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MODELLING SALT DISTRIBUTION AND ASSESSING WATER QUALITY PARAMETERS

FINAL PROJECT REPORT

BY

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Principal Investigator

SUMMARY

The project entitled "Modelling Salt Profile Distribution and Assessing Water Quality Parameters" was initiated in January, 1990. The objectives of the project were to study the effect of different salinity waters on soil properties and calibrate a computer model for local conditions. In addition to this, tubewell water quality data of SCARP-I was analysed by using different water quality standards used in the country. For obtaining data under local conditions, experiments were conducted in the Shah Kot scheme of SCARP-1 Project.

The computer model predicts salt distribution in the crop root zone. The results achieved by this model are encouraging, however these results requires further verification for longer period.

Analysis of the water quality data was carried out by using water quality standards putforth by WAPDA, Irrigation Department Punjab, and FAO guidelines. Computer programme was written to analyse data by the above standards. The data were analysed by using EC, SAR, and RSC Parameters. Classification was carried out by using individual as well as all the three parameters together.

The results show that different standards give different water suitability classes. The results achieved by one standard are quite different than those of the other standards. The results show that when the water classification was based on all the three parameters taken together, the number of useable tubewells decreased and correspondingly number of marginal and hazardous tubewells increased. But classifications based on any single parameter showed higher number of useable and less number of marginal and hazardous tubewells. The results show deteriorating water quality from the first to the last sampling periods. Statistical analysis of the results shows that water quality changes are significant only for RSC for 5% alpha level.

The effect of different amounts of tubewells water on soil salinity showed that the decrease in soil salinity was proportional to the amount of irrigation applied. Light irrigation and farmers method of irrigation only affected the upper soil layers whereas the medium irrigation and heavy irrigation decreased soil salinity at lower soil depths also. The sodium adsorption ratio followed the same pattern as that of soil salinity.

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CHAPTER I

INTRODUCTION

Irrigated agriculture plays an important role in meeting food and fibre needs of human kinds. Efficient irrigation requires careful water management to get greater production from the water used and to protect from salination, two major resources management goals in arid countries. Increasing world population demand judicious use of both land and water resources.

Pakistan has the largest contiguous irrigation system in the world. It serves nearly 14 million hectares with water delivered by unlined canals. Temperatures allow year-round cropping in an area where the rainfall is low and erratic. This irrigation system was originally designed by the British to combat famine, and it does not provide sufficient water for full crop production.

The large, aging, overstressed, gravity-flow irrigation system has a short water supply and large water losses. More than half of the water made available to the farmers is lost to deep percolation, much of which recharges the aquifer. This percolation not only deprives users of the water but raises the water table to cause waterlogging and field salination, factors that now threaten the productivity of about half of the total irrigated land. Conjunctive use of ground

and surface waters offer an effective response and can be coupled with the efficient management indispensable to preserving and increasing land productivity in the Indus Basin.

Canal water supply has caused a large spread of waterlogging and subsequently salinity problem in the country. The salinity problems may be called as secondary salinity which i caused due to evapotranspiration from high watertable and by thinly spreading the available supplies. The watertable rose, and drainage development lagged. Severe conditions of waterlogging and salinity drew Government attention in the 1950's when large-scale public tubewell projects, "Salinity Control and Reclamation Projects" (SCARPS) were initiated. These were multipurpose projects. Objectives of SCARP Projects were to lower water by pumping groundwater and the pumped water was be used to supplement canal water supplies.

The major drawback of using groundwater for irrigation is that its high salinity causes salts to accumulate in the root zone if sufficient leaching is not provided. The increased root zone salinity will decrease crop yield, and land may be slowly forced out of production. Since groundwater pumping is costly, farmers may be financially unable to pay for additional water that sacrifices the immediate benefits of crop production for the more nebulous long term benefits of slowing salination. This reluctance is aggravated by

uncertainities over the pumping amounts needed and how best to manage well water at the field scale.

Many standards have been suggested to classify irrigation water by different researchers and organizations. A water may be fit for irrigation according to one standard while the same may be unuseable according to the others. These standards are either based on total salt concentrations/TDS and SAR or TDS and RSC values. However, no conclusive answer have been putforth so far (see Chapter -II) . Therefore, suitability of an irrigation water needs to be evaluated on the basis of specific conditions under which it will be used including crops to be grown, soil properties, irrigation management, cultural practices and climatic conditions.

The site specific evaluation of an irrigation water is difficult as well as time consuming. However, computer application have made this task much easier; certain computer models are available which can predict the effect of irrigation water on soil properties under specific conditions. Therefore, the present study was under taken with the following objectives:-

1) To evaluate water quality of SCARP-I tubewells by different standards.

2) To predict the effect of different water qualities on crop yield and soil salinity.

3) To calibrate and verify model for salt distribution in root-zone.

CHAPTER II

REVIEW OF PAST STUDIES

Pakistan's economy depends largely on agriculture. Farming contributes 36 percent of the gross national product, accounts for 40 percent of the export earnings, employs more than 50 percent of the labour force, and supplies raw material requirements to agro-industries. However, drainage and salination are threatening the agricultural productivity of large areas receiving canal water. This chapter presents background information for dealing with these important national problems and condtributions from previous studies.

Climate

The climate of Pakistan ranges from humid in the northeast, where annual rainfall exceeds 76 cm (30 in), to semi-arid in the central parts to near-desert conditions in the south where annual precipitation is less than 10 cm (4 in). Most of the rain falls in June, July and August in the 'monsoon' season. Low and extremely unreliable rainfall necessitates irrigation for stable and permanent agriculture. Temperature extremes range from highs of 53 to lows of 5 degree °C during Summer and Winter seasons, respectively, with an average of about 25 degrees °C in the central part of the country.

Soils

The soils of the Indus Plain are basically alluvial deposited by rivers. Soil textures range from coarse to fine with 85 percent in the moderately coarse to moderately fine classes (WAPDA, 1979). Soil pH is generally basic, in the range of 8 to 8.5.

Farming Practices and Crops

Temperatures allow year-round cropping. The two principal crop seasons are the summer (Kharif) crop season, which has the advantage of the monsoon rains and extends from the middle of April to the middle of October, and the Winter (rabi) crop season cmprising the rest of the year. Principal Summer crops are cotton, maize, rice, sorghum and millet, while the principal winter crop is wheat. Sugarcane, pulses, oilseeds and fodder are grown in both seasons. For variation, short-duration crops are grown within both seasons. Therefore, a cropping intensity of 200 percent or more is possible. Sugarcane and Orchards are considered two-season crops and are counted twice in calculating the cropping intensity.

Wheat is the major staple food crop. Cotton and rice are the principal sources of foreign exchange. Fodder is consumed by livestock and draft animals, the main power source for many farmers.

Crop Yield

In spite of favourable climate and vast resources of land and water, very low yields per unit cropped area are attained for most crops. Many soils are low in plant nutrients and organic matter. Table 2.1 compares Pakistan's yields (irrigated) to those in other countries. Pakistani maximum and average yields, which are obtained either from progressive farmers or from experimental stations with optimal management, are listed along with the national average. The table shows average yields are only about half the maximum yield for each crop. The national average yields are much less than the maximum yields. This indicates that the country has great potential to increase its agricultural production. Comparison with yields of other countries shows that yields for Pakistan are less than for some other countries.

Groundwater Hydrology

The Indus Plain is a deep alluvial formation deposited by the Indus River and its five main tributaries: Jhelum, Chenab, Ravi, Sutlej and Beas. The alluvium consists of fine-to-medium grain sand, silt and clay. It forms a deep unconfined aquifer which has been histroically recharged by precipitation and percolation from the rivers. Slope of the plain is very gentle, about 0.2 m per km (0.0002). Depth of

Table 2.1 Comparative Crop Yields for Different Countries.

Country/Crop	Cotton	Maize (Kg/ha)	Rice	Wheat
Pakistan				
Potential: Maximum	2675	2137	6000	5700
Minimum	1000	1800	3200	2750
National Average	-	1258	2600	1567
Egypt	540	2240	3320	3060
E.Punjab (India)	1680	1060	202	2350
USA	480	3700	3790	1520
USSR	620	1070	2150	960
Turkey	731	-	-	1755
Australia	-	-	-	1783
France	-	-	-	5010
Mexico	905	-	-	3456
Bangladesh	-	-	1920	-
Thailand	-	-	1737	-
Philippines	-	-	1947	-
Japan	-	-	6126	-
Sudan	494	-	-	-
Iran	558	-	-	-

Source: (Ministry of Food and Agriculture and Cooperatives, 1984 and Ahmed and Chaudhry, 1990, Page 1.7)

the aquifer varies from 300 to 500 m (Mundorff et al.,1972

Before the introduction of the weir-controlled canal irrigation system in the Indus Plain, the groundwater table was deep under most of the area; the water table was in dynamic equilibrium, with the inflow being equal to the outflow. As a result of the additional recharge introduced by irrigation, the water table started rising at a rate of 15 to 75 cm/year (White House Report, 1964). Carlston (1953 identified the three main contributing factors (cited by Johnson, 1982) as leakage from the irrigation-distribution system, seepage from the irrigated fields, and obstruction of natural drainage due to various construction works. The position of the water table before and after the introduction of the large canal networks in the upper part of the basin is presented in Fig. 2.1. The figure shows that the water table rose from 20 to 30 m in 80 to 100 years in the middle of the Doabs (lands between rivers).

Hydrographs of the two observation wells (Fig. 2.2) show the water table positions before and after the introduction of the large-scale pumping of the Salinity Contro and Reclamation Projects (SCARPS) to combat the rise in water table. The figure shows that the water table started rising in 1895, when canal supply started in the area. The water table rose 18.3 m (60 feet) in 35 years, reaching very close to the land surface. After that, the rise in the water table slowed. The reason for the slower rise is not

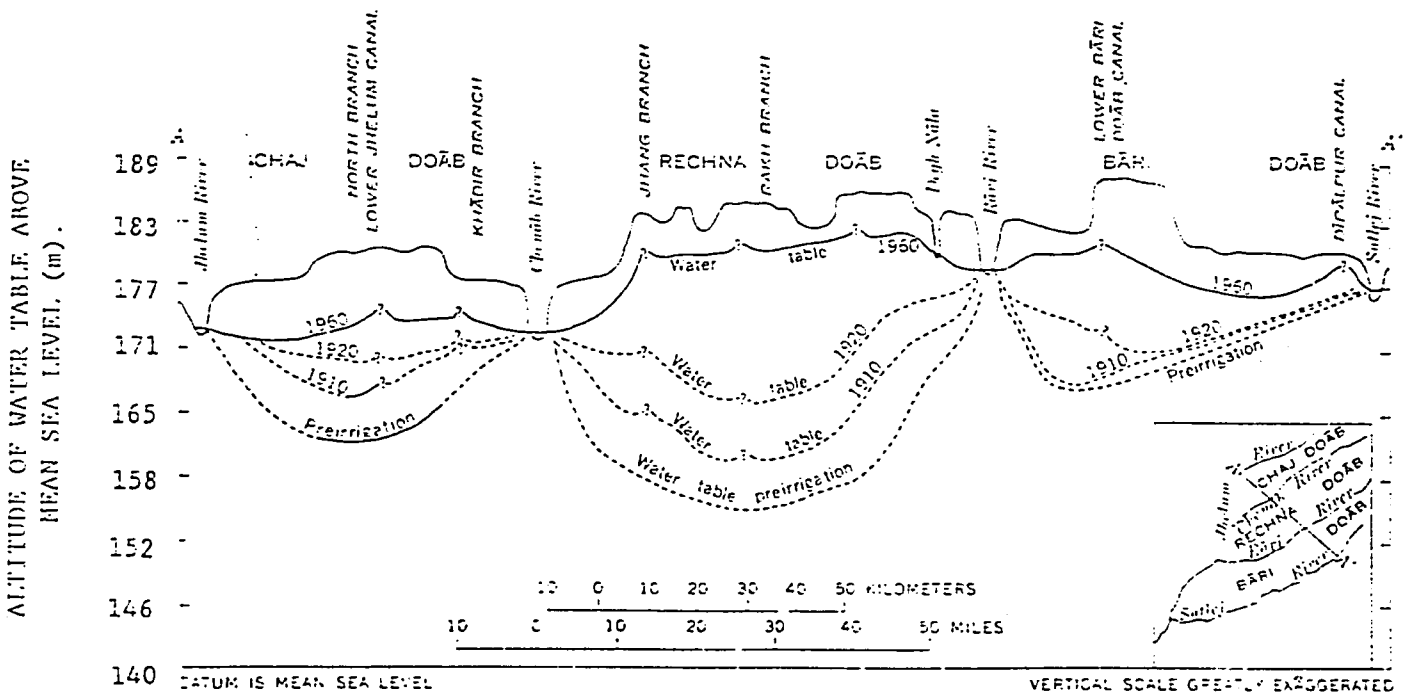

Fig. 2.1: Position of Groundwater Table Before and After the Introduction of Weir-Controlled Irrigation Canals in Various Doabs (adapted from Clarke and Barnes, 1969).

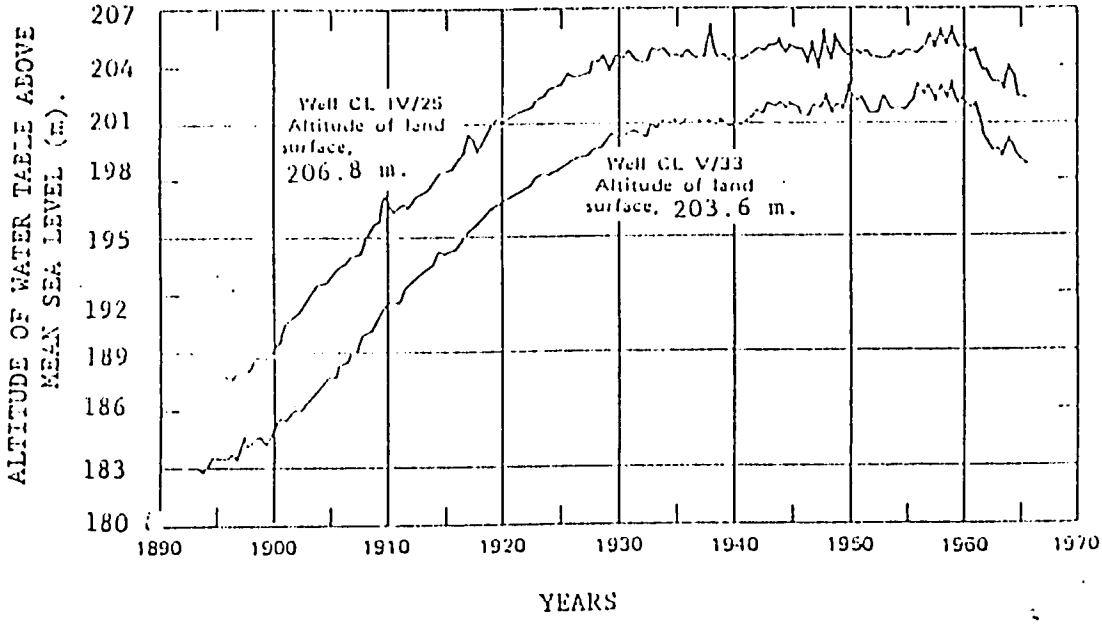

Fig. 2.2: Hydrographs of Observation Wells Showing Groundwater Levels Before and After the Implementations of the Public Tubewell Project in SCARP-1 (adapted from Malmberg, 1975).

known, but it might be due to increased evaporation as the water table approached the land surface. Evaporation from the high water table gave rise to salt accumulation in the upper soil strata and caused salinity problems in the crop root zone. The process of salinization was accelerated in areas where the irrigation supply was inadequate to leach the salts. The water table started to decline in 1960, when SCARP projects were initiated.

The alarming rate of groundwater-table rise indicates inefficient irrigation and inadequate drainage. The worldwide nature of the problem is seen in a similar situation reported in the San Joaquin Valley, California, where the water table rose 25 m in 35 years (Report of Agricultural Water Management Subcommittee, 1987, p. 3-11).

The quality of groundwater varies in vertical and horizontal directions and is related to recharge to the aquifer (WAPDA, 1979). In general, water from shallow wells located near sources of recharge is of good quality. Along the rivers and in the upper reaches of the doabs, where precipitation is a major source of recharge and maximum canal supply is available, groundwater usually contains less than 1000 ppm (parts per million) (1.56 dS/m) of dissolved solids. Changes in groundwater quality with depth and distance from the river are shown in Table 2.2.

TABLE 2.2: Variation in Groundwater Quality in Lower Bari Doab with Depth and Distance[1] from River, 1962.

Test hole number	Depth of Sample (m)	Total Dissolved Solids (ppm)[2]
106	32.91	1350
	73.15	2191
	99.97	3250
107	32.90	970
	66.45	1750
	99.97	3600
	133.50	8500
111	39.62	2240
	66.45	3270
	99.97	9100
	138.99	9110
112	32.90	320
	53.04	418
	79.86	3770
	106.68	3835
	140.21	7050

Source: Greenman et al. , 1967, p. H33)

1. Distance from river increases from test hole numbers 106 to 112.
2. 1 ppm = 1 mg/l

The last two decades have seen changes in water quality with the passage of time, most often a deterioration. This is supported by data collected during the "Diagnostic Analysis" study of the Water Management Synthesis II Project at Colorado State University (1985) as presented in Table 2.3. The table shows that the EC (electrical conductivity) of the selected public wells increased from 0.77 to 1.64 dS/m (decisiemens/m) on the average.

Surface-Water Hydrology

Before partition, the Indus River with its five tributaries was the source of surface-water to the whole Indus Plain, part of which now lies in India. After independence in 1947, India claimed full rights on the three eastern rivers, the Ravi, Sutlej, and Beas, which were irrigating over 2.2 million hectare of land in Pakistan (Bokhari, 1980). The resulting conflicts between the two countries were settled in 1960 by signing of the "Indus Water Treaty". According to this treaty, India was given full right to use all water of the three eastern rivers. Pakistan constructed large "link canals" to divert river water from the western rivers to the lands deprived of their historic canal-water supply by the treaty.

The flow of the Indus Basin rivers is derived from snow and glacier melt and rainfall primarily outside of the

Table 2.3: Change in Groundwater Quality for Selected Public Tubewells in a 20-year Period.

Tubewell Number	Electrical Conductivity 1965	1985 (dS/m)*	Change in EC	Percent Change
Thatti Utter Minor				
1-L	0.692	1.900	+1.208	175
2-L	0.445	1.580	+1.135	255
3-L	0.875	1.350	+0.475	54
Niazbeg Distributary				
5-L	1.557	2.050	+0.493	32
10-L	0.775	1.800	+1.025	132
11-L	0.615	1.250	+0.635	103
Jalleke Minor				
1-L	0.775	1.800	+1.025	132
2-L	0.650	1.100	+0.450	69
Average	0.770	1.640	+0.870	113

Source: (Water Management Synthesis II Project, 1985)

* 1 dS/m = millimhos/cm

Indus Plain. The total drainage area of the Indus rivers is 364,700 square miles, of which 44 percent lies outside Pakistan. The mean annual river flow is 17.10 MHM (million hectare-meters) (142 MAF, million acre-feet). Some of this flow cannot be diverted due to the insufficient storage capacity of existing dams and a lack of adequate dam sites to add storage, given the large seasonal and annual flow variations. The annual river flow is very unevenly distributed as shown in Fig.2.3. Of the annual river flow, 84 percent takes place from April to September. Out of the remaining 16 percent, nearly 8 percent occurs during March and October. This leaves only 8 percent of the annual flow in the remaining four months. As can be seen in Fig. 2.3 only 1.4 MHM (11 MAF) flow through the system during the critical winter months when the main food crop of the country, wheat, is grown.

Total annual river flows for 19 years are given in Table 2.4. It is apparent from this table that the river flow varies from year to year. The mean annual flow is 17.10 MHM and its standard deviation is 2.34 MHM. The greatest annual flow of 22.97 MHM (186.24 MAF) was in 1959-1960. The lowest amount, 11.84 MHM (96 MAF), was during 1974-75. This amount is less than the existing diversion capacity of the canal network of 16 MHM (130 MAF) annually, assuming that the flows are properly distributed for the canal to flow full.

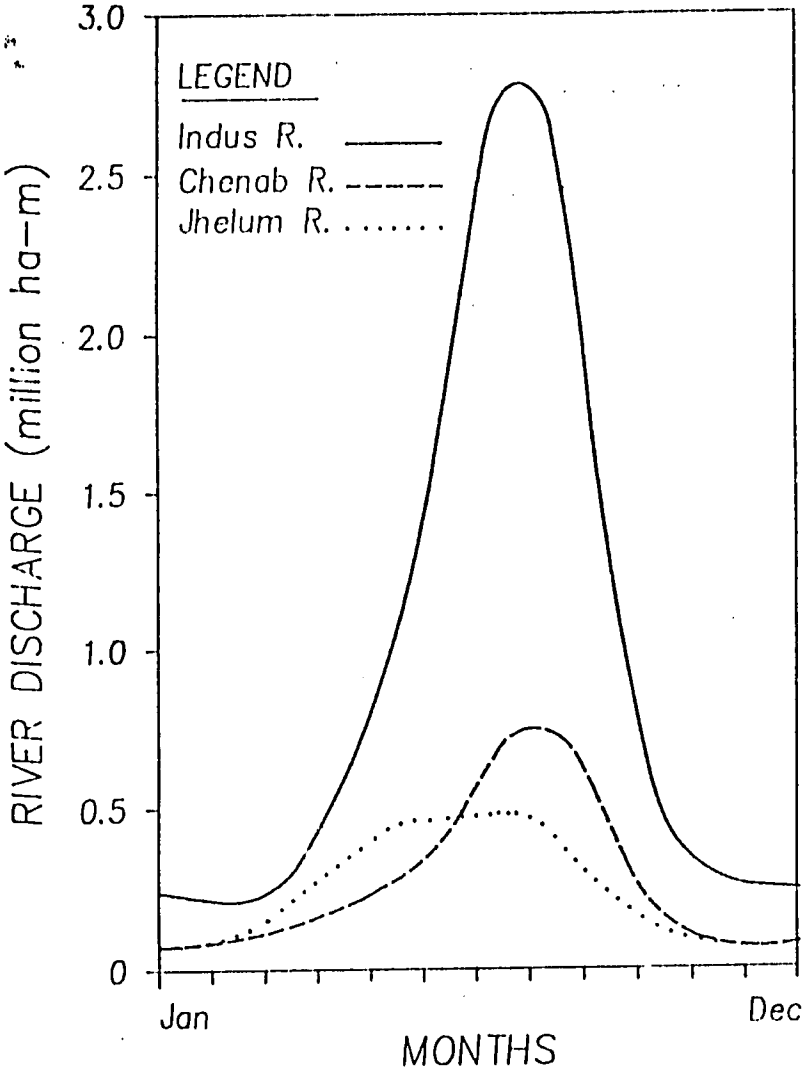

Fig. 2.3:Mean Monthly Discharge of Indus, Jhelum and Chenab Rivers in the Indus Basin of Pakistan (source: Bokhari, 1979).

Table 2.4: Total Annual River Flow in the Indus Basin, 1940-1978

Year	Total River Flow (million ha-m)	Year	Total River Flow (million ha-m)
1940-41	15.14	1959-60	22.97
1941-42	16.33	1960-61	17.93
1942-43	20.83	1961-62	17.28
1943-44	18.41	1962-63	13.47
1944-45	17.13	1963-64	16.62
1945-46	18.51	1964-65	17.04
1946-47	16.01	1965-66	17.05
1947-48	15.29	1966-67	17.30
1948-49	19-14	1967-68	17.95
1949-50	19.19	1968-69	17.10
1950-51	21.10	1969-70	16.51
1951-52	13.96	1970-71	13.01
1952-53	16.03	1871-72	12.77
1953-54	17.66	1972-73	15.55
1954-55	17.60	1973-74	20.24
1955-56	16.28	1974-75	11.84
1956-57	19.31	1975-76	16.18
1957-58	18.53	1976-77	18.04
1958-59	19.55	1977-78	14.85

Mean = 17.10

Standard deviation = 2.37

Total canal capacity is 7,323 cumecs (cubic meters per second) (259,000 cfs) (Ministry of Food and Agriculture and Cooperative, 1984, page 3).

The salt content of river water varies from 84 to 217 mg/l (0.13 to 0.34 dS/m). The dissolved solids vary seasonally and inversely with the volume of discharge, are lowest during the period of high flow (April to September) and highest during the period of low flow (October to March) The average salt concentration of river water of the upper Ind system varies from 150 to 180 mg/l (0.23 to 0.28 dS/m) (Mundorff et al., 1976).

Irrigation System

Although irrigation using inundation canals had been practiced along the rivers for centuries, a new era began in 1850 when the British started building large, weir-controlled canals to irrigate the vast tracks of land between the rivers. The system comprises 2 reservoirs (Tarbela and Mangla, of about 1.8 MHM capacity), 19 barrages and 45 unlined main canals of 63,100 km length. It commands 16 million ha. of which 58 percent is irrigated year-round and 42 percent only during the Kharif season when river flows are at peak. Canals vary from "minor" (small distributary), which carry 0.091-015 cumecs (3.2 to 5.3 cfs), to large canals the size of rivers that transfer water between river basins

and which have capacities of upto 650 cumecs. Measured at the headworks, the canals carry about 16 MHM annually.

The canal system delivers water to 90,000 'watercourses' (irrigation channels under farmer's control) at a constant, designed-supply level. A watercourse serves 50 farmers and 225 ha on average. The outlets (moghas) from the distributaries are designed to deliver a fixed quantity of water when the canal is flowing at full capacity. Design flows are based on the command area. Each farmer is allotted a fixed quantity of water proportional to his land-holding on a weekly or 10-day rotation period (locally called warabandi).

Water flows continuously from canals into distributaries, through moghas into watercourses, and then on rotation into farmer's channels and onto the fields. The system was deliberately designed to irrigate the maximum area with limited available water. Johnson (1982) mentioned the design criteria used by the British in the sub-continent as being; "to spread the available water as extensively as possible and in such a way as to prevent famine and to bring to maturity the largest crop area with minimum use of water" (P.150). The duty (at watercourse head) of water (land irrigated per unit discharge) is 4290 ha. per cumecs (300 acres per cfs) with some variation (300 to 350 acres per cfs). Originally, the system was designed for a 75-percent cropping intensity (area sown plus area sown more than once divided by the total area). With

design deliveries a farmer could grow crops on 25 percent of his land during Kharif and on 50 percent in rabi. Crop water requirements could be adjusted by reducing the cropped acreage during any season.

Groundwater-management practice in the Indus Basin is unique. The groundwater is mixed with canal water before delivery to the farmers. To synchronize with the canal supply, public wells pump water into irrigation channels. Thus the public wells enhance water supply, but do not completely meet the crop water demands. On the other hand, a farmer can use water from his tubewell (private) as and when needed to meet his crop water requirements.

System Limitations

One of the main inefficiencies of the present irrigation system is its high seepage loss. Research results (Clyma et al., 1981; Johnson et al., 1977) indicate that only 40 percent of the water is used by crops, and the rest is lost during conveyance and field application. On one end, high losses reduce the farmer's water supply; on the other end, they contribute to a rising water table and eventual waterlogging and salination. More efficient system management requires that irrigation canals be lined and that drainage, vertical or horizontal, be provided. In addition, Peterson (1986) cited the major operational limitations of the system to be due to

inadequate storage and provision for rotation of long canals serving a variable demand.

> One needs to be realistic about the Indus canal system's capability to supply full crop irrigation requirement on demand. The first consideration is the legal basis for water rights. Because overall canal supplies fall short of meeting full supply, for all of the lands with vested water rights. The only way for an individual to improve this is by adding groundwater..... The second considerations is the physical limitations of the system itself. The very long canals; relative lack of reservoir storage; inability to forecast short-term and long-term rainfall, system supplies and crop requirements accurately; and the limitation placed on varying canal discharge because of sediment loading, seriously limit system response. (P. 3).

Development of SCARP Projects

The British built the first large canal (upper bari doab) in 1859. The water table began to rise, but the trend had no immediate adverse effects since the water table was deep. The situation became more severe when the water table rose near the land surface under more of the irrigated area. Due to inadequate drainage, shortage of irrigation water for leaching, and a high evaporation rate, the salts accumulated in the crop root zone as the limited water was spread over more land to meet the growing needs of the country for food and fibre. Evaporation from the shallow groundwater increased, and the rate of salinization intensified. This impaired land

productivity, and land started going out of cultivation rapidly. By the 1950s, over 2 million ha of irrigated land had gone out of production and the amount was increasing at a rate of 29,000 ha each year during the 1940s and 1950s (White House Report, 1964).

Concerted efforts are being made to overcome the twin menace of waterlogging and salinity. The government of Pakistan established a central agency (Water and Power Development Authority, WAPDA) in 1958 to investigate, plan and implement water-resource development in the country. The United States government, World Bank and other donor agencies were asked to help solve the problem. In response, the U.S. government in 1961 sent a group of experts headed by Roger Revelle to investigate the problem and suggest remedial measures. The Revelle group in 1962 recommended large-scale pumping (SCARPs) in the affected areas to lower the water table and to provide additional water for irrigation if the pumped groundwater were not too salty (White House Report,1964).

More than 14000 public tubewells had been installed by WAPDA in 36 SCARPs. The capacity of these wells ranged from 56 to 142 I/s (2 to 5 cfs), and their depth varied from 91.5 to 122 m (300 to 400 ft). However, they fell short of planning expectations for reasons presented in an excellent discussion by Johnson (1982). He noted shortened tubewell life, rapid development of private tubewells and failure to achieve the desired cropping intensities as the major factors which

made the SCARPS projects less effective. A brief summary of different measures adopted by the Government is presented in Table 2.5. Nevertheless, the SCARP projects made a significant contribution to lowering the water table. Their demonstration of the significance of groundwater development to the private sector cannot be neglected. The private tubewells increased fivefold from 1965 to 1977 (WAPDA, 1979). Pumping from the private tubewells lowered the water table and increased the water supply significantly, as shown in Table 2.6 (Ahmad and Ahmed, 1987). Table 2.6 shows that private tubewells accounted for 26 percent of the farm water supply in 1980-81, while the public tubewells contributed only 7 percent. Moreover, farmers are able to use their flexibility in the operation of these wells to increase cropping intensity. The cropping intensity of farmers with private wells was higher. For the smaller farms (2-10 ha), it was close to the target value of 150 percent. The WAPDA's Revised Action Program' has shifted public-sector investment to the saline-groundwater areas leaving fres-groundwater zones to the private sector (WAPDA, 1979).

Another major effort which needs to be mentioned is the "On-Farm Water Management Program", started in 1976 in response to recommendations of extensive studies conducted by WAPDA and Colorado State University. These studies found

Table 2.5 A BRIEF SUMMARY OF MAJOR WATERLOGGING AND SALINITY MEASURES (Source: Sheikh, 1989)

1.	Canal Seepage Control	In 1917 a Drainage Board was set up to control seepage but without any success.
2.	Surface Drainage	Surface drains were constructed in son of the Waterlogged areas but the drain silted and choked up due to flat sl
3.	Canal Lining	Some canals like Haveli and Thal were lined but this measure was abandoned as being costly and also not very effective.
4.	Vertical Drainage along	In 1944, Rasual Tubewell Scheme along the Rechna Doab Canals was initiated. These tubewells were located along the canal banks and was not found effectiv
5.	Directorate of Land Reclamation	In 1945 the Directorate of Land Reclamation was established to evolve measures and methods for reclaiming saline lands.
6.	Soil Reclamation Board	The Soil Reclamation Board was set up in 1952 to carryout surveys and investigations on a pilot project near Farooqabad.
7.	Groundwater Development Organization (GDO)	In 1954 the GDO was set up to intensify groundwater investigation. This organization was later transferred to WAPDA in 1958 as Water and Soils Investigation Division (UASID).
8.	Water and Power Development Authority (WAPDA) - Vertical Drainage	WAPDA was created in 1958 to tackle the problem of waterlogging and Salinity at large scale. WAPDA installed deep high capacity tubewells (2-5 cfs) in the Salinity Control and Reclamation Projects (SCARP). To-date WAPDA has installed more than 14000 tubewells in 36 SCARPs).
9.	Revelle's Mission and other Consultants.	In 1961 a pannel of experts from USA visited the country and endorsed the measures adopted by WAPDA and recommended to lower the groundwater by 100 feet.

Table 2.5 continued.

10.	Private T/W	The PublicT/W projects motivated the farmers to install private T/W. These T/W have contributed significantly to lower watertable in fresh groundwater areas.
11.	SCARP Transition	The study is under way
12.	Horizontal Drainage	i) East Khairpur-1977-86 ii) Mardan 1983-87 iii) Drainage-IV 1987-to-date

Table 2.6. Annual Canal and Groundwater Supplies at Farm Gate (Watercourse Head).

Year	Canal Supply	Groundwater Public Tubewells	Pumped by Private Tubewells	Total Water at Watercourse Head
		(million ha-m)		
1969-70	6.33	0.45	1.49	8.27
1974-75	6.01	0.86	2.25	9.12
1977-78	7.48	0.77	2.66	10.91
1980-81	8.04	0.92	3.10	12.06

Source: (Ahmed, and Ahmed, 1987)

Table 2.7. Annual operational and maintenance cost of Punjab canals and tubewells in Rs. million.

Years	Canals	Tubewells	Total
1971-72	113.7	50.9	164.6
1974-75	196.0	116.4	312.4
1979-80	299.1	346.3	645.6
1982-83	494.3	513.2	1007.5
1983-84	563.6	632.2	1195.8
1984-85	661.4	722.6	1384.0

Source: (Ahmed and Chaudhry, 1990, page 10.8).

conveyance losses from the irrigation channels below outlets (in watercourses) to be 40 to 50 percent from the outlet to the farmer's field. Clyma et al. (1981) reported that only 42 percent of the water made available at the outlet is effectively used by crops. They reported conveyance and application efficiencies to be 60 and 70 percent, respectively, on the average. If main-canal efficiency is taken as 90 percent, then overall irrigation efficiency (from canal head to field) is only 38 percent, which makes the system very inefficient. Most of the rest of the water recharges the aquifer.

SCARP Transition

Due to the rapid involvement of private sector, the Government is now shifting emphasis of public sector from fresh groundwater area to saline groundwater area. Operational and maintenance cost of the existing SCARP tubewells is increasing very rapidly as is clear from Table 2.7.The table indicates that operational and maintenance of Scarp tubewell has surpassed the same for canals in Punjab during 1984-85. A study is being carried out to shift the operation of these tubewells to farmers. The farmers may continue with the operation of these tubewells or install their own tubewells by getting loan from the Government.

Water Quality Standards:

Water is of fundamental importance to all kinds of life. Pure water does not exist in a natural state and all irrigation supplies contain salts in different amounts. The concentration and composition of dissolved salts in water determine its quality for irrigation. The parameters which determine the water quality are:-

i) Total concentration of soluble salts which can be expressed as total dissolved solids (TDS) expressed in g/l, PPM or tons per acre foot (T/AF) (ii) in me/l (iii) Electrical conductivity (EC) expressed in dS/m or its equivalent at 25°C.

ii) Relative proportion of sodium to calcium and magnesium (sodicity hazard). Sodicity hazard is expressed as Sodium Adsorption Ratio (SAR) which high lights the tendency of a water to produce excessive exchangeable sodium. The high sodium in the soil decreases soil permeability, replaces essential plant nutrients from the clay complex and produces ion toxicity. It is calculated as under and all ionic values are expressed in me/l.

$$SAR = Na^{+} / \sqrt{(Ca^{++} + Mg^{++})/2}$$

iii) Carbonate and bicarbonate concentrations as related to the concentration of calcium

and magnesium (alkali hazard). Alkali hazard is calculated in terms of Residual Sodium Carbonate (RSC) which predicts the sodium hazard associated with $CaCO_3$ precipitation and is calculated as under. The RSC is expressed in me/l.

$$RSC = (CO_3 + HCO_3) - (Ca^{++} + Mg^{++})$$

iv) Concentration of elements that may be toxic to plants like boron (special ions hazard). Special ion hazard is determined in PPM because hazardous ion are generally found in 2-4 PPM is generally toxic to most of agricultural crops.

The canal supply in the country is insufficient to meet consumptive use of crops, therefore, to meet the deficiency, the groundwater is used for supplemental irrigation. But quality of groundwater is seldom comparable to canal water, often it contains excess of soluble salts or high quantity of carbonates and bicarbonates. In the past attempts have been made by various workers/organizations in Pakistan for preparing irrigation water classification schemes but no definite standards have been finalised. In determining the water quality standards it is assumed that water will be used under average conditions with respect to soil texture, infiltration rate, crops and climate.

Most of the standards are based on a single parameter such a total salt concentration, but some workers have also included sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) in their evaluation.

Hameed et al.(1966) stated that waters having EC less than 1500 micromhos/cm was safe, 1500 - 3000 microhmos/cm were marginal and those having EC above 3000 were unsafe.

Hussain et al. (1971) after 9 years of research study in SCARP-I concluded that tubewells water having EC more from 750 to 2000 micromhos/cm did not change the salinity level of the soil.

M/S Tipton and Kalmbach (1963) proposed that irrigation water having salinity less than 1500 ppm was safe for use. Those having 1500 to 3000 ppm were marginal and waters having salinity more than 3000 ppm were unsafe. Zaidi (1966) after monitoring the effects of long term use of tubewell waters in SCARP-I noted that EC and SAR generally decreased where tubewell waters with EC upto 2000 micromhos/cm was used after mixing with canal water, above this limit ECe and SAR of soils tended to increase.

Qayyum (1970) studied the effect of 52 selected tubewells and concluded that the use of waters of SAR 20 and TDS above 3000 ppm resulted in several soil and crop problems. Haider and Farooqi (1975) reported that in Mona Reclamation Experimental Project the deterioration in soils was observed when water having TDS more than 750 ppm was used.

Qayyum and Sabir (1975) while studying the criteria of irrigation water quality observed that TDS of 2000 ppm or above and SAR exceeding 10 caused an appreciable rise in soil SAR. They also observed that at low salt Concentrations TDS less than 600 ppm, SAR value upto 17.5 did not increased soil SAR.

Water quality standards adopted by various agencies and departments for planning of projects in Pakistan are given in Table 2.8. The agencies/departments are Messers Tipton Kalmbach, Hunting Technical Sciences, Irrigation and Agricultural Consultants, The Punjab Irrigation Department and the Water and Power Development Authority.

In addition to the standards mentioned above, some tentative guide lines have also been given by the FAO experts (Ayers and West Cot, 1985). These guidelines take into account the EC and the potential sodium hazard of the water simultaneously yet the guidelines do not give definite answer.

After considering the fore-going discussions and review of the numerious schemes that have been proposed for classifying waters with respect to their suitability for irrigation purpose, one can readily see that they have been more or less designed for general use. While some of the schemes are useful in indicating the potential

Table 2.8: Water Quality Standards Adopted by Various Agencies for Different Projects of Pakistan.

TDS in ppm, E.C in micromhos/cm, RSC in mq/l

Agency	Project	Usable/ Safe	Marginal	Hazardous
1. Messers Tipton & Kalmbach (1965)	SCARP-III	TDS 1000 SAR 10 RSC 1.25	TDS 1000-2000 SAR 10-20 RSC 1.25-2.5	Exceeding margin limits.
2. Messers T & K (1966)	SCARP-V	TDS 1500	TDS 1500-4000	TDS more than 4000
3. "	Lower Rachna	TDS-1500 SAR 5	TDS 1500-2000 SAR 5-12	TDS more than 2500 SAR more than 12
4. "	Regional Plan Northern Indus Plain	TDS 1500	TDS 1500-4000	TDS more than 4000
5. Hunting Technical Services and Sir MacDonald & Partners	Regional Plan Lower Indus Plan	TDS 1500 SAR 7.5		
6. Irrigation & Agricultural Consultants Associations (IACA) (1960)	Pakistan	TDS 1000	TDS 1000-3000	TDS more than 3000
7. The Punjab Irrigation Department	Punjab	TDS 500 SAR 0-6 RSC 0-1.25	TDS 500-700 SAR 6-10 RSC 1.25-2.50	TDS more than 700 SAR more than 10 RSC more than 2.5
8. Water and Power Development Authority	SCARPS	EC 1500 SAR 10 RSC 2.5	1500-2700 10-18 2.5-5.0	EC more than 270 SAR more than 18 RSC more than 5.0

of arbitrary waters for irrigation, the actual suitability of a given water for irrigation purpose depends on the specific conditions of use. These conditions include the crops to be grown, various soil properties, irrigation management practices (especially adding a leaching fraction and using it for leaching), frequency of irrigation, climatic conditions and certain cultural and management practice.

CHAPTER III

METHODOLOGY AND DATA COLLECTION

The project was approved in September, 1989 but the funds were received in February, 1991. The project work was started in December, 1989. Field experiments were set-up at three selected sites in Shah Kot Scheme of the Salinity Control and Reclamation Project-I (SCARP-I) in District Sheikhupura as shown in Fig.3. A winter crop (Rabi) and a summer crop (kharif) were planted at the experimental sites. Other data required for the study was collected from various agencies such as Water and Power Development Authority (WAPDA) and Department of Agriculture. Details of the field experiments and data collected is given in the following pages.

3.1: Wheat Experiments

The field experiments were conducted on the selected experimental sites during Rabi and Kharif 1989-90. The textural and initial chemical status of the selected sites is given in Table 3.1 and detail chemical analyses of water and soi are given in Table 3.2, 3.3 and 3.4. During Rabi season, the effect of different leaching fractions on the soil salinity and wheat yield was studied. The following treatments were tested:-

T_1 = Light Irrigation

T_2 = Medium Irrigation

T_3 = Heavy Irrigation

T_4 = Farmer's Practices

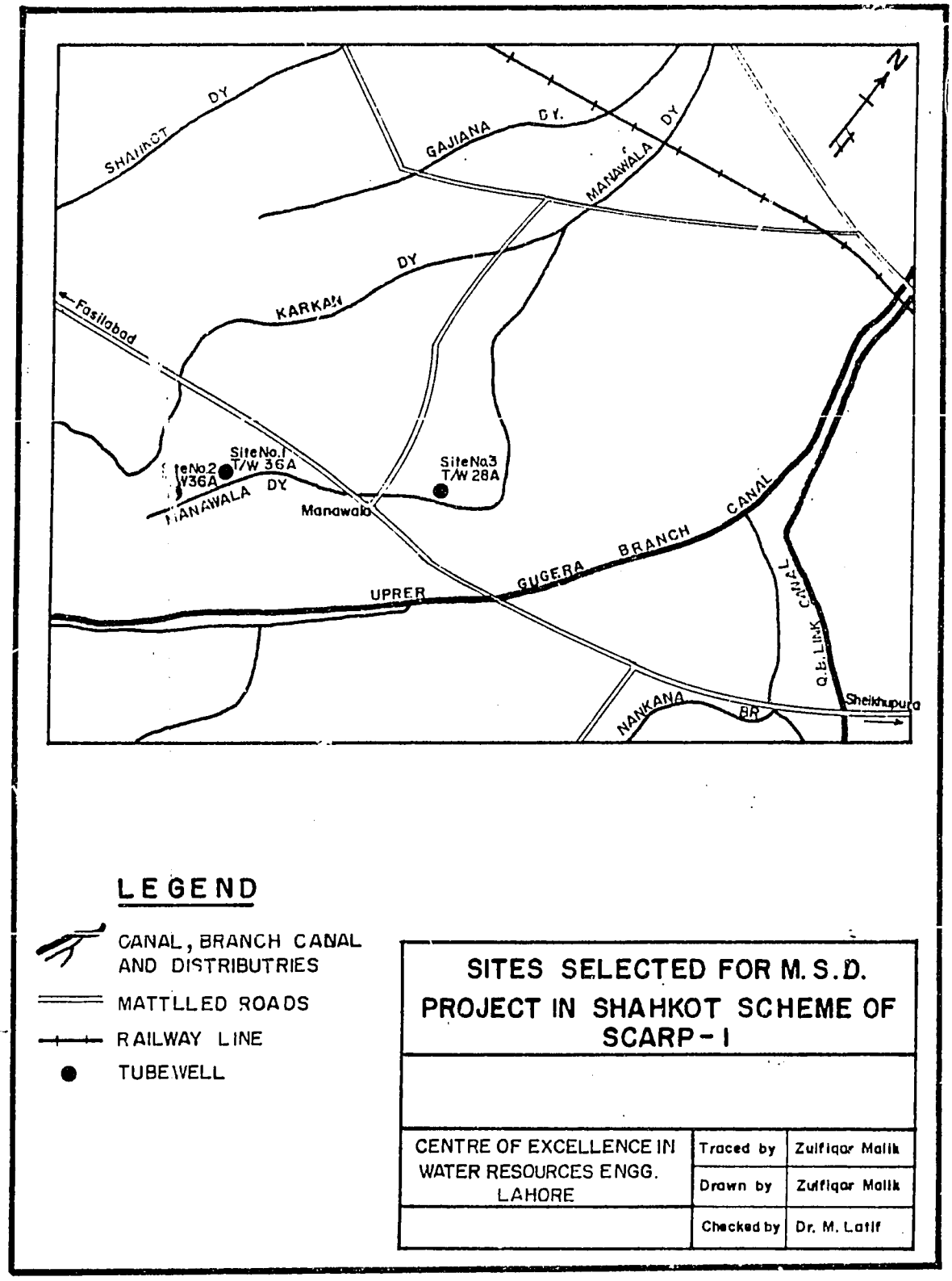
SHAHKOT DY
GAJIANA DY.
MANAWALA DY
KARKAN DY
Fasilabad
SiteNo.1 T/W 36A
SiteNo.2 T/W 36A
SiteNo.3 T/W 28A
MANAWALA DY
Manawala
UPRER GUGERA BRANCH CANAL
Q.B. LINK CANAL
NANKANA BR
Sheikhupura
N
LEGEND
CANAL, BRANCH CANAL AND DISTRIBUTRIES
MATTLLED ROADS
RAILWAY LINE
TUBEWELL
SITES SELECTED FOR M.S.D. PROJECT IN SHAHKOT SCHEME OF SCARP-I
CENTRE OF EXCELLENCE IN WATER RESOURCES ENGG. LAHORE
Traced by Zulfiqar Malik
Drawn by Zulfiqar Malik
Checked by Dr. M. Latif

Fig. 3.1:

Table 3.1: Textural and Initial Chemical Status of Selected Sites in Shahkot Scheme of SCARP-I

Site No.	EC,(dS/m)	pH	SAR	Soil Texture	Salinity Status
1	3.4	8.88	26.19	Loamy Sand	Nonsaline sodic
2	8.94	8.48	24.15	Sandy Loam	Saline sodic
3	1.03	8.10	7.36	Loamy Sand	Nonsaline-nonsodic(Normal)

Table 3.2: Water Analysis of Selected Tubewells of Shahkot Scheme of SCARP-1, January, 1990

	Tubewell No. 36 A	Tubewell No. 28
EC (uS/cm)	2600	1820
pH	9.0	8.8
Ca + Mg (me/l)	3.2	2.0
Na	22.0	15.0
K	0.3	0.2
CO_3	1.0	1.4
HCO_3	7.0	5.0
Cl	11.8	6.9
SO_4	6.3	4.7
SAR	17.4	15.0
RSC	4.8	4.4

Table 3.3: Initial Physical and Chemical Status of Selected Sites

Sr. No.	Tubewell No.	Date	Treatment	Depth (cm)	Soil Texture	Saturation (%)	PH	Electrical Conductivity E.C(dS/m)	Sodium Adsorption Ratio SAR	Residual Sodium Carbonate RSC (me/l)
					SITE-I					
1.	36-A	7-12-89	Initial	0-15	Loamy Sand	27.36	9.0	3.86	27.95	2.9
2.	"	7-12-89	"	15-30	Loamy Sand	25.6	8.9	2.81	28.02	3.6
3.	"	7-12-89	"	30-45	Loamy Sand	25.96	8.8	3.0	25.69	1.8
4.	"	7-12-89	"	45-60	Loamy Sand	26.66	8.8	3.27	21.74	2.3
5.	"	7-12-89	"	60-75	Loamy Sand	26.83	8.8	3.68	25.69	2.8
6.	"	7-12-89	"	75-90	Loamy Sand	22.53	9.0	3.8	28.07	2.5
					Average	26.99	8.88	3.40 Average	26.19	2.65
					SITE-2					
1.	36-A	12-1-90	Initial	0-15	Sandy Loam	33.46	8.8	10.2	48.10	-
2.	"	12-1-90	"	15-30	Sandy Loam	31.93	8.6	11.35	39.53	-
3.	"	12-1-90	"	30-45	Sandy Loam	34.10	8.4	12.95	35.21	-
4.	"	12-1-90	"	45-60	Sandy Loam	34.33	8.35	8.12	23.89	-
5.	"	12-1-90	"	60-75	Sandy Loam	35.6	8.35	6.51	24.79	-
6.	"	12-1-90	"	75-90	Sandy Loam	36.46	8.35	4.52	21.45	-
					Average	34.31	8.48	8.94 Average	30.01	-
					SITE-3					
1.	28-A	31-3-90	Initial	0-15	Sandy Loam	35.36	8.1	0.82	5.72	4.5
2.	"	31-3-90	"	15-30	Sandy Loam	20.9	7.95	0.76	4.89	0.5
3.	"	31-3-90	"	30-45	Sandy Loam	23.8	8.0	0.97	5.72	1.0
4.	"	31-3-90	"	45-60	Sandy Loam	20.46	8.2	0.81	8.08	2.6
5.	"	31-3-90	"	60-75	Sandy Loam	21.56	8.25	0.95	10.39	3.1
6.	"	31-3-90	"	75-90	Sandy Loam	28.83	8.1	1.88	9.33	3.1
					Average	25.19	8.1	1.03 Average	7.35	1.95

Table 3.4: Initial Ionic Composition of the Selected Site

Sr. No.	Date	Depth (cm)	Soil Texture	Saturation %	PH	Electrical Conductivity E.C(ds/m)	Cations (meq/l) Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Anions (meq/l) CO_3^{--}	HCO_3^{--}	Cl^{-}	SO_4^{--}	Sodium Adsorption Ratio SAR	Residual Sodium Carbonate RSC(me/l)
						SITE-I										
1.	7-12-89	0-15	Loamy Sand	27.36	9.0	3.86	3.6	37.5	0.6		4.0	2.5	22.5	9.7	27.95	2.9
2.	7-12-89	15-30	Loamy Sand	25.6	8.9	2.81	2.4	30.7	0.4		3.0	3.0	15.75	5.45	28.02	3.6
3.	7-12-89	30-45	Loamy Sand	25.96	8.8	3.0	3.2	32.5	0.38		2.0	3.0	16.5	8.5	25.69	1.8
4.	7-12-89	45-60	Loamy Sand	26.66	8.8	3.27	3.2	27.5	0.33		1.50	4.0	18.75	8.5	21.74	2.3
5.	7-12-89	60-75	Loamy Sand	26.83	8.8	3.68	3.2	32.5	0.27		3.0	3.0	21.25	9.65	25.69	2.8
6.	7-12-89	75-90	Loamy Sand	29.53	9.0	3.8	3.0	34.38	0.93		3.0	2.5	21.5	11.0	28.07	2.5
			Average	26.99	8.88	3.40								Average	26.19	2.65
						SITE-2										
1.	12-1-90	0-15	Sandy Loam	33.46	8.8	10.2	7.6	93.76	1.6		2.5	3.75	52.0	43.75	39.[illegible]	-
2.	12-1-90	15-30	Sandy Loam	31.93	8.6	11.35	12.8	100	0.87		1.0	2.5	74.75	34.75	35.[illegible]	-
3.	12-1-90	30-45	Sandy Loam	34.10	8.4	12.95	25.2	125	0.65		1.0	3.0	95.5	30.0	35.21	-
4.	12-1-90	45-60	Sandy Loam	34.33	8.35	8.12	14.8	65	0.30		0.5	1.25	55	24.55	23.89	-
5.	12-1-90	60-75	Sandy Loam	35.6	8.35	6.51	9.4	53.75	0.45		2.0	1.0	40.75	21.35	24.79	-
6.	12-1-90	75-90	Sandy Loam	36.46	8.35	4.52	5.4	35.25	0.27		0.5	1.25	27.75	15.8	21.45	-
			Average	34.31	8.48	8.94								Average	30.01	
						SITE-3										
1.	31-3-90	0-15	Sandy Loam	35.56	8.1	0.82	3	7	0.25		2.0	5.5	3.0	-	5.72	4.5
2.	31-3-90	15-30	Sandy Loam	20.9	7.85	0.76	3	6	0.2		1.0	2.5	3.25	-	4.89	0.5
3.	31-3-90	30-45	Sandy Loam	23.8	8.0	0.97	3	7	0.1		1.0	3.0	4.0	1.7	5.72	1.0
4.	31-3-90	45-60	Sandy Loam	20.46	8.2	0.81	1.5	7	0.1		0.1	4.0	4.0	-	8.08	2.6
5.	31-3-90	60-75	Sandy Loam	21.56	8.25	0.95	1.5	9	0.15		0.1	4.5	4.0	1.0	10.39	3.1
6.	31-3-90	75-90	Sandy Loam	28.83	8.1	1.88	4.5	14	0.09		0.1	2.0	8.75	3.45	9.33	-
			Average	25.19	8.1	1.03								Average	7.35	1.95

In this experiment the controlled irrigation was compared with farmer's practices. The wheat crop was sown on 3rd December, 1989 which was harvested on April 24, 1990. This experiment was carried out at two different sites under the command of tubewell No:36 of the Shahkot Scheme of SCARP-I. The amounts of irrigation applied and rainfall at the above sites are given in Table 3.5. After the harvest of the wheat crop the total yield (Grain + Straw) was noted. Then threshing was carried out and grain yield was recorded.

At site No.3 the comparison of tubewell water and canal water on wheat crop was carried out but due to non availability of the tubewell water (tubewell defect) desired results were not achieved, therefore the wheat yield data under tubewell water was only available.

3.2 Kharif Fodder Experiments

After harvesting the wheat crop, kharif crop (Sorghum Fodder) was sown at site No.1 only. The irrigation treatments were the same as that of the wheat experiment. The sorghum crop was sown on June 13, 1990 and harvested on August 22, 1990. The crop was harvested and the fresh fodder yield was recorded. The amount of the irrigation water applied during the crop growth period is given in Table 3.5.

Table 3.5: Irrigation Applied and Rainfall Data of different Experimental Sites, inches

SITE - 1 Wheat Crop

(a) Wheat Crop

Date of Irrigation	Light T_1	Med T_2	Heavy T_3	Farmer T_4
10-12-89	(Pre-sowing irrigation)			
11-1-90	3.05	3.16	4.04	3.32
8-2-90	1.6	2.37	3.28	1.92
Total:	8.65	9.53	11.32	9.24
Rainfall				
20-12-89	0.67	-	-	-
21-12-89	0.02	-	-	-
6-1-90	0.22	-	-	-
22-1-90	0.45	-	-	-
28-1-90	0.09	-	-	-
7-2-90	0.03	-	-	-
8-2-90	0.12	-	-	-
13-2-90	0.29	-	-	-
18-2-90	0.05	-	-	-
24-2-90	0.29	-	-	-
25-2-90	2.00	-	-	-
27-2-90	0.37	-	-	-
28-2-90	0.16	-	-	-
18-3-90	1.03	-	-	-
20-3-90	0.04	-	-	-
22-3-90	0.58	-	-	-
30-3-90	0.21	-	-	-
7-4-90	0.43	-	-	-
7-5-90	0.02	-	-	-
Total	7.07			

(b) Fodder Crop

10-6-90	(Pre-sowing irrigation)			
1-8-90	3.15	3.56	3.88	3.39
22-8-90	2.75	3.07	3.47	3.12
	5.90	6.63	7.35	6.61

Table 3. 5: (Continue)

Rainfall

9-6-90	0.0394	"	"	"
10-6-90	0.0394	"	"	"
1-7-90	1.0591	"	"	"
10-7-90	0.787	-	-	-
11-7-90	0.±77	-	-	-
18-7-90	0.512	-	-	-
21-7-90	1.98	-	-	-
8-8-90	0.15	-	-	-
9-8-90	0.38	-	-	-
14-8-90	1.22	-	-	-
22-8-90	0.55	-	-	-

SITE 2

(c) - Wheat Crop

Irrigation data (Wheat Crop)

11-12-89	(Pre-sowing irrigation)			
11-1-90	3.34	3.68	3.79	4
10-2-90	2.91	3.27	3.63	4
	6.25	6.85	7.42	8.0

(d) Fodder Crop

28-6-90	(Pre-sowing irrigation)			
16-8-90	3.39	3.47	3.87	3.4

SITE - 3 (Wheat)

1-6-90	4.00
24-7-90	3.92
18-8-90	3.55
15-9-90	3.36

3.3: Soil Salinity

Soil samples were taken at monthly intervals to determine salinity changes in the root zone. First sampling was done at the onset of the experiments. The sample were taken upto 90 cm depth for each 15 cm interval i.e. 0-15 cm, 15-30 cm etc. Chemical analyses of these samples were carried out in the laboratory. Electrical conductivity (EC), sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) were determined from the chemical analyses.

3.4: Tubewell Water Quality Data

Water and Power Development Authority (WAPDA) initiated SCARP-I during 1961-63 in Rachna Doab. Historic data of water quality of 2013 tubewells of SCARP-I was collected and computerised. These data will be analysed to study changes in water quality by using different water quality standards as given in Table 3.6.

TABLE 3.6: Water Quality Standards Adopted by WAPDA, Punjab Irrigation Department and F. A. O.

A) WAPDA - 1978

Category	Usable	Marginal	Hazardous
Electrical Conductivity (μScm^{-1})	0 - 1500	1500-2700	> 2700
SAR	0 - 10	10 - 18	> 18
RSC (me/l)	0 - 2.5	2.5 - 5.0	> 5.0

B) Punjab Irrigation Department

EC μScm^{-1}	0 - 800	800 -1100	> 1100
TDS (ppm)	0 - 500	500 - 700	> 700
SAR	0 - 6	6 - 10	> 10
RSC (meq/l)	0 - 1.25	1.25-2.50	> 2.50

C) F.A.O. - 1985

Irrigation Problems	Units	Degree of Restriction on Use		
		None	Slight to Moderate	Severe
Salinity				
EC_w	dS/m	< 0.7	0.7-3.0	> 3.0
(or) TDS	mg/l	<450	450-2000	>2000
Infiltration				
SAR=0-3 and EC_w=		>0.7	0.7 - 0.2	<0.2
=3-6 =		>1.2	1.2 - 0.3	<0.3
=6-12 =		>1.9	1.9 - 0.5	<0.5
=12-20 =		>2.9	2.9 - 1.3	<1.3
=20-40 =		>5.0	5.0 - 2.9	<2.9

3.5: Depth to Water Table

International Irrigation Management Institute (IIMI), Lahore installed piezometers near site 1. Data of these piezometers were collected from IIMI and is given in Table 3.7. The data are also plotted in Fig. 3.2 which shows that water table seldom rises more than 4.5 m close to the surface.

Table 3.7 PIEZOMETER READINGS FOR MANAWALA DISTRIBUTARY RD 143
GROUNDWATER PHREATIC SURFACE REDUCED LEVELS IN METERS

	BORE HOLE REFERENCE								
DAYS DATE\NUME	1	2	3	4	5	6	7	8	
REDUCED L	30.695	30.81	30.805	29.94	30.475	30.017	29.985	29.89	29.9
0 11/7/89	25.365	25.24	25.185	25.165	25.15	25.115	25.085	25.015	25.0
8 19/7/89	25.415	25.33	25.25	25.205	25.155	25.13	25.1	25.995	25.0
13 24/7/89	25.35	25.165	25.165	25.17	25.14	25.09	25.075	25.96	25.0
16 27/7/89	25.12	25.035	25.115	25.13	25.13	25.085	25.04	25.03	25.
19 30/7/89	25.285	25.05	25.126	25.149	25.145	25.059	25.074	25.139	24.9
20 31/7/89	25.315	25.055	25.13	25.155	25.15	25.05	25.085	25.175	25.0
23 3/8/89	25.39	25.13	25.205	25.21	25.24	25.175	25.155	25.555	25.1
26 6/8/89	25.43	25.19	25.26	25.275	25.305	25.24	25.205	25.575	25.2
29 9/8/89	25.445	25.22	25.29	25.295	25.335	25.26	25.23	25.485	25.2
33 13/8/89	25.41	25.213	25.27	25.282	25.255	25.237	25.223	25.285	25.2
35 15/8/89	25.435	25.21	25.26	25.275	25.285	25.225	25.22	25.185	25.2
39 19/8/89	25.425	25.19	25.265	25.245	25.31	25.23	25.22	25.36	25
42 22/8/89	25.395	25.19	25.255	25.255	25.315	25.21	25.19	25.1	25.2
47 27/8/89	25.41	25.2	25.27	25.265	25.35	25.23	25.215	25.595	25.2
50 30/8/89	25.435	25.21	25.285	25.285	25.375	25.265	25.24	25.175	25.2
53 2/9/89	25.445	25.22	25.29	25.315	25.37	25.27	25.28	25.395	25.2
55 4/9/89	25.445	25.245	25.3	25.355	25.37	25.28	25.32	25.175	25.2
58 7/9/89	25.445	25.25	25.295	25.365	25.335	25.27	25.32	25.21	25.2
61 10/9/89	25.435	25.355	25.32	25.355	25.335	25.245	25.28	25.105	25
64 13/9/89	25.45	25.415	25.32	25.355	25.301	25.226	25.276	25.086	25.2
65 14/9/89	25.457	25.422	25.327	25.358	25.29	25.22	25.275	25.08	2
67 16/9/89	25.47	25.435	25.34	25.365	25.325	25.225	25.225	25.06	25.1
68 17/9/89	25.445	25.422	25.33	25.33	25.31	25.208	25.2	25.05	25.
69 18/9/89	25.42	25.41	25.32	25.295	25.295	25.19	25.185	25.043	25.
71 20/9/89	25.4	25.245	25.255	25.24	25.28	25.155	25.155	25.03	25.
74 23/9/89	25.32	25.155	25.18	25.17	25.26	25.11	25.105	25	25
77 26/9/89	25.3	25.095	25.16	25.15	25.245	25.1	25.095	24.98	2
124 12/11/89	25.08	24.893	24.99	24.935	25.117	24.95	24.885	24.905	24
139 27/11/89	25.225	25.134	25.125	25.04	25.225	25.055	24.985	25.005	25
153 11/12/89	25.15	25.98	25.065	25.007	25.195	25.02	25.965	24.965	25
165 23/12/89	25.22	25.144	25.155	25.052	25.252	25.074	25.982	25.01	25
182 9/1/90	25.253	25.146	25.21	25.205	25.342	25.186	25.155	25.112	25
195 22/1/90	25.231	25.151	25.204	25.201	25.332	25.174	25.145	25.095	25
210 6/2/90	25.215	25.124	25.19	25.18	25.333	25.329	25.132	25.09	25
223 19/2/90	25.215	25.144	25.16	25.167	25.295	25.289	25.11	25.04	25
237 5/3/90	25.215	25.263	25.33	25.323	25.447	25.442	25.26	25.2	25

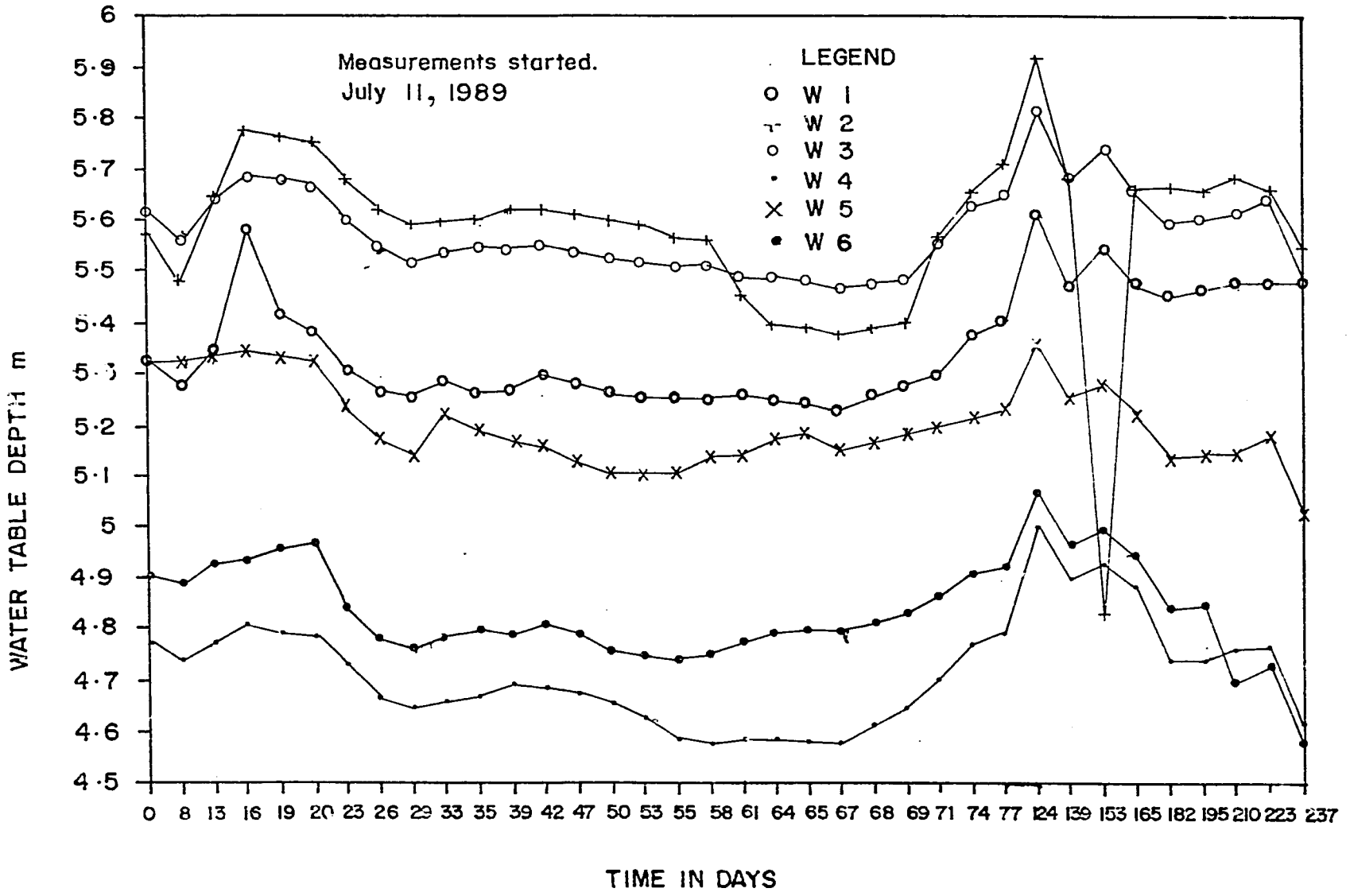

FIG. 3·2 WATER TABLE DEPTH, MANAWALA

CHAPTER IV

RESULTS AND DISCUSSION

4.1. Water Quality Standards

Data of 2013 tubewells of SCARP-I was classified by using WAPDA, Irrigation and FAO standards as discussed in Chapter 3. A computer program was written to classify water quality data using these standards. Sample outputs from the program are given in Appendix I for WAPDA standards. Results are summarised in Tables 4.1 to 4.10.

4.2: Changes with Respect to Electrical Conductivity

Water quality classification and changes w.r. to EC are given in Tables 4.1, 4.5 and 4.9 based on WAPDA, Irrigatio Department and FAO standards respectively. These tables show that water quality standards have significant bearing on water suitability classification. For example, 71.8%, 33.9% an 25.7% tubewells are useable in the beginning according to the WAPDA, Ir gation and FAO standards respectively. The same percentages are 68.9, 27.8 and 19.3% at the end of the samplin period. For WAPDA standards usable and hazardous tubewells decreased 2.9 percent and 0.4 percent respectively whereas the marginal tubewells increased by 3.3 percent. For the Irrigatio standards, the useable tubewells decreased by 6.1 percent while marginal and hazardous classes increased by 1.3 percent and 4.8 percent respectively. These results clearly indicate that there is deteriorating trend of water quality regardless of the standards used. For more clearity, the results are als plotted in Fig. 4.1.

Table 4.1: Tubewell water suitability based on EC using WAPDA standards

Name of Scheme	First sampling			Last Sampling			
	Usable	Marginal	Haz	Usable	Marginal	Haz.	Total
1. Beranwala	58 (46.0)*	63 (50.0)	5 (4.0)	52 (41.3)	67 (53.2)	7 (5.6)	126
2. Chechoki Malian	11 (91.7)	1 (8.3)	0 (0)	12 (100)	0 0	0 0	12
3. Churkana	24 (100)	0 (	0	23 (95.8)	1 (4.2)	0 0	24
4. Hafizabad	293 (93.9)	19 (6.1)	0 (0)	274 (87.8)	38 (12.2)	0 (0)	312
5. Harse Sheikh	43 (97.7)	1 (2.3)	0 (0)	43 (97.7)	1 (2.3)	0 (0)	44
6. Jaranwala	78 (60.0)	39 (30.0)	13 (10.0)	79 (60.8)	36 (27.7)	15 (11.5)	130
7. Khanqa Dogran	210 (99.5)	1 (0.5)	0 0	210 (99.5)	1 (0.5)	0 0	211
8. Pindi Bhattian	19 (90.5)	2 (9.5)	0 (0)	18 (85.7)	3 (14.9)	0 (0)	21
9. Sangla Hill	161 (69.1)	65 (27.9)	7 (3.0)	164 (70.4)	65 (27.9)	4 (1.7)	233
10. Shadman	144 (99.3)	1 (0.7)	0 (0)	144 (99.3)	1 (0.7)	0 (0)	145
11. Shahkot	140 (38.3)	140 (38.3)	86 (23.5)	136 (37.2)	161 (44,0)	69 (18.9)	366
12. Zafarwal	263 (67.6)	96 (24.7)	30 (7.7)	232 (59.6)	117 (30.1)	40 (10.3)	389
Total	1445 (71.8)	426 (21.1)	142 (7.1)	1387 (68.9)	492 (24.4)	134 (6.7)	2013
No. of T/W changed				-58 -(4.0)	66 (15.5)	-8 -(5.6)	
Percent change from the 1st sampling				-(2.9)	(3.3)	-(0.4)	

*Number in parenthesis represents percentage.

Table 4.2: Tubewell water suitability based on RSC using WAPDA standards

Name of Scheme	First sampling			Last sampling			
	Usable	Marginal	Haz.	Usable	Marginal	Haz	Total
1. Beranwala	34 (27.0)	26 (20.6)	66 (52.4)	17 (13.5)	29 (23.0)	80 (63.5)	126
2. Chechoki Malian	11 (91.7)	0 (0)	1 (8.3)	12 (100)	0 (0)	0 (0)	12
3. Churkana	6 (25.0)	5 (20.8)	13 (54.2)	5 (20.8)	15 (62.5)	4 (16.7)	24
4. Hafizabad	171 (54.8)	85 (27.2)	56 (17.9)	101 (32.4)	159 (51.0)	52 (16.7)	312
5. Harse Sheikh	39 (88.6)	5 (11.4)	0 (0)	35 (79.5)	7 (15.9)	2 (4.5)	44
6. Jaranwala	92 (70.8)	29 (22.3)	9 (6.9)	95 (73.1)	33 (25.4)	2 (1.5)	130
7. Khanqa Dogran	172 (81.5)	29 (13.7)	10 (4.7)	102 (48.3)	101 (47.9)	8 (3.8)	211
8. Pindi Bhattian	2 (9.5)	12 (57.1)	7 (33.3)	1 (4.8)	15 (71.4)	5 (23.8)	21
9. Sangla Hill	55 (23.6)	79 (33.9)	99 (42.5)	37 (15.9)	81 (34.8)	115 (49.4)	233
10. Shadman	102 (70.3)	37 (25.5)	6 (4.1)	79 (54.5)	65 (44.8)	1 (0.7)	145
11. Shahkot	62 (16.9)	88 (24.0)	216 (59.0)	38 (10.4)	77 (21.0)	251 (68.6)	366
12. Zafarwal	215 ((55.3)	136 (35.0)	38 (9.8)	208 (53.5)	164 (42.2)	17 (4.4)	389
Total	963 (47.8)	533 (26.5)	517 (25.7)	730 (36.3)	747 (37.1)	536 (26.6)	2013
No. of T/W changed				-233 -(24.2)	214 (40.2)	3 (0.6)	
Percent change from the 1st sampling				-(11.5)	(10.6)	(0.9)	

Table 4.3: Tubewell water suitability based on SAR using WAPDA standards

Name of Scheme	First sampling			Last sampling			
	Usable	Marginal	Haz.	Usable	Marginal	Haz.	Total
1. Beranwala	65 (51.6)	51 (40.5)	10 (7.9)	73 (57.9)	47 (37.3)	6 (4.8)	126
2. Chechoki Malina	12 (100)	0 (0)	0 (0)	12 (100)	0 (0)	0 (0)	12
3. Churkana	20 (83.3)	4 (16.7)	0 (0)	24 (100)	0 (0)	0 (0)	24
4. Hafizabad	290 (92.9)	21 (6.7)	1 (0.3)	302 (96.8)	10 (3.23)	0 (0)	312
5. Harse Sheikh	44 (100)	0 0	0 0	42 (95.5)	2 (4.5)	0 (0)	44
6. Jaranwala	104 (80.0)	24 (18.5)	2 (1.5)	102 (78.5)	25 (19.2)	3 (2.3)	130
7. Khanqa Dogran	211 (100)	0 0	0 0	211 100	0 0	0 0	211
8. Pindi Bhattian	20 (95.2)	1 (4.8)	0 0	18 (85.7)	3 (14.3)	0 (0)	21
9. Sangla Hill	173 (74.2)	56 (24.0)	4 (1.7)	173 (74.2)	55 (23.6)	5 (2.1)	233
10. Shadman	144 (99.3)	1 (0.7)	0 (0)	142 (97.9)	3 (2.1)	0 (0)	145
11. Shahkot	161 (44.0)	139 (38.0)	66 (18)	161 (44)	157 (42.9)	48 (13.1)	366
12. Zafarwal	302 (77.6)	78 (20.1)	9 (2.3)	311 (79.9)	72 (18.5)	6 (1.5)	389
Total	1549 (77.0)	372 (18.5)	92 (4.5)	1571 (78.0)	374 (18.6)	68 (3.4)	2013
				+22 (1.4)	+2 (0.5)	-24 (-26.1)	
Percent change from the 1st sampling				(1.0)	(0.1)	(-1.1)	

Table 4.4: Tubewell water suitability based on EC, RSC AND SAR using WAPDA standards based on all parameters

Name of Scheme	First sampling			Last Sampling			
	Usable	Marginal	Haz.	Usable	Marg.	Haz.	Total
1. Beranwala	29 (23.0)	30 (23.8)	67 (53.2)	13 (10.3)	33 (26.2)	80 (63.5)	126
2. Chechoki Malian	11 (91.7)	0 (0)	1 (8.3)	12 (100.0)	0 (0)	0 (0)	12
3. Chuharkana	6 (25.0)	5 (20.8)	13 (54.2)	5 (20.8)	15 (62.5)	4 (16.7)	24
4. Harse Sheikh	39 (88.6)	5 (11/4)	0 (0)	35 (79.5)	7 (15.9)	2 (4.5)	44
5. Hafizabad	167 (53.5)	89 (28.5)	56 (17.9)	101 (32.4)	159 (51.0)	52 (16.7)	312
6. Jaranwala	64 (49.2)	45 (34.6)	21 (16.2)	70 (53.8)	44 (33.8)	16 (12.3)	130
7. Khanqa Dogran	172 (81.5)	29 (13.7)	10 (4.7)	101 (47.9)	102 (48.3)	8 (3.8)	211
8. Pindi Bhattian	2 (9.5)	12 (57.1)	7 (33.3)	1 (4.8)	15 (71.4)	5 (23.8)	21
9. Shadman	101 (69.7)	38 (26.2)	6 (4.1)	79 (54.5)	65 (44.8)	1 (0.7)	145
10. Shahkot	41 (11.2)	92 (25.1)	233 (63.7)	21 (5.7)	80 (21.9)	265 (72.4)	366
11. Sangla Hill	50 (21.5)	80 (34.3)	103 (44.2)	36 (15.5)	80 (34.3)	117 (50.2)	233
12. Zafarwal	158 (40.6)	170 (43.7)	61 (15.7)	123 (31.6)	212 (54.5)	54 (13.9)	389
Total	840 (41.7)	595 (29.6)	578 (28.7	597 (29.7)	812 (40.3)	604 (30.0)	2013
No. of T/W changed				-243	+217	+26	
				-28.9%	+36.5%	4.5%	
Percent change from the 1st sampling				-12.0	10.7	1.3	

*Number in parenthesis represents percentage

Table 4.5: Tubewell water suitability based on EC using irrigation standards

Name of Scheme	First sampling			Last sampling			
	Usable	M	Haz	Usable	M.	Haz.	Total
1. Beranwala	13 (10.3)	15 (11.9)	98 (77.8)	14 (11.1)	8 (6.3)	104 (82.5)	126
2. Chechoki Malian	11 ((91.7)	0 (0)	1 (8.3)	12 (100)	0 (0)	0 (0)	12
3. Churkana	9 (37.5)	7 (29.2)	8 (33.3)	9 (37.5)	10 (41.7)	5 (20.8)	24
4. Hafizabad	144 (46.2)	92 (29.5)	76 (24.4)	108 (34.6)	107 (34.3)	97 (31.1)	312
5. Harse Sheikh	24 (54.5)	10 (27.7)	10 (22.7)	28 (63.6)	9 (20.5)	7 (15.9)	44
6. Jaranwala	44 (33.8)	17 (13.1)	69 (53.1)	36 (27.7)	18 (13.8)	76 (58.5)	130
7. Khanqa Dogran	164 (77.7)	31 (14.7)	16 (7.6)	146 (69.2)	49 (23.2)	16 (7.6)	211
8. Pindi Bhattian	1 (4.8)	10 (47.6)	10 (47.6)	2 (9.5)	6 (28.6)	13 (61.9)	21
9. Sangla Hill	53 (22.7)	64 (27.5)	116 (49.8)	49 (21.0)	70 (30.0)	114 (48.9)	233
10. Shadman	105 (72.4)	33 (22.8)	7 (4.8)	88 (60.7)	36 (24.8)	21 (14.5)	145
11. Shahkot	29 (7.9)	38 (10.4)	299 (81.7)	22 (6.0)	38 (10.4)	306 (83.6)	366
12. Zafarwal	86 (22.1)	89 (22.9)	214 (55.0)	46 (11.8)	82 (21.1)	261 (67.1)	389
Total	683 (33.9)	406 (20.2)	924 (45.9)	560 (27.8)	433 (21.5)	1020 (50.7)	2013
No. of T/W changed				-123 -(18.0)	+27 (6.7)	+96 (10.4)	
Percent change from the 1st sampling				-(6.1)	(1.3)	(4.8)	

Table 4.6: Tubewell water suitability based on RSC using irrigation standards

Name of Scheme	Usable	M.	Haz.	Usable	M.	Haz.	Total
1. Beranwala	21 (16.7)	13 (10.3)	92 (73.0)	6 (4.8)	11 (8.7)	109 (86.5)	126
2. Chechoki Malian	7 (58.3)	4 (33.3)	1 (8.3)	8 (66.7)	4 (33.3)	0 (0.0)	12
3. Chuharkana	4 (16.7)	2 (8.3)	18 (75.0)	3 (12.5)	2 (8.3)	19 (79.2)	24
4. Hafizabad	115 (36.9)	56 (17.9)	141 (45.2)	29 (9.3)	72 (23.1)	211 (67.6)	312
5. Harse Sheikh	30 (68.2)	9 (20.5)	5 (11.4)	28 (63.6)	7 (15.9)	9 (20.5)	44
6. Jarawala	70 (53.8)	22 (16.9)	38 (29.2)	69 (53.1)	26 (20.0)	35 (26.9)	130
7. Khanqa Dogran	124 (58.8)	48 (22.7)	39 (18.5)	18 (8.5)	84 (39.8)	109 (51.7)	211
8. Pindi Bhattian	0 (0.0)	2 (9.5)	19 (90.5)	0 (0.0)	1 (4.8)	20 (95.2)	21
9. Sangla Hill	36 (15.5)	19 (8.2)	178 (76.4)	23 (9.9)	14 (6.0)	196 (84.1)	233
10. Shadman	63 (43.4)	39 (26.9)	43 (29.7)	31 (21.4)	48 (33.1)	66 (45.5)	145
11. Shahkot	35 (9.6)	29 (7.9)	302 (82.5)	26 (7.1)	12 (3.3)	328 (89.6	366
12. Zafarwal	111 (28.5)	104 (26.7)	174 (44.7)	69 (17.7)	139 (35.7)	181 (46.5)	389
Total	616 (30.6)	347 (17.2)	1050 (52.2)	310 (15.4)	420 (20.9)	1283 (63.7)	2013
No. of T/W changed				-306 (-49.7)	73 (21.0)	233 (22.2)	
Percent change from the 1st sampling				(-15.2)	(3.7)	(11.50)	

Table 4.7: Tubewell water suitability base on SAR using irrigation standards

Name of Scheme	First sampling			Last Sampling			
	Using	M.	Haz.	Using	M.	Haz.	Total
1. Beranwala	23 (18.3)	42 (33.3)	61 (48.4)	21 (16.7)	52 (41.3)	53 (42.1)	126
2. Chechoki Malian	11 (91.7)	1 (8.3)	0 (0.0)	12 (100)	0 (0.0)	0 (0.0	12
3. Chuharkana	13 (54.2)	7 (29.2)	4 (16.7	17 (70.8)	7 (29.2)	0 (0.0)	24
4. Hafizabad	225 (72.1)	65 (20.8)	22 (7.1)	222 (71.2)	80 (25.6)	10 (3.2)	312
5. Harse Sheikh	35 (79.5)	9 (20.5)	0 (0.0)	37 (84.1)	5 (11.4)	2 (4.5)	44
6. Jaranwala	61 (46.9)	43 (33.1)	26 (20.0)	62 (47.7)	40 (30.8)	28 (21.5)	130
7. Khanqa Dogran	184 (87.2)	27 (12.8)	0 (0.0)	190 (90.0)	21 (10.0)	0 (0)	211
8. Pindi Bhattian	11 (52.4)	9 (42.9)	1 (4.8)	6 (28.6)	12 (57.1)	3 (14.3)	21
9. Sangla Hill	84 (36.1)	89 (38.2)	60 (25.8)	95 (40.8)	78 (33.5)	60 (25.8)	233
10. Shahdman	112 (77.2)	32 (22.1)	1 (0.7)	115 (79.3)	27 (18.6)	3 (2.1)	145
11. Shahkot	60 (16.4)	104 (28.4)	202 (55.2)	44 (12.0)	117 (32.0)	205 (56.0)	366
12. Zafarwal	167 (42.9)	135 (34.7)	87 (22.4)	160 (41.1)	151 (38.8)	78 (20.1)	389
Total	986 (49.0)	563 (28.0)	464 (23.0)	981 (48.7)	590 (29.3)	442 (22.0)	2013
No. of T/W changed				-5 -(0.5)	27 (4.8)	-22 (-4.7)	
Percent change from the 1st sampling				-(0.3)	(1.3)	(1.0)	

Table 4.8: Tubewell Water Suitability based on EC, RSC and SAR using Irrigation Standards based on all parameters

Name of Scheme	First Sampling			Last sampling			
	Usable	Marginal	Haz.	Usable	Marg.	Haz.	Total
1. Beranwala	6 (4.8)*	12 (9.5)	108 (85.7	5 (4.0)	7 (5.6)	114 (90.5	126
2. Chechokimalian	7 (58.3)	4 (33.3)	1 (8.3)	8 (66.7)	4 (33.3)	0	12
3. Chuharkana	4 (16.7)	2 (8.3)	18 (75.0	3 (12.5)	2 (8.3)	19 (79.2)	24
4. Harse Sheikh	20 (45.5)	12 (27.3)	12 (27.3)	24 (54.5)	9 (20.5)	11 (25.0)	44
5. Hafizabad	82 (26.3)	77 (24.7)	153 (49.0)	29 (9.3)	71 (22.8)	212 (67.9)	312
6. Jaranwala	35 (26.9)	17 (13.1)	78 (60.0)	31 (23.8)	19 (14.6)	80 (61.5)	130
7. Khanqa Dogran	110 (52.1)	58 (27.5)	43 (20.4)	17 (8.1)	84 (39.8)	110 (52.1)	211
8. Pindi Bhattian	0 (0)	2 (9.5)	19 (90.5)	0 (0)	1 (4.8)	20 (95.2)	21
9. Shadman	45 (31.0)	51 (35.2)	49 (33.8)	29 (20.0)	49 (33.8)	67 (46.2)	145
10. Shahkot	17 (4.6)	16 (4.4)	333 (91.0)	14 (3.8)	7 (1.9)	345 (94.3)	366
11. Sangla Hill	26 (11.2)	20 (8.6)	187 (80.3)	22 (9.4)	13 (5.6)	198 (85.0)	233
12. Zafarwal	29 (7.5)	90 (23.1)	270 (69.4)	12 (3.1)	60 (15.4)	317 (81.5)	389
Total	381 (18.9)	361 (17.9)	1271 (63.1)	194 (9.6)	326 (16.1)	1493 (74.2)	2013
No. of T/W changed				-187 (-49%)	-35 (9.7)	+222 (17.5)	
Percent change from the 1st sampling				(-9.3)	(-9.3)	(11.1)	

*Number in parenthesis represents percentage

Table 4.9: Tubewell water suitability based on EC using FAO guidelines

Name of Scheme	First Sampling Restriction on use			Last sampling			
	None	Moderate	Severe	None	Moderate	Severe	Total
1. Beranwala	11 ((8.7)	113 (89.7	2 (1.6)	11 (8.7)	112 (88.9)	3 (2.4)	126
2. Chechoki Mallian	11 (91.7)	1 (8.3)	0 (0)	12 (100)	0 0	0 0	12
3. Churkana	7 (29.2)	17 (70.8)	0 0	7 (29.2)	17 (70.8)	0 0	24
4. Harse Sheikh	22 (50.0)	22 (50.0)	0 (0)	26 (59.1)	18 (40.9)	0 0	44
5. Hafizabad	88 (28.2)	224 (71.8)	0 (0)	61 (19.6)	251 (80.4)	0 0	312
6. Jaranwala	40 (30.8)	81 (62.3)	9 (6.9)	29 (22.3)	89 (68.5)	12 (9.2)	130
7. Khanqa Dogran	138 (65.4)	73 (34.6)	0 (0)	97 (46.0)	114 (54.0)	0 0	211
8. Pindi Bhattian	0 (0)	21 (100)	0 (0)	1 (4.8)	20 (95.2)	0 (0)	21
9. Sangla Hill	36 (15.5)	192 (82.4)	5 (2.1)	34 (14.6)	197 (84.5)	2 (0.9)	233
10. Shadman	88 (60.7)	57 (39.3)	0 0	65 (44.8)	80 (55.2)	0 (0)	145
11. Shahkot	25 (6.8)	274 (74.9)	67 (18.3)	19 (5.2)	298 (81.4)	49 (13.4)	366
12. Zafarwal	51 (13.1)	318 (81.7)	20 (5.1)	27 (6.9)	335 (86.1)	27 (6.9)	389
Total	517 (25.7)	1393 (69.2)	103 (5.1)	389 (19.3)	1531 (76.1)	93 (4.6)	2013
No. of T/W changed				-128	+138	-10	
Percent changed from the first sampling				(-6.4)	(6.9)	(-0.5)	

Table 4.10: Tubewell water suitability based on EC and SAR using FAO guidelines

Name of Scheme	First Sampling			Last sampling			
	None	Moderate	Severe	None	Moderate	Severe	Total
1. Beranwala	17 (13.5)	107 (84.9)	2 (1.6)	13 (10.3)	112 (88.9)	1 (0.81)	126
2. Chechoki Malian	0	12 (100)	0	0 0	12 (100)	0 0	12
3. Choharkana	0	24 (100)	0	0 0	24 (100)	0 0	24
4. Hafizabad	52 (16.7)	259 (83.0)	1 (0.3)	34 (10.9)	278 (89.1)	0 0	312
5. Harse Sheikh	4 (9.1)	40 (90.9)	0 0	1 (2.3)	43 (97.7)	0 0	44
6. Jaranwala	32 (24.6)	96 (73.8)	2 (1.5)	38 (29.2)	91 (70.0)	1 (0.8)	130
7. Khanqa Doqran	18 (8.5)	189 (89.6)	4 (1.9)	27 (12.8)	184 (87.2)	0 0	211
8. Pindi Bhattian	2 (9.5)	19 (90.5)	0 (0)	0 (0)	21 (100)	0 0	21
9. Sangla Hill	14 (6.0)	215 (92.3)	4 (1.7)	17 (7.3)	215 (92.3)	1 (0.4)	233
10. Shadman	7 (4.8)	138 (95.2)	0 (0)	13 (9.0)	132 (91.0)	0 0	145
11.	68 (18.6)	290 (79.2)	8 (2.2)	59 (16.1)	300 (82.0)	7 (1.9)	366
12.	81 (20.8)	304 (78.1)	4 (1.0)	134 (34.4)	253 (65.0)	2 (0.5)	389
Total	295 (14.7)	1693 (84.1)	25 (1.2)	336 (16.7)	1665 (82.7)	12 (0.6)	2013
No. of T/W				41 (13.9)	-28 -(1.7)	-13 -(52.0)	
Percent change from the 1st sampling				2.0	-(1.4)	-(0.6)	

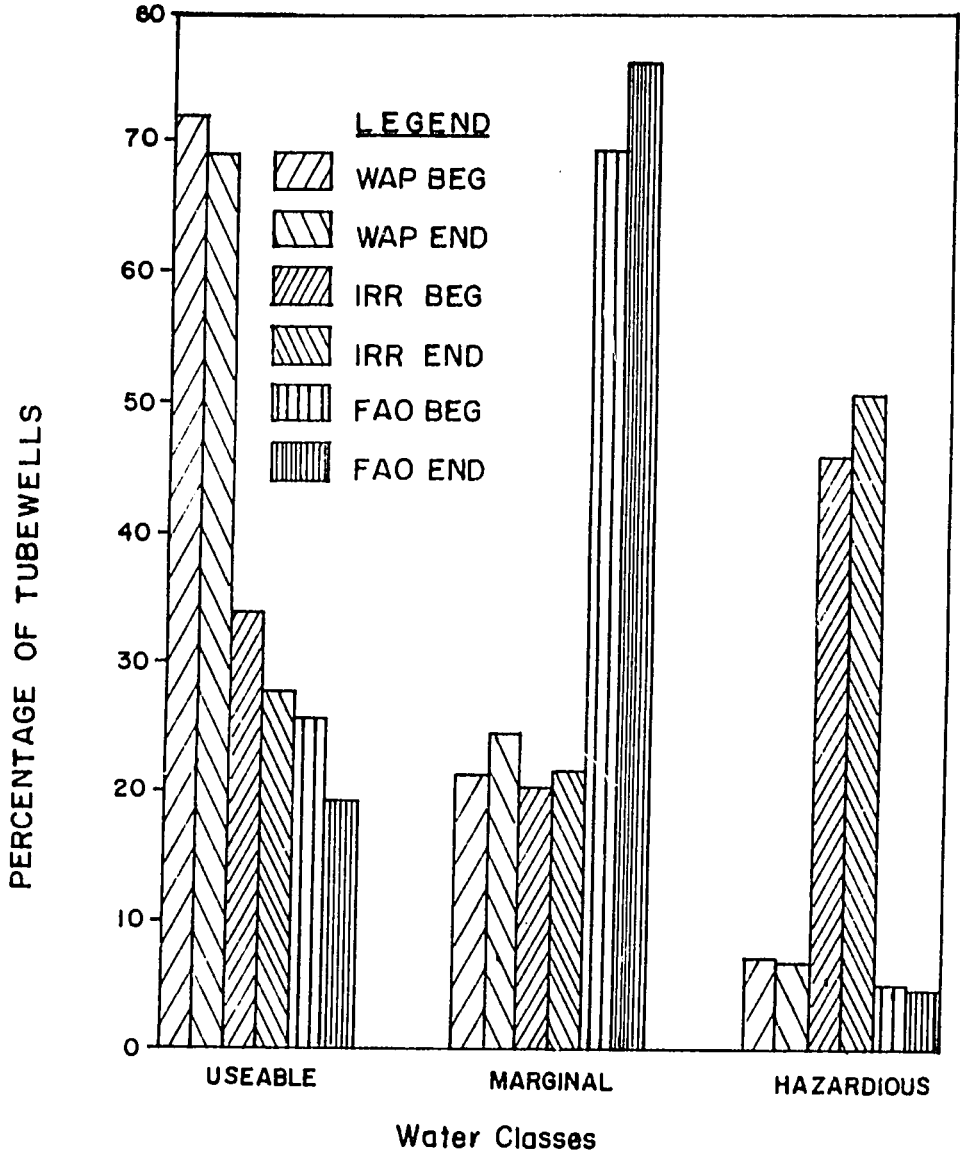

Fig. 4·1 Tubewell Water Quality of SCARP-I using WAPDA, Irrigation and FAO Standards for EC

4.3: Changes with Respect to Residual Sodium Carbonate (RSC)

The results of water suitability based on RSC are summarised in Tables 4.2 and 4.6 using WAPDA and Irrigation Department Standards. These tables show similar trend as that of EC in which deterioration trend is more significant which is also clear from Fig. 4.2. For WAPDA standards the usable tubewells decreased by 11.5 percent and the marginal and hazardious classes increased by 10.6 and 0.9 percent respecitvel; The same values are 15.2, 3.7 and 11.5 percent respectively for irrigation standards.(Tabler4.6).

4.4: Changes with Respect to Sodium Adsorbation Ratio (SAR).

Tubewell water suitability using WAPDA and Irrigation limits are given in Tables 4.3 and 4.7 based on SAR. Mixed trend of water quality improvement and deterioration is evident from the above tables and Fig. 4.3. But the changes are not significant based on this parameter.

4.5: Classification Based on all Parameters.

Generally water is classified using any one parameter values and no attention is paid to the values of the other parameters. For example, if classification is based on EC; water may be useable considering EC limits but RSC and SAR values may be high. Therefore, analysis of the data was also carried out using all values of the parameters for useable, marginal and hazardous classess. The results are given in Tables 4.7 and 4.8 for WAPDA and Irrigation standards respectively.

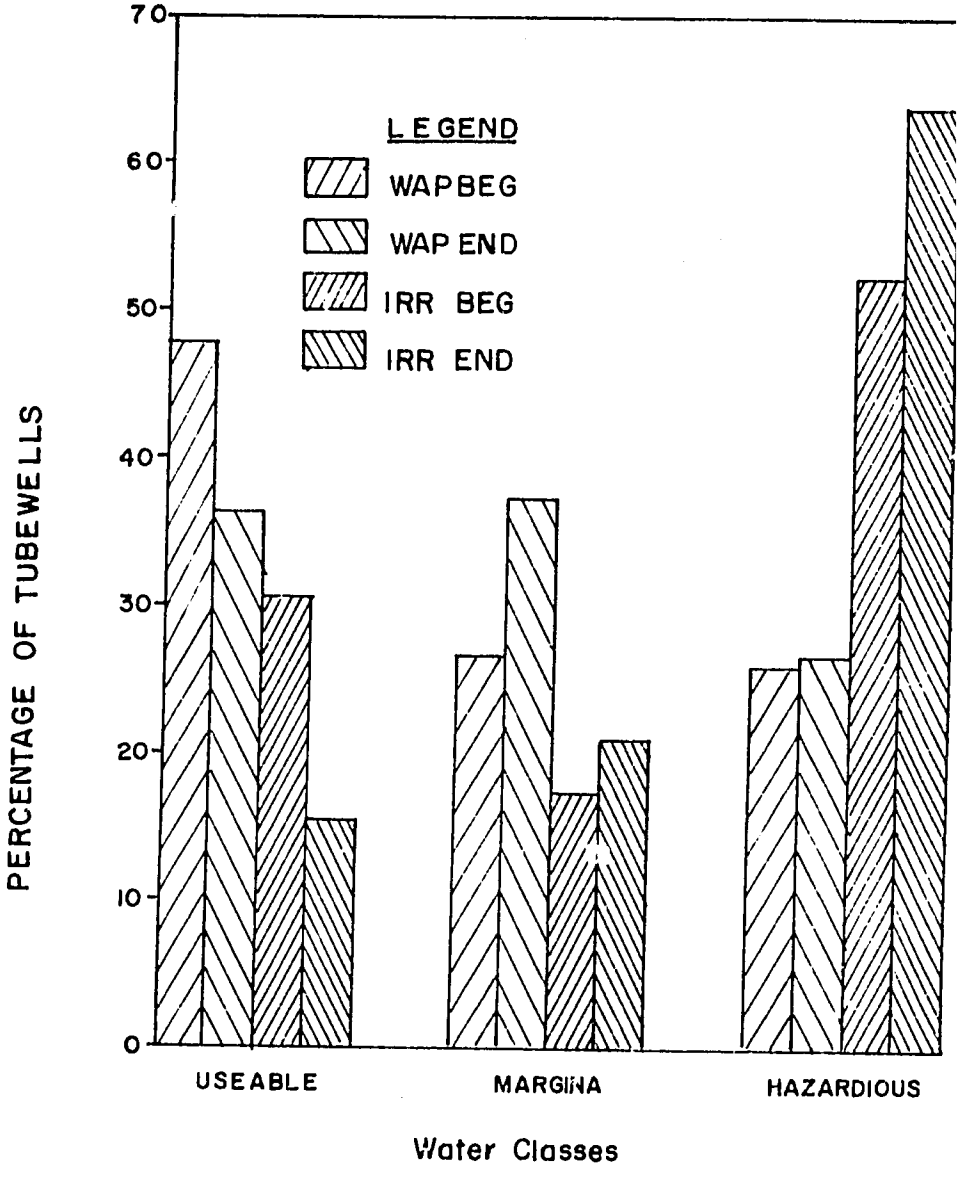

Fig. 4·2 Tubewell Water Quality of SCARP-I using WAPDA and Irrigation Standards for RSC

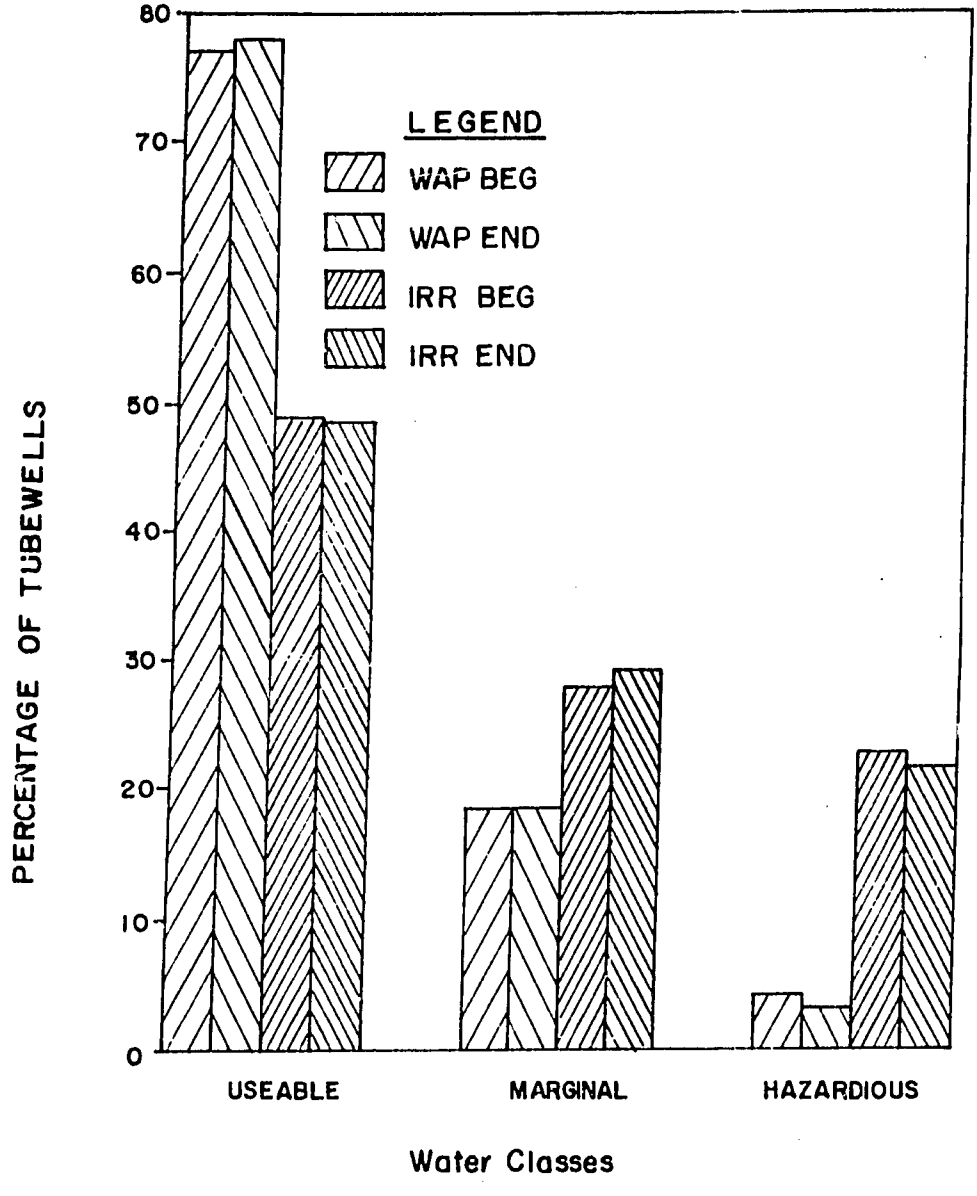

Fig. 4·3 Tubewell Water Quality of SCARP-I using WAPDA and Irrigation Standards for SAR

The results are also plotted in Fig. 4.4 for easy interpretion. The useable tubewells have reduced by 12 and 9.3 percent for WAPDA and Irrigation standards respectively. For the WAPDA standards the marginal and hazardous tubewells increased from 10.7 and 1.3 percent respectively. For Irrigation standards, the marginal tubewells decreased by 1.8 percent but hazardous ones increased by 11.1 percent. Thus water quality deteriorating trend is evident by the classification based on all parameters as well.

Water suitability classification based on EC, EC and SAR using FAO guidelines are given in Tables 4.9 and 4.10. These results are also plotted in Fig. 4.4a for more elaboration.

4.6 Statistical Analysis

Paired t-test for dependent groups can be used to determine whether the changes occurred are significant or not (Dowdy and Wearden, 1982, page 179). The test statistic is calculated by the following equation:

$$t = \frac{y-\mu_d}{s/\sqrt{n}}$$

where
y = mean of the difference of two groups,
s = standard deviation, and
n = is the number of pairs.

Null hypothesis of $u_d = 0$ was tested for 5 percent alpha. The t statistics were calculated for all the cases discussed earlier and results are presented in Table 4-10a. For 12-1=11 degree of freedom, and 5 percent alpha, value of t from the table is 2.201. The null hypothesis will be rejected if calculated t value is greater than the table t-value. This means that changes in water quality are significant which are indicated by an asterisks in the table. For single parameter, the results are significant for RSC only regardless of the standards. It implies that this parameter has pronounced effect on water quality classification in this area than EC and SAR.

The t statistics for the case for all the three parameters are also given in bottom of Table 4-10a. The results are significant for the useable and marginal classes for WAPDA and for hazardous class for PID standard. This again shows that classification based on all the parameters is more conservative.

Table 4-10a, Calculated t-values for Statistical Analysis.

Parameter	Class	WAPDA	PID	FAO
EC	Useable	1.2284	1.1311	1.2657
EC	Marginal	-1.3176	0.0934	-1.3176
EC	Hazardous	0.0326	-0.9138	0.1956
RSC	Useable	2.8116*	2.4133*	
RSC	Marginal	-2.9536*	-1.0042	
RSC	Hazardous	0.8936	-2.8300*	
SAR	Useable	-0.5606	-0.2253	-0.0092**
SAR	Marginal	0.1996	-0.1685	-0.2714**
SAR	Hazardous	1.3821	0.5228	0.2606**
All	Useable	2.8186*	1.4412	
All	Marginal	-2.8508*	1.0178	
All	Hazardous	0.8537	-2.4308*	

* Significant at 5% alpha

** Classification based on EC & SAR

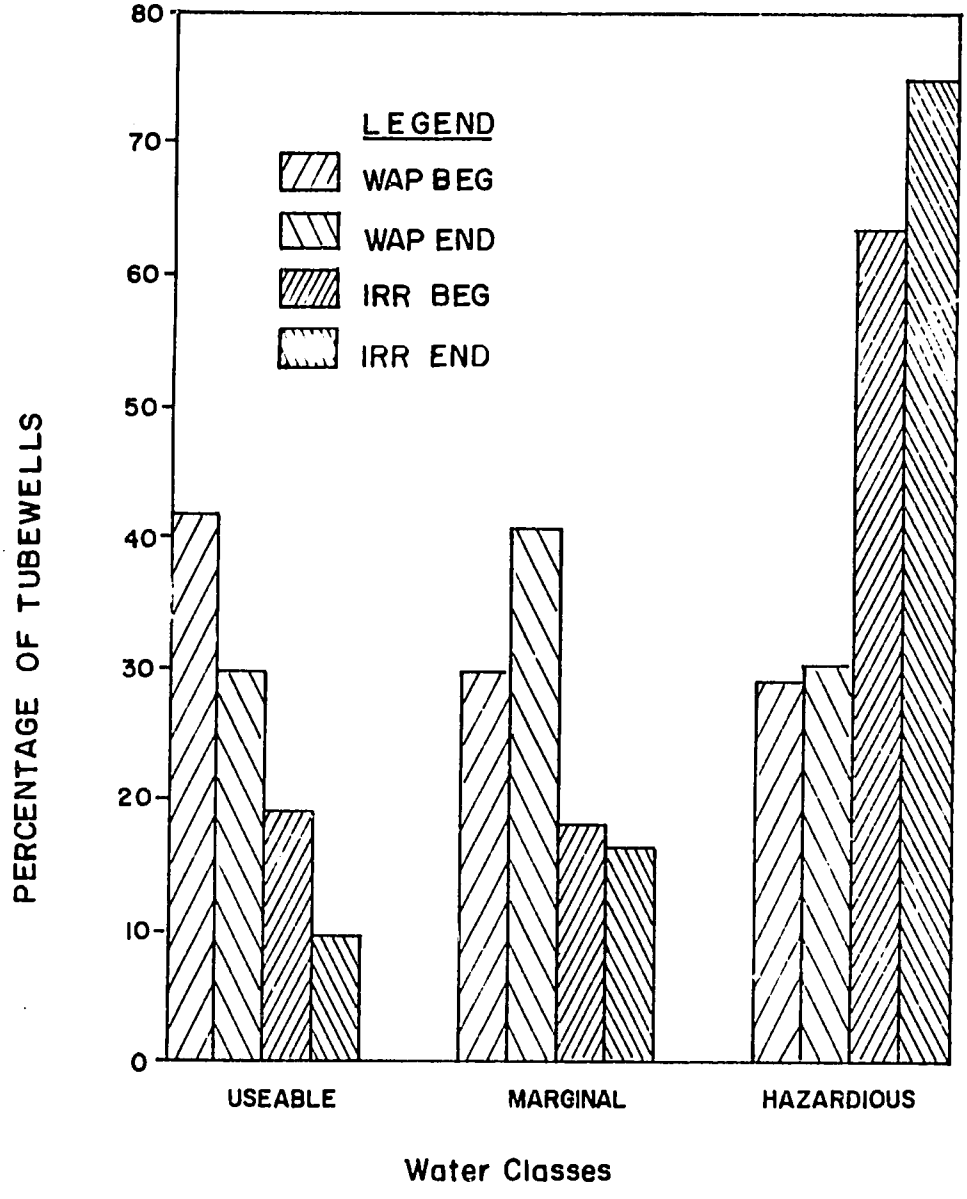

Fig. 4·4 Tubewell Water Quality of SCARP-I using WAPDA and Irrigation Standards for all Parameters

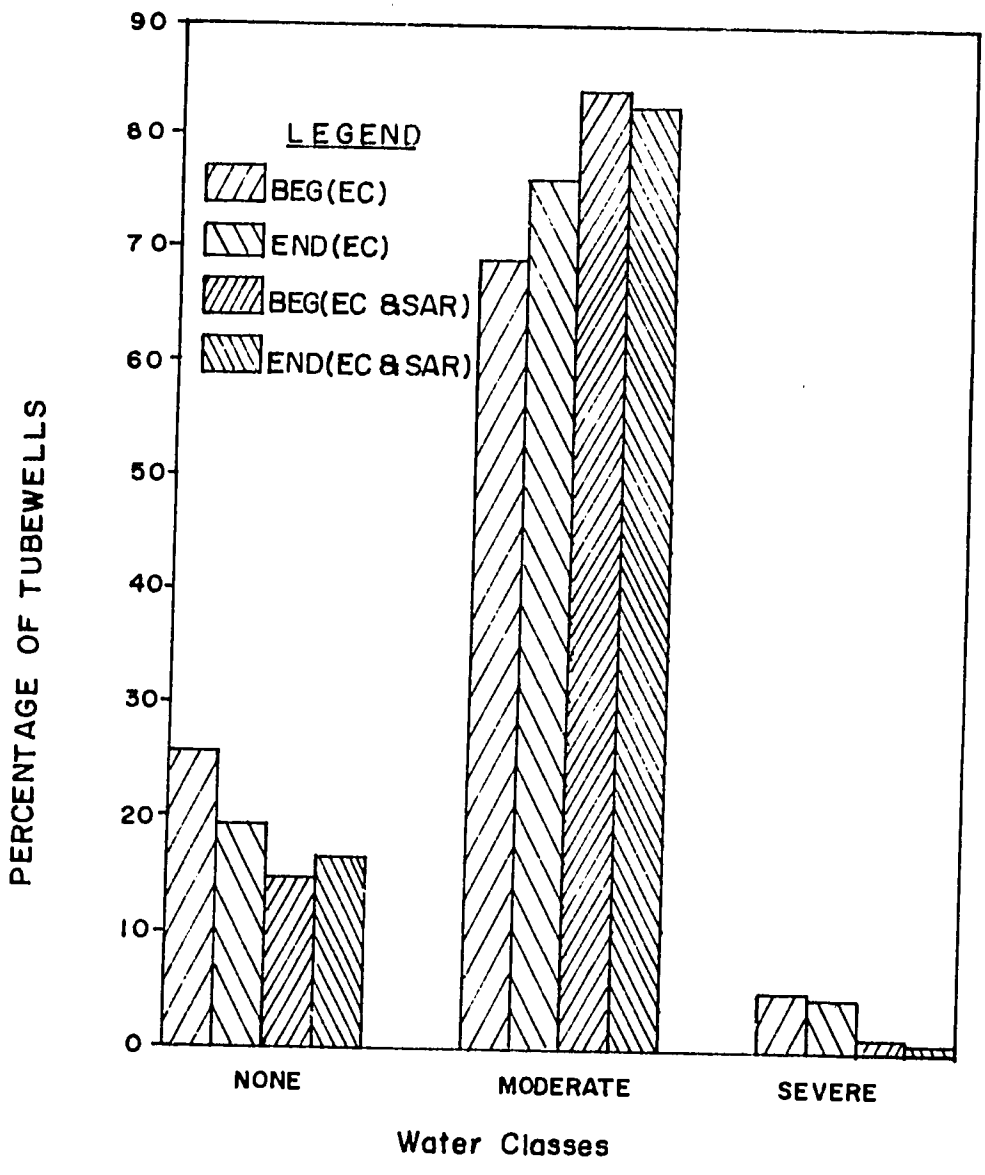

Fig. 4·4a Tubewell Water Quality of SCARP-I using FAO Standards for EC, EC and SAR

4.6: Root Zone Salinity Modelling

Salinity control using leaching as management tool, is extensively practiced in irrigated agriculture to mitigate the effect of salts on crops. Irrigation water is the major source of salts reaching the irrigated fields. Much of the applied water is either evaporated or transpired leaving salts in the root zone and thus increasing electrical conductivity (EC) of the remaining soil water (Ayers and Westcot, 1985). The highest rate of concentration occurs near the soil surface where the largest amount of water is extracted by plant roots between irrigation events.

When a field is irrigated, the applied water is mostly retained in the upper part of the root zone where plant roots have extracted the majority of the water and where direct evaporation occurs as well. Leaching is also granter in the upper part of the root zone. When rain or applied water fills the upper root zone near saturation, excess water percolates downward, leaching residual salts. Salinity of irrigation water generally does not remain constant during the growing season of a crop. It may vary due to return flow along a river reach or due to different proportions of water being used from different sources having different ECs.

Some researchers have developed models that can be used to describe salt movement phenomena (Childs and Hanks, 1975; Roades, 1984) and others. These models are complex and require much data which limit their use. A simple model is developed based on mass balance and water extraction patterns to model the downward movement of salts through the crop root zone as a result of irrigation. The equation directly relate the amount of water leached from the root zone when irrigation is applied to the physical properties of the soil. The model predicts the amount of water displaced from a given layer of soil by an irrigation:

$$D = (ID-ET) * (\frac{FC - ET}{SAT}) * (\frac{FC - ET}{FC}) \qquad (1)$$

where D= depth of water displaced from the layer, ID= depth of irrigation water entering the soil layer, ET= depth of water extracted from the layer by evapotranspiration since the last irrigation filled the soil to field capacity (FC) and saturation (SAT) respectively, expressed as depth of water.

The water displaced is assumed to be proportional to the water content remaining in the soil before irrigation and the amount of irrigation water applied. The displacement D, is directly proportional to irrigation water applied, ID. For ET= 0, equation 1 reduces to D=ID(FC/SAT), which makes the displacement fraction equal to the fraction of the voids represented by field capacity.

To calculate the salt profile in the root zone, the total depth of the root zone for a mature crop is divided into finite layers of equal thickness. Equation 1 can be used to calculate the water displaced (from the remaining soil water in each layer) in a serial fashion. Total water passing through each layer is calculated from a water balance for the layer taking the displaced water into account. The EC of the soil layer after irrigation is calculated using the soil water remaining in the layer following irrigation and consisting of water retained from the irrigation water, the undisplaced soil water and their respective ECs. Similarly, the EC of the draining water (which becomes the irrigation water for the next layer) is calculated using the amount of water displaced from the remaining soil water from the overlying layer, and the total water passing through the layer and their ECs. The water passing out one layer becomes the water entering the succeeding layer. For more detail, the reader is referred to Latif and Willardson (1990).

The model was checked for different soil types from the data given by Hansen et al. (1979, P.52) assuming identical climate and crop conditions for many years. The soil profile EC was assumed to be uniform

with depth at the beginning of the simulation period. By the end of the fourth year of simulation, the soil profile salt distribution reached a steady state condition. The simulated soil-salinity profiles for different soil layers at the end of four years are presented in Fig. 4.5. The curves show that EC is low near the soil surface where there is higher leaching, and it increases with depth. The higher EC for the finer-texured soils is related to the soil physical properties (more water of higher salt concentration is retained).

The above model is good for simulation of water and salt movement for long term conditions. Soil water computations are performed on daily basis whereas salinity status is updated after each irrigation. The only two irrigations were applied to wheat crop and daily data of water budget components was not collected due to lack of such facility, therefore, the model could not be calibrated. However, the predicted salinity profiles by the model are in good agreement as found in lysimeter study (Bower et al. 1969).

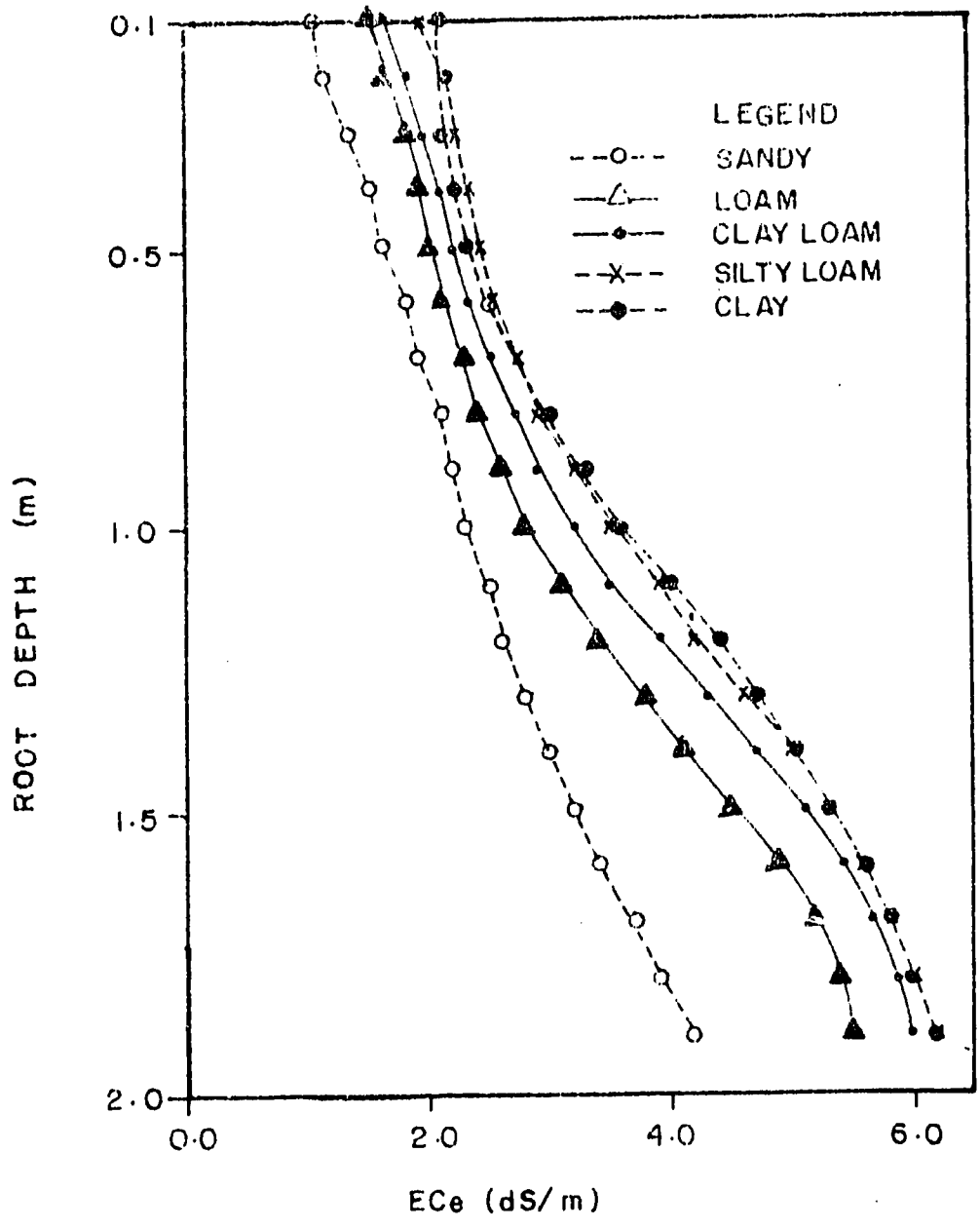

Fig.4.5: Final Predicted Soil-Salinity Profiles for Differe Soil Types Assuming Constant Crop Water Requiremen and Same Amount and Rainfall Pattern After Four Ye of Simulation.

4.7: Effect of Different Amounts of Tubewell Water on Soil Salinity

Different amounts of tubewell water were applied at sites 1 and 2 to study the built up of soil salinity under the command of tubewell No:36 as discussed earlier. The soil samples were collected at one month intervals. For salinity determination, the samples were analysed in the laboratory. For site 1, measured electrical conductivity (EC) data is presented in Table 4.11. The data is also plotted in Figs. 4.6 to 4.9.

Figure 4.6 shows that the light irrigation decreased soil salinity significantly at 0-15 cm. It decreased from 3.9 to 1.91 dSm^{-1} at the end of the experiment. At 30-cm and 45-cm depths, the soil salinity remained almost unchanged while it increased at deeper depths.

Medium irrigation decreased the soil salinity slightly at all the five depths. The decrease was more in the upper depths as compared to deeper depths. The heavy irrigation decreased soil salinity significantly at all the depths and the effect was greater in upper part of the soil profile. With farmer's method of irrigation, there was a small decrease in salinity at 15-45 cm depths and it increased at all the other depths having a significant effect at lower three depths.

Table 4.11: Measured EC at Site 1.

ECS1T1

Date	Month	EC15	EC30	EC45	EC60	EC75	EC90
1-12-89	1	3.9	2.8	3	3.3	3.7	3.8
24-1-89	2	2.75	2.37	2.7	2.6	3.3	3
28-2-90	3	1.37	1.18	2.35	3.89	4.54	5.69
31-3-90	4	0.82	0.76	0.97	0.81	0.95	1.88
24-4-90	5	1.66	2.43	2.59	3.53	3.31	3.02
1-6-90	6	2.31	1.78	1.79	2.09	2.48	4.34
28-6-90	7	4.5	2.06	2.375	1.955	1.745	2.16
1-8-90	8	5.045	3.51	3.51	6.67	7.07	7.09
2-9-90	9	2.57	2.98	5.22	5.375	5.66	6.125
28-9-90	10	2.79	3.05	3.505	4.21	5.775	6.525
2-11-90	11	1.91	2.47	2.905	3.02	4.345	5.425
		2.57	2.25	2.79	3.41	3.92	4.53

ECS1T2

Date	Month	EC15	EC30	EC45	EC60	EC75	EC90
7-12-90	1	3.9	2.8	3	3.3	3.7	3.8
28-2-90	2	2.23	2.32	2.44	2.45	2.67	3.74
31-3-90	3	1.09	1.4	1.34	1.76	1.74	1.61
24-4-90	4	0.87	0.83	1.52	1.98	2.65	2.77
1-6-90	5	1.37	1.46	1.89	2.03	2.14	2.35
28-6-90	6	1.95	2.165	2.2	2.89	2.965	2.535
1-8-90	7	1.001	1.835	2.415	2.795	4.08	4.87
22-8-90	8	1.345	1.57	2.37	3.13	4.5	5.05
20-9-90	9	2.4	2.07	2.14	2.2	2.52	2.26
28-9-90	10	1.94	2.015	2.17	2.635	2.86	3.15
2-11-90	11	1.99	1.45	1.515	1.85	2.1	2.245
		1.62	1.71	2.00	2.37	2.82	3.06

ECS1T3

Date	Month	EC15	EC30	EC45	EC60	EC75	EC90
7-12-90	1	3.9	2.8	3	3.3	3.7	3.8
28-2-90	2	1.77	2.94	3.09	3.52	4	4.56
31-3-90	3	1.15	1.18	1.65	2.17	1.8	1.68
24-4-90	4	1.16	1.92	2.04	1.9	2.06	2.41
1-6-90	5	2.59	2.43	2.56	2.45	2.6	2.99
28-6-90	6	2.725	2.74	2.615	2.75	2.075	1.695
1-8-90	7	1.22	2.68	3.25	3.28	4.16	4.47
22-8-90	8	3.25	3.18	4	3.58	4.76	4.7
2-9-90	9	3.235	3.305	3.93	4.16	3.93	4.785
28-9-90	10	1.71	1.71	1.665	1.76	1.815	1.525
2-9-90	11	1.51	1.965	1.54	1.925	2.31	2.59
		2.03	2.41	2.63	2.75	2.95	3.14

ECS1T4

Date	Month	EC15	EC30	EC45	EC60	EC75	EC90
7-12-90	1	3.9	2.8	3	3.3	3.7	3.8
28-2-90	2	4.68	3.26	3.99	2.84	3.93	3.38
31-3-90	3	1.27	1.55	1.85	1.8	2.18	2
24-4-90	4	0.93	0.68	0.95	1.2	1.34	1.56
1-6-90	5	4.02	4.01	4.53	5.03	6.06	6.29
28-6-90	6	2.74	2.45	3.025	3.36	4.055	4.075
1-8-90	7	6.27	3.69	3.58	3.9	4.47	3.94
20-8-90	8	1.64	2.105	2.675	2.41	3.1	2.655
2-9-90	9	1.195	4.465	4.78	6.235	6.915	6
28-9-90	10	2.78	2.965	3.378	4.39	5.125	4.655
2-11-90	11	2.465	3.055	3.64	5.18	7.32	4.219
		3.10	2.82	3.24	3.63	4.45	4.08

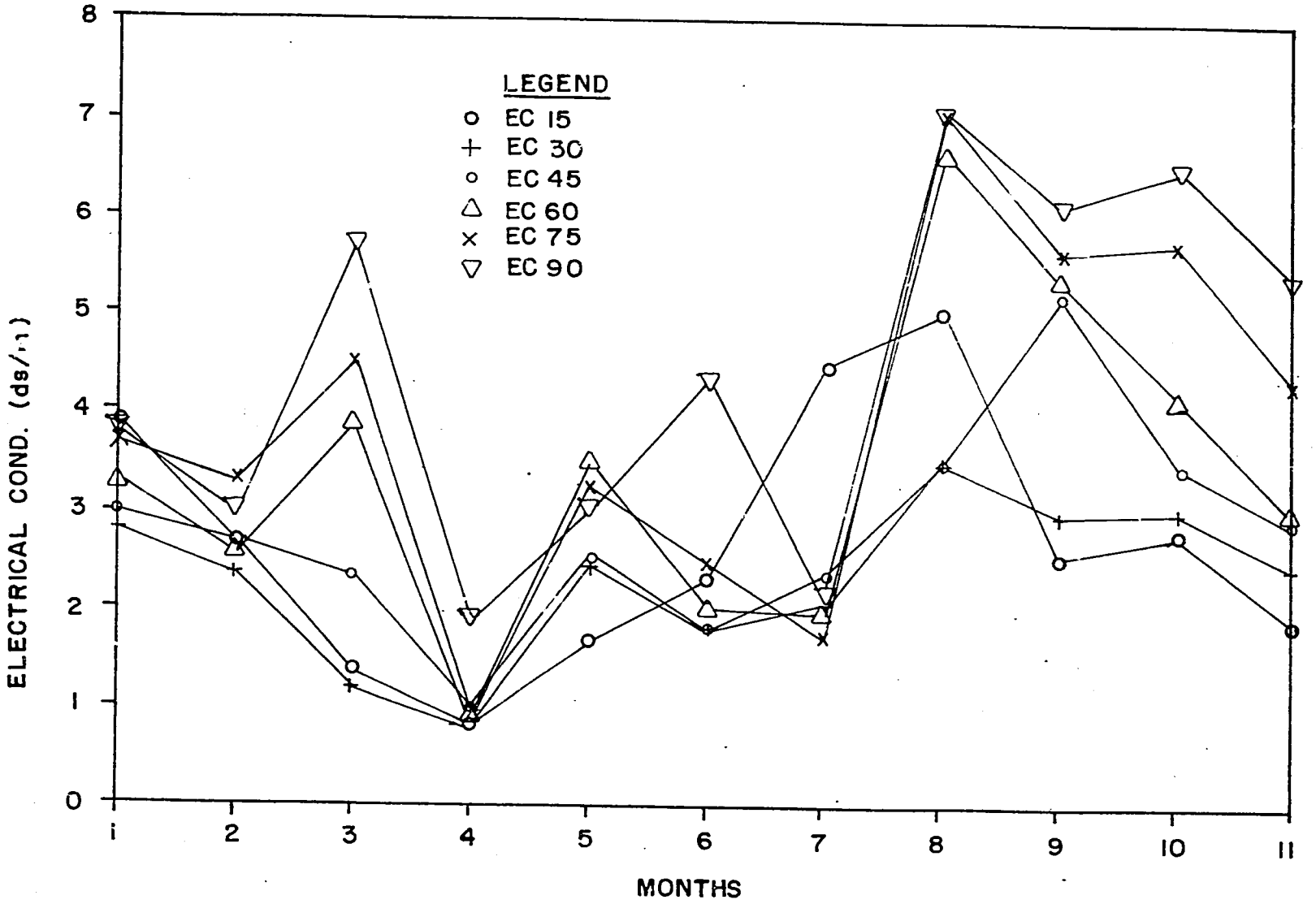

FIG. 4·6 MEASURED EC AT SITE 1st TREATMENT 1st

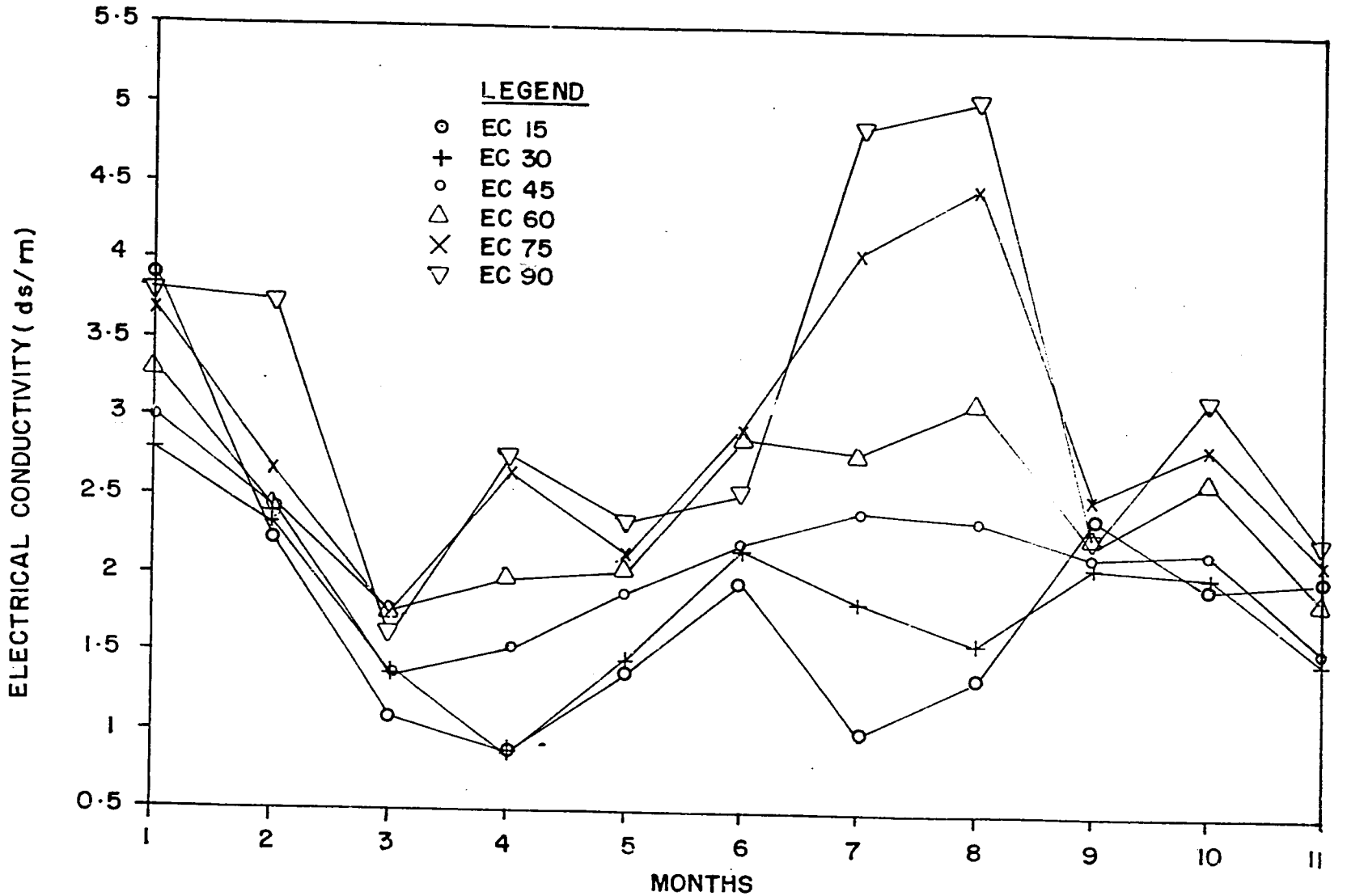

FIG. 4·7 MEASRED EC AT SITE 1st. TREAMENT 2nd

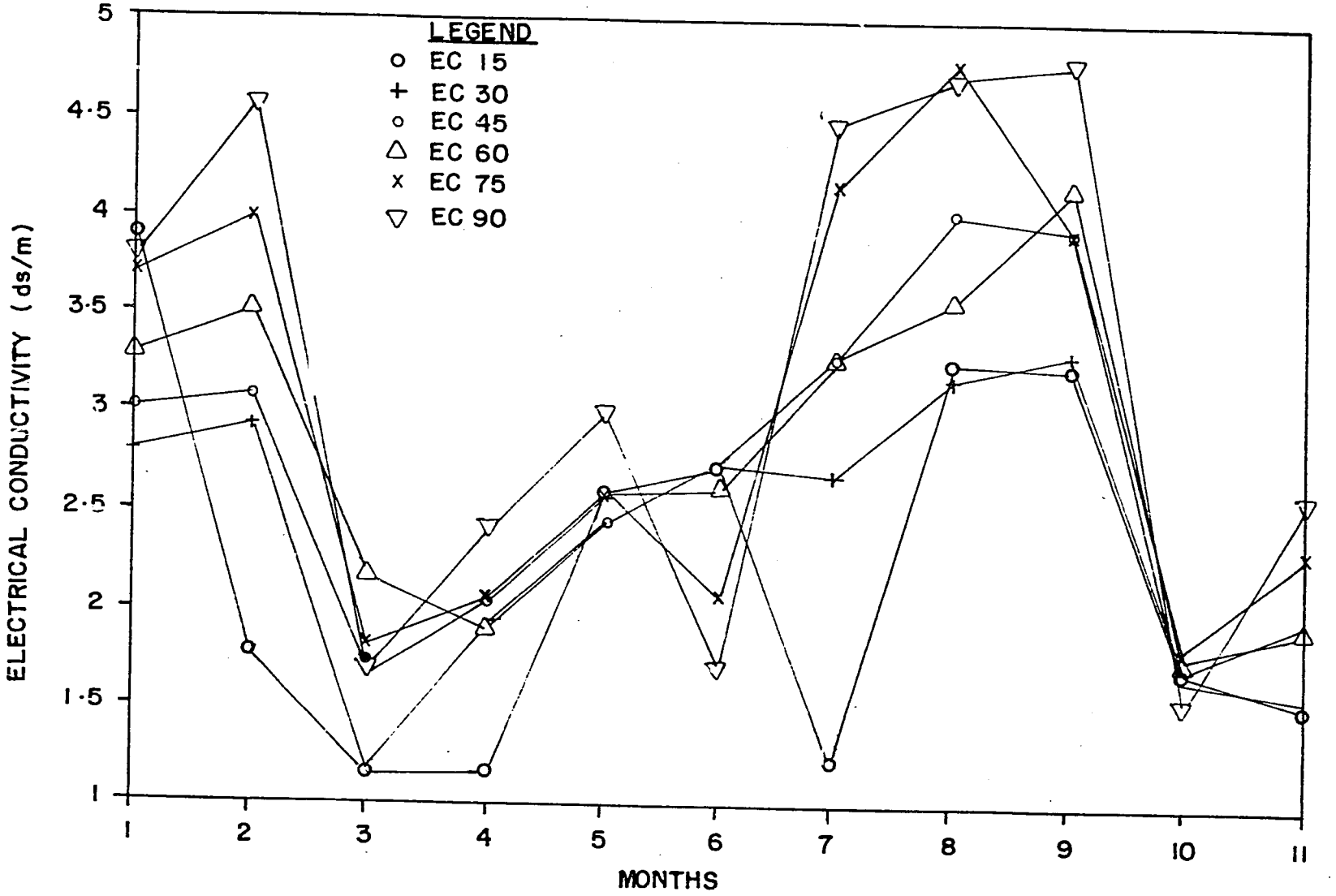

FIG. 4·8 MEASURED EC AT SITE 1st. TREATMENT 3rd

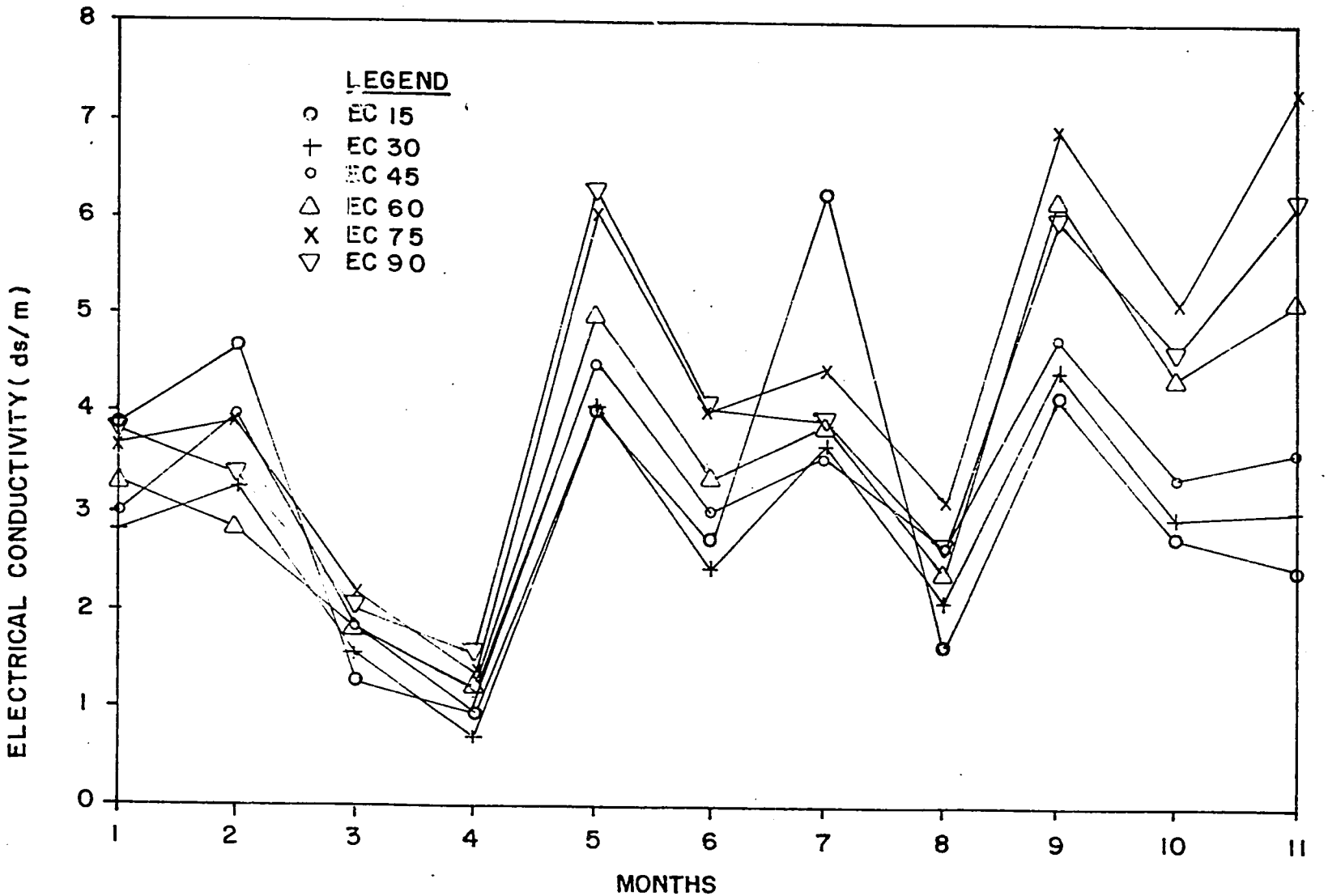

FIG. 4·9 MEASURED EC AT SITE 1st TREATMENT 4th

The results of the soil salinity at site 2 are presented in Table 4.12 and Figs. 4.10 to 4.13. At this site the initial salinity of the soil as compared to the site 1 was quite high, therefore, the results at this site are different than site 1.

Table 4.12 : Measured EC at Site 2.

ECS2T1

Date	Month	EC15	EC30	EC45	EC60	EC75	EC90
12-1-90	1	10.2	11.35	12.95	8.12	6.51	4.52
31-3-90	2	14.6	11.4	11.65	17.85	14	10
24-4-90	3	10.4	9.4	14	14.5	14.1	13.3
11-6-90	4	18.1	11.9	13.75	12.95	11.1	8.9
28-6-90	5	25.65	13.15	13.4	12.9	12.45	11.05
1-8-90	6	18.85	18.35	18.65	19.1	19.45	6.03
2-9-90	7	13.7	29.65	26.2	20.55	15.55	10.45
28-9-90	8	10.2	11.4	15.5	15.3	14.7	12.55

ECS2T2

Date	Month	EC15	EC30	EC45	EC60	EC75	EC90
12-1-90	1	10.2	11.35	12.95	8.12	6.51	4.52
31-3-90	2	12.8	9.7	14.5	15.2	13.6	15.2
24-4-90	3	12.8	12.2	13	11.6	10.1	9
1-6-90	4	11.1	10.25	13.5	18.2	19.25	17.3
23-6-90	5	16.7	8.9	8.59	8.35	9.29	10.5
1-8-90	6	10.7	16.86	20.4	21.3	21.15	20.6
2-9-90	7	6.35	18.1	17.35	15.3	12.95	13.8
28-9-90	8	7.408	17.1	16.9	13.05	12.55	10.35

ECS2T3

Date	Month	EC15	EC30	EC45	EC60	EC75	EC90
12-1-90	1	10.2	11.35	12.95	8.12	6.51	4.52
31-3-90	2	4.6	6.57	12.4	13.7	11.1	8.13
24-4-90	3	5.9	8.3	9.9	8.5	12.6	17.5
1-6-90	4	10.25	9.54	13	16.95	16.85	12.7
28-6-90	5	9.58	6.63	11.05	13.5	13.05	12.7
1-8-90	6	8.8	18.7	21.4	22.9	20.65	18.1
2-9-90	7	2.725	3.615	6.165	8.59	9.176	10.075
28-9-90	8	2.9	5.285	8.76	11.3	12.40	15.2

ECS2T4

Date	Month	EC15	EC30	EC45	EC60	EC75	EC90
12-1-90	1	10.2	11.35	12.95	8.12	6.51	4.52
31-3-90	2	10.35	8.82	11.1	9.5	7.64	5.41
24-4-90	3	16.1	14.1	16.1	13.3	10.2	8
1-8-90	6	12.05	7.83	6.05	5.84	5.27	4.36
2-9-90	7	23.75	15.70	9.265	5.500	4.435	5.620
28-9-90	8	10.25	6.38	5.74	4.97	4.81	5.36

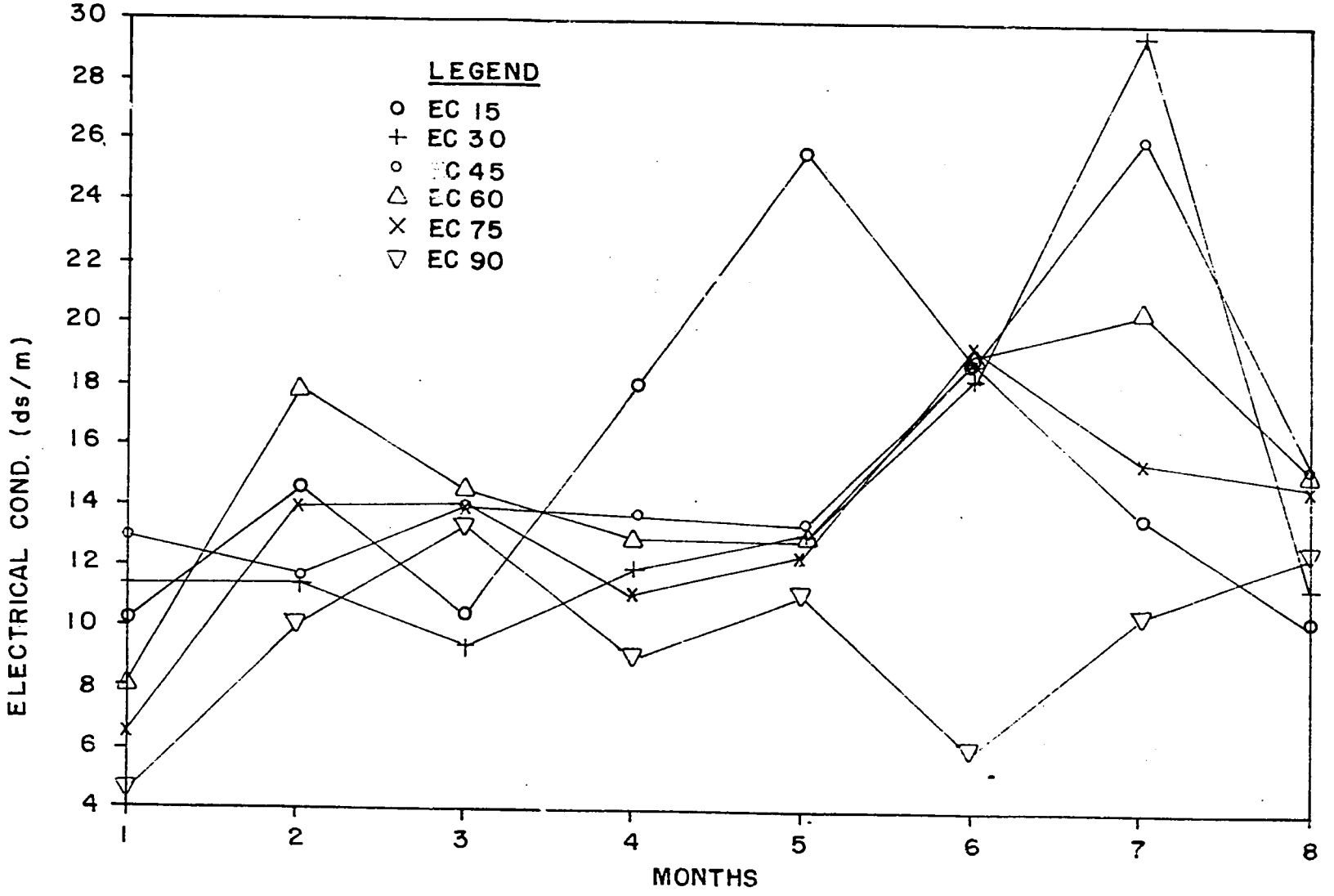

FIG. 4·10 MEASURED EC AT SITE 2nd. TREATMENT 1st.

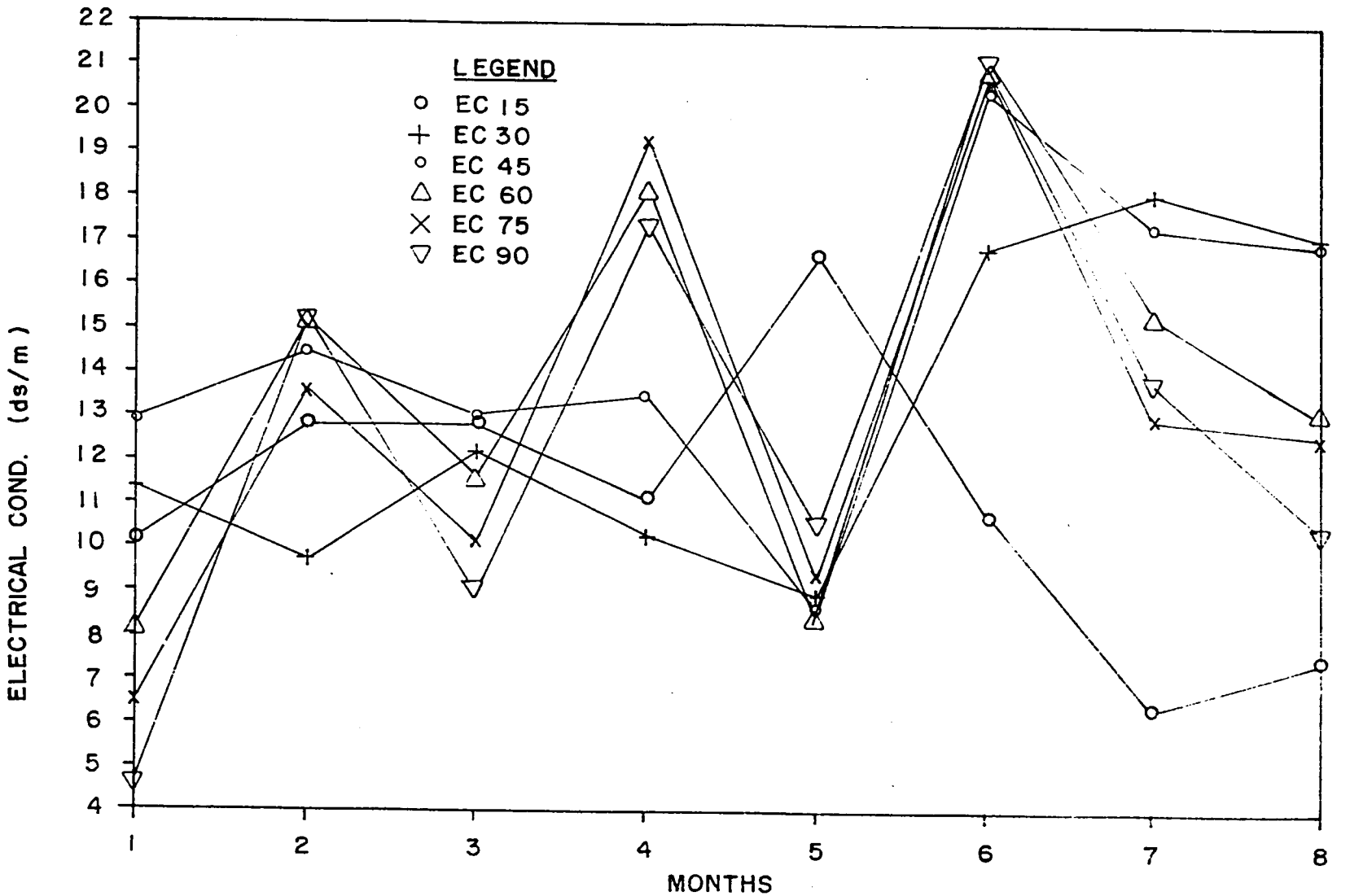

FIG. 4·11 MEASURED EC AT SITE 2nd. TREATMENT 2nd

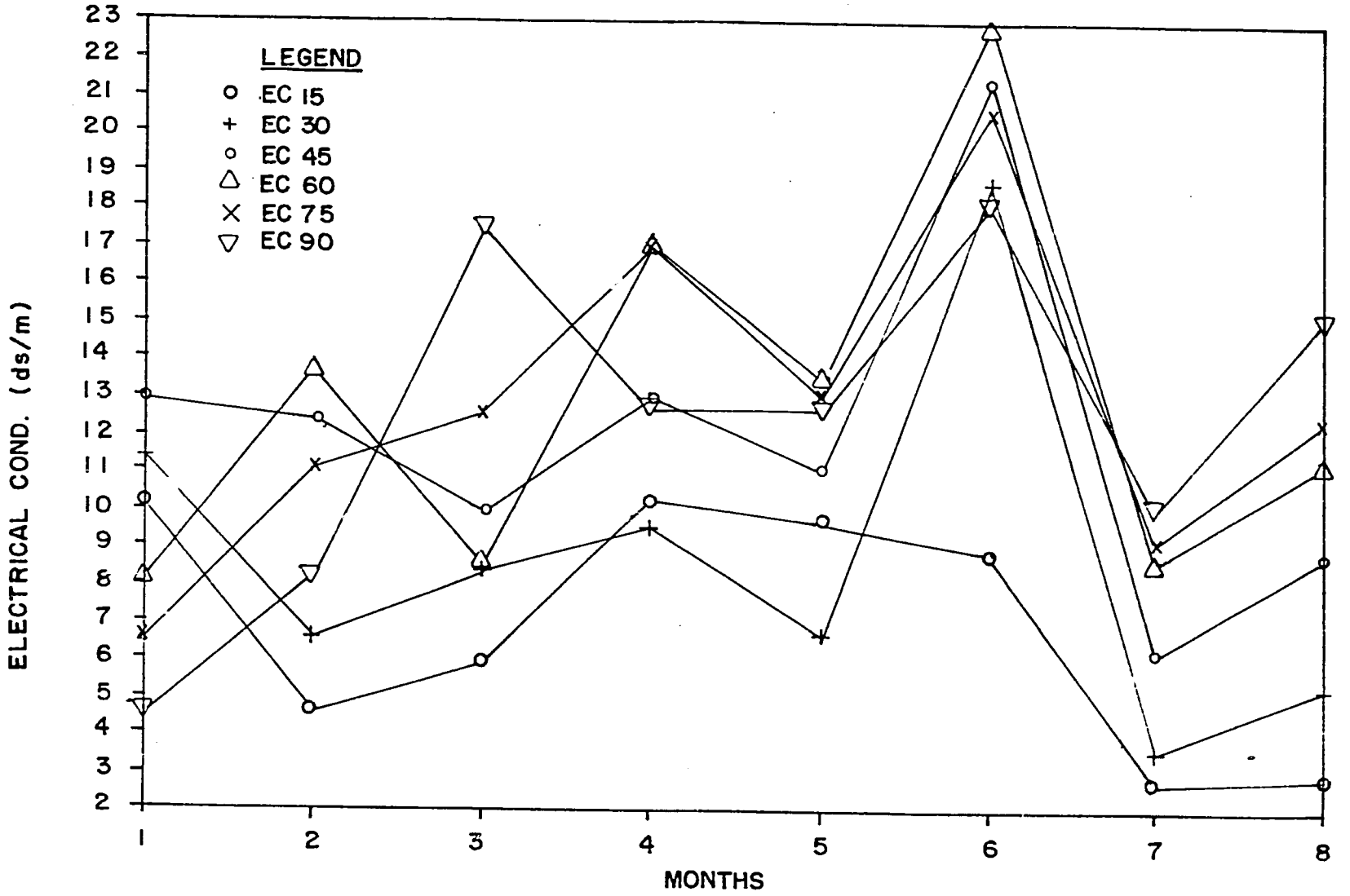

FIG. 4·12 MEASURE EC AT SITE 2nd. TREATMENT 3rd

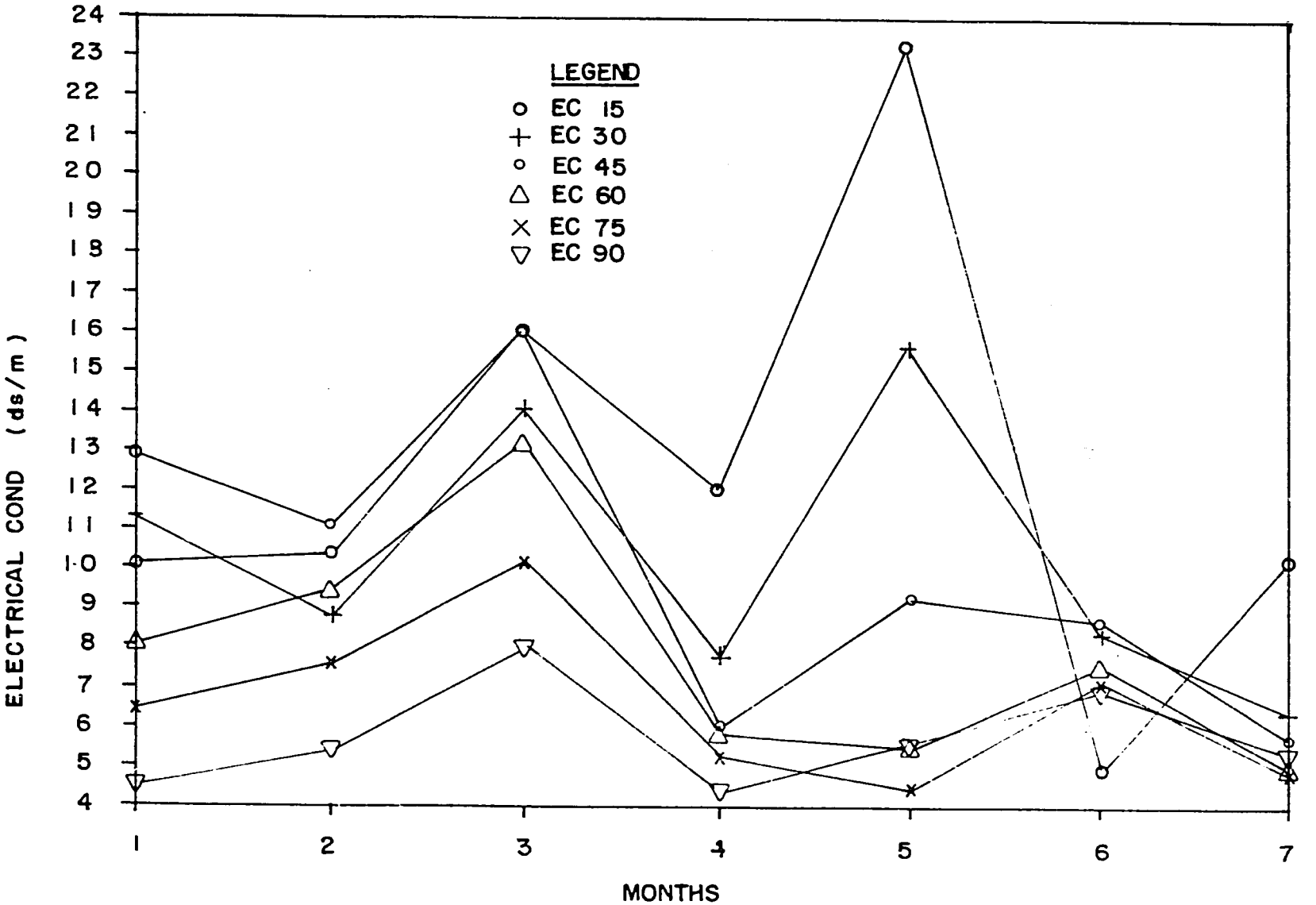

FIG. 4·13 MEASURED EC AT SITE 2nd. TREATMENT 4th

At site No.2 the light irrigation with saline tubewell water did not show any change in soil salinity in the upper soil layers (0-15, 15-30 cm) but had a significant effect on all other depths at the end of the experiment when compared to the ECe values at the on set of the experiments (Table 4.12 and Figs.4.10 to 4.13). However, the surface salinity increased significantly during May and June when the temperature was very high and later decreased due to monsoon rains.

The medium irrigation decreased the soil salinity significantly in 0-15 cm soil depth and raised the salt content sufficiently at all other depths at the end of the experiment as compared to the soil salinity at the beginning of the experiment.

The heavy irrigation decreased the soil salinity significantly upto 45 cm soil depth and increased significantly in the deeper layers.

With farmer's method of irrigation the salinity decreased significantly upto 45 cm soil depth and after that either it increased or decreased but the change was not very drastic.

In general the data show that light irrigation with saline water is not effective in decreasing the soil salinity and the heavy irrigations are required to make the crop rootzone suitable for crop growth.

The salts which are washed down with heavy irrigati and move up due to increase in temperature during summer are again washed down by the monsoon rains.

The effect of heavy irrigation in decreasing the soil salinity have also been reflected in the wheat yield (Table 4.13) Both total and grain yields are maximum where heavy irrigation was applied. This was followed by medium and farmer's irrigation. The yield was minimum where only light irrigations was given to the wheat crop.

4.8: The Effect of Different Amounts of Irrigation Water on Wheat and Maize Fodder Yield

The effect of different amounts of irrigation water on the wheat yield at site No:1 and 2 and sorghum fodder yield at site 1 is given in Tables 4.13 to 4.14 and in Table 4.15 respectively.

The data of wheat yield at site No:1 (Table 4.13) show that maximum yield was obtained with light irrigation which was followed by farmer's method of irrigation. The heavy irrigation gave better yield than medium irrigation.

Wheat yield at site No:2 (Table 4.14) was significantly higher with heavy irrigation as compared to light, medium and farmers irrigation.

The significant increase in the wheat yield as compared to the other treatments at site 1 is beyond our expectations as more salts have been decreased with higher quantum of water (Table 4.13) and more wheat yield was expected with heavy irrigation like wheat yield at site 2. However, it is difficult to explain the discrepancy in such short term experiments.

The effect of different amount of irrigation water on sorghum fodder yield is shown in Table 4.16. The light irrigation plot was harvested by the farmer without giving any notice to the Principal Investigator, therefore,

Table 4.13: The Effect of Different Amounts of Irrigation Water on Total Wheat Yield. (Kg/hectare) at Site No: 1

Total Yield (Grain + Straw)

	R_1^*	R_2	R_3	Average + St.Deviation
T_1	9990	8880	9240	9370 ± 566
T_2	6700	6750	5100	6183 ± 938
T_3	6470	6040	7060	6523 ± 512
T_4	6680	7030	8750	7487 ± 1108

Grain Yield

T_1	4415	4010	4135	4187 ± 207
T_2	2755	2600	1820	2392 ± 501
T_3	2505	2475	3000	2660 ± 294
T_4	2970	2790	3860	3206 ± 572

Straw Yield

T_1	4490	4870	5105	4822 ± 310
T_2	4125	4150	3280	3852 ± 495
T_3	3965	3565	3060	3530 ± 453
T_4	4710	3240	4890	4280 ± 905

R* Replication

Table 4.14: The Effect of Different Quantity of Irrigation Water on Wheat Yield (Kg/hectare) at Site No:2

Treatment	Grain + Straw	Grain
T_1	1845.92	1003.4
T_2	2257.9	1128.9
T_3	2927.9	1411.7
T_4 (F)	2728.1	1240.5

Table 4.15: The Effect of Canal Water on the Wheat Yield (Kg/hectare) at Site No: 3

Total Yield (Wheat + Straw)			
R_1	R_2	R_3	Average ± St.Dev.
5760	5460	5100	5440 ± 330
Grain Yield			
2400	1960	1955	2105 ± 255
Straw Yield			
3360	3500	3045	3002 ± 233

Table 4.16: The Effect of Different Irrigation Fractions on Sorghum Fodder Yield (Kg/hectare) at Site No.1

Treatment	Sorghum Fodder Yield(Kg/hectare)
T_1	Not available*
T_2	18300
T_3	16660
T_4	29400

*Plot harvested by the farmer and fodder yield not recorded.

the fodder yield from the light irrigation plot is not available. The comparison of the medium, heavy and farmer's irrigation indicate that maximum fodder yield was obtained with farmers method of irrigation as compared to medium and heavy irrigation. In this case, also heavy irrigation gave less yield as compared to the medium irrigation and farmer's irrigation.

4.9: Effect of Different Amounts of Tubewell Water on Soil Sodium Adsorption Ratio

The sodium adsorption ratio indicates the relative proportion of sodium to calcium and magnesium cations in soil solution. It predicts the potential sodium hazard. Soil samples which were collected from the experimental sites to see the effect of different amounts of the irrigation water on soil salinity were also analysed for sodium, calcium and magnesium to calculate the sodium adsorption ratio (SAR).

For site 1 and site 2, the SAR values at different depths and different times are given in Table 4.17, Table 4.18 and Figs. 4.14, 4.15, 4.16, 4.17, 4.18, 4.19, 4.20, 4.21 respectively. Fig.4.14 shows that light irrigation significantly decreased the SAR at 0-15 cm, 15-30 cm, and 30-45 cm. At the end of the experiment it decreased from 28 to 15.8, 16.1 and 18.7 respectively. At other depths SAR remained unchanged.

Medium irrigation(Fig.4.15)decreased SAR significantly at all the depths and the decrease was relatively more at 0-15 cm and 15-30 cm depths. Similar effect on soil SAR was observed with heavy irrigation (Fig. 4.16).

With farmer's method of irrigation (Fig. 4.17), there was small decrease in soil SAR as compared to the light, medium and heavy irrigation. However, the decrease was more in the supper soil depths as compared to the lower.

Table 4.17: SODIUM ADSORPTION RATIO

SAR AT SITE I

Date	Month	SAR 15	SAR 30	SAR 45	SAR 60	SAR 75	SAR 90
	SAR S_1 T_1						
7-12-89	1	28	28	25.7	21.7	25.7	28.0
24-1-90	2	18.6	18.1	19.4	22.6	23.2	33.0
28-2-90	3	10.2	19.6	29.0	27.8	45.0	21.3
31-3-90	4	5.7	4.9	5.7	8.1	10.4	9.3
24-4-90	5	10.6	15.9	14.3	21.2	24.5	28.3
1-6-90	6	10.8	11.4	12.5	16.0	15.9	27.2
28-6-90	7	28.6	9.9	11.0	11.6	9.1	9.9
1-8-90	8	20.9	25.0	30.4	37.3	37.9	36.7
2-9-90	9	17.9	16.0	15.1	30.2	37.6	34.8
28-9-90	10	15.6	18.0	29.0	28.0	39.3	37.3
2-11-90	11	7.3	10.1	13.9	11.4	23.4	24.8
		15.8	16.1	18.7	21.4	26.5	26.4
	SAR S_1 T_2						
7-2-89	1	28	28	25.7	21.7	25.7	28.0
28-2-90	2	13.3	16.3	16.3	17.9	18.6	22.8
31-3-90	3	11.5	14.5	15.6	17.0	18.5	17.3
24-4-90							
1-6-90	5	7.8	10.7	14.0	15.0	17.3	13.4
28-6-90	6	8.0	9.9	13.9	15.1	15.1	17.9
1-8-90	7	12.0	11.4	13.4	23.4	21.4	6.10
22-8-90	8	5.7	11.0	16.5	21.5	28.6	30.2
2-9-90	9	13.1	11.3	13.4	13.4	12.9	16.2
28-9-90	10	10.6	16.0	14.3	17.9	18.0	19.6
2-11-90	11	4.8	5.4	4.2	6.3	8.3	8.5
		11.5	13.5	14.7	16.9	18.4	13.9
	SAR S_1 T_3						
7-2-89	1	28	28	25.7	21.7	25.7	28.0
28.2.90	2	14.9	18.8	20.4	23.0	22.7	24.7
31-3-90	3	10.0	15.6	12.5	15.9	11.3	10.7
24-4-90	4						
1-6-90	5	13.1	21.9	16.0	17.3	16.0	23.1
28-6-90	6	17.9	12.8	15.2	14.0	16.3	11.4
1-8-90	7	4.9	3.5	4.5	4.0	3.0	2.5
22-8-90	8	19.6	18.0	21.2	19.7	22.8	23.1
2-9-90	9	20.0	16.3	25.0	22.7	24.5	30.2
28-9-90	10	9.8	7.8	11.6	9.1	13.1	13.9
2-11-90	11	5.5	5.6	5.5	7.2	8.3	5.9
		14.4	14.8	15.8	15.5	16.4	17.4
	SAR S_1 T_4						
7-2-89	1	28	28	25.7	21.7	25.7	28.0
28-2-90	2	26.9	21.4	24.5	21.5	24.5	23.7
31-3-90	3	10.7	12.5	17.4	17.5	11.3	17.4
244-90	4						
1-6-90	5	22.4	29.8	27.5	32.2	35.5	34.8
28-6-90	6	56.7	13.9	18.0	18.1	18.1	23.1
1-8-90	7	27.9	21.9	19.7	19.0	23.3	25.3
22-8-90	8	13.9	13.4	11.3	10.3	8.5	7.8
2-9-90	9	22.6	27.8	30.2	38.1	42.8	36.8
28-9-90	10	12.6	18.8	18.4	26.2	24.2	25.3
2-11-90	11	17.0	22.0	30.0	35.8	39.6	34.8
		23.9	20.9	22.3	24.0	25.4	25.7

Table 4.18: SODIUM ADSORPTION RATIO AT SITE-2

Date	Month	SAR 15	SAR 30	SAR 45	SAR 60	SAR 75	SAR 90
		SAR S_2 T_1					
12-1-90	1	48.0	39.5	35.2	23.9	24.8	21.5
	2	77.5	56.1	35.7	28.7	25.6	15.9
	3						
1-6-90	4	104.8	67.8	43.0	40.6	36.6	32.3
28-6-90	5	81.5	66.1	49.8	46.0	41.0	27.4
1-8-90	6	85.4	100.1	107.5	104.3	104.8	97.1
2-9-90	7	78.0	83.2	69.0	47.7	36.8	29.3
28-9-90	8	53.1	56.6	45.7	30.4	28.7	22.5
		75.5	67.1	55.1	45.9	42.6	35.1
		SAR S_2 T_2					
12-1-90	1	48.0	39.5	35.2	23.9	24.8	21.5
	2	64.5	75.6	67.4	53.0	32.8	45.7
	3	14.4	9.8	8.9	9.0	8.6	9.2
1-6-90	4	8.1	74.4	83.2	74.1	84.9	86.8
28-6-90	5	69.1	56.6	54.4	55.2	56.7	44.6
1-8-90	6	53	88	120.9	93.3	83.1	79.2
2-9-90	7	40.8	93.2	92.6	125.2	93.3	111.9
28-9-90	8	30.4	48.9	43.6	48.0	52.0	37.6
		41.0	60.8	63.3	60.2	54.5	54.6
		SAR S_3 T_3					
12-1-90	1	48	39.5	35.2	23.9	24.8	21.5
31-3-90	2	38.5	53.2	94.5	120.0	95.7	30.0
24-4-90	3						
1-6-90	4	62.6	63.9	79.9	90.3	108.8	109.9
28-6-90	5	65.4	51.9	45.1	44.6	65.6	49.0
1-8-90	6	68.9	94.1	58.0	115.5	173.9	276.0
2-9-90	7	12.0	28.0	54.0	77.0	88.0	83.0
28-9-90	8	13.9	32.9	55.7	66.1	70.0	80.0
		44.2	51.9	60.3	76.8	89.5	99.9
		SAR S_4 T_4					
12-1-90	1	48	39.5	35.2	23.9	24.8	21.5
31-3-90	2	51.6	47.6	38.0	39.8	35.8	25.0
24-4-90	3	5.3	27.8	25.9	22.9	18.5	18.8
1-6-90	4						
28-6-90	5						
1-8-90	6	49.5	34.7	26.7	22.0	20.3	18.1
2-9-90	7	67.0	48.7	34.0	23.6	51.9	42.3
28-9-90	8	21.7	26.0	20.5	18.4	15.5	13.9
		40.5	37.4	30.1	25.1	27.8	23.3

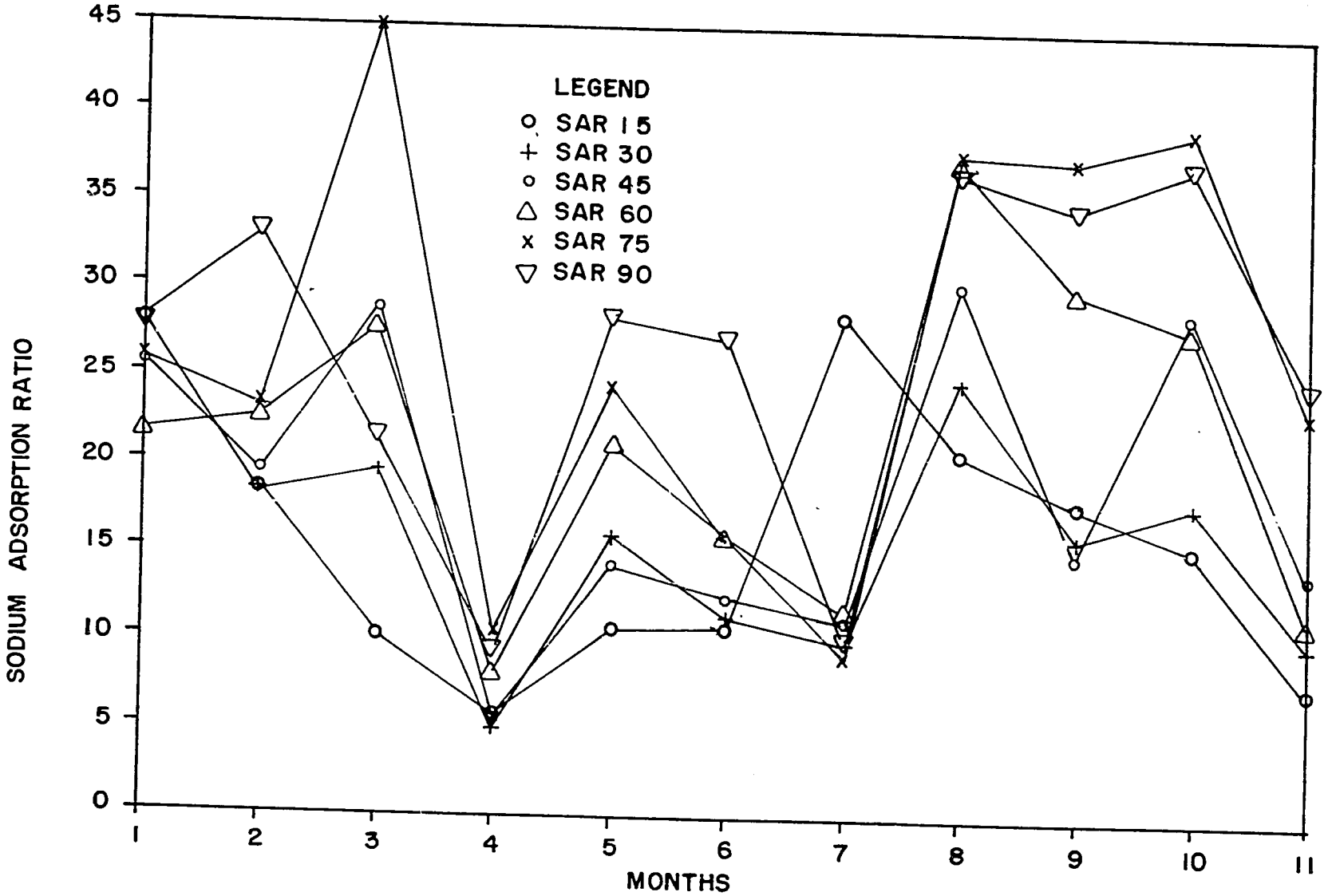

FIG. 4·14 MEASURED SAR AT SITE Ist. TREATMENT Ist

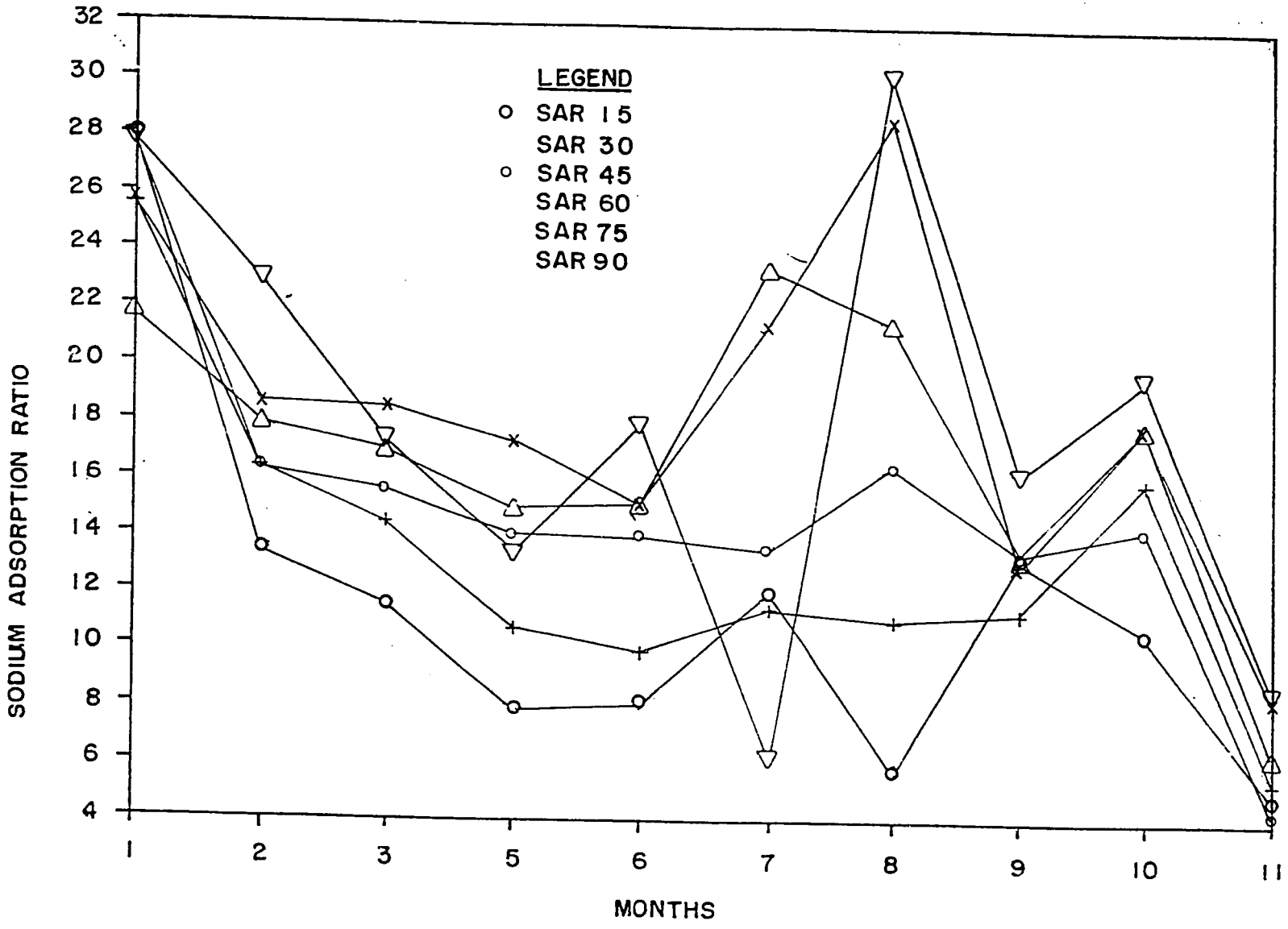

FIG. 4·15 MEASURED SAR AT SITE 1st. TREATMENT 2nd

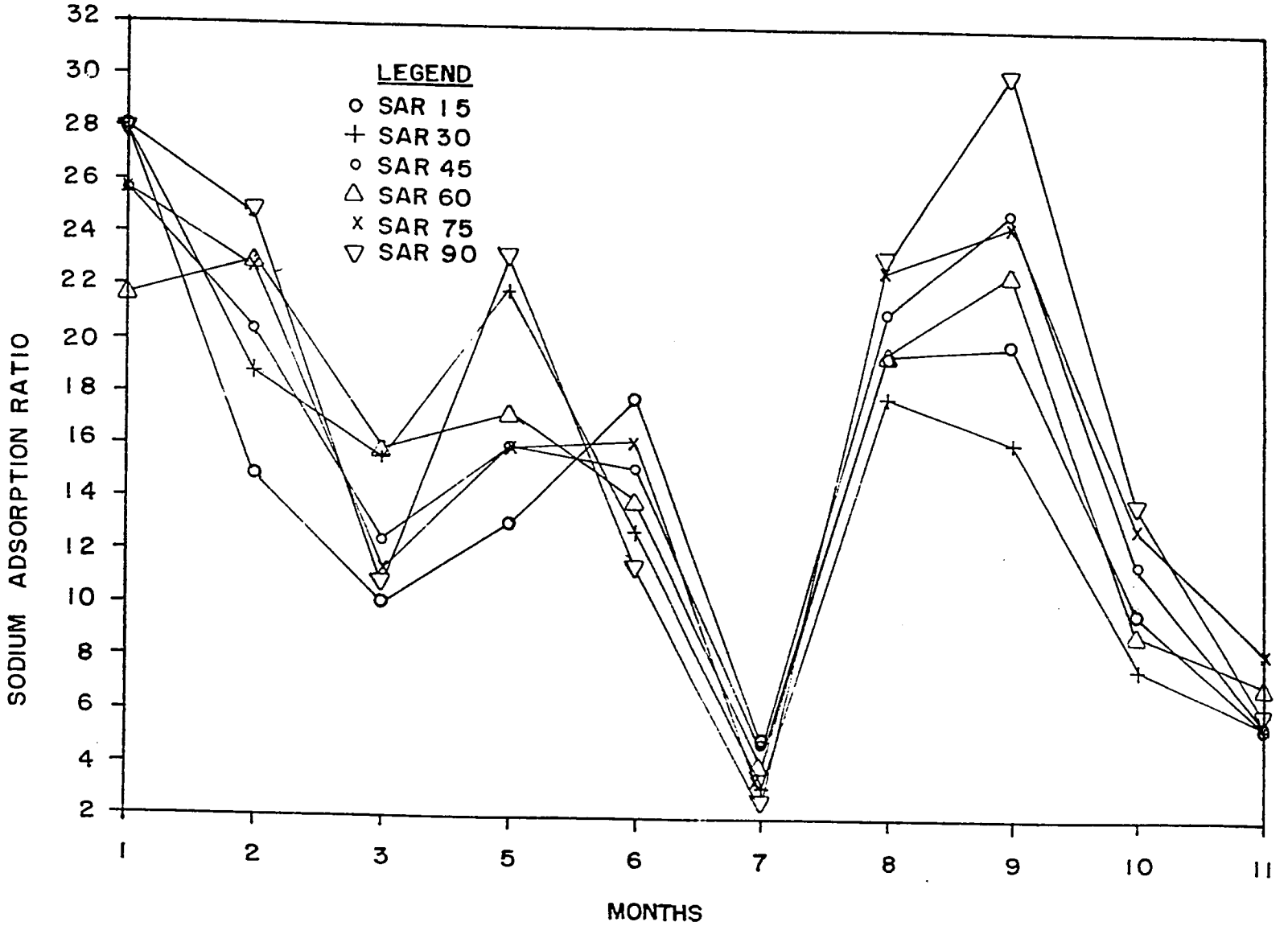

FIG. 4·16 MEASRED SAR AT SITE 1st. TREATMENT 3rd

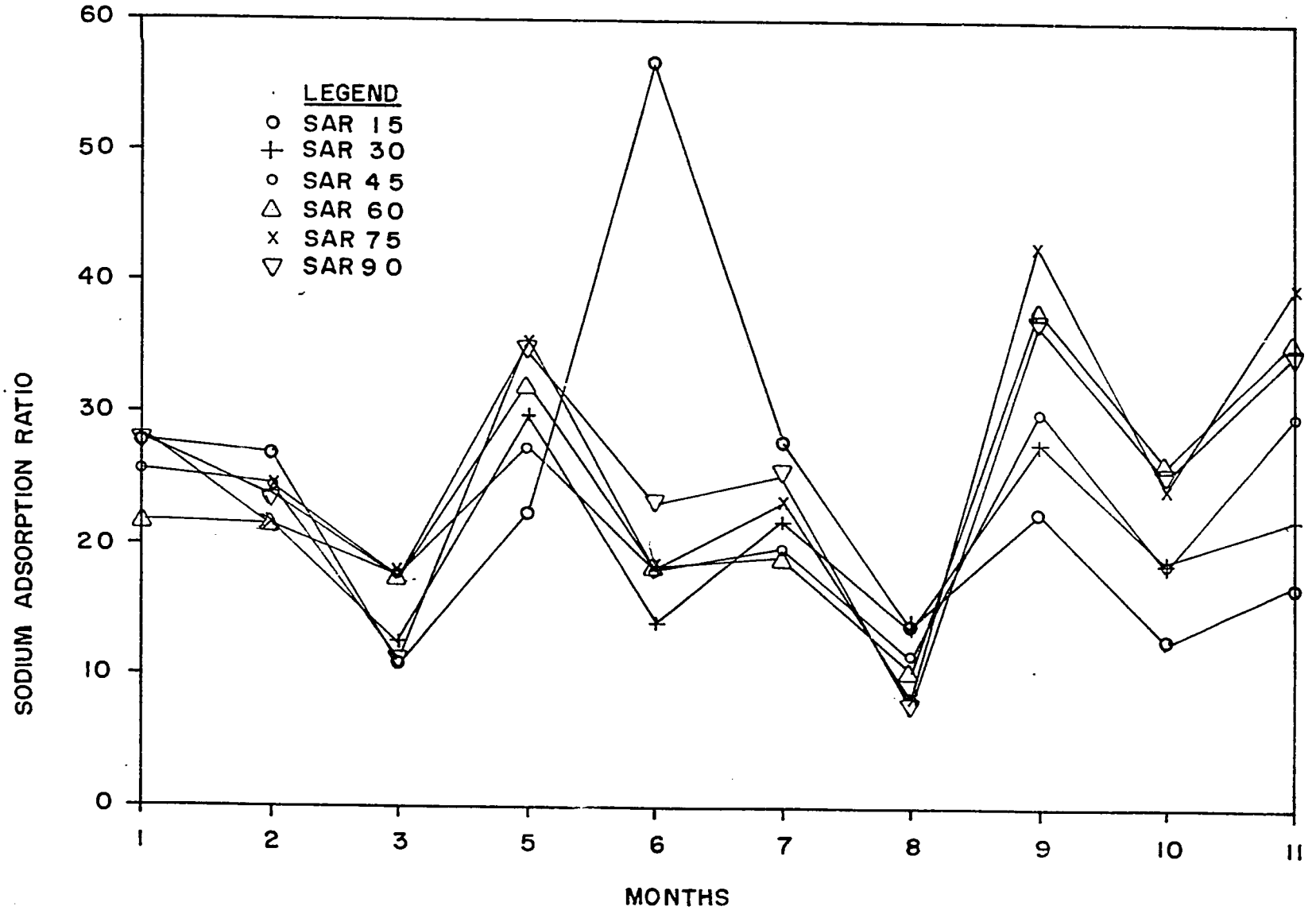

FIG. 4·17 MEASURED SAR AT SITE Ist. TREATMENT 4th

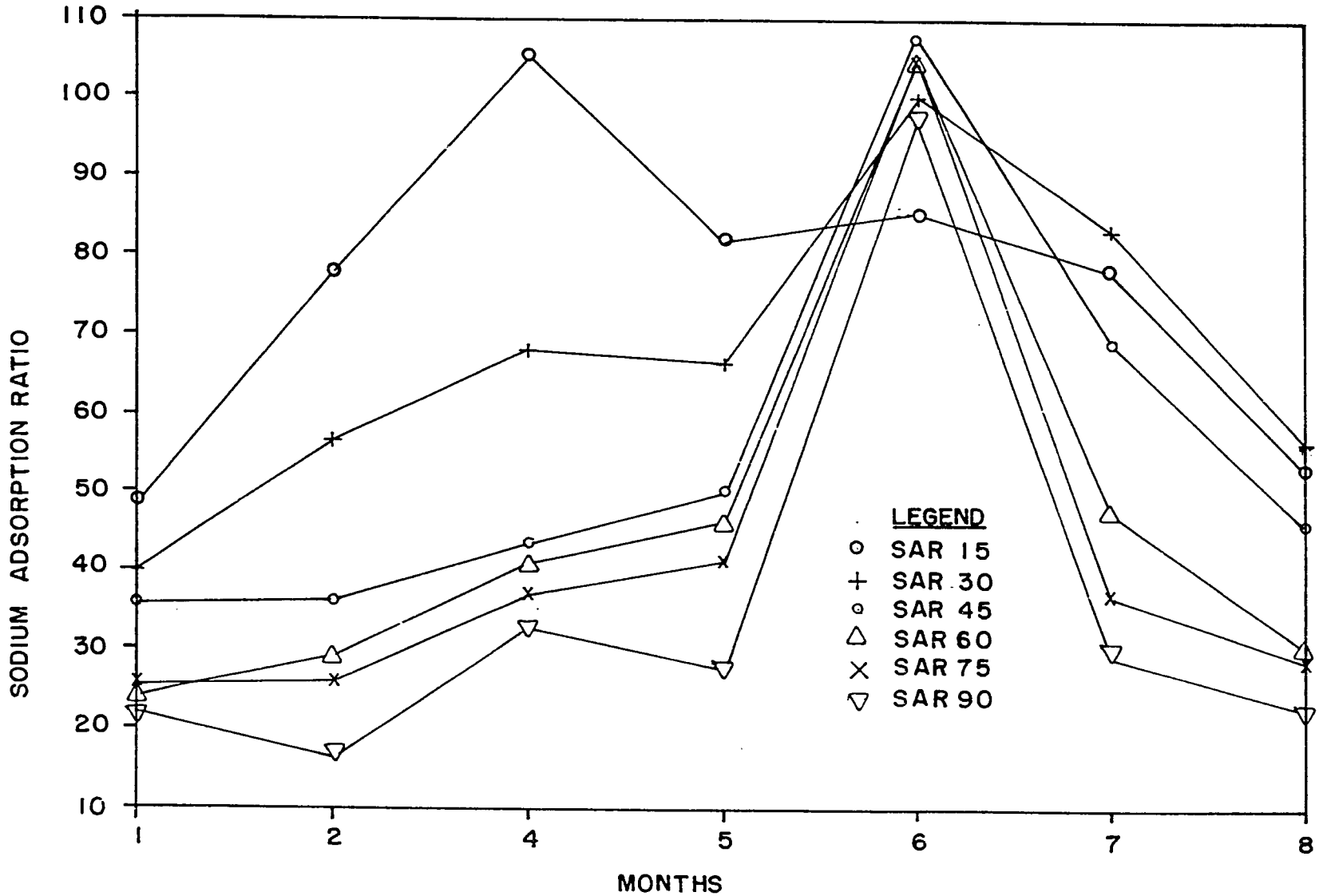

FIG. 4·18 MEASURED SAR AT SITE 2nd TREATMENT 1st.

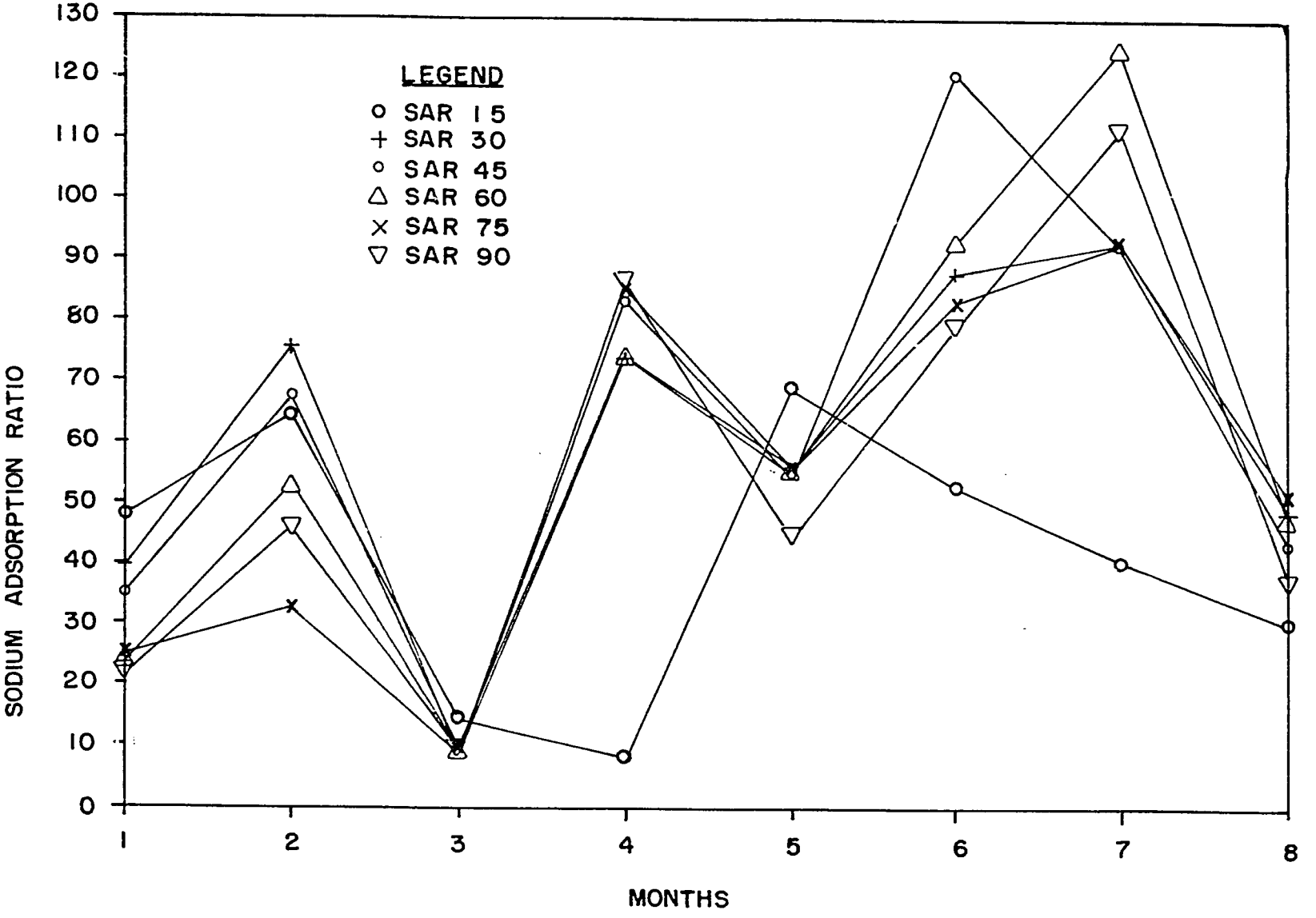

FIG. 4·19 MEASURED SAR AT SITE 2nd TREATMENT 2nd.

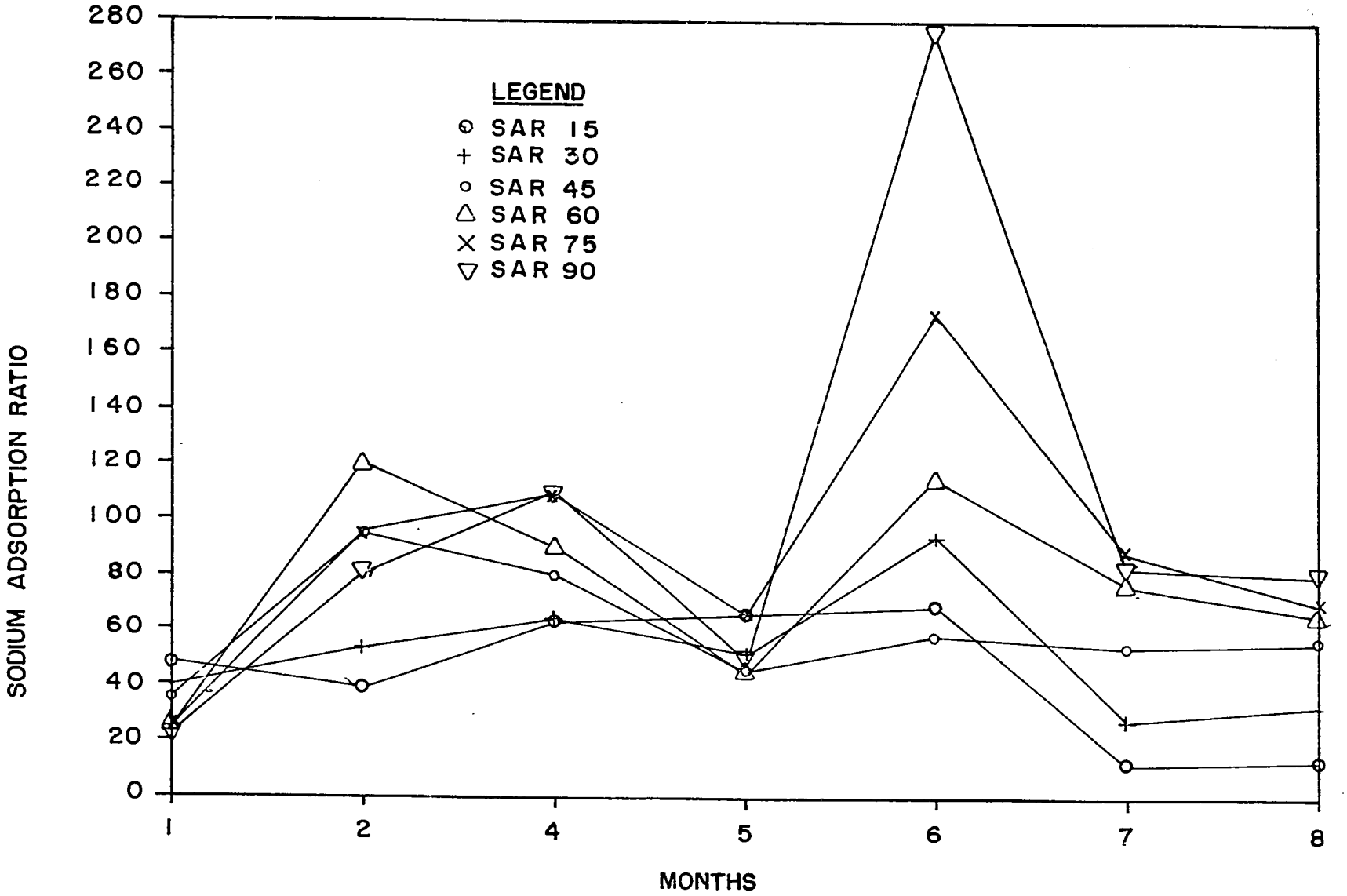

FIG. 4·20 MEASURED SAR AT SITE 2nd. TREATMENT 3rd

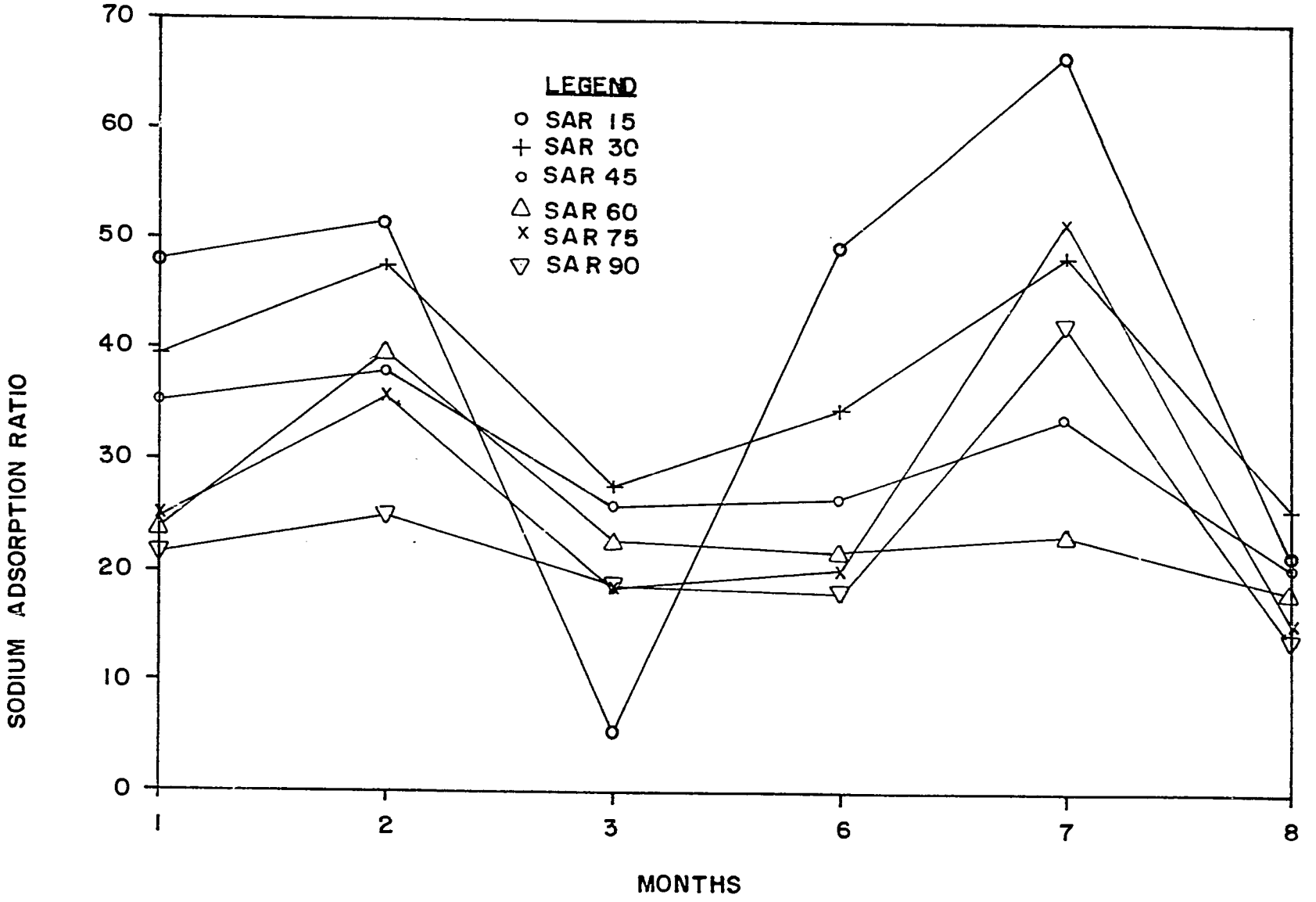

FIG. 4·21 MEASURED SAR AT SITE 2nd. TREATMENT 4th.

The results of the soil SAR at the end of the experiment at site 2. (Table 4.18 and Figs. 4.18, 4.19, 4.20, 4.21) show that under light irrigation (Fig. E) SAR increased significantly and the effect was more at 0-15 cm and 15-30 cm soil depths. With medium and heavy irrigation (Fig. 4.18, 4.20) SAR only slightly decreased at 0-15 cm and at all other depth it increased significantly. With farmer's method of irrigation, (Fig. 4.21) the SAR decreased slightly at 0-15 cm, 15-30 cm and 30-45 cm where it increased slightly at lower soil depths.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The water quality data of SCARP-I was analysed by WAPDA, Irrigation and FAO standards using individual water quality parameters as well as all of them taken together. The results show that there is deteriorating trend of water quality regardless of the standards used and the change in the RSC of the water is significant as compared to the EC and SAR (Figs. 4.1, 4.2, 4.3). When the data were analysed on the basis of all the three water quality parameters, the percentages of useable and marginal tubewells have reduced considerably and there is corresponding increase in the hazardous tubewells (Figs. 4.4, 4.4a).

The effect of different amount of irrigation water on soil salinity build up on nonsaline soil (Site No.1) and saline soil (Site No.2) showed that light irrigation decreased soil salinity at upper depth (0-15 cm) only whereas heavy irrigation significantly decrease soil salinity at the lower depths also. The farmer's method of irrigation decrease salinity upto 45 cm depth. The results also showed that if the soil is left fallow during summer, the salts move up to the surface quickly.

The effect of different amounts of irrigation water on soil SAR indicated that light irrigation decrease

the SAR significantly upto 45 cm. The medium and heavy irrigation decreased soil SAR at all the depths with more effect on the surface layers (0-30 cms).

Results for the root zone salinity prediction model look satisfactory with present limited data. However, more long time investigations are needed to further verify the model.

RECOMMENDATIONS

Based on the results of the study following it is recommendations are made:

1. Water quality in any project area should be evaluated on the basis of all the three water quality parameters. This will help in avoiding any risk of using unfit irrigation water.

2. Inorder to know the true picture of change in water quality in a project area, the same water quality standard should be used which was adopted for the initial evaluation. Mixing of various standards will give erroneous results.

3. The existing water quality standards given by various agencies should be used as a guidelines and there standards should be thoroughly evaluated on different soil types in different agro-climatic regions.

4. Medium irrigation with saline water should be applied on nonsaline soils, however heavy irrigations of saline water are required for saline soils. to leach salts below the root zone.

5. Limited field experimental work is not enough for developing and calibrating any computer model. Long time study should be undertaken to predict complex interactions of plant, soil and salts added by irrigation water.

REFERENCES

1. Ahmed, C. N. and Ahmed, N. 1987. Increased crop production through conjunctive use of surface and groundwater. Proc. of International Symposium on Conjunctive Use of Surface and Groundwater for Agric., Vol.II, CEWRE Pub. 57, Centre of Excellence in Water Resources Engineering. Lahore, p: 429-454.

2. Ahmad, N., and Chaudhry, G. R., 1990. Summaries of Irrigated Agriculture of Pakistan, 61-B/2 Gulberg-3, Lahore.

3. Ayers, R. S. and Westcot, D. W. 1985. Water quality for Agriculture, FAO Paper No. 29, Rev. 1. Rome, Itly.

4. Baig, A. 1989. Trend and causes of change of groundwater quality in SCARP-I. An M.Phil thesis, CEWRE, Lahore.

5. Bokhari, S.M.H. 1979. Case study on the demand/supply [illegible]onship for the Indus River Basin. Water Supply [illegible]anagement Journal, 3: 77-115.

6. Bokhari, S. M.H. 1980. Case study on waterlogging and salinity problems in Pakistan. Water Supply and Management Journal, 4: 171-192.

7. Bower, C.A., Ogata, G. and Tucker, J.M. 1969. Rootzone salt profiles and alfalfa growth as influenced by irrigation water salinity and leaching fraction. Agronomy Journal Vol.61, Page 783-785.

8. Clarke, F.E., and Barnes, I. 1969. Evaluation and control of corrosion and encrustation in tubewells of the Indus Plain, West Pakistan, U.S. Geological Survey, Water Supply Paper No. 1608-L.

9. Clyma, W., Kemper, W. D., and Ashraf, M. 1981. Reducing farm delivery losses in Pakistan. Trans. ASAE, 24 (2): 367-374.

10. Dowdy, S. and Wearden, S. 1983. Statistics for Research, John Wiley & Sons, New York.

11. Greenman, D. W., Swarzenski, W. V. and Bennet, G. D., 1967. Groundwater hydrology of the Punjab, West Pakistan with emphasis on problem caused by canal irrigation. U.S. Geological Survey Water Supply Paper No. 1608-H.

12. Haider, G. and Farooqi, M.A.R. 1975. Effect of tubewell water of different qualities on soil under the existing on farm management practices. Proceedings of the

International Conference on Waterlogging and Salinity, Lahore, pp. 237-248.

13. Hameed, A., Randawa, M.S. and Gowans, K.D. 1960. Appraisal of quality of tubewell waters of SCARP-I, WAPDA, Lahore.

14. Hussain, G., Rana, M.G. and Nur-ud-Din. 1971. Soil Monitoring Studies in SCARP-I. WASID Publication No. 106.

15. Johnson, S. H. III, Early, A.C., and Lowdermilk, M. K. 1977. Water problems in the Indus Food Machine. Water Resources Bulletin, 13(6):1253-1268.

16. Johnson, S. H. III, 1982. Large scale irrigation and drainage systems in Pakistan: a case study of rigidities in public decision making. Food Research Institute Studies, XVIII (2): 149-180.

17. Latif, M. and Willardson, L. S. 1990. Modelling salt profile distribution for dynamic conjunctive use irrigation. Proceedings of the 14th Congress on Irrigation and Drainage held in Brazil, Vol.1-B, Page 647-662.

18. Malmberg, G.T., 1975. Reclamation by tubewell drainage in Rechna Doab and adjacent areas, Punjab region, Pakistan. U.S. Geological Survey Water Supply Paper No. 1608-I.

19. Ministry of Food and Agriculture and Cooperatives, 1984. Pakistan's On-Farm Water Management Program. Water Management Wing, Islamabad.

20. Mundroff, M.J. Benett, G.D., and Ahmed M., 1972. Electrical analog studies of flow to wells in the Punjab aquifer of West Pakistan. U.S. Geological Survey Water Supply Paper No. 1608-N.

21. Mundroff, M. J. Carrigan, P. H. Jr., Steele, T. D., and Randall, A. D. 1976. Hydrologic evaluation of SCARP Projects in the Indus Plain, Pakistan: a summary. U.S. Geological Survey Paper No. 1608-Q.

22. Peterson, D. F. 1986. Past 1987 strategy for irrigation USAID/Pakistan, Water Management Synthesis II, Report 45, Utah State University, Logan, Utah, U.S.A.

23. Qayyum, M.A. 1970. Tubewell quality in relation to crop and soil management in SCARP-I.

24. Qayyum, M.A. and Sabir, F. 1975. Criteria for irrigation water quality. Proceedings CENTO Scientific Programme:

The Optimum use of Water in Agriculture, Faisalabad. pp: 70-86.

25. Report of Agricultural Water Management sub-Committee. 1987. Farm Water Management options for drainage reduction. San Joaquin Valley Drainage Programme, California.

26. Sheikh, I.A. 1989. Country report on problem of waterlogging and salinity in Pakistan. Information Seminar on Waterlogging and Salinity Research in some Major Problem Countries, Lahore.

27. M/S. Tipton and Kalmbach. 1963. Feasibility report of SCARP-III, WAPDA, Lahore.

28. Water Management Synthesis II Project 1985. Command water management Punjab, Pre-rehabilitation diagnostic analysis of the Niazbeg sub project. WMS Report 52, Colorado State University, U.S.A.

29. Water and Power Development Authority (WAPDA), Master Planning Division. 1979. Revised action programme for irrigated agriculture (3 Vols.), Lahore

30. Water and Power Development Authority (WAPDA). 1979. Changes in the chemical quality of groundwater in SCARP-I. C.M.O. Publication No. 77.

31. White House, Department of the Interior, Panel on Waterlogging and Salinity in West Pakistan. 1964. Report on land and water development in the Indus Plain.

APPENDIXES

Appendix-I

Computer Programme for Water Quality Classification Based on EC, RSC and SAR. 109-115

Appendix-II

Sample Output of Water Quality Programme for Single Parameter using WAPDA Standards for Shahkot Scheme. 116-221

```
C       PROGRAM TO SORT DATA USING FIRST & LAST VALUES FOR EACH TUBEWELL
C       BASED ON SINGLE PARAMETER AND IT ALSO GIVES COMMULATIVE RESULTS.

        CHARACTER TW*5,DATE*5,TITLE1*80,INFILE*12
        INTEGER EC,USEEC,USERSC,USESAR,HAZEC,HAZRSC,HAZSAR,
       .TUSEEC,TMAREC,THAZEC,TUSSAR,TMASAR,THASAR,TUSRSC,TMARSC,THARSC
        DIMENSION DATE(30),EC(30),RSC(30),SAR(30)
        WRITE(*,1)
1       FORMAT(/5X,'INPUT FILE NAME ===> ',$)
        READ(*,2)INFILE
2       FORMAT(A)
        OPEN(UNIT = 2, FILE = INFILE, STATUS = 'OLD')
        WRITE(*,3)
3       FORMAT(5X,'NUMBER OF TUBEWELLS TO BE CHECKED ===> ',$)
        READ(*,*)NG
        READ(2,10)TITLE1
10      FORMAT(A//)
        WRITE(*,11)TITLE1
11      FORMAT(/10X,A)
        WRITE(*,12)
12      FORMAT(/10X,'SORTING OF DATA --- BASED ON SINGLE PARAMETER'
       +' (WAPDA STANDARDS)'/)
        TUSEEC = 0
        TMAREC = 0
        THAZEC = 0
        TUSSAR = 0
        TMASAR = 0
        THASAR = 0
        TUSRSC = 0
        TMARSC = 0
        THARSC = 0
        DO 80 K = 1,NG
        USEEC = 0
        USESAR = 0
        USERSC = 0
        MAREC = 0
        MARSAR = 0
        MARRSC = 0
        HAZEC = 0
        HAZSAR = 0
        HAZRSC = 0
        INC = 0
        READ(2,4)TW,NGR
4       FORMAT(A,I3)
        WRITE(*,6)TW,NGR
6       FORMAT(/21X,'TUBEWELL NO. ',A,' ( NO. OF OBSERVATIONS ',I3,' )'/)
        WRITE(*,7)
7       FORMAT(21X,'DATE',14X,'EC',13X,'RSC',13X,'SAR')
        INC=INC+NGR-1
        READ(2,20)(DATE(I),EC(I),RSC(I),SAR(I),I=1,NGR)
20      FORMAT(7X,A,4X,I4,3X,F5.2,1X,F5.2)
        DO 70 I = 1,NGR,INC
        WRITE(*,30)DATE(I),EC(I),RSC(I),SAR(I)
30      FORMAT(20X,A,10X,I6,10X,F6.2,10X,F6.1)
        IF (EC(I).LE.1500) THEN
        USEEC = USEEC + 1
```

```
      ELSE IF (EC(I).GT.1500.AND.EC(I).LE.2700) THEN
      MAREC = MAREC + 1
      ELSE IF (EC(I).GT.2700) THEN
      HAZEC = HAZEC + 1
      ENDIF

      IF(RSC(I).LE.2.5) THEN
      USERSC = USERSC + 1
      ELSE IF(RSC(I).GT.2.5.AND.RSC(I).LE.5.0) THEN
      MARRSC = MARRSC + 1
      ELSE IF(RSC(I).GT.5.0) THEN
      HAZRSC = HAZRSC + 1
      ENDIF

      IF(SAR(I).LE.10.0) THEN
      USESAR = USESAR + 1
      ELSE IF (SAR(I).GT.10.0.AND.SAR(I).LE.18.0) THEN
      MARSAR = MARSAR + 1
      ELSE IF(SAR(I).GT.18.0) THEN
      HAZSAR = HAZSAR + 1
      ENDIF

70    CONTINUE
      TUSEEC = TUSEEC+USEEC
      TMAREC = TMAREC+MAREC
      THAZEC = THAZEC+HAZEC
      TUSSAR = TUSSAR+USESAR
      TMASAR = TMASAR+MARSAR
      THASAR = THASAR+HAZSAR
      TUSRSC = TUSRSC+USERSC
      TMARSC = TMARSC+MARRSC
      THARSC = THARSC+HAZRSC
      WRITE(*,40) USEEC,USERSC,USESAR
40    FORMAT(/36X,'USEEC',10X,'USERSC',10X,'USESAR'/25X,3(10X,I6))
      WRITE(*,50) MAREC,MARRSC,MARSAR
50    FORMAT(/36X,'MAREC',10X,'MARRSC',10X,'MARSAR'/25X,3(10X,I6))
      WRITE(*,60) HAZEC,HAZRSC,HAZSAR
60    FORMAT(/36X,'HAZEC',10X,'HAZRSC',10X,'HAZSAR'/25X,3(10X,I6)/)
80    CONTINUE
      WRITE(*,81)
81    FORMAT(/20X,'[SUMMARY OF RESULTS --- BASED ON SINGLE PARAMETER]')
      WRITE(*,85)
85    FORMAT(20X,54('-'))
      WRITE(*,90)TUSEEC,TMAREC,THAZEC
90    FORMAT(/20X,'TOTAL ==>',7X,'USEEC',11X,'MAREC',11X,'HAZEC'//
     .       25X,3(10X,I6))
      WRITE(*,100)TUSRSC,TMARSC,THARSC
100   FORMAT(/20X,'TOTAL ==>',6X,'USERSC',10X,'MARRSC',10X,'HAZRSC'//
     .       25X,3(10X,I6))
      WRITE(*,110)TUSSAR,TMASAR,THASAR
110   FORMAT(/20X,'TOTAL ==>',6X,'USESAR',10X,'MARSAR',10X,'HAZSAR'//
     .       25X,3(10X,I6)/)
      WRITE(*,85)
      WRITE(*,*)'
      STOP
      END
```

```
C       PROGRAM TO SORT DATA USING FIRST & LAST VALUES FOR EACH TUBEWELL -
C       BASED ON SINGLE PARAMETER IT ALSO GIVES SEPARATE RESULTS ALONGWITH
C       PERCENTAGE.

        CHARACTER TW*5,DATE*5,TITLE1*80,INFILE*12
        INTEGER EC,
       +CUSEEC,CMAREC,CHAZEC,CUSSAR,CMASAR,CHASAR,CUSRSC,CMARSC,CHARSC
        DIMENSION DATE(30),EC(30),SAR(30),RSC(30)
        WRITE(*,1)
1       FORMAT(/1X,'INPUT FILE NAME ===> ',$)
        READ(*,2)INFILE
2       FORMAT(A)
        OPEN(UNIT = 2, FILE = INFILE, STATUS = 'OLD')
        WRITE(*,3)
3       FORMAT(1X,'NUMBER OF TUBEWELLS TO BE CHECKED ===> ',$)
        READ(*,*)NG
        READ(2,10)TITLE1
10      FORMAT(A//)
        WRITE(*,11)TITLE1
11      FORMAT(/12X,A)

        ITUSEEC = 0
        ITMAREC = 0
        ITHAZEC = 0
        ITUSRSC = 0
        ITMARSC = 0
        ITHARSC = 0
        ITUSSAR = 0
        ITMASAR = 0
        ITHASAR = 0

        LTUSEEC = 0
        LTMAREC = 0
        LTHAZEC = 0
        LTUSRSC = 0
        LTMARSC = 0
        LTHARSC = 0
        LTUSSAR = 0
        LTMASAR = 0
        LTHASAR = 0

        ITOTEC = 0
        ITOTRS = 0
        ITOTSA = 0
        LTOTEC = 0
        LTOTRS = 0
        LTOTSA = 0

        PIUEC = 0.
        PIMEC = 0.
        PIHEC = 0.
        PIURSC = 0.
        PIMRSC = 0.
        PIHRSC = 0.
        PIUSAR = 0.
        PIMSAR = 0.
```

```
      PIHSAR = 0.
      PLUEC = 0.
      PLMEC = 0.
      PLHEC = 0.
      PLURSC = 0.
      PLMRSC = 0.
      PLHRSC = 0.
      PLUSAR = 0.
      PLMSAR = 0.
      PLHSAR = 0.

      DO 80 K = 1,NG
      IUSEEC = 0
      IUSRSC = 0
      IUSSAR = 0
      IMAREC = 0
      IMARSC = 0
      IMASAR = 0
      IHAZEC = 0
      IHARSC = 0
      IHASAR = 0

      LUSEEC = 0
      LMAREC = 0
      LHAZEC = 0
      LUSRSC = 0
      LMARSC = 0
      LHARSC = 0
      LUSSAR = 0
      LMASAR = 0
      LHASAR = 0

      CUSEEC = 0
      CMAREC = 0
      CHAZEC = 0
      CUSRSC = 0
      CMARSC = 0
      CHARSC = 0
      CUSSAR = 0
      CMASAR = 0
      CHASAR = 0

      INC = 0

      READ(2,4)TW,NGR
4     FORMAT(A,I3)
C      WRITE(*,6)TW,NGR
6     FORMAT(//21X,'TUBEWELL NO. ',A,' ( NO. OF OBSERVATIONS ',I3,' )'/)
C      WRITE(*,7)
7     FORMAT(/21X,'DATE',14X,'EC',13X,'SAR',13X,'RSC')
      INC=INC+NGR-1
      READ(2,20)(DATE(I),EC(I),RSC(I),SAR(I),I=1,NGR)
20    FORMAT(7X,A,4X,I4,3X,F5.2,1X,F5.2)
      DO 70 I = 1,NGR,INC
      IF(I.GT.1)GO TO 25
C      WRITE(*,30)DATE(I),EC(I),RSC(I),SAR(I)
```

```
30    FORMAT(/20X,A,10X,I6,10X,F6.2,10X,F6.2)
      IF (EC(I).LE.1500) THEN
      IUSEEC = IUSEEC + 1
      ELSE IF (EC(I).GT.1500.AND.EC(I).LE.2700) THEN
      IMAREC = IMAREC + 1
      ELSE
      IHAZEC = IHAZEC + 1
      ENDIF

      IF(RSC(I).LE.2.5) THEN
      IUSRSC = IUSRSC + 1
      ELSE IF (RSC(I).GT.2.5.AND.RSC(I).LE.5.0) THEN
      IMARSC = IMARSC + 1
      ELSE
      IHARSC = IHARSC + 1
      ENDIF

      IF(SAR(I).LE.10.0) THEN
      IUSSAR = IUSSAR + 1
      ELSE IF(SAR(I).GT.10.0.AND.SAR(I).LE.18.0) THEN
      IMASAR = IMASAR + 1
      ELSE
      IHASAR = IHASAR + 1
      ENDIF

      IF(NGR.EQ.1) GO TO 71
      GO TO 70
25     WRITE(*,30)DATE(I),EC(I),RSC(I),SAR(I)
5     IF (EC(I).LE.1500) THEN
      LUSEEC = LUSEEC + 1
      ELSE IF (EC(I).GT.1500.AND.EC(I).LE.2700) THEN
      LMAREC = LMAREC + 1
      ELSE
      LHAZEC = LHAZEC + 1
      ENDIF

      IF(RSC(I).LE.2.5) THEN
      LUSRSC = LUSRSC + 1
      ELSE IF (RSC(I).GT.2.5.AND.RSC(I).LE.5.0) THEN
      LMARSC = LMARSC + 1
      ELSE
      LHARSC = LHARSC + 1
      ENDIF

      IF(SAR(I).LE.10.0) THEN
      LUSSAR = LUSSAR + 1
      ELSE IF(SAR(I).GT.10.0.AND.SAR(I).LE.18.0) THEN
      LMASAR = LMASAR + 1
      ELSE
      LHASAR = LHASAR + 1
      ENDIF

0     CONTINUE

1     CUSEEC = CUSEEC+IUSEEC+LUSEEC
      CMAREC = CMAREC+IMAREC+LMAREC
```

```
      CHAZEC = CHAZEC+IHAZEC+LHAZEC
      CUSRSC = CUSRSC+IUSRSC+LUSRSC
      CMARSC = CMARSC+IMARSC+LMARSC
      CHARSC = CHARSC+IHARSC+LHARSC
      CUSSAR = CUSSAR+IUSSAR+LUSSAR
      CMASAR = CMASAR+IMASAR+LMASAR
      CHASAR = CHASAR+IHASAR+LHASAR

      ITUSEEC = ITUSEEC+IUSEEC
      ITMAREC = ITMAREC+IMAREC
      ITHAZEC = ITHAZEC+IHAZEC
      ITUSRSC = ITUSRSC+IUSRSC
      ITMARSC = ITMARSC+IMARSC
      ITHARSC = ITHARSC+IHARSC
      ITUSSAR = ITUSSAR+IUSSAR
      ITMASAR = ITMASAR+IMASAR
      ITHASAR = ITHASAR+IHASAR

      LTUSEEC = LTUSEEC+LUSEEC
      LTMAREC = LTMAREC+LMAREC
      LTHAZEC = LTHAZEC+LHAZEC
      LTUSRSC = LTUSRSC+LUSRSC
      LTMARSC = LTMARSC+LMARSC
      LTHARSC = LTHARSC+LHARSC
      LTUSSAR = LTUSSAR+LUSSAR
      LTMASAR = LTMASAR+LMASAR
      LTHASAR = LTHASAR+LHASAR

C      WRITE(*,40) CUSEEC,CUSRSC,CUSSAR
40    FORMAT(//36X,'USEEC',10X,'USERSC',10X,'USESAR'//25X,3(10X,I6))
C      WRITE(*,50) CMAREC,CMARSC,CMASAR
50    FORMAT(//36X,'MAREC',10X,'MARRSC',10X,'MARSAR'//25X,3(10X,I6))
C      WRITE(*,60) CHAZEC,CHARSC,CHASAR
60    FORMAT(//36X,'HAZEC',10X,'HAZRSC',10X,'HAZSAR'//25X,3(10X,I6)/)
80    CONTINUE
      ITOTEC = ITOTEC+ITUSEEC+ITMAREC+ITHAZEC
      ITOTRS = ITOTRS+ITUSRSC+ITMARSC+ITHARSC
      ITOTSA = ITOTSA+ITUSSAR+ITMASAR+ITHASAR
      LTOTEC = LTOTEC+LTUSEEC+LTMAREC+LTHAZEC
      LTOTRS = LTOTRS+LTUSRSC+LTMARSC+LTHARSC
      LTOTSA = LTOTSA+LTUSSAR+LTMASAR+LTHASAR

      PIUEC = ITUSEEC*100/FLOAT(NG)
      PIMEC = ITMAREC*100/FLOAT(NG)
      PIHEC = ITHAZEC*100/FLOAT(NG)
      PIURSC = ITUSRSC*100/FLOAT(NG)
      PIMRSC = ITMARSC*100/FLOAT(NG)
      PIHRSC = ITHARSC*100/FLOAT(NG)
      PIUSAR = ITUSSAR*100/FLOAT(NG)
      PIMSAR = ITMASAR*100/FLOAT(NG)
      PIHSAR = ITHASAR*100/FLOAT(NG)
      PLUEC = LTUSEEC*100/FLOAT(NG)
      PLMEC = LTMAREC*100/FLOAT(NG)
      PLHEC = LTHAZEC*100/FLOAT(NG)
      PLURSC = LTUSRSC*100/FLOAT(NG)
      PLMRSC = LTMARSC*100/FLOAT(NG)
```

```
      PLHRSC = LTHARSC*100/FLOAT(NG)
      PLUSAR = LTUSSAR*100/FLOAT(NG)
      PLMSAR = LTMASAR*100/FLOAT(NG)
      PLHSAR = LTHASAR*100/FLOAT(NG)

      WRITE(*,85)
85    FORMAT(/7X,'[SUMMARY OF RESULTS BASED ON SINGLE PARAMETER'
     +' - WAPDA STANDARDS]')
      WRITE(*,105)
      WRITE(*,90)ITUSEEC,PIUEC,ITUSRSC,PIURSC,ITUSSAR,PIUSAR
90    FORMAT(/1X,'TOTAL (BEGINING) ==>',4X,'USEEC',14X,'USERSC',14X,
     + 'USESAR'//24X,3(I6,1X,'(',F5.1,'%)',5X))
      WRITE(*,100)ITMAREC,PIMEC,ITMARSC,PIMRSC,ITMASAR,PIMSAR
100   FORMAT(//1X,'TOTAL (BEGINING) ==>',4X,'MAREC',14X,'MARRSC',14X,
     + 'MARSAR'//24X,3(I6,1X,'(',F5.1,'%)',5X))
      WRITE(*,110)ITHAZEC,PIHEC,ITHARSC,PIHRSC,ITHASAR,PIHSAR
110   FORMAT(//1X,'TOTAL (BEGINING) ==>',4X,'HAZEC',14X,'HAZRSC',14X,
     + 'HAZSAR'//24X,3(I6,1X,'(',F5.1,'%)',5X))
      WRITE(*,103) ITOTEC,ITOTRS,ITOTSA
103   FORMAT(/25X,'-----',14X,'------',14X,'------'//
     +1X,'GRAND TOTAL ==>',8X,I6,2(14X,I6))
      WRITE(*,105)
105   FORMAT(/1X,78('-'))
      WRITE(*,120)LTUSEEC,PLUEC,LTUSRSC,PLURSC,LTUSSAR,PLUSAR
120   FORMAT(/1X,'TOTAL (ENDING) ==>',6X,'USEEC',14X,'USERSC',14X,
     + 'USESAR'//24X,3(I6,1X,'(',F5.1,'%)',5X))
      WRITE(*,130)LTMAREC,PLMEC,LTMARSC,PLMRSC,LTMASAR,PLMSAR
130   FORMAT(//1X,'TOTAL (ENDING) ==>',6X,'MAREC',14X,'MARRSC',14X,
     + 'MARSAR'//24X,3(I6,1X,'(',F5.1,'%)',5X))
      WRITE(*,140)LTHAZEC,PLHEC,LTHARSC,PLHRSC,LTHASAR,PLHSAR
140   FORMAT(//1X,'TOTAL (ENDING) ==>',6X,'HAZEC',14X,'HAZRSC',14X,
     + 'HAZSAR'//24X,3(I6,1X,'(',F5.1,'%)',5X))
      WRITE(*,103) LTOTEC,LTOTRS,LTOTSA
      WRITE(*,105)
      WRITE(*,*) '
      STOP
      END
```

MSD8

INPUT FILE NAME ===> SHAHK.DAT
NUMBER OF TUBEWELLS TO BE CHECKED ===> 366

DATA OF SHAHKOT SCHEME SCARP-1 (WATER QUALITY).

[SUMMARY OF RESULTS BASED ON SINGLE PARAMETER - WAPDA STANDARDS]

TOTAL (BEGINING) ==>	USEEC	USERSC	USESAR
	140 (38.3%)	62 (16.9%)	161 (44.0%
TOTAL (BEGINING) ==>	MAREC	MARRSC	MARSAR
	140 (38.3%)	88 (24.0%)	139 (38.0%
TOTAL (BEGINING) ==>	HAZEC	HAZRSC	HAZSAR
	86 (23.5%)	216 (59.0%)	66 (18.0%
	---	---	---
GRAND TOTAL ==>	366	366	366

TOTAL (ENDING) ==>	USEEC	USERSC	USESAR
	136 (37.2%)	38 (10.4%)	161 (44.0%)
TOTAL (ENDING) ==>	MAREC	MARRSC	MARSAR
	161 (44.0%)	77 (21.0%)	157 (42.9%)
TOTAL (ENDING) ==>	HAZEC	HAZRSC	HAZSAR
	69 (18.9%)	251 (68.6%)	48 (13.1%)
	---	---	---
GRAND TOTAL ==>	366	366	366

Stop - Program terminated.

CEWRE Sun 29-03-1992 13:40:27.79
C:\WQ>

SD2

INPUT FILE NAME ===> SHAHK.DAT
NUMBER OF TUBEWELLS TO BE CHECKED ===> 366

DATA OF SHAHKOT SCHEME SCARP-1 (WATER QUALITY).

SORTING OF DATA --- BASED ON SINGLE PARAMETER (WAPDA STANDARDS)

TUBEWELL NO. 3 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
10-62	880	.03	6.4
06-81	890	4.00	5.7

USEEC	USERSC	USESAR
2	1	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 4 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
08-60	820	2.11	7.5
07-85	940	3.40	4.4

USEEC	USERSC	USESAR
2	1	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 5 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
12-59	1050	2.43	5.7
06-81	870	4.10	5.7

USEEC	USERSC	USESAR
2	1	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 5A (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
08-60	825	3.28	6.0
05-85	1410	5.90	8.3

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 6 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
08-60	1090	3.80	7.7
06-85	990	4.20	5.1

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	2	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 7 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
08-62	1110	4.62	7.9
03-77	1060	4.01	6.8

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	2	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 7A (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
10-62	920	4.46	5.2
07-81	1000	4.40	5.6

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	2	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 8 (NO. OF OBSERVATIONS 17)

DATE	EC	RSC	SAR
08-60	1350	5.79	11.0
02-85	1390	4.90	6.7

USEEC	USERSC	USESAR
2	0	1
MAREC	MARRSC	MARSAR
0	1	1
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 8A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-62	1010	4.46	4.2
07-82	1280	5.30	7.1

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 9 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
08-60	1570	6.10	11.0
07-85	1620	6.45	11.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 10 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
08-60	2000	5.59	13.0
07-85	1420	6.40	9.2

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 11 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
02-62	1860	5.45	9.3
04-85	1420	7.65	11.0

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 11A (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
04-62	1010	4.72	7.7
11-82	1000	5.80	8.2

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 12 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
02-62	2180	9.17	13.0
02-85	1320	6.25	8.1

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 12A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
08-60	1900	8.09	15.0
07-85	1400	6.60	11.0

USEEC	USERSC	USESAR
1	0	0
MAREC	MARRSC	MARSAR
1	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 13 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
04-62	1400	5.27	9.6
07-85	1250	5.20	6.8

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 13A (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
08-60	1300	6.10	9.3
07-85	1480	5.00	7.9

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 14 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
08-60	900	4.04	7.7
03-85	1300	4.85	6.5

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	2	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 15 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
02-62	1330	5.23	5.1
07-85	1090	5.90	7.3

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 16 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
08-60	630	3.00	5.5
07-82	1450	6.50	9.2

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 16A (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
08-60	900	2.08	4.5
10-85	1000	5.70	7.3

USEEC	USERSC	USESAR
2	1	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 17 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
08-60	1820	11.30	15.0
07-85	1010	4.40	6.1

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	1	1
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 18 (NO. OF OBSERVATIONS 19)

DATE	EC	RSC	SAR
02-62	1100	2.95	5.3
07-85	1000	5.00	6.6

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	2	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 19 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	2000	13.46	17.0
03-85	1750	10.10	15.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 20 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
08-62	1390	7.14	11.0
05-85	1400	6.20	8.4

USEEC	USERSC	USESAR
2	0	1

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 20A (NO. OF OBSERVATIONS 18)

DATE	EC	RSC	SAR
12-59	630	.00	1.9
03-81	880	2.90	4.7

USEEC	USERSC	USESAR
2	1	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 21 (NO. OF OBSERVATIONS 3)

DATE	EC	RSC	SAR
11-62	1100	4.58	6.3
03-81	880	2.90	4.7

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	2	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 22 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
12-59	1420	6.81	11.0
03-85	1990	8.60	17.0

USEEC	USERSC	USESAR
1	0	0
MAREC	MARRSC	MARSAR
1	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 23 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
08-62	1510	7.38	11.0
07-85	1720	7.60	12.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 23A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-62	2000	5.28	13.0
12-85	1820	6.85	14.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 24 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
12-59	1490	3.66	7.7
07-85	1880	6.40	14.0

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	1	1
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 25 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
12-59	1540	3.70	10.0
03-85	1650	6.00	11.0

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
2	1	1

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 26 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
12-59	1250	3.77	7.1
07-85	1280	3.00	5.5

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	2	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 26A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	3000	2.89	16.0
03-85	2300	4.10	14.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	2	2

HAZEC	HAZRSC	HAZSAR
1	0	0

TUBEWELL NO. 27 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
02-62	1700	3.36	11.0
07-85	1520	4.40	8.7

USEEC	USERSC	USESAR
0	0	1
MAREC	MARRSC	MARSAR
2	2	1
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 27A (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	2000	1.97	10.0
11-85	2000	3.00	10.0

USEEC	USERSC	USESAR
0	1	2
MAREC	MARRSC	MARSAR
2	1	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 28 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
10-62	1600	4.54	8.7
07-85	1700	5.50	12.0

USEEC	USERSC	USESAR
0	0	1
MAREC	MARRSC	MARSAR
2	1	1
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 28A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-62	1900	6.54	14.0
03-81	1580	6.00	12.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 29 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
08-62	3780	3.84	22.0
11-81	1870	5.70	12.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	1	1

HAZEC	HAZRSC	HAZSAR
1	1	1

TUBEWELL NO. 29A (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
03-72	1590	3.37	10.0
05-85	1830	5.70	13.0

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
2	1	1

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 30 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	2480	6.98	17.0
03-81	2100	4.88	12.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	1	2

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 31 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	2800	2.88	14.0
07-85	2270	4.90	13.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	2	2
HAZEC	HAZRSC	HAZSAR
1	0	0

TUBEWELL NO. 31A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	2210	5.27	12.0
07-85	2120	7.90	15.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 32 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
10-62	2400	2.34	12.0
03-85	2320	5.00	14.0

USEEC	USERSC	USESAR
0	1	0
MAREC	MARRSC	MARSAR
2	1	2
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 32A (NO. OF OBSERVATIONS 17)

DATE	EC	RSC	SAR
10-62	2440	2.80	12.0
03-85	2390	3.50	12.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	2	2
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 33 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
02-62	2580	3.69	14.0
03-85	2200	5.40	13.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	1	2

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 34 (NO. OF OBSERVATIONS 17)

DATE	EC	RSC	SAR
03-60	3160	7.17	17.0
03-85	2150	4.60	11.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	1	2

HAZEC	HAZRSC	HAZSAR
1	1	0

TUBEWELL NO. 34A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	2000	8.92	11.0
08-85	2030	8.00	14.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 35 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	2510	4.47	13.0
03-81	2700	4.90	15.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	2	2
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 35A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-62	2000	6.71	12.0
05-85	1460	5.40	10.0
	USEEC	USERSC	USESAR
	1	0	1
	MAREC	MARRSC	MARSAR
	1	0	1
	HAZEC	HAZRSC	HAZSAR
	0	2	0

TUBEWELL NO. 36 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	2020	5.85	12.0
05-85	2020	7.00	13.0
	USEEC	USERSC	USESAR
	0	0	0
	MAREC	MARRSC	MARSAR
	2	0	2
	HAZEC	HAZRSC	HAZSAR
	0	2	0

TUBEWELL NO. 36A (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
02-62	2120	2.18	13.0
11-85	2520	5.40	14.0
	USEEC	USERSC	USESAR
	0	1	0
	MAREC	MARRSC	MARSAR
	2	0	2
	HAZEC	HAZRSC	HAZSAR
	0	1	0

TUBEWELL NO. 37 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
10-62	1800	7.81	12.0
02-85	1800	6.80	13.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 37A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
09-60	1940	9.09	16.0
11-85	1800	5.60	12.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 38 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
08-61	1630	4.52	17.0
03-81	880	4.20	7.2

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	2	1

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 38A (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
08-61	1330	8.98	10.0
05-85	1330	4.80	8.2

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 38B (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
02-62	1000	5.24	7.0
03-85	1010	5.30	7.6

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 39 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	1300	5.06	7.8
03-85	2501	5.50	8.6

USEEC	USERSC	USESAR
1	0	2
MAREC	MARRSC	MARSAR
1	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 39A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
08-61	1190	5.91	7.8
03-85	1230	5.00	7.0

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 40 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
08-62	650	2.70	3.3
07-85	1100	5.10	7.2

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 41 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
08-61	1420	4.62	9.3
11-85	1120	4.80	7.3

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	2	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 42 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	1100	4.58	7.1
05-85	750	4.30	5.5

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	2	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 42A (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
10-62	1150	5.03	10.0
06-85	1200	5.80	8.0

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 43 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
08-62	1150	5.16	8.5
06-85	1280	5.70	8.2

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 43A (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
07-63	1340	5.24	10.0
12-76	1020	4.18	7.2

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 44 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
08-62	1260	4.16	7.2
10-72	1200	4.96	7.3

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	2	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 45 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	1400	6.18	8.2
06-85	1300	7.20	10.0

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 45A (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
02-62	1230	6.11	7.5
05-85	1490	7.30	11.0

USEEC	USERSC	USESAR
2	0	1

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 46 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
08-61	1520	8.21	12.0
06-85	1350	6.20	9.7

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 46A (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
02-62	910	3.94	4.6
12-76	1350	5.70	8.7

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 47 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-62	1300	4.20	7.1
06-81	1700	7.40	12.0

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	1	1
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 47A (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
02-62	1500	6.13	8.5
06-81	1400	6.60	10.0

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 48 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
08-61	1260	7.83	8.7
07-85	1300	5.10	6.8

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 48A (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	1620	4.55	5.0
03-81	1500	7.40	9.1

USEEC	USERSC	USESAR
1	0	2

MAREC	MARRSC	MARSAR
1	1	0

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 48B (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
09-61	2170	8.57	12.0
03-81	2650	8.90	16.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 49 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-62	1500	6.90	8.2
06-81	1700	7.40	11.0

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 50 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-62	650	1.27	1.9
02-85	1230	5.30	9.0

USEEC	USERSC	USESAR
2	1	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 51 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
10-62	1400	5.17	11.0
12-85	1400	6.20	10.0

USEEC	USERSC	USESAR
2	0	1
MAREC	MARRSC	MARSAR
0	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 52 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	1310	2.36	3.7
03-85	1330	6.05	9.2

USEEC	USERSC	USESAR
2	1	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 52A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
10-62	1340	4.08	7.6
03-85	1490	5.15	8.1

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 53 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
02-62	1400	4.95	5.9
03-81	1530	6.64	11.0

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	1	1

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 54 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	1300	3.73	6.4
06-85	1510	6.60	10.0

USEEC	USERSC	USESAR
1	0	2

MAREC	MARRSC	MARSAR
1	1	0

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 54A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	1500	3.75	5.9
06-81	1430	5.00	7.6

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	2	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 55 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	1510	4.02	6.9
03-85	1350	6.10	9.2

USEEC	USERSC	USESAR
1	0	2
MAREC	MARRSC	MARSAR
1	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 55A (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
08-61	1410	6.54	10.0
03-85	1660	7.75	11.0

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 56 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
02-62	2590	10.19	14.0
05-75	2040	9.22	18.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 57 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	2400	5.36	11.0
03-85	2410	9.20	16.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 57A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-62	2600	11.90	17.0
08-85	2200	8.40	16.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 58 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	3000	6.07	16.0
03-81	2600	5.60	14.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	0	2

HAZEC	HAZRSC	HAZSAR
1	2	0

TUBEWELL NO. 58A (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	2600	3.38	11.0
12-85	2250	8.10	14.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	1	2

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 59 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
02-62	2700	8.00	15.0
10-85	2350	8.10	15.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 59A (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	4000	8.60	22.0
03-85	3000	8.90	17.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	1
HAZEC	HAZRSC	HAZSAR
2	2	1

TUBEWELL NO. 61 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
07-63	3200	9.45	25.0
02-85	2600	9.50	18.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 62 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	2910	7.03	14.0
05-85	3000	7.30	16.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	2
HAZEC	HAZRSC	HAZSAR
2	2	0

TUBEWELL NO. 62A (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
02-62	3210	11.38	22.0
05-75	3200	8.94	23.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 63 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
10-62	3800	6.09	20.0
03-85	3350	10.20	21.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 66A (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
02-62	4000	12.13	22.0
12-85	3920	11.10	21.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 67 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
02-62	1790	8.04	13.0
12-85	1050	7.30	11.0

USEEC	USERSC	USESAR
1	0	0
MAREC	MARRSC	MARSAR
1	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 67A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	1700	7.94	13.0
12-85	1450	7.40	10.0

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 67B (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
08-61	1410	5.38	9.9
03-85	1600	7.80	11.0

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 68 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
08-61	1080	2.88	5.8
03-85	1500	5:30	8.9

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 69 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
12-59	1580	5.47	8.9
12-85	2220	8.80	16.0

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
2	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 69A (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
12-59	1190	2.90	5.0
03-85	1690	6.40	11.0

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	1	1

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 70 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
08-62	1700	7.52	13.0
02-85	1800	8.45	16.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 71 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
11-62	1700	9.06	12.0
03-81	1800	7.60	13.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 72 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
01-61	870	2.77	3.6
11-85	1010	4.10	5.4

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	2	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 73A (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
10-62	1090	2.39	7.0
03-85	1110	4.90	8.6

USEEC	USERSC	USESAR
2	1	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 76 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
10-62	1490	4.18	12.0
01-82	1100	4.20	5.2

USEEC	USERSC	USESAR
2	0	1
MAREC	MARRSC	MARSAR
0	2	1
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 76A (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
05-62	1540	7.99	11.0
03-85	1320	8.20	9.2

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 77 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
10-62	1300	2.91	8.5
03-85	1200	5.70	8.6

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 78 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
05-62	1100	4.93	7.0
03-85	1120	5.05	7.5

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 79 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
05-62	1360	4.62	9.8
04-85	1120	5.40	7.8

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 80 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
10-62	1300	4.60	11.0
10-85	1110	5.30	7.6

USEEC	USERSC	USESAR
2	0	1
MAREC	MARRSC	MARSAR
0	1	1
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 82A (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
05-62	1950	9.30	18.0
01-85	1630	8.75	17.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 83 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
02-62	2000	9.36	13.0
07-85	920	3.30	4.7

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	1	1
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 84 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	900	3.39	3.1
07-85	920	3.70	5.3

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	2	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 85 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
10-62	800	1.39	4.5
07-85	1060	3.35	5.6

USEEC	USERSC	USESAR
2	1	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 86 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
11-60	1300	7.03	11.0
01-85	1120	5.15	7.5

USEEC	USERSC	USESAR
2	0	1

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 86A (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
10-60	1180	3.35	8.3
05-85	1310	6.40	9.6

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 87 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
11-60	1380	6.68	10.0
05-85	1190	5.70	9.6

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 88 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
11-60	1400	6.48	9.5
01-85	1330	5.80	9.3

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 88A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
03-62	1200	5.77	9.9
07-82	1580	5.00	10.0

USEEC	USERSC	USESAR
1	0	2
MAREC	MARRSC	MARSAR
1	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 89 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
03-62	1400	7.05	9.7
01-85	1410	6.05	9.9

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 89A (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
03-62	1150	4.01	8.5
01-85	1620	5.25	12.0

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	1	1

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 90 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
08-62	1500	5.34	12.0
01-82	1640	4.30	9.6

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	1	1

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 90A (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
01-61	1550	5.62	13.0
07-85	1670	4.15	11.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	1	2
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 91 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
03-62	1600	5.89	13.0
01-85	1600	5.90	12.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 92 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
03-62	1350	5.36	9.5
06-85	1710	6.10	13.0

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 92A (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
03-62	1700	4.80	12.0
03-85	1700	6.50	15.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	1	2
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 93 (NO. OF OBSERVATIONS 19)

DATE	EC	RSC	SAR
03-62	1300	4.17	7.1
11-85	1490	5.20	9.1

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 93A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
10-62	1830	4.73	12.0
01-85	1810	6.70	13.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	1	2

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 94 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
03-62	1200	5.43	7.9
03-81	1210	5.40	9.9

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 94A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
11-62	1060	3.71	8.0
06-85	1030	5.40	9.1

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 94B (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
02-62	880	1.99	3.7
11-85	1020	5.80	9.8

USEEC	USERSC	USESAR
2	1	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 95 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
02-62	1500	4.01	8.2
03-85	1260	5.70	9.8

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 96 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
11-62	1300	7.66	11.0
03-77	1320	6.70	10.0

USEEC	USERSC	USESAR
2	0	1
MAREC	MARRSC	MARSAR
0	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 97 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
01-62	500	.00	1.4
06-85	620	2.20	3.5

USEEC	USERSC	USESAR
2	2	2

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 98 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
01-62	900	4.49	4.0
06-85	830	3.30	4.2

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	2	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 99 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
01-62	560	1.83	1.8
06-85	920	4.30	4.9

USEEC	USERSC	USESAR
2	1	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 100 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
01-62	800	3.07	5.0
12-85	970	4.10	5.1

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	2	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 101 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
11-62	1080	3.29	5.7
10-85	960	4.50	5.4

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	2	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 102 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
01-62	1350	6.48	8.2
12-85	1040	4.70	6.0

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 103 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
01-62	995	3.70	3.4
03-85	1120	4.90	6.9

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	2	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 104 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
01-62	890	3.77	4.5
03-85	1100	4.40	6.4

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	2	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 105 (NO. OF OBSERVATIONS 18)

DATE	EC	RSC	SAR
01-62	920	3.24	3.8
12-85	1290	5.80	8.5

USEEC	USERSC	USESAR
2	0	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 106 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
08-61	1820	10.56	12.0
10-85	1790	9.50	14.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 107 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
01-62	1700	10.51	15.0
05-85	1210	6.30	9.1

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 108 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
08-61	1410	6.08	8.7
03-77	1860	6.20	11.0

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 108A (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
01-62	900	2.13	3.3
02-85	1410	6.50	8.3

USEEC	USERSC	USESAR
2	1	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 109 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
02-62	1900	6.33	10.0
02-85	1430	7.40	9.4

USEEC	USERSC	USESAR
1	0	2
MAREC	MARRSC	MARSAR
1	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 109A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	1700	7.09	10.0
02-85	1510	7.70	12.0

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
2	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 110 (NO. OF OBSERVATIONS 19)

DATE	EC	RSC	SAR
02-62	1800	6.81	8.6
05-85	1800	8.80	13.0

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
2	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 110A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	1800	5.82	13.0
05-85	1250	5.90	8.0

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 111 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	1600	6.13	8.7
02-85	1610	6.10	9.1

USEEC	USERSC	USESAR
0	0	2
MAREC	MARRSC	MARSAR
2	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 111A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	1630	4.90	6.8
02-81	1900	4.89	9.0

USEEC	USERSC	USESAR
0	0	2
MAREC	MARRSC	MARSAR
2	2	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 112 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
11-62	600	2.33	2.9
03-85	1510	7.90	9.5

USEEC	USERSC	USESAR
1	1	2
MAREC	MARRSC	MARSAR
1	0	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 112A (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
01-62	430	.47	.9
05-85	1180	5.70	7.3

USEEC	USERSC	USESAR
2	1	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 113 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	2000	11.62	13.0
05-85	1520	8.50	1.3

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
2	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 114 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
02-62	1750	10.59	13.0
05-85	2120	10.90	18.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 115 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
11-62	1060	4.60	6.0
02-85	1220	6.60	11.0

USEEC	USERSC	USESAR
2	0	1

MAREC	MARRSC	MARSAR
0	1	1

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 115A (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
11-62	1600	7.67	9.8
10-85	1250	5.90	10.0

USEEC	USERSC	USESAR
1	0	2
MAREC	MARRSC	MARSAR
1	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 116 (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
02-62	2260	9.12	14.0
02-85	1720	8.10	12.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 116A (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
02-62	1890	8.59	11.0
03-85	1980	9.50	16.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 117 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
08-61	2320	6.32	14.0
02-85	2030	9.70	16.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 117A (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
11-62	1450	7.69	10.0
08-77	1550	8.80	12.0

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 118 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
02-62	1620	7.18	9.6
05-85	1520	6.70	10.0

USEEC	USERSC	USESAR
0	0	2

MAREC	MARRSC	MARSAR
2	0	0

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 118A (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
10-63	1760	8.35	14.0
02-85	1700	8.40	13.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 119 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
08-61	1800	2.37	8.3
03-85	1600	7.20	11.0

USEEC	USERSC	USESAR
0	1	1
MAREC	MARRSC	MARSAR
2	0	1
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 120 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	1650	6.80	10.0
12-85	1520	7.30	12.0

USEEC	USERSC	USESAR
0	0	1
MAREC	MARRSC	MARSAR
2	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 121 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
11-62	1060	4.67	6.3
03-85	1410	6.35	8.3

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 121A (NO. OF OBSERVATIONS 17)

DATE	EC	RSC	SAR
11-62	710	1.16	3.1
03-85	1900	8.00	13.0

USEEC	USERSC	USESAR
1	1	1
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 122 (NO. OF OBSERVATIONS 18)

DATE	EC	RSC	SAR
02-62	1610	5.08	8.3
02-85	1880	7.40	13.0

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
2	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 123 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
02-62	1450	6.30	11.0
05-85	0	100.12	.0

USEEC	USERSC	USESAR
2	0	1

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 124 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
02-62	1200	4.67	9.2
01-85	1710	7.20	12.0

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	1	1

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 125 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
02-62	1320	5.64	8.2
02-85	1920	8.70	16.0

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 125A (NO. OF OBSERVATIONS 3)

DATE	EC	RSC	SAR
11-62	3200	15.60	26.0
07-66	3200	10.94	18.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	1
HAZEC	HAZRSC	HAZSAR
2	2	1

TUBEWELL NO. 126 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	925	2.93	6.2
05-85	2000	9.70	16.0

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	1	1
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 126A (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
05-62	2790	12.23	19.0
02-73	2910	14.32	18.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	1
HAZEC	HAZRSC	HAZSAR
2	2	1

TUBEWELL NO. 127 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-62	1100	5.05	8.2
01-78	2000	6.50	7.9

USEEC	USERSC	USESAR
1	0	2

MAREC	MARRSC	MARSAR
1	0	0

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 128 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-62	2400	9.98	16.0
02-85	2200	9.10	15.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 129 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-62	1500	6.20	12.0
02-73	2200	9.71	15.0

USEEC	USERSC	USESAR
1	0	0

MAREC	MARRSC	MARSAR
1	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 130 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-61	1290	5.28	10.0
03-85	3580	14.20	23.0

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 130A (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
02-62	3400	10.57	24.0
12-85	2650	10.10	26.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	0	0

HAZEC	HAZRSC	HAZSAR
1	2	2

TUBEWELL NO. 131 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
10-61	2990	2.95	17.0
02-85	2800	9.90	22.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	1	1

HAZEC	HAZRSC	HAZSAR
2	1	1

TUBEWELL NO. 132 (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
02-62	3800	15.94	32.0
07-66	3500	13.42	28.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 132A (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
11-62	3000	10.31	16.0
03-75	1000	6.26	7.9

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
1	2	0

TUBEWELL NO. 133 (NO. OF OBSERVATIONS 17)

DATE	EC	RSC	SAR
01-62	2420	10.55	15.0
03-85	2790	10.80	24.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 134 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
01-61	3600	1.87	16.0
03-75	2900	9.56	17.0

USEEC	USERSC	USESAR
0	1	0

MAREC	MARRSC	MARSAR
0	0	2

HAZEC	HAZRSC	HAZSAR
2	1	0

TUBEWELL NO. 135 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	4000	6.93	18.0
0-72	4250	5.93	18.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	2
HAZEC	HAZRSC	HAZSAR
2	2	0

TUBEWELL NO. 136 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
06-61	4250	10.71	20.0
10-77	2970	10.90	22.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 136A (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	3950	9.80	17.0
03-85	3860	8.80	20.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	1
HAZEC	HAZRSC	HAZSAR
2	2	1

TUBEWELL NO. 137 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
03-62	2500	10.68	17.0
03-85	3090	9.80	20.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 138 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
06-61	3600	14.91	24.0
12-72	2200	8.10	15.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 138A (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
10-63	2500	13.84	25.0
03-73	2910	10.82	17.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 139 (NO. OF OBSERVATIONS 3)

DATE	EC	RSC	SAR
06-61	5500	11.69	30.0
07-63	6200	9.02	37.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 140A (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
06-61	4200	10.86	21.0
04-67	5500	9.41	38.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 141 (NO. OF OBSERVATIONS 5)

DATE	EC	RSC	SAR
06-61	3800	9.76	19.0
04-70	3090	10.05	21.0
	USEEC	USERSC	USESAR
	0	0	0
	MAREC	MARRSC	MARSAR
	0	0	0
	HAZEC	HAZRSC	HAZSAR
	2	2	2

TUBEWELL NO. 142 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
06-61	2700	15.53	18.0
12-72	2800	8.49	13.0
	USEEC	USERSC	USESAR
	0	0	0
	MAREC	MARRSC	MARSAR
	1	0	2
	HAZEC	HAZRSC	HAZSAR
	1	2	0

TUBEWELL NO. 142A (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
06-61	3200	14.19	25.0
12-66	2900	13.61	22.0
	USEEC	USERSC	USESAR
	0	0	0
	MAREC	MARRSC	MARSAR
	0	0	0
	HAZEC	HAZRSC	HAZSAR
	2	2	2

TUBEWELL NO. 143 (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
06-61	2800	11.49	22.0
12-66	2400	6.87	13.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 144 (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
09-61	2400	10.18	14.0
12-66	2250	9.37	15.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 145 (NO. OF OBSERVATIONS 5)

DATE	EC	RSC	SAR
07-61	1000	8.90	7.9
04-67	2800	7.46	18.0

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
1	2	0

TUBEWELL NO. 146 (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
06-61	3700	12.21	24.0
04-73	3850	4.27	24.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
2	1	2

TUBEWELL NO. 147 (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
06-61	4000	5.68	32.0
11-73	3750	5.25	21.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 147A (NO. OF OBSERVATIONS 3)

DATE	EC	RSC	SAR
06-61	4000	15.29	32.0
07-66	3600	13.35	31.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 149 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
06-61	4500	13.01	31.0
04-72	1580	2.98	10.0

USEEC	USERSC	USESAR
0	0	1
MAREC	MARRSC	MARSAR
1	1	0
HAZEC	HAZRSC	HAZSAR
1	1	1

TUBEWELL NO. 149A (NO. OF OBSERVATIONS 5)

DATE	EC	RSC	SAR
06-61	5000	5.56	20.0
04-67	5000	6.35	26.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 150 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
06-61	4000	12.50	29.0
04-72	2220	2.64	12.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	1	1

HAZEC	HAZRSC	HAZSAR
1	1	1

TUBEWELL NO. 151 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
06-61	4500	6.06	20.0
04-72	2600	2.65	14.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	1	1

HAZEC	HAZRSC	HAZSAR
1	1	1

TUBEWELL NO. 151A (NO. OF OBSERVATIONS 2)

DATE	EC	RSC	SAR
06-61	4000	6.74	21.0
06-61	4100	.00	18.0

USEEC	USERSC	USESAR
0	1	0

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
2	1	1

TUBEWELL NO. 152 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
07-61	4500	5.32	21.0
03-73	4500	7.81	23.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 153 (NO. OF OBSERVATIONS 2)

DATE	EC	RSC	SAR
07-61	5000	.96	40.0
07-61	4200	10.17	22.0

USEEC	USERSC	USESAR
0	1	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	1	2

TUBEWELL NO. 153A (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
07-61	4000	.75	21.0
05-72	2450	1.22	12.0

USEEC	USERSC	USESAR
0	2	0

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
1	0	1

TUBEWELL NO. 155 (NO. OF OBSERVATIONS 3)

DATE	EC	RSC	SAR
07-61	4600	3.64	19.0
11-65	4700	2.00	19.0

USEEC	USERSC	USESAR
0	1	0

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
2	0	2

TUBEWELL NO. 156 (NO. OF OBSERVATIONS 5)

DATE	EC	RSC	SAR
07-61	2900	12.38	24.0
08-71	600	1.12	4.0

USEEC	USERSC	USESAR
1	1	1

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
1	1	1

TUBEWELL NO. 157 (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
07-61	4200	11.94	31.0
04-72	3200	8.89	23.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 158 (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
07-61	3000	16.75	29.0
05-72	390	.00	1.4

USEEC	USERSC	USESAR
1	1	1
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
1	1	1

TUBEWELL NO. 159 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
07-61	3000	14.93	27.0
05-72	330	.00	.9

USEEC	USERSC	USESAR
1	1	1
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
1	1	1

TUBEWELL NO. 159A (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
07-61	3800	13.97	25.0
04-73	3430	5.02	20.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 160 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
06-61	4000	4.75	20.0
01-73	3740	5.18	19.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
2	1	2

TUBEWELL NO. 161 (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
07-61	4000	6.49	27.0
12-72	4000	.59	14.0

USEEC	USERSC	USESAR
0	1	0

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
2	1	1

TUBEWELL NO. 162 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
07-61	3800	5.52	17.0
03-73	4050	5.25	20.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
2	2	1

TUBEWELL NO. 162A (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
07-61	4400	6.25	27.0
03-73	4040	5.34	21.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 163 (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
07-61	3300	14.00	28.0
03-73	3000	12.73	25.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 163A (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
07-61	3300	17.78	28.0
06-67	3120	15.53	21.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 164 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
11-65	4000	10.30	26.0
03-73	3990	8.06	20.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 165 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
07-61	3300	4.13	31.0
03-73	3190	10.93	26.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
2	1	2

TUBEWELL NO. 166 (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
07-61	3200	4.29	18.0
06-73	3730	5.34	19.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	1	1

HAZEC	HAZRSC	HAZSAR
2	1	1

TUBEWELL NO. 166A (NO. OF OBSERVATIONS 2)

DATE	EC	RSC	SAR
07-61	3500	5.71	21.0
02-66	3300	7.50	21.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 167 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
10-61	4500	.00	19.0
06-73	3740	4.85	22.0

USEEC	USERSC	USESAR
0	1	0

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
2	0	2

TUBEWELL NO. 168 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
01-62	900	3.88	3.9
10-85	900	5.20	7.5

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 168A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
01-62	1400	7.58	9.0
02-85	1170	7.02	8.9

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 169 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
01-62	1700	7.67	9.4
06-85	1620	8.10	12.0

USEEC	USERSC	USESAR
0	0	1
MAREC	MARRSC	MARSAR
2	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 169A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
01-62	1360	7.97	9.5
03-85	1250	6.60	9.6

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 170 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
01-62	900	2.41	4.0
03-85	1010	4.60	5.6

USEEC	USERSC	USESAR
2	1	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 171 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
01-62	1380	6.01	9.7
02-81	1600	5.57	9.3

USEEC	USERSC	USESAR
1	0	2

MAREC	MARRSC	MARSAR
1	0	0

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 172 (NO. OF OBSERVATIONS 19)

DATE	EC	RSC	SAR
01-62	1800	8.67	11.0
02-85	1700	6.20	9.3

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
2	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 172A (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
01-62	1400	6.22	8.2
02-85	1420	6.80	9.7

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 173 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
12-59	1100	2.94	5.6
06-85	1460	5.80	8.7

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 173A (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
12-59	1790	10.27	10.0
03-85	1530	6.80	8.5

USEEC	USERSC	USESAR
0	0	2
MAREC	MARRSC	MARSAR
2	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 174 (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
01-62	1900	5.64	8.2
02-85	1310	6.40	10.0

USEEC	USERSC	USESAR
1	0	2
MAREC	MARRSC	MARSAR
1	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 175 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
11-62	1780	6.11	7.2
02-85	1530	6.90	9.9

USEEC	USERSC	USESAR
0	0	2

MAREC	MARRSC	MARSAR
2	0	0

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 175A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
11-62	1700	6.60	8.2
02-85	1750	7.30	11.0

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
2	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 176 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
01-62	2600	5.13	9.3
10-72	2050	5.97	10.0

USEEC	USERSC	USESAR
0	0	2

MAREC	MARRSC	MARSAR
2	0	0

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 177 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
01-62	1250	3.00	5.7
03-75	1200	6.36	9.0

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 178 (NO. OF OBSERVATIONS 19)

DATE	EC	RSC	SAR
12-59	1540	5.64	9.8
02-85	1550	5.70	10.0

USEEC	USERSC	USESAR
0	0	2
MAREC	MARRSC	MARSAR
2	0	0
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 178A (NO. OF OBSERVATIONS 14)

DATE	EC	RSC	SAR
11-62	1400	.00	5.0
02-85	1510	5.40	8.8

USEEC	USERSC	USESAR
1	1	2
MAREC	MARRSC	MARSAR
1	0	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 179 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
12-59	1350	2.31	5.2
02-85	1620	5.00	8.9

USEEC	USERSC	USESAR
1	1	2
MAREC	MARRSC	MARSAR
1	1	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 180 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-60	1700	7.25	10.0
03-82	1760	5.10	9.7

USEEC	USERSC	USESAR
0	0	2

MAREC	MARRSC	MARSAR
2	0	0

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 181 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
09-62	1900	3.53	11.0
02-85	1810	6.30	11.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	1	2

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 182 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
06-63	2500	7.71	20.0
02-85	2050	8.40	13.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	1

HAZEC	HAZRSC	HAZSAR
0	2	1

TUBEWELL NO. 183 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
11-62	1720	8.62	11.0
10-72	2000	8.23	13.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 184 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
05-62	2150	8.05	13.0
02-73	2450	9.46	15.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 184A (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
11-62	1820	7.90	17.0
02-73	1600	5.58	7.7

USEEC	USERSC	USESAR
0	0	1
MAREC	MARRSC	MARSAR
2	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 185 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
09-61	1850	9.24	12.0
10-85	2100	8.50	15.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 185A (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
05-62	1970	8.08	16.0
10-72	1900	8.62	14.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 186 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
03-60	1660	2.36	8.7
04-76	1600	6.40	10.0

USEEC	USERSC	USESAR
0	1	2

MAREC	MARRSC	MARSAR
2	0	0

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 187 (NO. OF OBSERVATIONS 19)

DATE	EC	RSC	SAR
07-60	1850	7.31	13.0
02-85	1440	4.40	8.2

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	1	1

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 187A (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
11-62	1950	10.86	14.0
03-75	1900	9.64	13.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 188 (NO. OF OBSERVATIONS 17)

DATE	EC	RSC	SAR
09-60	1600	1.34	12.0
02-85	1690	6.00	12.0

USEEC	USERSC	USESAR
0	1	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 189 (NO. OF OBSERVATIONS 17)

DATE	EC	RSC	SAR
09-60	1800	8.13	11.0
02-85	1850	8.20	16.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 190 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
06-63	3000	8.02	21.0
01-85	2450	9.70	2.0

USEEC	USERSC	USESAR
0	0	1
MAREC	MARRSC	MARSAR
1	0	0
HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 191 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
06-63	3000	8.33	25.0
12-77	2210	7.00	11.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 192 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
03-60	1960	11.33	16.0
05-75	1950	7.92	12.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 192A (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
07-61	3100	13.13	19.0
05-75	2400	10.66	17.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 193 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
03-60	3440	4.89	16.0
01-76	3240	9.71	19.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	1	1
HAZEC	HAZRSC	HAZSAR
2	1	1

TUBEWELL NO. 194 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
03-60	3200	6.61	16.0
05-75	1600	3.52	11.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	1	2
HAZEC	HAZRSC	HAZSAR
1	1	0

TUBEWELL NO. 194A (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
01-62	3000	10.95	17.0
07-81	2250	7.98	12.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	0	2
HAZEC	HAZRSC	HAZSAR
1	2	0

TUBEWELL NO. 195 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
10-61	2650	.81	13.0
02-81	2450	5.33	12.0

USEEC	USERSC	USESAR
0	1	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 196 (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
01-62	3500	12.76	19.0
07-66	2900	8.82	16.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
2	2	1

TUBEWELL NO. 197 (NO. OF OBSERVATIONS 5)

DATE	EC	RSC	SAR
07-61	3000	8.16	17.0
04-71	3170	10.91	18.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	2

HAZEC	HAZRSC	HAZSAR
2	2	0

TUBEWELL NO. 198 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
06-60	1510	3.61	8.0
12-72	3000	7.62	14.0

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
1	1	1

HAZEC	HAZRSC	HAZSAR
1	1	0

TUBEWELL NO. 198A (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
02-60	3800	6.06	20.0
12-72	3150	7.24	14.0

USEEC 0	USERSC 0	USESAR 0
MAREC 0	MARRSC 0	MARSAR 1
HAZEC 2	HAZRSC 2	HAZSAR 1

TUBEWELL NO. 199 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
07-61	3400	8.66	17.0
10-68	3150	8.78	18.0

USEEC 0	USERSC 0	USESAR 0
MAREC 0	MARRSC 0	MARSAR 2
HAZEC 2	HAZRSC 2	HAZSAR 0

TUBEWELL NO. 199A (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
06-61	2700	4.65	16.0
03-73	2800	7.30	14.0

USEEC 0	USERSC 0	USESAR 0
MAREC 1	MARRSC 1	MARSAR 2
HAZEC 1	HAZRSC 1	HAZSAR 0

TUBEWELL NO. 200 (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
06-61	2700	10.67	18.0
12-72	2200	5.50	10.0

USEEC 0	USERSC 0	USESAR 1
MAREC 2	MARRSC 0	MARSAR 1
HAZEC 0	HAZRSC 2	HAZSAR 0

TUBEWELL NO. 200A (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
07-61	2800	10.08	17.0
12-72	2200	7.13	12.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	0	2

HAZEC	HAZRSC	HAZSAR
1	2	0

TUBEWELL NO. 201 (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
07-61	2600	12.36	25.0
04-72	1500	5.95	12.0

USEEC	USERSC	USESAR
1	0	0

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
0	2	1

TUBEWELL NO. 201A (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
11-62	3800	9.76	16.0
07-69	3970	10.49	20.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
2	2	1

TUBEWELL NO. 202 (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
07-61	2700	11.99	21.0
05-79	2900	12.05	19.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	0	0
HAZEC	HAZRSC	HAZSAR
1	2	2

TUBEWELL NO. 203 (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
07-61	4000	19.81	31.0
07-66	3400	14.21	21.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 203A (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
07-61	3200	12.78	20.0
07-66	2550	10.07	14.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 204 (NO. OF OBSERVATIONS 5)

DATE	EC	RSC	SAR
07-61	3400	13.29	21.0
07-66	2650	13.33	24.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	0	0
HAZEC	HAZRSC	HAZSAR
1	2	2

TUBEWELL NO. 204A (NO. OF OBSERVATIONS 5)

DATE	EC	RSC	SAR
07-61	2800	14.26	19.0
07-66	2650	13.21	22.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	0	0

HAZEC	HAZRSC	HAZSAR
1	2	2

TUBEWELL NO. 205 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
03-62	2000	8.93	14.0
02-85	1760	6.50	10.0

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
2	0	1

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 205A (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
11-62	1600	6.09	8.5
02-85	1720	7.20	10.0

USEEC	USERSC	USESAR
0	0	2

MAREC	MARRSC	MARSAR
2	0	0

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 206 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
02-62	1500	8.09	11.0
02-81	1950	6.16	11.0

USEEC	USERSC	USESAR
1	0	0
MAREC	MARRSC	MARSAR
1	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 206A (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
11-62	2000	9.39	11.0
11-72	1950	8.31	10.0

USEEC	USERSC	USESAR
0	0	1
MAREC	MARRSC	MARSAR
2	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 207 (NO. OF OBSERVATIONS 20)

DATE	EC	RSC	SAR
02-62	1600	6.48	7.9
02-85	1610	7.40	12.0

USEEC	USERSC	USESAR
0	0	1
MAREC	MARRSC	MARSAR
2	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 208 (NO. OF OBSERVATIONS 16)

DATE	EC	RSC	SAR
12-61	2580	9.56	12.0
02-85	1780	8.40	13.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 209 (NO. OF OBSERVATIONS 17)

DATE	EC	RSC	SAR
08-62	1790	6.32	11.0
02-85	1800	8.70	13.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 210 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
08-62	1900	10.62	14.0
02-81	1950	9.23	13.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 211 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
12-59	1820	7.76	12.0
09-71	2400	9.70	16.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 212 (NO. OF OBSERVATIONS 5)

DATE	EC	RSC	SAR
08-62	2150	9.66	15.0
12-66	2300	9.23	16.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 212A (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
05-62	3400	14.21	25.0
07-66	2540	6.63	13.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 213 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
05-62	2290	9.42	16.0
11-72	2170	7.25	11.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 213A (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
05-62	2600	12.89	19.0
12-66	2400	5.86	18.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	1
HAZEC	HAZRSC	HAZSAR
0	2	1

TUBEWELL NO. 214 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
10-61	1200	1.14	9.5
11-85	1470	4.60	10.0

USEEC	USERSC	USESAR
2	1	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 214A (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
07-63	1650	4.26	12.0
10-85	1500	4.20	8.5

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	2	1

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 215 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
08-60	1800	5.31	13.0
05-85	1410	4.30	13.0

USEEC	USERSC	USESAR
1	0	0

MAREC	MARRSC	MARSAR
1	1	2

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 216 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
10-60	1730	7.76	7.3
03-85	1570	5.01	12.0

USEEC	USERSC	USESAR
0	0	1
MAREC	MARRSC	MARSAR
2	0	1
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 216A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
10-60	1800	1.49	8.1
12-85	1550	4.80	9.1

USEEC	USERSC	USESAR
0	1	2
MAREC	MARRSC	MARSAR
2	1	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 217 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-60	1300	1.08	7.0
11-76	1550	1.58	8.3

USEEC	USERSC	USESAR
1	2	2
MAREC	MARRSC	MARSAR
1	0	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 217A (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
07-60	2780	9.79	18.0
10-77	1640	5.30	12.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	0	2
HAZEC	HAZRSC	HAZSAR
1	2	0

TUBEWELL NO. 218 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
08-62	1100	3.66	7.4
05-85	1740	4.60	11.0

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	2	1

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 218A (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	1700	3.50	11.0
03-85	1510	4.20	8.3

USEEC	USERSC	USESAR
0	0	1

MAREC	MARRSC	MARSAR
2	2	1

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 219 (NO. OF OBSERVATIONS 15)

DATE	EC	RSC	SAR
08-62	1790	2.70	11.0
02-77	1650	4.50	12.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	2	2

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 219A (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
11-62	1320	2.14	5.2
12-85	1440	4.00	10.0

USEEC	USERSC	USESAR
2	1	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 220 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
10-60	1420	2.50	8.4
12-77	1750	6.50	12.0

USEEC	USERSC	USESAR
1	1	1
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 220A (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
12-62	1400	5.56	6.6
03-85	1410	4.70	7.7

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 221 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
09-61	880	1.54	3.3
12-85	840	2.50	5.0

USEEC	USERSC	USESAR
2	2	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 221A (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
10-61	1330	2.44	8.5
05-85	1250	3.90	8.2

USEEC	USERSC	USESAR
2	1	2

MAREC	MARRSC	MARSAR
0	1	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 222 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
02-60	1850	3.66	9.9
11-77	2500	.00	11.0

USEEC	USERSC	USESAR
0	1	1

MAREC	MARRSC	MARSAR
2	1	1

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 222A (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
10-62	580	.90	3.6
12-77	2700	.50	12.0

USEEC	USERSC	USESAR
1	2	1

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 223 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
10-62	2900	.00	11.0
03-85	2000	7.00	20.0

USEEC	USERSC	USESAR
0	1	0

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
1	1	1

TUBEWELL NO. 224 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	1850	2.62	12.0
08-75	1700	4.94	12.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	2	2

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 224A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
02-60	2050	.93	8.8
03-85	2090	1.10	14.0

USEEC	USERSC	USESAR
0	2	1

MAREC	MARRSC	MARSAR
2	0	1

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 225 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
08-60	2000	2.22	11.0
05-85	1880	3.50	13.0

USEEC	USERSC	USESAR
0	1	0

MAREC	MARRSC	MARSAR
2	1	2

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 226 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
10-62	2650	3.12	12.0
03-81	2800	.00	9.4

USEEC	USERSC	USESAR
0	1	1

MAREC	MARRSC	MARSAR
1	1	1

HAZEC	HAZRSC	HAZSAR
1	0	0

TUBEWELL NO. 226A (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
10-62	2200	5.86	16.0
08-78	2200	2.34	11.0

USEEC	USERSC	USESAR
0	1	0

MAREC	MARRSC	MARSAR
2	0	2

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 227 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
12-62	1850	5.50	12.0
01-85	1900	4.70	14.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	1	2

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 228 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
07-62	2200	5.91	13.0
03-77	2000	7.40	18.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 229 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
08-62	2050	6.78	17.0
05-75	1850	6.56	14.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 230 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
02-60	1800	5.26	13.0
03-77	2410	5.50	16.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 231 (NO. OF OBSERVATIONS 13)

DATE	EC	RSC	SAR
02-60	2350	.29	9.6
03-77	3850	1.09	17.0

USEEC	USERSC	USESAR
0	2	1
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
1	0	0

TUBEWELL NO. 231A (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
02-60	4400	.00	14.0
11-73	3020	.00	11.0

USEEC	USERSC	USESAR
0	2	0

MAREC	MARRSC	MARSAR
0	0	2

HAZEC	HAZRSC	HAZSAR
2	0	0

TUBEWELL NO. 232 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
02-60	1930	4.46	12.0
12-73	1200	3.50	7.2

USEEC	USERSC	USESAR
1	0	1

MAREC	MARRSC	MARSAR
1	2	1

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 232A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
03-60	3480	5.00	16.0
05-77	1950	4.30	11.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	2	2

HAZEC	HAZRSC	HAZSAR
1	0	0

TUBEWELL NO. 233 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
09-61	2480	12.37	18.0
04-73	2980	13.43	30.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	0	1
HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 234 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
09-61	2430	11.16	20.0
12-73	1450	4.41	8.8

USEEC	USERSC	USESAR
1	0	1
MAREC	MARRSC	MARSAR
1	1	0
HAZEC	HAZRSC	HAZSAR
0	1	1

TUBEWELL NO. 235 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
10-63	2400	10.42	15.0
05-75	1920	6.76	19.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	1
HAZEC	HAZRSC	HAZSAR
0	2	1

TUBEWELL NO. 236 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
10-62	2350	9.12	15.0
03-81	2200	8.70	16.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 238 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	3420	14.02	20.0
12-77	3200	11.10	21.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 238A (NO. OF OBSERVATIONS 5)

DATE	EC	RSC	SAR
10-63	3500	9.99	20.0
04-73	3050	10.73	18.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
2	2	1

TUBEWELL NO. 239 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	3630	13.02	20.0
03-77	3440	12.40	24.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 240 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
10-62	460	.00	1.0
03-82	380	.90	1.8

USEEC	USERSC	USESAR
2	2	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 241 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	2400	.37	20.0
11-77	550	1.15	3.6

USEEC	USERSC	USESAR
1	2	1
MAREC	MARRSC	MARSAR
1	0	0
HAZEC	HAZRSC	HAZSAR
0	0	1

TUBEWELL NO. 241A (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
09-61	2330	10.11	17.0
12-72	2700	6.56	16.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	0	2
HAZEC	HAZRSC	HAZSAR
0	2	0

TUBEWELL NO. 242 (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
10-62	2000	4.10	11.0
12-72	2300	5.15	12.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
2	1	2
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 242A (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
10-61	700	.65	6.2
03-77	940	2.02	11.0

USEEC	USERSC	USESAR
2	2	1

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 243 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
10-62	5300	6.93	53.0
12-72	1550	6.29	12.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
1	0	1

HAZEC	HAZRSC	HAZSAR
1	2	1

TUBEWELL NO. 244 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
11-62	3800	2.69	17.0
12-72	4000	2.31	17.0

USEEC	USERSC	USESAR
0	1	0

MAREC	MARRSC	MARSAR
0	1	2

HAZEC	HAZRSC	HAZSAR
2	0	0

TUBEWELL NO. 244A (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
10-62	4100	.00	16.0
04-70	5400	.00	15.0

USEEC	USERSC	USESAR
0	2	0
MAREC	MARRSC	MARSAR
0	0	2
HAZEC	HAZRSC	HAZSAR
2	0	0

TUBEWELL NO. 245 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	4800	6.52	29.0
05-75	3900	4.18	22.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
2	1	2

TUBEWELL NO. 246 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
11-62	2800	8.35	20.0
05-75	3040	9.32	30.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
2	2	2

TUBEWELL NO. 246A (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
11-62	2680	5.96	16.0
05-75	2900	7.22	18.0

USEEC	USERSC	USESAR
0	0	0
MAREC	MARRSC	MARSAR
1	0	2
HAZEC	HAZRSC	HAZSAR
1	2	0

TUBEWELL NO. 247 (NO. OF OBSERVATIONS 6)

DATE	EC	RSC	SAR
11-62	2700	6.84	17.0
05-75	2600	4.12	19.0

USEEC	USERSC	USESAR
0	0	0

MAREC	MARRSC	MARSAR
2	1	1

HAZEC	HAZRSC	HAZSAR
0	1	1

TUBEWELL NO. 248 (NO. OF OBSERVATIONS 3)

DATE	EC	RSC	SAR
09-69	5650	.00	14.0
12-72	5000	.00	17.0

USEEC	USERSC	USESAR
0	2	0

MAREC	MARRSC	MARSAR
0	0	2

HAZEC	HAZRSC	HAZSAR
2	0	0

TUBEWELL NO. 249 (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
01-71	5000	.00	17.0
05-75	6000	.00	11.0

USEEC	USERSC	USESAR
0	2	0

MAREC	MARRSC	MARSAR
0	0	2

HAZEC	HAZRSC	HAZSAR
2	0	0

TUBEWELL NO. 249A (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
10-62	200	.00	.8
04-70	6000	11.00	11.0

USEEC	USERSC	USESAR
1	1	1
MAREC	MARRSC	MARSAR
0	0	1
HAZEC	HAZRSC	HAZSAR
1	1	0

TUBEWELL NO. 250 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
09-61	344	.00	2.6
02-82	640	1.80	2.9

USEEC	USERSC	USESAR
2	2	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 251 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	200	.00	.9
01-82	300	.00	.7

USEEC	USERSC	USESAR
2	2	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 252 (NO. OF OBSERVATIONS 11)

DATE	EC	RSC	SAR
10-62	580	2.92	5.1
03-81	280	.10	.4

USEEC	USERSC	USESAR
2	1	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 252A (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
10-62	290	.00	.5
03-81	480	1.90	3.0

USEEC	USERSC	USESAR
2	2	2

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 253 (NO. OF OBSERVATIONS 10)

DATE	EC	RSC	SAR
09-61	241	.00	.4
11-85	390	.00	.3

USEEC	USERSC	USESAR
2	2	2

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 254 (NO. OF OBSERVATIONS 5)

DATE	EC	RSC	SAR
07-63	1500	5.52	11.0
03-75	240	.04	.5

USEEC	USERSC	USESAR
2	1	1

MAREC	MARRSC	MARSAR
0	0	1

HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 254A (NO. OF OBSERVATIONS 4)

DATE	EC	RSC	SAR
07-63	1400	5.39	8.9
11-72	1020	4.87	6.9

USEEC	USERSC	USESAR
2	0	2
MAREC	MARRSC	MARSAR
0	1	0
HAZEC	HAZRSC	HAZSAR
0	1	0

TUBEWELL NO. 255 (NO. OF OBSERVATIONS 12)

DATE	EC	RSC	SAR
10-62	300	.00	2.5
01-82	300	.05	.1

USEEC	USERSC	USESAR
2	2	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 256 (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
07-63	730	1.74	4.5
11-77	500	1.53	3.0

USEEC	USERSC	USESAR
2	2	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 257 (NO. OF OBSERVATIONS 7)

DATE	EC	RSC	SAR
08-62	450	.00	1.1
03-77	500	.69	1.3

USEEC	USERSC	USESAR
2	2	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 258 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
12-63	340	.00	.1
11-81	450	.40	.8

USEEC	USERSC	USESAR
2	2	2

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 259 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	600	4.10	15.0
11-81	960	3.20	6.1

USEEC	USERSC	USESAR
2	0	1

MAREC	MARRSC	MARSAR
0	2	1

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 259A (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	200	.00	.1
03-81	260	.00	.2

USEEC	USERSC	USESAR
2	2	2

MAREC	MARRSC	MARSAR
0	0	0

HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 260 (NO. OF OBSERVATIONS 9)

DATE	EC	RSC	SAR
10-62	640	2.12	3.6
11-77	780	2.15	4.1

USEEC	USERSC	USESAR
2	2	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 261 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
10-62	450	.00	1.2
11-81	730	1.25	2.9

USEEC	USERSC	USESAR
2	2	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	0	0

TUBEWELL NO. 262 (NO. OF OBSERVATIONS 8)

DATE	EC	RSC	SAR
10-62	490	1.06	2.7
02-77	610	1.77	3.1

USEEC	USERSC	USESAR
2	2	2
MAREC	MARRSC	MARSAR
0	0	0
HAZEC	HAZRSC	HAZSAR
0	0	0

[SUMMARY OF RESULTS --- BASED ON SINGLE PARAMETER]

TOTAL ==>	USEEC	MAREC	HAZEC
	276	301	155
TOTAL ==>	USERSC	MARRSC	HAZRSC
	100	165	467
TOTAL ==>	USESAR	MARSAR	HAZSAR
	322	296	114