Paper No. 145

Maintenance, operation and construction of Scarp-Tubewells with special reference to SCARP-II

By

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MAINTENANCE, OPERATION AND CONSTRUCTION OF SCARP-TUBEWELLS WITH SEPCIAL REFERENCE TO SCARP–II

SH. ABDUL HAMID ARIF *

1. INTRODUCTION.

With the introduction of canal irrigated agricultural around the turn of the century it was felt during 1940-50 that water table had risen in vast areas of Punjab irrigated by canals and attendent problem of soil salinity had also cropped up. As based on detailed geo-hydrological investigations salinity control and reclamation projects (SCARP) were implemented and a large network of tubewells was installed in the affected areas. This was done with a view to provide sub-surface drainage as well as additional water for irrigation.

To assess and evaluate the achievement of objectives, the monitoring of SCARPs. was considered imperative to evolve better techniques for operation, maintenance and construction etc.

The operation and maintenance of tubewells after construction was entrusted with Irrigation and Power Department Govt. of the Punjab, as it involved distribution of tubewell water in admixture with canal water supplies. However, the monitoring and evaluation of the various parameters was entrusted with WAPDA, to carry out detailed annual studies of various parameters, viz water table control, eradication of soil salinity and tubewell characteristics.

Some of the related aspects have been discussed herein with special reference to SCARP-II to assess the various parameters.

2. OPERATION AND MAINTENANCE

Scarp-II lies in Chaj Doab of Punjab under the command of Upper Jhelum Canal and Lower Jhelum Canal systems covering an area of about 1.65 million

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acres. In all 2205 fresh water tubewells ranging in capacity from 2 cs. to 5 cs. and 821 drainage tubewells 1 to 2.5 cusecs capacity in saline areas were installed. The location of the project and tubewells is shown in Fig-1.

The general statistics of the project are given in Table—1.

Irrigation tubewells were installed during the year 1962-71 and progressively put into operation during 1963-73. Out of total installed tubewells, 1718 tubewells were installed with Fiber Glass screen and remaining with Mild Steel screen with a designed capacity of 8423 cusecs. The average utilization rate to be achieved was 40 percent.

WATER TABLE CONTROL.

In SCARP-II before the implementation of the Project the areas in 0-5', 5-10' and more than 10' depth, to water table was 11%, 40% and 49% respectively and water table was rising at an alarming rate The average water table depth was 9.4 feet. After the commissioning of the tubewells the water logging was significantly controlled by 1975 and the water logged area (0-5') was appreciably reduced to 0.8% and average water table showed a depletion of 1.5 feet. However, the situation changed with the passage of time and during 1983 the area under 0.5', 5-10' more than 10' increased to 15,40 & 45% respectively. The average water table rose by 2.2 feet during 1975-83. Refer to Figure 2 & 3 which show the water table trend during 1964 to 1983. Table-II shows the percentage of area with different depths to water table from 1974 to 1984 as based on the studies carried out by Monitoring & Evaluation Cells, WAPDA. The rise in water table is attributed to the following factors:-

i) Increase in canal water supplies from 1.66 M.A.F. in 1973-74 to 3.03 Million Acre Feet in 1982-83.

Table – 1

STATISTICS OF SCARP–II

Scheme	No. of tubewells installed								Period		Pumping capacity Median (cusecs)		
	2.0	2.5	3.0 C U S	3.5 E C S	4.0	4.5	5.0	Total	Acceptance Tests	Commi-ssioning	Designed	Acceptance Tests	Capacity (gpm ft/d/d)
Lalian	16	18	32	18	36	43	–	163	1962-63	1963-64	573.5	676.3	90.0
									1963-64	1964-66	435.0	435.4	87.0
Mona	2	35	39	38	24	–	–	138	1963-64	1964-66	2.5	2.6	51.4
									1963-64	1964-66	437.5	456.0	87.0
									1966-67	1967-69	136.0	210.9	80.0
Khadir	33	–	45	–	51	–	84	213	1966-67	1967-69	649.0	670.5	96.5
									1966-67	1967-69	825.0	981.4	91.5
									1966-67	1967-69	275.0	336.0	44.0
Phalia	57	–	88	–	105	–	85	335	1966-67	1967-69	948.0	1246.0	110.0
									1966-67	1967-69	1223.0	1582.0	104.5
Busal	28	–	50	–	88	–	83	249	1966-67	1967-69	973.0	1391.0	124.0
									1965-67	1967-69	105.0	126.8	47.0
Sohawa	44	–	69	–	69	–	67	249	1965-67	1967-69	801.0	1102.0	129.0
									1965-67	1967-69	9-6.0	1228.8	123.0
Lower-Hujjan	6	–	19	–	16	–	10	51	1966-67	1968-69	183.0	231.0	103.0

Kot Moman	15	–	52	–	64	–	101	232	1969-70	1970-72	947.0	1173.4	95.0
Shah Jiwana	22	–	53	–	59	–	109	244	1970-71	1972-73	987.0	1133.0	89.0
Ara	24	–	64	–	87	–	156	331	1970-71	1972-73	1368.0	1663.8	84.0
Total											1564.5	1803.4	–
SCARP II	242	53	512	56	599	43	695	2205	1962-71	1963-73	6856.0	8710.7	–
											2.5	2.6	–
											8423.0	10516.7	–

Adopted from Pump and Tubewells Performance Report SCARP-II 1983-84, Monitoring and Evaluation Research and Development, WAPDA, Lahore.

TABLE–II.

Statement Showing percentage of area with different depth of water from N.S.L. in Chaj Doab. (June)

Year.	0–5′	5–10′	More than 10′
1974	4.77	28.85	66.38
1975	0.8	47.03	52.89
1976	10.80	42.17	47.03
1977	9.05	50.74	40.21
1978	12.00	44.00	44.00
1979	15.00	40.00	45.00
1980	7.00	53.75	39.25
1981	7.50	50.00	42.50
1982	16.25	41.25	42.50
1983	15.00	45.00	40.00
1984	6.40	54.50	39.10

ii) Reduction in tubewell pumpage i.e. 2.06 M.A.F. in 1974-75 to 1.95 in 1982-83.

iii) Higher rain fall after 1973-74.

Table–III shows annual pumpage, quantity of water pumped and utilization rate of tubewells during the year 1974-75 to 1984-85.

However the water logged area having depth to water within 0.5' has again been reduced to 6.4% during 1984 as a result of less rain fall and increased pumpage.

ADDITIONAL IRRIGATION WATER SUPPLIES AND CROPPING INTENSITY.

The cropping intensity increased to 120.6 percent during 1982-83 from 86-7 in the pre-project year 1963-64. Figure-4 shows the increasing trend in cropping intensity. The intensity achieved is far less than the projected figure of 135 percent. The slow rise may be attributed to the introduction of relatively higher delta crops, deficient and erratic irrigation supplies, unplanned cropping pattern and lack of proper infra-structure and agricultural inputs.

OPERATION OF TUBEWELLS.

The average expected life of tubewells in SCARP-II was estimated about 12 years whereas most of the tubewells have outlived beyond their normal expected life. However the reduction in discharge is a natural consequence.

The number of tubewells have deteriorated discharge is shown in Table-IV. It would be seen that during 1983-84 about 90% of the total tubewells installed in the fresh water areas had discharges within 80% of the designed discharge. The

TABLE-III.

Statement Showing Annual Pumpage, Quantity of Water Pumped and Utilization Rate of T/Wells.

Year.	Annual Installed capacity) (acre feet).	Actual pumpage Kharif (acre feet)	Rabi (acre feet).	Total acre feet.	% age utilization	Intensity Pre-project	Achieved
1974-75	4633700	1174749	1259797	2434546	52.54	86.7%	108.81 %
1975-76	4576068	1037816	880472	1918288	41.92		105.95 %
1976-77	4526853	866552	920197	1786749	39.47		110.34 %
1977-78	4636114	927282	802916	1730198	37.32		109.33 %
1978-79	4630084	907183	909702	1814845	39.24		113.55 %
1979-80	4694756	1053329	971050	2024379	43.12		116.00 %
1980-81	4631241	1016526	915628	1932154	41.72		117.50 %
1981-82	3642492	1065243	828853	1894096	52.00		120.00 %
1982-83	4503427	999964	826626	1826590	40.56		120.60 %
1983-84	4537805	882747	1146106	2028853	44.71		–
1984-85	4512064	1266333	1164766	2431099	53.88		–

The values given are based on the field data of SCARP-II.

TABLE-IV

Schemewise analysis of reduction in discharge capacity of tubewells in Scarp-II during 1983-84.

	Scheme	Screen Material	No. of considered Tubewells	Discharge capacity of tubewells (gpm)		Reduction discharges capacity of tubewells since acceptance tests (gpm)			
				Acceptance tests	Subsequent tests	Components			Total
						Lowering SWL	Well deteri-Oration	Pump defect	
1.	Lalina	M.S.	95	175902	117283	+2534	31836	29317	58619
						(+ 1.4%)	(18.1%)	(16.6%)	(33.3%)
2.	Khadir	M.S.	32	53510	35613	325	12075	5297	17897
						(1.0%)	(22.5)	(9.9%)	(33.49)
		F.G.	76	173413	121899	2127	15121	34266	51514
						(1.2%)	(8.7%)	(19.8%)	29.7%)
		Total:	108	226923	157512	2652	27196	39563	69411
						(1.1%)	(12.0%)	(17.4%)	(30.5%)

3.	Phalia	M.S.	13	28191	15053	621	6564	5953	13138
						(2.2%)	23.3%)	(21.1%)	46.6%)
		F.G.	67	156524	108204	3602	20336	24382	48320
						(2.3%)	(13.0%)	(15.5%)	(30.8%)
		Total	80	184715	123257	4223	26900	30335	61458
						(2.3%)	(14.5%)	(16.4%)	(33.2%)
4.	Busal	F.G.	98	247897	162383	+372	26091	59795	85514
						(+0.1%)	(10.4%)	(24.1%)	(34.4%)
5.	Sohawa	M.S.	–	–	–	–	–	–	–
		F.G.	47	113133	64806	806	22307	25214	48327
						(0.7%)	(19.7%)	(22.3%)	42.7%)
6.	Lower HUjjan	F.G.	8	16091	13098	+204	315	282	2993
						(+1.2%)	(1.9%)	(17.9%)	(18.6%)
7.	Kot Moman	F.G.	41	97911	85505	895	2441	9070	12406
						(0.9%)	(2.4%)	(9.33%)	(12.6%)
8.	Shah Jewana	F.G.	175	362501	236145	19551	60170	46095	136350
						(5.34)	(16.7%)	(12.83%)	(34.8%)
9.	Ara	FG.	230	521473	419975	9991	35918	55589	10149
						(1.9%)	(6.8%)	(10.7%)	(19.4%)

Total:	M.S.	140	257603	167949	+1388	50475	40567	89654
					(+0.5%)	(19.6%)	(15.7%)	(34.8%)
Total:	F.G.	742	1688934	1212015	36396	183239	257293	476928
					(2.2%)	10.8%)	(15.2%)	(28.2%)
Grand Total:	MS + FG	882	1934546	1379964	35008	233714	297860	566582
					(1.8%)	(12.0%)	(15.3%)	(29.1%)

Adopted from pump and Tubewell performance report.

SCARP-II 1983-84, Monitoring and Evaluation Research and Development, WAPDA, Lahore.

aggregate discharge capacity of the whole project had reduced to 7136 cusecs, which was 15.3 percent less than the designed capacity of the project i.e. 8423 cusecs.

REHABILITATION OF TUBEWELLS

Like any other machinery the servicing and rehabilitation of the tubewells is considered essential with the passage of time. The deterioration in discharge due to Bio Chemical action sets in and in case suitable measures are not taken well intime, the specific capacity of tubewell i.e. discharge per foot of draw down reduces and the pumpage becomes un-economical with the reduced discharge.

The deterioration of wells is generally due to factors as enumerated below:-

a) Invasion of the gravel pack by fines from the aquifer 'bridging' that reduce the permeability of the pack.

b) Incurstation i.e. deposition of carbonates in the gravel pack adjacent to the face of the screen.

c) Possible growth of salime-forming and filament algea or iron bacteria that block the pack.

d) Blockage of slots or structural damage to mettalic screens by corrosion.

e) Break in casing or screen.

f) Changes in aquifer characteristics.

g) Combination of the above.

In number of cases the defects in pumping machinery also result in reduction of discharge.

Since the commissioning of tubewells in various schemes of SCARP-II, the number of dead tubewells and tubewells having discharges less than 25%, 25-50% and above 50% of the designed capacity is shown in Table-V. It would be seen that though most of the tubewells have outlived their normal expected life span yet their performance is satisfactory. However in future it is anticipated that the number of dead tubewells will increase more rapidly with the passage of time as most of the schemes have been in operation for more than 15 years.

The existing techniques deployed for rehabilitation and servicing of tubewells include a variety of mechanical and chemical methods or combination of both. It is generally experienced that when the reduction in discharge has just set in the recovery by rehabilitation is more effective. When a tubewell has deteriorated to a considerable extent and the pumping is less than 50% or below, the chances of rehabilitation are considerably reduced. therefore periodic rehabilitation and servicing of tubewells is a pre-requisite for prolonged life of tubewells.

SALINE ZONE TUBEWELLS.

In Saline Zone areas of SCARP-II, 821 and along R.Q. Link, 40 tubewells were installed during the year 1976-80. The Saline Zone project covers a gross area of 6.47 lac acres lying in Sargodha District (Gigure-1). Considering the quality of effluent, tubewells installed along distributries, minors and water courses, were of low capacity viz 0.5 cusecs to 1 cusec whereas the capacity of drainage tubewells located along drains was of 2.5 cusecs each.

There are two types of tubewells installed in Saline Zone i.e.:

TABLE–V.

Statement Showing No. of dead T/Wells and T/Wells haing discharge from 0–50%, 51–80%, 81–100% in SCARP II.

Year	Total No. of T/Wells.	T/Wells which have ceased to be functional due to		Total	%age
		Bore damaged	Deteriorated T/Wells having discharge below 50%		
1973-74	2087	51	21	72	3.6
1976-77	2087	78	68	146	7.0
1977-78	2087	92	74	166	7.9
1981-82	2184	163	142	305	13.9
1982-83	2184	179	137	316	14.4
1983-84	2191	191	139	330	15.0

T/Wells falling under discharge reduction ranges of designed discharge Ending 1983-84.

Present Discharge.	No. Of tubewells.			Total Tested
	Lalian T.O.D.*	Sargodha T.O.D.	Mandi Bahauddin T.O D.	
0-50 %	45	25	69	139
51-80%	78	86	167	331
81-100%	452	530	574	1550

* Tubewell operation Division.

1. Deep Tubewells along drains.

2. Shallow tubewells along distributries, minors and water courses.

Within a few years of installation of these tubewells, large number of break downs took place due to corrosion and incrustation of the turbine pumps and mild steel bousing pipes. Mostly the mild steel reducer connecting the fiber glass screen and mild steel housing was affected. Figure-2 shows the photograph of column pipes attacked by corrosion.

The deterioration was so alarming that WAPDA had to undertake repairs and modifications of the tubewells within a few years of installation.

The mild steel shafts of turbine pumps had to be replaced by stainless steel, shafts alongwith epoxy resin coating on column pipes to guard against corrosion, which was not only time consuming but very costly also.

The life span of tubewells in saline zone is expected to fall much short of the estimated life of 12 years in the project. Out of a total of 782 tubewells about 200 tubewells have deteriorated in discharge upto 50 percent and about 30 tube-wells have been rendered bore damaged.

As based on the observations and field data suitable measures are deemed essential to overcome the problem of fast deterioration of saline zone tubewells for future and for replacement of existing dead tubewells. These are;

1. Use of inert material PVC/Fiber Glass from bottom to top viz screen and casing both of the same material.

2. Shallow low capacity 0.5 to 1.00 tubewells within possibly 100 feet depth instead of 200 to 250 ft. deep tubewells with capacity of 2.5 cusecs.

3 Use of centrifugal pumps instead of costly turbine pumps as centrifugal pumps can be replaced after 3-4 years of useful life.

OPERATIONAL PROBLEMS.

Some of the operational problems as based on the field experience are summarized below:

1. Tubewell Operators.

The Tubewell Operator plays a vital role in efficient operation & maintenance of the T/Well. He is required to reside at tubewell site and provide round the clock vigil. This objective has however, not been achieved because in most cases tubewells are located at un-attractive and far flung places having no incentive to keep the operators present day and night. Action against the defaulters suffer due to dual application of Industrial Relations Ordinance and E&D rules.

To overcome the problem for smooth and orderly functioning of SCARPS, they should only be governed by E.& D. Rules like other regular employees alongwith incentives in the form of better facilities etc

For future schemes it would be more appropriate and practicable to have one operation room for a group of 6-10 tubewells where operations are supervised round the clock with control pannels and instruments to overcome the difficulty of absentee operators and related problems. The operation records will also be more reliable and authentic.

The field staff though they have been made regular yet the service rules of various categories of field staff have not been prescribed, which requires to be framed to ensure prospects of promotion.

2. **Career Planning.**

Engineers of Irrigation Department should be associated with WAPDA in the Planning and Execution of future Scarp projects. This will not only provide them with background of the SCARP stretegy but would also be helpful in the better maintenance and operation of these projects.

Staff be provided with suitable opportunities of specialized practical training as well as acedemic training to better understand the SCARP stretegy, local as well as foreign training can be gainfully utilized for this purpose.

3. **Load Shedding.**

Due to limited energy resources and ever increasing energy demands load shedding has almost become a regular feature. During winter season when generation of electric energy falls short of the requirements, frequent closures and reoperation of tubewells coupled with erratic energy supplies results in excessive burning of motors causing great set back to the operational efficiency of the tubewells. The load shedding hours generally ranging from S-12 hours a day, keep on changing and a lot of difficulty is experienced to keep the operators watchful and save the machinery from damage as well as to utilize the available working hours to the maximum to sustain the level of irrigation in the area. Intermittent supplies for a few hours render the use of tubewells ineffective for irrigational use.

4. **Transformers and Electrical Faults of Tubewells.**

The delay in rectifying the electric faults particularly; transformer faults, constitutes a great restraint in smooth operation of tubewells. At times 3 to 6 months are required to get the transformers repaired or replaced. It would be more appropriate if seperate cell of WAPDA is made responsible to look after the SCARP tubewells thereby reducing the time in attending to the electrical faults. Statement

showing tubewells remaining out of operation due to transformer defects during 1984-85 is shown in Table-VI.

5. Theft of Components of Tubewells

Theft of starter components of tubewells due to lack of proper watch and ward by Operators is quite common. Despite best efforts a number of theft cases occur every year. Once a component has been stolen the procedural bottle-necks make it impossible to put the tubewell back in operation by providing a new component unless the case is registered by the police, copy of F.I.R. is supplied and the investigation is finalized by the police, which results in inordinate delay in re-operation of tubewells.

6. Technical Problems.

The tubewell water is discharged at the outlet head for admixture with canal water and used for irrigation The water course linking the tubewell water with the canal water course generally joins at right angle. The abrupt entry of 3 to 5 cusecs tubewell water in canal water causes considerable afflux and back water effect entailing reduction of working head of outlet. In many cases modularity of the outlet is totally upset and withdrawal from the canal is considerably reduced. This defect of construction requires to be studied and suitable modifications at the juncture of canal and tubewell water courses are necessary to remove the defect and maintain full withdrawal of the outlet from the channel.

CONSTRUCTION OF TUBEWELLS.

General.

For the construction of tubewells the design and depth is mainly dependent upon the required discharge, geohydrological properties of the aquifer etc. In the

TABLE–VI.

STATEMENT SHOWING MONTHWISE TRANSFORMERS BURNT IN SCARP–II DURING THE PERIOD 7/84 TO 6/85.

Month.	T/Wells Installed.	Operable Tubewells.	No. of Transformers burnt.	% Age.
7/84	2184	2023	48	2.3
8/84	2184	2023	34	1.6
9/84	2184	2023	35	1.7
10/84	2184	2023	36	1.7
11/84	2184	2023	34	1.6
12/84	2191	2026	24	1.1
1/85	2191	2026	40	1.9
2/85	2191	2026	26	1.2
3/85	2191	2026	23	1.1
4/85	2191	2026	35	1.7
5/85	2191	2026	32	1.5
6/85	2191	2026	40	1.9
			407	
	Total Average per month		34	1.6

Punjab Plain the aquifers are quite transmissive and the ground water generally occurs under water table conditions. Generally it is possible to install tubewells ranging from 1-5 cusecs capacity within less than 100 feet depth to over 400 feet depth, depending upon the occurence of previous strata.

In SCARP-II, tubewells in fresh water areas ranging from 2 to 5 cusecs capacity were installed with an average capacity of 3.7 cusecs. These tubewells were installed invariably with deep turbine pumps to allow for lowering of water table to greater depths of 30 to 40 feet below N.S.L. However, it soon became evident that lowering of the water table to such great depths was neither feasible nor practicable in view of the increased cost of pumpage and hydrologic factors.

Capacity of Tubewells

It is recognized that though large capacity deep tubewells render the project cost more economical but their maintenance and operation is rather cumbersome and costly.

The advantages of having small capacity tubewells are, better command and control, higher irrigation efficiency and elimination of lengthy water courses, lessor distribution losses and low power consumption charges.

Presently in the SCARP areas, to achieve water table control and for economical pumpage the depth to water table is required to be maintained between 10-15 feet with an average of about 12.5 feet. It has also been felt necessary to install small capacity tubewells i.e. 1.5 to 3 cusecs capacity whenever a large capacity tubewell is to be replaced. However, in case a large capacity tubewell is already serving only one outlet then it is not split up to avoid chak- bandi, warabandi and other problems.

Another advantage achieved by res-tricting the depth of the tubewells was relatively better quality of ground water. In most of the situations fresh water is over-lying the saline water at greater depth and with the passage of time and greater magnitude of pumpage, the quality is liable to deteriorate due to upconing of saline water. In the past situation arose at about 70 sites and the tubewells had to be abandoned as these tubewells started prepaying brackish water.

Selection of Material

The choice and selection of suitable material for construction of tubewells has remained under studies by various formations for a long time. Initially mild steel screen and casing was used but subsequently with a view to check corrosion and incrustation, screen made of inert material was adopted. Table-IV shows the schemewise performance of tubewells in SCARP-II installed with mild steel and fiber glass screen. The well deterioration in case of mild steel screen was more pronounced as compared to fiber glass screen. It would be seen that whereas well deterioration in case of mild steel screens ranged from 18.1% to 22.5%, for fiber glass it ranged from 8.7% to 19.7%.

Section of Pump.

SCARP tubewells in fresh water areas were mostly installed with turbine pumps to cater for greater draw downs and anticipated lowering of water table. However with the change of considerations that water table is to be lowered and maintained at an average depth of about 12 feet and the small capacity tubewells are to be installed, it has become possible to resort to the use of centrifugal pumps. It would not only be more economical to install tubewells upto 1.5 to 2.0 cusecs capacity were-ever the depth to water table and anticipated draw downs permit the use of these pumps. The centrifugal pumps are easier to maintain at lessor cost.

The use of centrifugal pumps is also considered more appropraite for small

capacity shallow drainage tubewells in saline zone where incrustation and corrosion of turbine pumps is rather common. As the lowerting of water table in saline zone is only to be achieved to the extent of eradication of water logging, the use of centrifugal pumps is considered highly economical in view of the lesser capital and maintenance cost.

References.

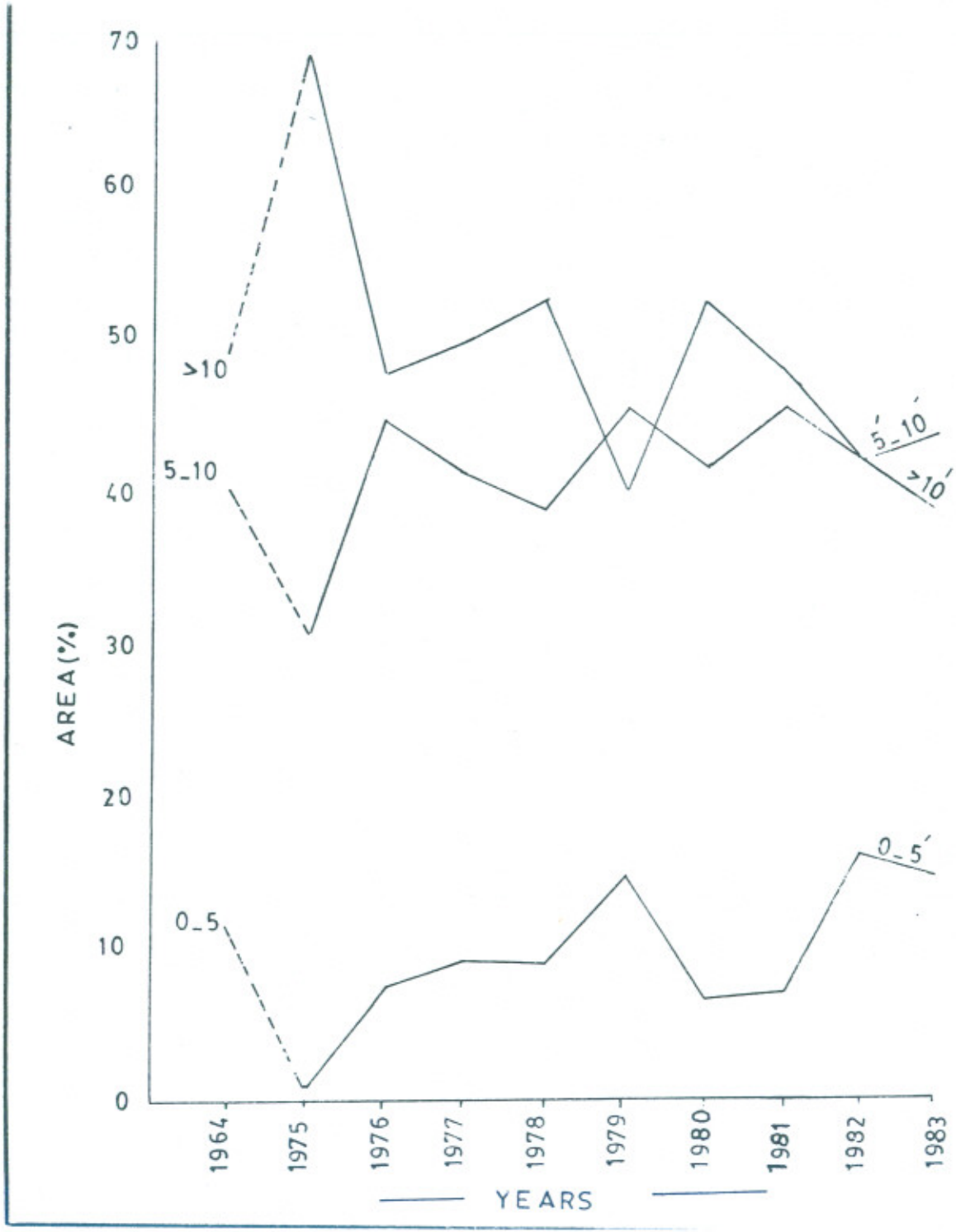
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SCARP – II

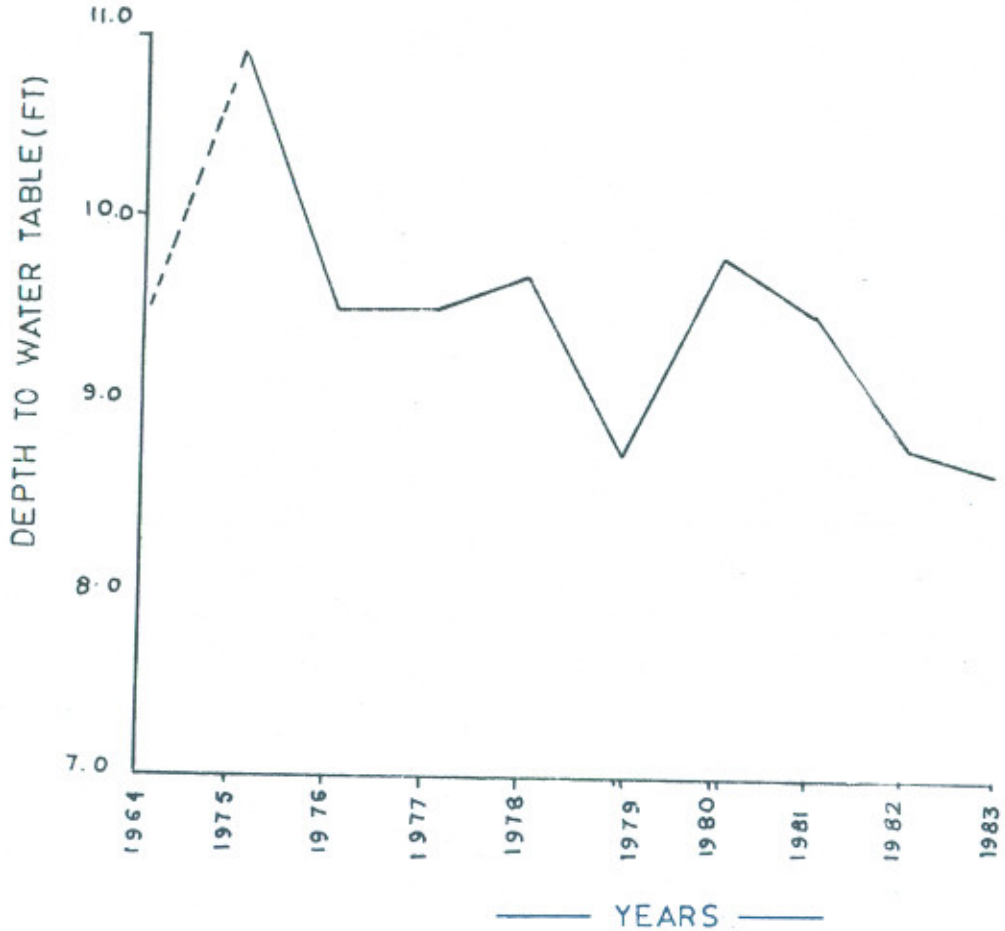
DEPTH TO WATER TABLE
IN JUNE (%)

ADOPTED FROM SCARPS
MONITORING AND EVALUATION M & E R & D
WAPDA LAHORE

FIG: 3

SCARP II

AVERAGE DEPTH TO WATER TABLE IN JUNE (FT)



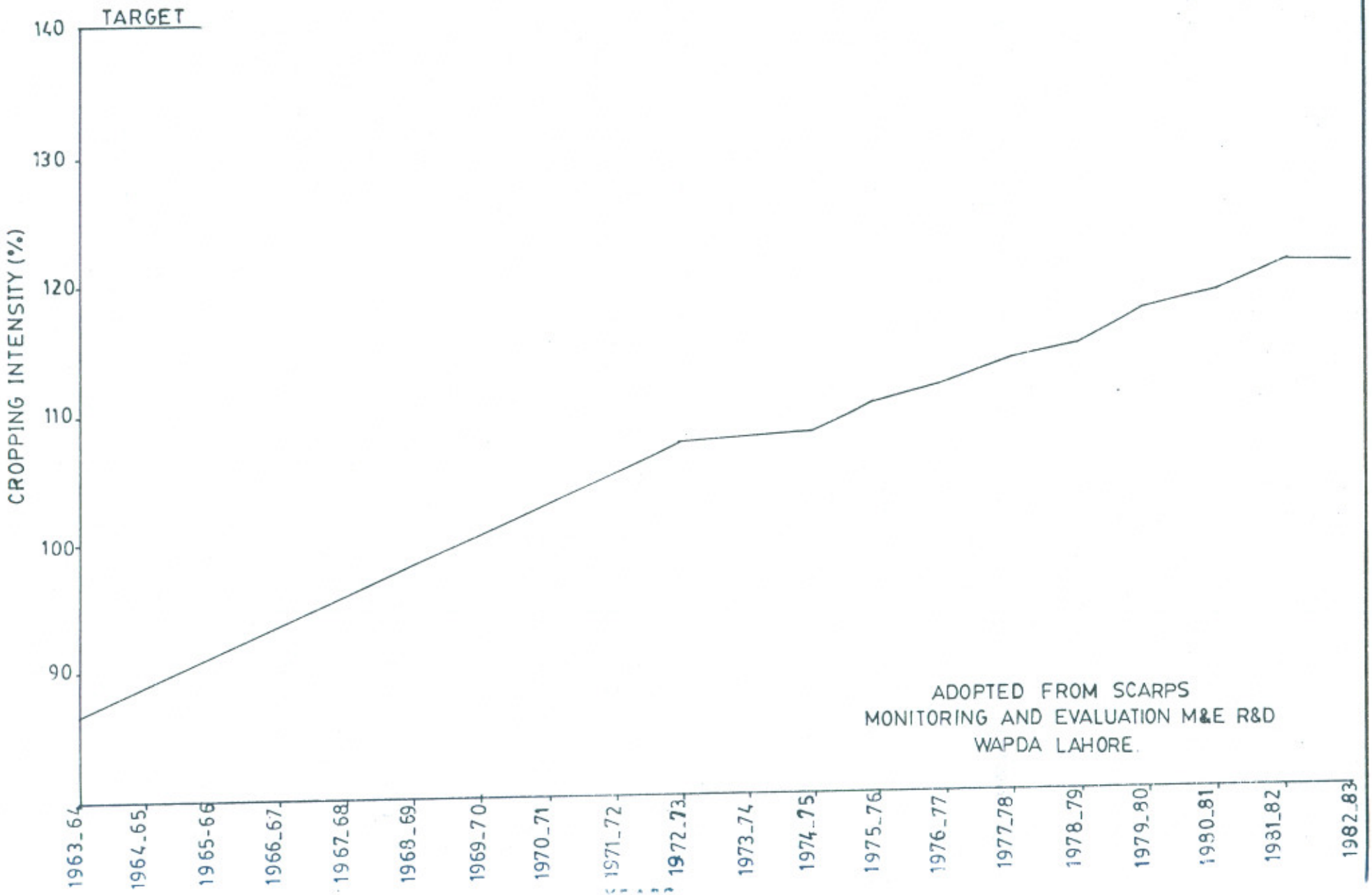
ADOPTED FROM SCARPS
MONITORING AND EVALUATION M&E R&D
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FIG 4

SCARP_II

CROPPING INTENSITY
(% OF C. C. A)



ADOPTED FROM SCARPS
MONITORING AND EVALUATION M&E R&D
WAPDA LAHORE.

INDEX PLAN

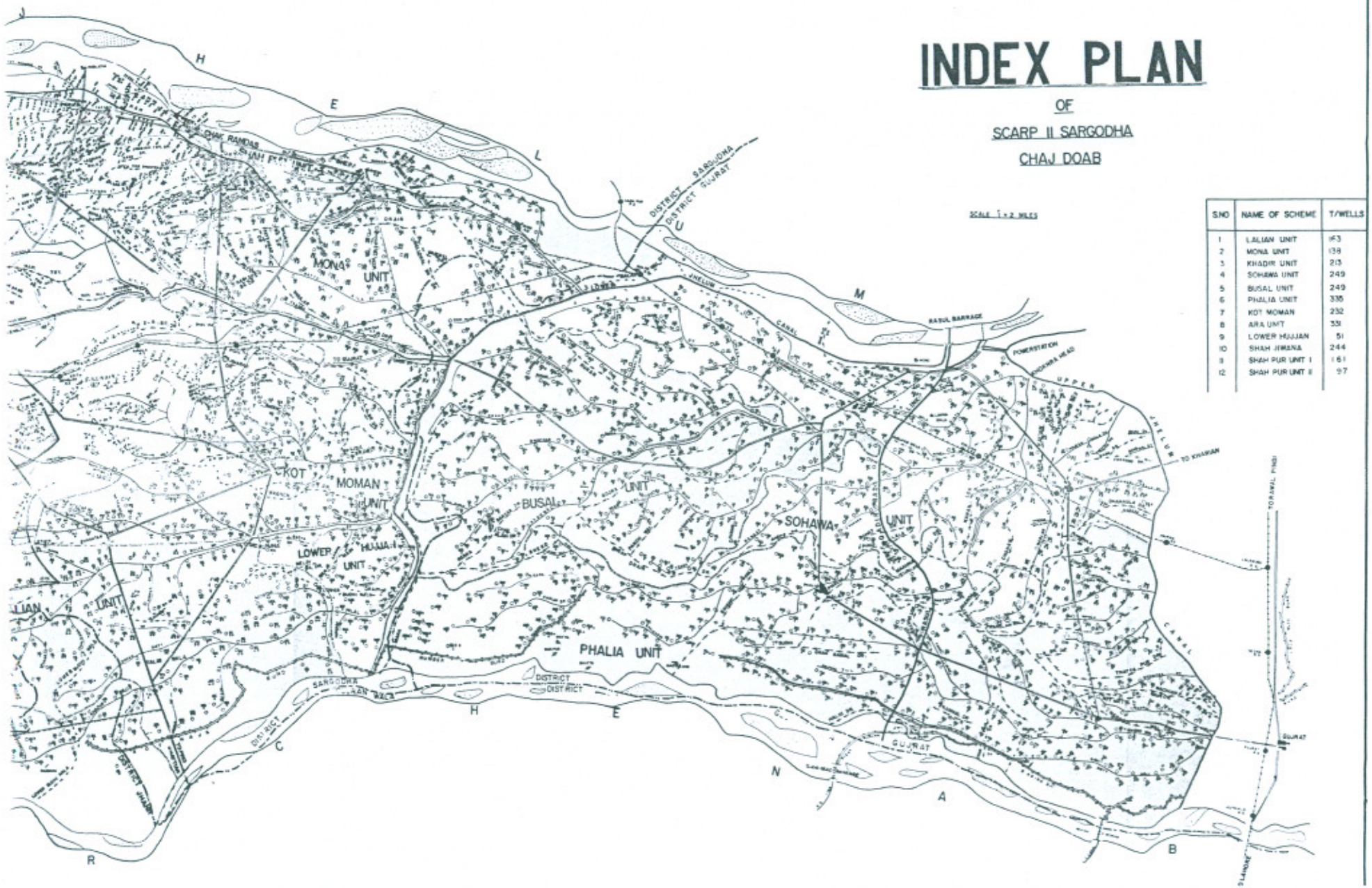
OF

SCARP II SARGODHA

CHAJ DOAB

SCALE 1 = 2 MILES

S.NO	NAME OF SCHEME	T/WELLS
1	LALIAN UNIT	163
2	MONA UNIT	138
3	KHADIR UNIT	213
4	SOHAWA UNIT	249
5	BUSAL UNIT	249
6	PHALIA UNIT	335
7	KOT MOMAN	232
8	ARA UNIT	331
9	LOWER HUJJAN	51
10	SHAH JIWANA	244
11	SHAH PUR UNIT I	161
12	SHAH PUR UNIT II	97




REFERENCES
DETAIL OF TUBEWELLS IN SALINE ZONE AREA
SHAH PUR UNIT
SALINE ZONE AREA
JHANG
SARGODHA
JIWANA UNIT
SHAH
KHADIR UNIT
LALIAN UNIT
KHOT
CHAK RAHEJA
DISTRICT JHANG
RIVER

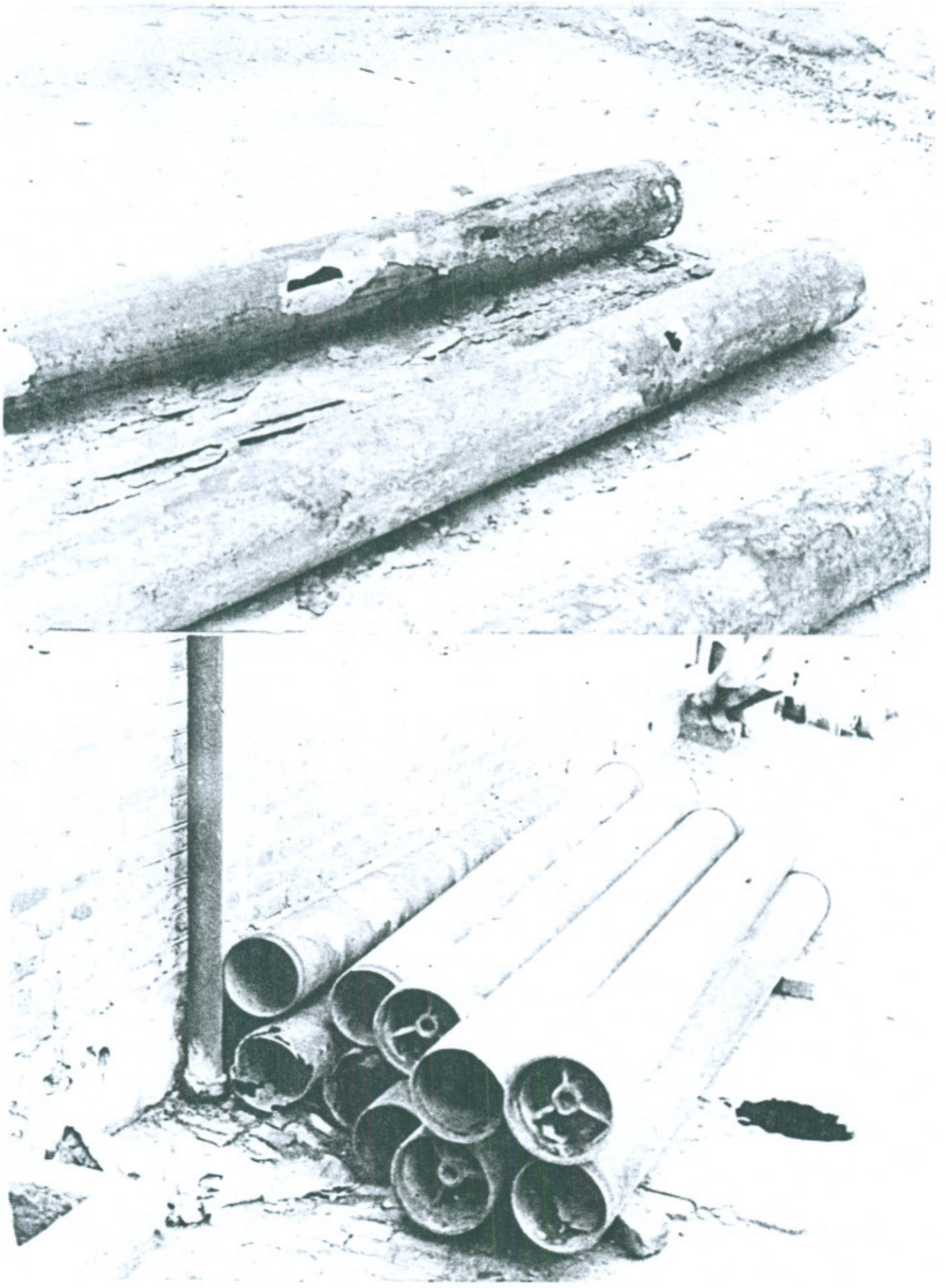


Fig-2 Showing column Pipes affected by corrosion and incrustation, in Saline Zone of SCARP-II.