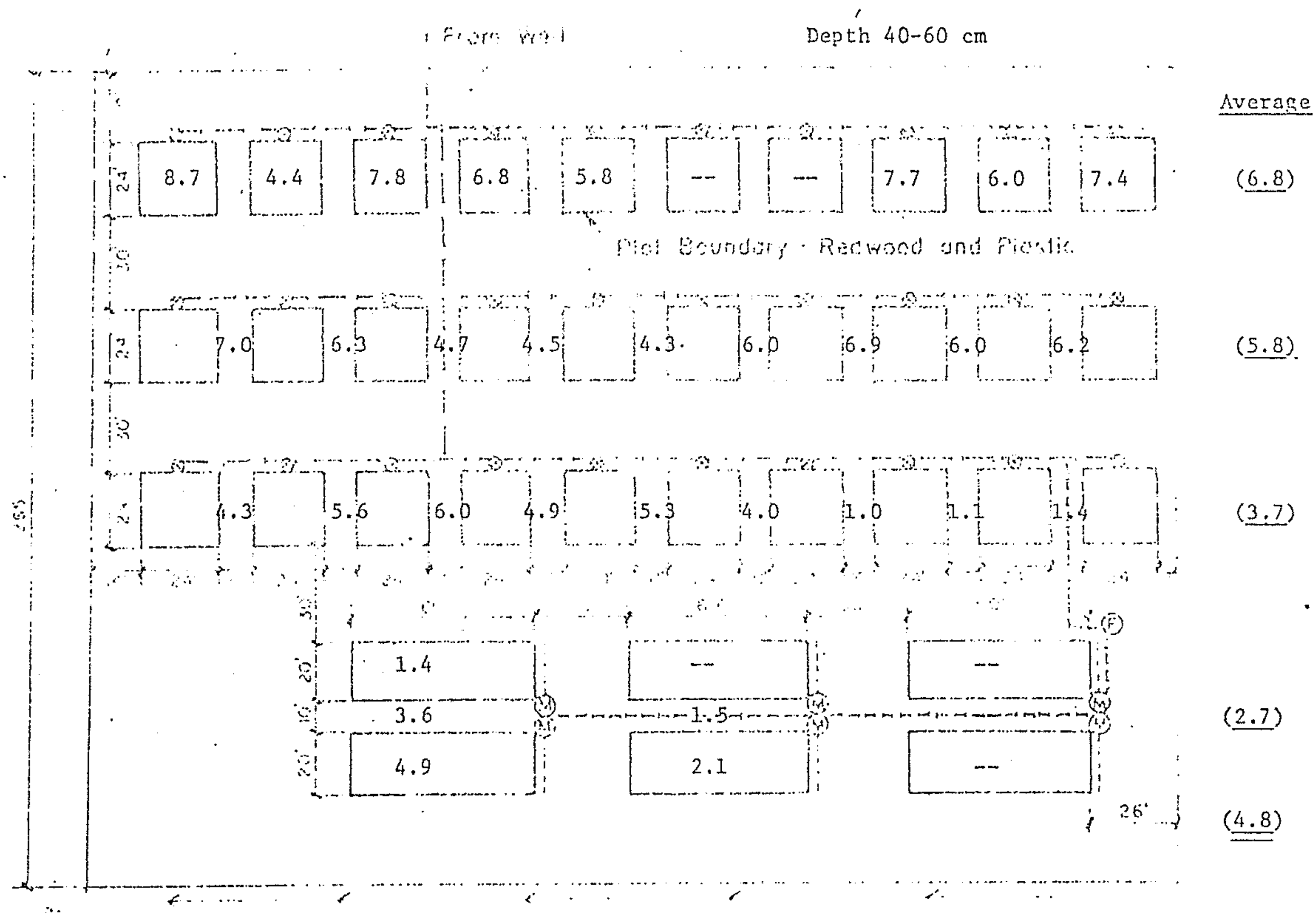

Fig. 4. Electrical conductivities (mmhos/cm at 25°C) of saturation extracts of soil samples from the 40-60 cm depth; before planting; Spring 1972.

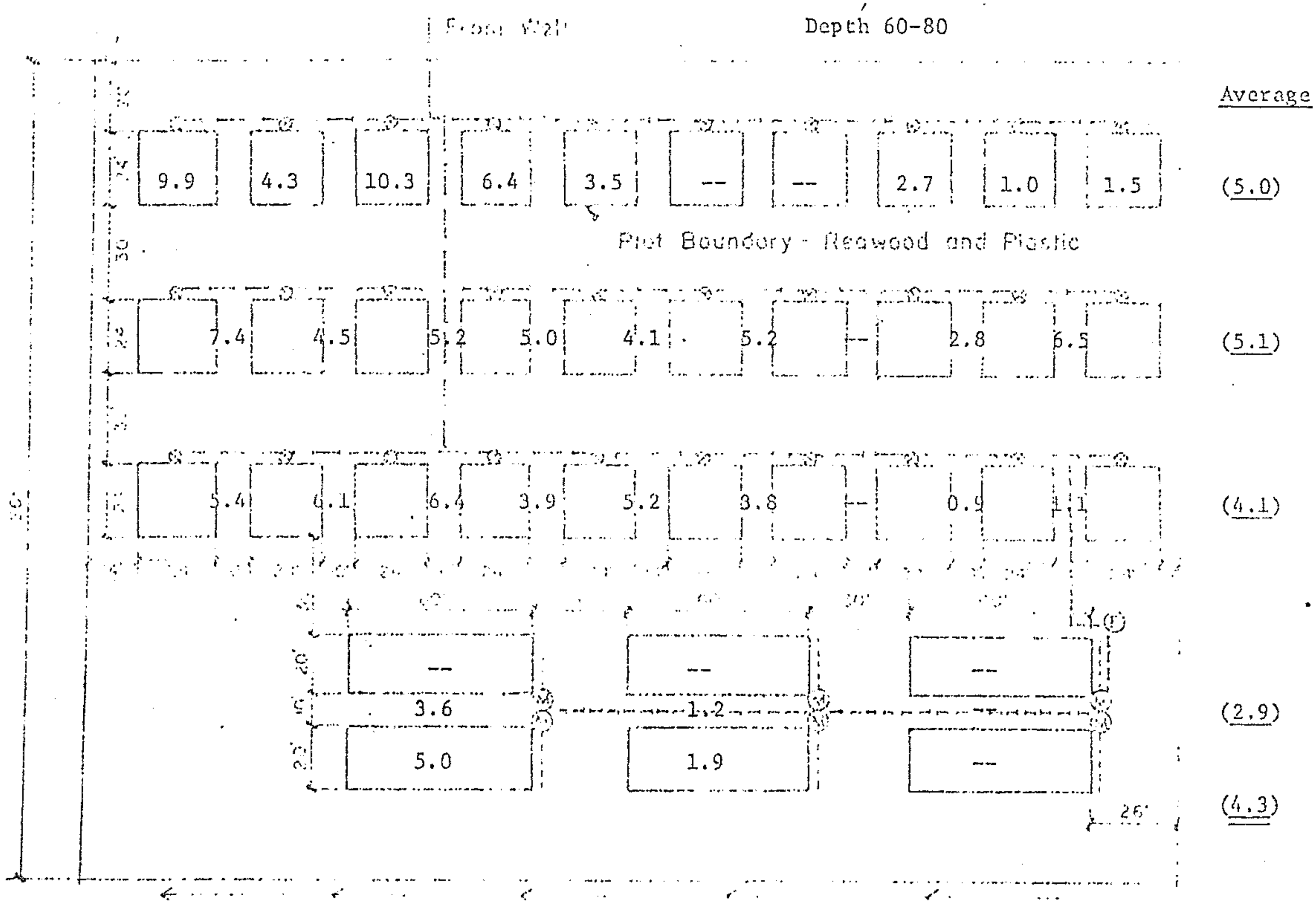

Fig. 5. Electrical conductivities (mmhos/cm at 25°C) of saturation extracts of soil samples from the 60-80 cm depth; before planting; Spring 1972.

depth before the start of the irrigation treatments partially explains the large variation in electrical conductivity of the samples removed with the suction cups (See Quarterly Report, July, August, September, WRRI Report #11).

3. Determine Hydraulic Characteristics of Soil

Progress has been made in determining the hydraulic characteristics of the soil. Two 24 x 24' plots, fully instrumented with neutron access tubes and tensiometers, were flood irrigated with 16 inches of water and then covered with polyethylene plastic to prevent evaporation. After covering the plots with plastic the changes in water content were measured at 12.5 cm depth increments with a neutron meter. The changes in soil-water tension at 30 cm depth intervals were measured at regular time intervals with tensiometers. Computer programs were written to convert neutron meter readings into soil water contents, to calculate potential gradients from the tensiometer readings, to calculate soil water fluxes from changes in soil water content, and to calculate hydraulic conductivities from the fluxes and potential gradients for each 30 cm layer in these plots. An effort will be made to measure the hydraulic conductivity of the subsoil below each plot. The first row of plots has been irrigated for this purpose with 12 inches of water, and all tensiometers have been repaired, and adjusted. After four more inches is applied, these plots will be covered, and the drainage through the 120-150 cm layer followed.

4. Analyse Water Samples from Suction Cups--Deep Wells and Del Rio Drain

No soil solution samples have been extracted from the plots since the October quarterly report.

Sampling of the deep wells and the Del Rio Drain water were continued, as well as the continuous monitoring of the quantity of flow in the Del Rio Drain.

One full year of drain flow data is now available. Figure 6 presents data on the rate of flow at Station A, 2.8 miles above the plot site and at Station B which is adjacent to the plot site. Figure 7 shows the conductivity of the water at A, and Figure 8 shows the conductivity of the water at B.

Table 3 summarizes conductivity of well samples for the total sampling period to date. Monthly conductivities reported are the mean for that month's readings (four or five observations).

5. Modify Irrigation Scheduling Program

This job has not been completed and it appears a meeting with personnel from the Salt River Project will be required to expedite this task.

6. No report.

7. No report.

8. Summarize Work for Crop Year

As evidenced by Items 2 and 3 of this report, work on this item is progressing on schedule.

Table 3. Monthly average EC (mmhos/cm) - deep well samples

Month	depth in feet				
	19	25	35	50	75
April	1.66	1.70	1.60	1.36	1.08
May	1.62	1.48	1.60	1.58	1.14
June	1.58	1.42	1.61	1.68	1.16
July	1.55	1.41	1.60	1.67	1.16
August	1.47	1.36	1.55	1.36	1.10
September	1.41	1.40	1.56	1.43	1.11
October	1.36	1.41	1.56	1.40	1.12
November	1.34	1.45	1.59	1.38	1.12
December	1.32	1.50	1.60	1.42	1.03

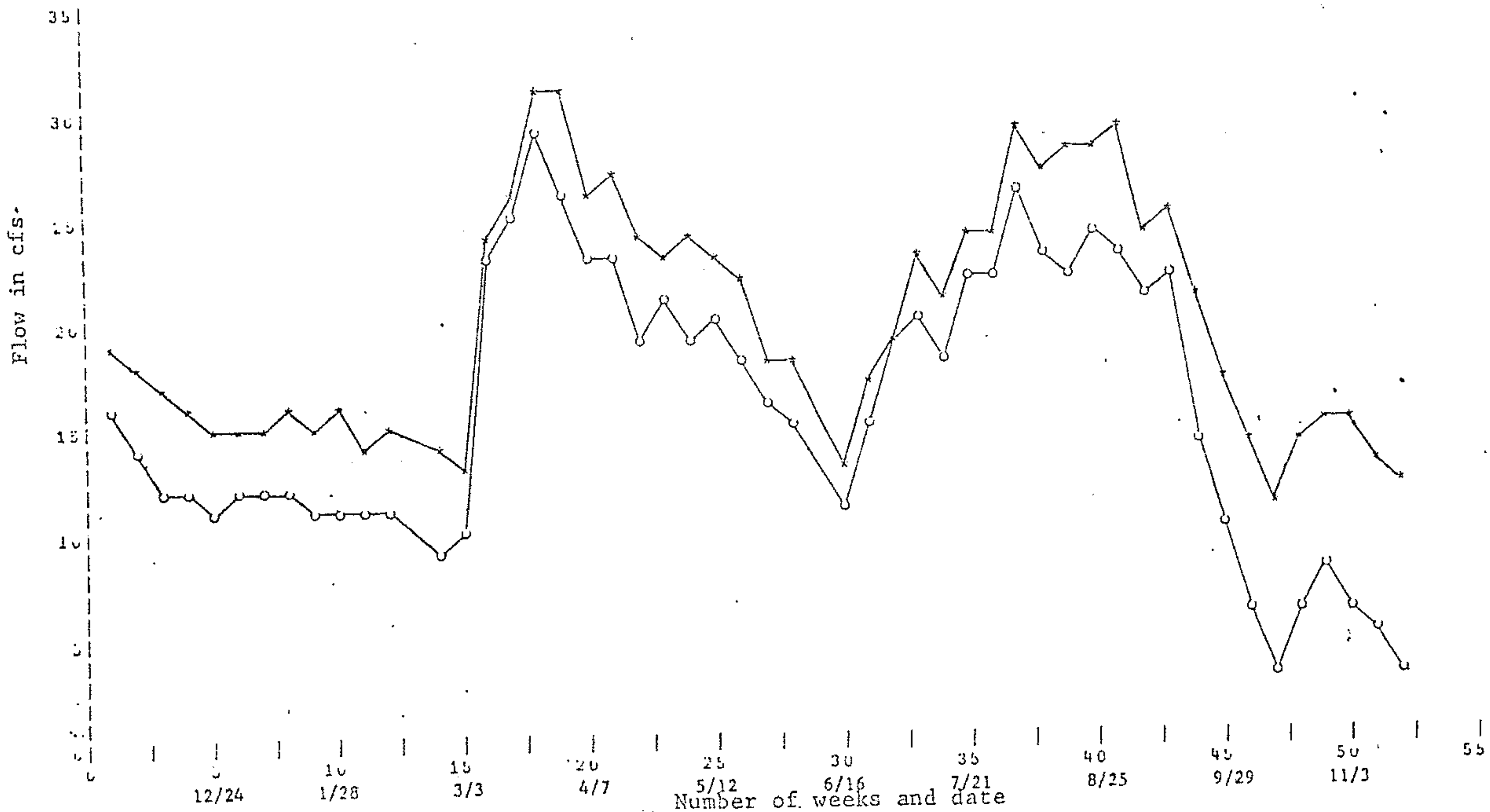

Fig. 6. Flow in Del Rio Drain, 1971-1972.

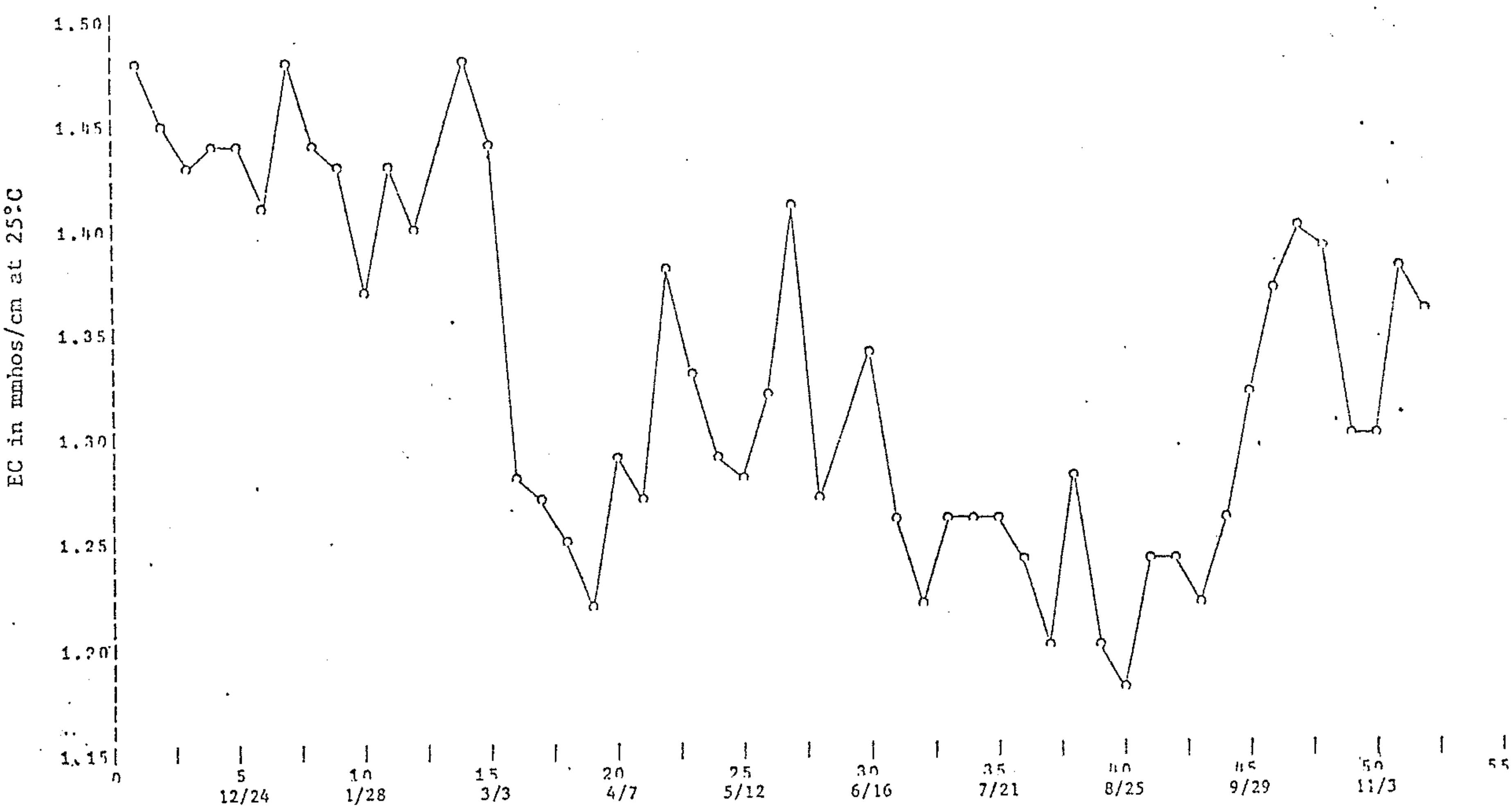

Fig. 7. Conductivity of drainage water at Site A, 1971-1972.

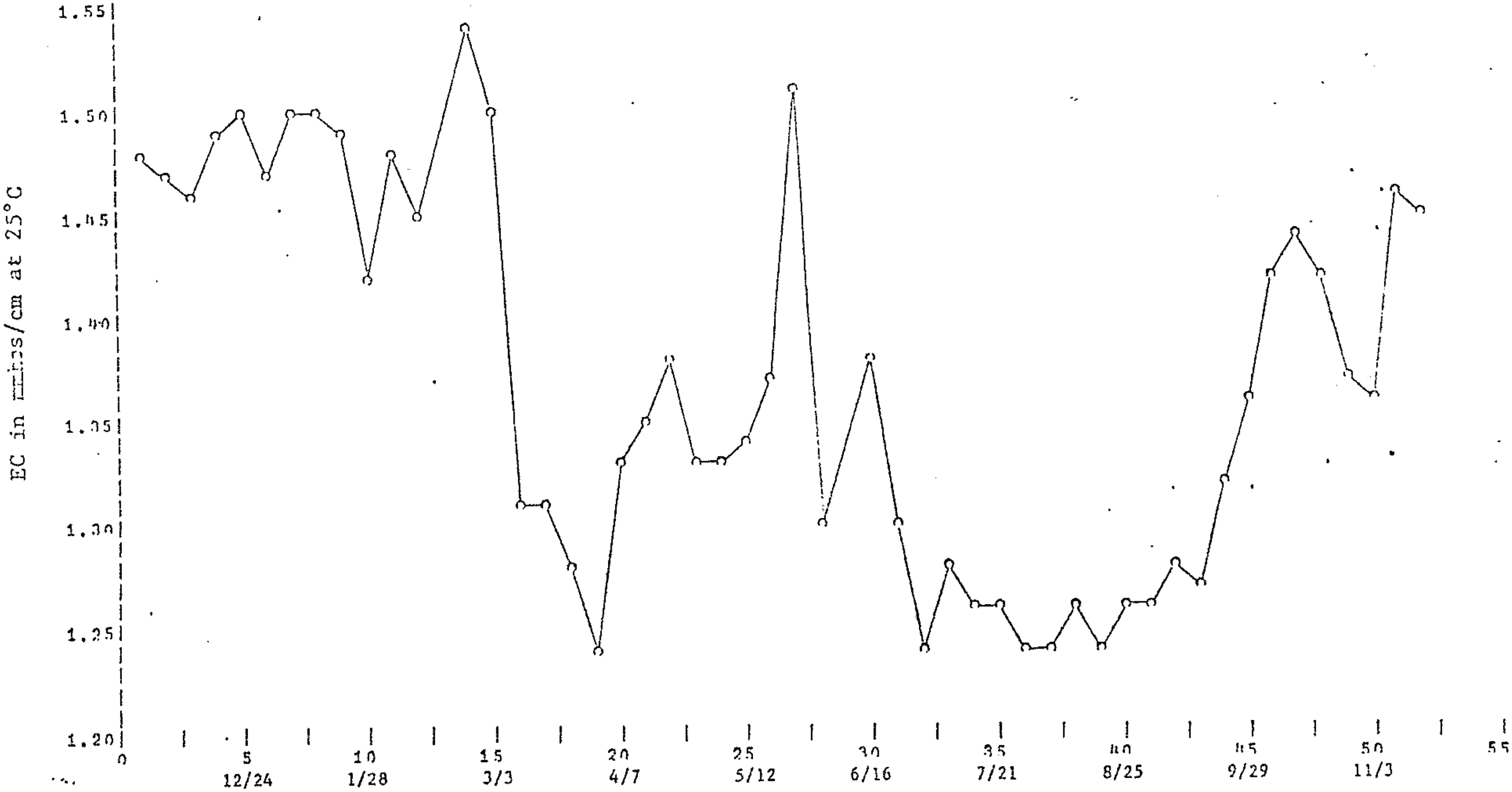

Fig. 8. Conductivity of drainage water at Site B, 1971-1972.

9. Analyze data on Salt and Water Movement and Effects of the Treatments

Progress as again indicated under Items 2 and 3 is being made in this regard. Complete analysis awaits definitive data on hydraulic conductivities under each plot.

10. Revisions in Project or Data Collection

As was indicated before it appears that the amount of water applied to the surface irrigated plots was higher than planned for. This coming project year the crop coefficients used to calculate evapotranspiration from the class A evaporation pan data will be adjusted downward. Also, the soil-water potential in one row of plots will be monitored with dial type tensiometers placed at 25 and 50 cm below the soil surface.