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IRRIGATION SYSTEMS MANAGEMENT RESEARCH (ISM/R) PROJECT

FINAL REPORT

PUBLIC AND PRIVATE TUBEWELL PERFORMANCE

- A Data Base of SCARPs Tubewells
- The Preparation of Computerized Database for SCARPs Tubewells
- Development of Methods of Tubewells Rehabilitation
- Factors Associated with Deterioration of SCARP Tubewells

SCARPs Monitoring Organization
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A DATA BASE OF SCARP TUBEWELLS

SCARPS MONITORING ORGANIZATION

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FOREWORD

As part of its activities, under the Irrigation System Management Research Project (ISM/R) financed by the US AID , the SCARP Monitoring Organization, which has been carrying out the monitoring of the SCARP Tubewells, has created a large data base covering the constructional features and characteristics of the tubewells and complete time-series record of their performance including the results of the chemical analyses of the tubewell waters conducted over time.

While the number of tubewells originally installed under the SCARPs exceeds 13000, the constructional record that has been fallen in the data base covers 7137 tubewells in the Punjab. The constructional record of wells that had been replaced has not been taken in the data base, as it was not easily accessible.

The time series data about of well performance and ground water quality, however, covers 12065 originally installed tubewells and 1514 replaced tubewells.

This publications brings out the information in the data base and its extent. The data may be accessed by perspective data users for their specific purposes.

Chief Engineer,
SMO.

ACKNOWLEDGEMENTS

The author expresses his appreciation to the Government of Pakistan and USAID through the International Irrigation Management Institute (IIMI) for their financial support of this study. Technical assistance from IIMI-Pakistan through its staff members. Dr. Edward J. Vander Velde and Mr. Badruddin was helpful in guiding the study. The contribution of Mr. Waseem Ahmed Chishty and Muhammad Naeem Research Assistants in the development of database system and of Mr. Munir Ahmed, Stenographer, for typing are also acknowledged. The author acknowledges also the guidance and facilities provided by Mr. Muhammad Ishaq Khan Niazi, Chief Engineer SCARPs Monitoring, and under him by Mr. Muhammad Memon, Senior Geologist, Salinity Control and Reclamation Projects.

A DATA BASE OF SCARP TUBEWELLS

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I. INTRODUCTION

As part of its activities, under the Irrigation System Management Research Project (ISM/R) financed by the US AID, the SCARP Monitoring Organization, which has been carrying out the monitoring of the SCARP Tubewells, has created a large data base carrying the constructional features and characteristics of the tubewells and complete time-series record of their performance including the results of the chemical analysis of the tubewell waters conducted over time.

While the intention was to check a sufficiently large and diverse data base for investigating the causes of well deterioration, the data base as developed is expensive enough be used for many other analytical purposes. It also provides a ready means for retrieving data of interest selectively. Although country wide the number of tubewells originally installed in SCARPs is over 13000, (of which 1500 have been replaced). The constructional record that has been taken in the data base covers 7137 all the original compute tubewells in all SCARPs Projects in the Punjab. The constructional record of SCARP tubewells in other provinces and those that has been replaced has not been taken in the data base as it was not easily accessible.

* Junior Geologist SCARPs Monitoring, WAPDA

The time series data about well performance and ground water quality is, however, more expensive and covers 12065 original tubewells and 1514 replaced tubewells in all the SCARPs.

This publication brings out the specifics and coverage of the data has been entered in the data base and the way the data base has been set up.

Information has also been included for prospective data users and how to access any particular data.

II. SET UP OF THE DATA BASE

The data base has been developed by using the software Dbase-III plus a relational data base program developed by and registered to Ashton-Tate, which has the facility for relative retrieval of data according to specific criteria.

III. DATA COVERAGE AND SOURCES OF INFORMATION

That data in the data base consists of :

1- Tubewell construction record

2- Tubewell Performance Record and

3- Chemical Analysis, Tubewell Waters.

The information relating to tubewell construction (Lithology, Tubewell Constructional Features, Tubewell

Development, Initial Well Performance and Well Equipment, has been obtained from the, construction files of individual tubewells in which all relevant information has been recorded on standard forms of the time of well construction, and equipment installation.

The information about tubewell performance, based on subsequent short specific capacities tests, was obtained from the ledgers maintained by the SMO.

The results of the chemical analysis of the tubewell waters, carried out by SMO, were similarly obtained from the ledgers maintained by the SMO.

IV ORGANIZATION OF DATA

The data base was designed to be organized in five computer data base files, regarding well performance, well construction, water quality, well equipment and well lithology. All available public tubewells data, collected from different WAPDA and irrigation Department records were organized under the categories shown in Table-1 to 4.

V. INFORMATION IN DATA FILES

The data has been organized in five data files and these data files have the following information:

Well Performance File:

The data in this file cover measurement, discharge, static and pumping water levels and the inferred specific capacity during the short specific capacity tests.

Well Construction File:

The data in this file covers design capacity, construction agency, drilling method, bore hole diameter, well depth, length and diameter of screen,housing pipe length, screen slot length and width, slot orientation, number of slot per foot of screen, well development method, hours of well development, and final acceptance test data.

Water Quality File:

The data in this file cover the sampling and results of the detailed chemical analysis of the well water for all the major.

Cations: Ca,Mg,Na,K, as well as Ec,TDS and SAR
Anions: Co3,HCO3,CL,SO4

Well Equipment File:

The data in this file covers:

Pump: Make, Serial No, Depth set, number of stages,

Motor: Make, Serial No, Horse Power, RPM,

Control Box: Make, Serial No.

Well Lithology File:

The data in this file cover the description of the formation materials by depth intervals in the categories of clay, silty clay, coarse sand, medium sand, fine sand and kanker.

VI. DATA COVERAGE

Although about 13,000 tubewells have been installed in the various SCARPs in the country, with quite a few of

these having been replaced, entering on to the data base, their construction data has progressed to include about 7,311 tubewells. The original (as constructed) record of the SCARP tubewells included in the data base under the three files is in table-5.

As far as the time series record (well performance and water quality) is concerned it covers 12,065 tubewells. The time coverage of the data in the data base is shown in Table-6.

For the replaced tubewells, the data coverage of performance record is in table-7. This brings out the number of tubewells for which data are available for varying periods of record from 4 to 15 years. The table brings out that the number of tubewells in the record decrease with time which is due mainly to the progressive replacement of the tubewells.

VII. DATA STORAGE

It is essential that great care and consideration be given to the Organization of data storage and preservation. Data has been stored on a large number of 1.2 to 1.44 megabyte diskettes. The storage system have the facility for selection of a specific item of data at a specific location and also be exampleable to include new well or new data as they become available.

About 30 high density diskettes have been used to store the 13,000 public tubewells data. Three sets of diskettes of each data base files have been made to preserve the data of all SCARPs tubewells. The data of 13000 public tubewells have also been saved on a tap that have sufficient capacity to store all the data of SCARPs tubewells regarding well performance, well construction, water quality, well equipment and well lithology.

VIII. ACCESS TO DATA

After computerization of all SCARPs tubewells, now this massive data has been brought under one roof. About 30 high density diskettes have been used to computerized all the SCARPs tubewells data.

The data can be supplied to any other agency with the prior approval of the Chief Engineer SCARPs Monitoring Organization(SMO). All data in the files are available in the form of soft or hard copy. Any agency or department interested in having any information about any particular tubewell or Scheme or SCARP can access the data base upon request.

Table 1. Public Tubewell data base files.

Field name	Description
Data in well performance file.	
SCARP	Name of Scarp e.g Scarp I, Scarp II.
LOC	Scheme of the Scarp e.g BRW means Beranwala Scheme
WELL NO	Identification Number
SFX	Suffix to the well number e.g A,B,C etc
YY	Years of specific capacity test.
MM	Month of specific capacity test.
ENTRY	A for acceptance and S for subsequent test
PLVL	Pumping level in (ft) from measuring point
WLVL	Static water level in ft.
Q	Discharge during test in gpm.
Data in Well Lithology File	
SCARP	Name of Scarp e.g Scarp I , Scarp II etc
LOC	Scheme of the Scarp e.g BRW means Beranwala
WELL NO	Identification Number
SFX	Suffix to the well number e.g A,B,C etc
DFROM	Depth started,Starting point of the log
DTO	Depth end, ending point of the formation
SAND1	First type of formation
SAND2	Second type of formation

Table 2. Data in Well Construction file.

Field Name	Description
SCARP	Name of the Scarp
LOC	Scheme of the Scarp
REP	This code has been used for replaced tubewells.
CONTRACTOR	This field represent the agency name involved in Tubewell construction.
DRILMETHOD	Type of drilling method RR represent reverse rotary, PC for percussion
DRILHRS	Drilling time in (hours)
COMPDATE	This is the date of Tubewell completion.
GBAGUSED	Gravel bags used around the screen of the tubewells
DEVMTHD	Development method e.g raw hiding or air surging RH represent raw hiding, AS for air surging.
DEVHRS	Development time in (hours)
DEVSAND	Development sand 0 represent free from sand 1 represent traces -1 represent data not available
IEC	Initial electrical conductivity
FEC	Final electrical conductivity
DEVMTHD2	Development method no 2 (Air surging)
DEVHRS2	Development hours of the method no 2 (Air surging)
BOREHOLE	Bore hole diameter in inches
DEPTH	Depth of the well in feet.
HOUSLEN	Housing pipe length in inches
HOUSDIA	Housing pipe diameter

BLKCASDIA	Blank casing diameter in inches (10" diameter of casing)
BLKCASDI8	Blank casing diameter in inches (8" diameter of casing)
BLKCASLE8	Blank casing length of the eight inches diameter.
BLKCASLEN	Blank casing length of the ten inches diameter.
SLTCASDIA1	Diameter of the screen of ten inches diameter.
SLTCASDIA2	Diameter of the screen of eight inches diameter
SLTCASLEN1	Length of the screen of ten inches diameter.
SLTCASLEN2	Length of the screen of eight inches diameter.
HOSMAT	Housing pipe material MS represent mild steel.
SCRMAT	Type of screen material MS: mild steel FG: fiber glass BR: brass PVC: pvc
SCRSLOTW1	Width of the screen of ten inches diameter in inches.
SCRSLOTW2	Width of the screen of eight inches diameter in inches.
SLOTL1	Length of the slot in inches of ten inches screen diameter.
SLOTL2	Length of the slot in inches of eight inches screen diameter
NOSLOT1	Number of slot of the ten inches screen diameter.
NOSLOT2	Number of slot of the eight inches screen diameter.
SCROPEN	Open area in percentage of the screen

SCRORIENT	Screen slot orientation V: vertical slot D:diagonal slot H:horizontal slot
MPAGLEVEL	Measuring point above ground level in ft
SWLBMP	Static water level below measuring point
FATDD	Draw down in feet at the time of first acceptance test.
FATSND	Sand contents at the time of acceptance test. 0 for free from sand 1 for traces
QDESIGN	Design discharge in cusecs
QACTUAL	Actual discharge in gpm.

Table 3. Data in Water Quality file

Field name	Description	Field Name	Description
SCARP	Name of Scarp	PH	PH
LOC	Name of Scarp Scheme	RSC	Residue sodium carbonate
WELLNO	Identification of well number	SAR	Sodium absorption ratio
SFX	Suffix to well no	Q	Discharge
LABNO	Laboratory number	DEPTH	Depth
LABYR	Laboratory year	TEMP	Temperature
SAMPDATE	Date of sample test		
CA	Calcium		
MG	Magnasium		
NA	Sodium		
K	Pottasium		
CO3	Carbonate		
HCO3	Bicarbonate		
CL	Chloride		
SO4	Sulfate		
NO3	Nitrate		
F	Flouride		
CATIONS	Cations		
SIO2	Silica		
FE	Iron		
B	Boron		
TDS	Total dissolved solids		
EC	Electrical conductivity		

Table 4 Data in Well equipment file

Field name	Description
SCARP	Name of Scarp
LOC	Scheme Name
WELL NO	Identification of the well
SFX	Suffix to the well no e.g A,B,C etc
DISCHARGE	Design discharge
DATE	Date of installation of the equipment
PUMP	
MAKE	Name of the Manufacturing company
SERIALNO	Serial number of the pump
BOWLDIAM	Bowle diameter in inches
BOWLALENTH	Length of the Bowle assembly in ft
NOOFSTAGE	Number of stages
DEPTHSET	Setting depth of the bowl assembly
MOTOR	
MAKE1	Name of the manufacturing company.
SERIALNO1	Serial number of the motor
HP1	Horse power of motor
RPM1	Revolution per minute of motor
CONTROL BOX	
MAKE2	Name of manufacturing company
SERIALNO2	Serial number of control box cabinet
HP2	Horse power of the control box.

Table 5. Status of data availability in database (original record)

Sr. No.	SCARPs	Schemes	Total No. of wells	Well Construction Computerized data	Well Equipment Computerized data	Well Lithology Computerized data
1	SCARP-I	Beranwala	129	126	127	70
2		Chichokimallian	12	0	10	10
3		Chukarkana	25	0	23	15
4		Hafizabad	321	320	290	225
5		Harse Sheikh	46	45	43	24
6		Jaranwala	133	9	133	80
7		Khanqah Dogran	213	209	210	163
8		Pindi Bhattian	21	6	20	17
9		Sangla Hill	236	232	233	120
10		Shadman	152	89	150	92
11		Shahkot	378	375	283	85
12		Zafarwal	403	390	400	220
1	SCARP-II	Ara	331	331	330	150
2		Busal	248	240	212	0
3		Khadir	213	213	92	213
4		Kot Moman	232	232	230	0
5		Lalian	163	163	160	163
6		Lower Hujjan	51	51	50	0
7		Mona	138	138	137	138
8		Phalia	335	335	100	0
9		Shah Jewana	244	244	0	0
10		Sohawa	249	249	245	0
1	SCARP-III	Alipur	552	541	363	0
2		Kot Adu	523	523	522	0
3		Rangpur	582	549	580	528
1	SCARP-IV	Mangantwala	341	312	311	311
2		Muridke	656	624	622	627
1	SCARP-V	Khairwala	48	33	45	0
2		Satiana	71	0	70	0
3		Shorkot K.P.	101	98	95	57
	SCARP-VI	Allahabad	672	576	0	382
1	SUKH BEAS SCARP	Sukh Beas	101	26	99	26
1	SCARP-VIII	Minchanabad-I	100	32	20	48
2		Minchanabad-II	126			
		Grand Total	8146	7311	6209	3764

Table 6. Status of data availability in database (time series record)

Sr. No.	SCARPs	Schemes	Total Nos. of Wells	Comput-erized	Period of Constr-uction	Period of Perfor-mance	period of Water Quality data
1	SCARP-I	Beranwala	129	129	1960	1960-1991	1960-1989
2		Chichokimallian	12	12	1960	1960-1988	1961-1989
3		Chukarkana	25	25	1955	1965-1989	1961-1989
4		Hafizabad	321	321	1960	1960-1990	1960-1989
5		Harse Sheikh	46	46	1961	1961-1990	1961-1989
6		Jaranwala	133	133	1960	1960-1991	1961-1989
7		Khanqah Dogran	213	213	1960	1960-1989	1960-1989
8		Pindi Bhattian	21	21	1959	1961-1990	1962-1988
9		Sangla Hill	236	236	1960	1960-1991	1960-1989
10		Shadman	152	152	1961	1961-1990	1961-1989
11		Shahkot	378	378	1961	1962-1991	1961-1989
12		Zafarwal	403	403	1962	1962-1990	1961-1989
1	SCARP-II	Ara	331	331	1970	1970-1990	1970-1985
2		Busal	248	248	1966	1966-1991	1976-1985
3		Khadir	213	24	1965	1965-1989	1967-1985
4		Kot Moman	232	232	1969	1970-1989	1969-1985
5		Lalian	165	165	1963	1963-1989	1964-1985
6		Lower Hujjan	51	51	1966	1966-1989	1976-1985
7		Mona	138	138	1964	1964-1990	1964-1985
8		Phalia	345	345	1946	1966-1990	1972-1985
9		Shah Jewana	251	251	1970	1970-1990	1969-1985
10		Sohawa	261	261	1966	1966-1991	1965-1985
11		Saline Zone	795	725	1978	1978-1990	
1	SCARP-III	Alipur	395	395	1967	1967-1991	1969-1985
2		Kot Adu	523	523	1968	1968-1989	1971-1985
3		Rangpur	582	582	1969	1969-1989	1969-1986
4		Saline Zone	141	135	1977	1977-1990	
1	SCARP-IV	Mangantwala	341	338	1968	1969-1989	1969-1987
2		Murdki	656	656	1967	1969-1991	1971-1987
1	SCARP-V	Khairwala	48	0			
2		Satiana	71	71	1977	1977-1990	1979-1985
3		Shorkot K.P.	101	101	1976	1976-1990	1976-1987
	SCARP-VI	Allahabad	672	666	1977	1977-1990	1976-1987
1	SUKH BEAS	Sukh Beas	101	100	1983	1994-1988	-
1	SCARP-VIII	Minchanabad-I	100	99	1977	1977-1987	-
2		Minchanabad-II	126	126	1979	1980-1987	-
	SIND SCARP		2851	2817	1967	1967-1986	-
			414	407	1973	1973-1987	
1	NON SCARP	Qadirabad	45	45	1979	1979-1989	
2		Rasul Scheme	164	164	1985	1985-1989	
		Grand Total	12430	12065			

Table 7. Period of record for replaced wells

Sr. No.	SCARPS	SCHEMES	Computerized Wells	T/wells after different period			
				4 Years	8 Years	12 Years	15 Years
	SCARP-I						
1		Beranwala	10	9	8	6	1
2		Chichokimallian	9	7	7	7	3
3		Chukarkana	27	19	19	11	7
4		Hafizabad	138	122	114	77	15
5		Harse Sheikh	12	12	9	6	-
6		Jaranwala	32	32	31	19	-
7		Khanqah Dogran	8	7	6	1	-
8		Pindi Bhattian	19	17	16	5	1
9		Sangla Hill	21	20	17	9	1
10		Shadman	59	56	54	38	6
11		Shahkot	34	34	33	21	8
12		Zafarwal	295	272	250	135	16
	SCARP-II						
1		Ara	8	8	7	3	2
2		Busal	5	4	4	1	-
3		Khadir	18	16	13	1	-
4		Kot Moman	4	4	2	1	1
5		Lalian	6	4	3	-	-
6		Lower Hujjan	1	1	1	1	1
7		Mona	3	3	2	1	-
8		Phalia	27	20	9	2	-
9		Shah Jewana	7	7	6	-	-
10		Sohawa	20	19	15	6	1
	SCARP-III						4
1		Alipur	73	54	30	10	7
2		Kot Adu	328	13	10	8	-
3		Rangpur	126	49	27	1	-
	SCARP-IV						
1		Mangantwala	137	128	80	10	-
2		Murdki	87	79	39	9	-
		Grand Total	1514	1016	812	389	74

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THE PREPARATION OF COMPUTERISED DATA BASE FOR SCARPs TUBEWELLS

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1.	Mirza Muhammad Rafiq	Junior Engineer
2.	Muhammad Naeem	Research Assistant
3.	Mr. Munir Ahmed	Stenographer

THE PREPARATION OF COMPUTERIZED DATABASE FOR SCARPS TUBEWELLS

I. INTRODUCTION

Widespread waterlogging and salinity problems had developed in Pakistan following extensive development of Irrigation in the Indus Plains in the absence of adequate drainage. In the 1960's the Government of Pakistan embarked on a program to deal with the salinity and waterlogging problems through a series of Salinity Control and Reclamation Projects (SCARPs). In these SCARPs tubewell were installed for Sub-surface drainage by WAPDA and transferred to the Provincial Irrigation Department for operation. So far approximately thirteen thousand public tubewell of various capacities have been constructed under these projects. In addition, a large number of private tubewells have been installed inside and outside the SCARPs areas to supplement the canal supplies.

Under the Irrigation System Management Research Project (ISM/R), a sub-project titled "Public and Private Tubewells Performance" was taken up by the WAPDA SCARPs Monitoring Organization and was started in mid 1986 sponsored and co-financed by USAID with technical guidance furnished by the Department of Agricultural Engineering, University of IDAHO U.S.A, as consultant.

Under this sub-project the following major activities were outlined:

i) Identification of the characteristics of public and Private tubewell.

ii) Identification and documentation of data to access the extent and severity of problems.

iii) Identification of the causes of tubewell deterioration.

iv) Development of various method to skim the layers of fresh water over saline water.

v) Recommendation for improvements in design, construction operation and maintenance of public and private tubewell.

In order to carry through the activities under this sub-project the development of data base system for tubewells was considered to be a fundamental requirement. The primary purpose of creating the data base was to provide a ready means for the analysis of the diverse factors which impart on the performance of the tubewells.

An early examination of the data indicated that while adequate information was available on the constructional and operational input of the SCARPs tubewells. Hardly any information could be had on the characteristic or performance of private tubewells. As the collection of the relevant information in the private tubewells would have involved a major activity, it was decided that under the project the research activities should be restored to SCARPs tubewells only.

The creation of data base for SCARPs tubewells was therefore taken up as a major activity under the project.

This report describe the development of data base for the SCARPs tubewells and brings out all relevant information pertaining to it.

II. CHOICE OF SOFTWARE

For creating the data base consideration was paid to different commercially available computer programms, finally software selected with the advice of consultant was dBASE-III plus , a relational data base programme developed by and registered to Ashton-Tate.

The selection of dBASE III plus software was based on the following reasons.

i) Easy data retrieval with multiple selection/sorting by parameter and location.

ii) Interfacing with statistical and graphics software.

iii) Data base modifications or additions at a later date.

III. DATA FILES AND FORMATS

After examining the availability of the different types of information for the SCARPs Tubewells, it was decided to create the following files.

i) Well Performance file.

ii) Well Construction file.

iii) Water Quality file.

iv) Well Operation file.

v) Well Equipment file.

vi) Well Environment file.

Subsequently however it was decided to eliminate the files on well operation and well environment on the ground that their complete data was not available and also not valid. Criteria used in selecting the computerized data input files were:

i) Consistency with historic recording format.

ii) Segregation of time-variable date (monthly or annual entries) from time constant date.

iii) Convenience for analysis and output.

iv) Logical and organized data entry and storage.

v) Availability of specific data to other users and organizations.

For each data input files, separate formats according to which the tubewell data is computerized and stored was prepared. All the inputs of each data base file on which data was computerized are given in Table 1 to 4. After the design of data base system then it was implemented in three phased programme developed by the consultants.

IV. DATA BASE IMPLEMENTATION

Data base system was implemented in three phases and the Phased programme of data collection and computerization of public tubewells data was developed for the following reasons:

i) It avoids becoming overwhelmed with data.

ii) It allows modification of the procedures at interim stages.

iii) Identification of required input to the data base.

iv) Development of data input format consistent with data needs and which:

- minimize storage requirement
- are expandable to include new monthly or annual records as they become available.
- can perform checked on the validity of input data.
- minimize data input time

V. PHASING OF DATA BASE SYSTEM

Data base system was implemented in three phases as discussed below:

Phase-I Data base design and testing:

The objectives of this phase included identification of needed input to the data base. Software selection, Organization and documentation and testing of data formats. The phase-I have the following steps:

i) Identification of required parameters and data sources needed to calculate listed indicators.

The parameters necessary to measurer calculate the specified indicators are listed as potential input parameters to the data base. The availability and source of this data is then identified and recorded.

ii) Design data collection programs to supplement currently available information and fulfill the specified data requirement.

Not all data required is available from past records very little little data is available for private

tubewell. Data availability and accuracy is examined to determine about additional data collection programs are necessary and achieved.

iii) Testing the data base system

Simple sorting, selection and analysis procedures are executed to determine any system deficiencies which may exist.

iv) Modification in the data base system

The data base system is modified to remove deficiencies in format or processing capabilities. In the well construction file. Some modification has been carried out in the format to enter new entry.

Phase-II

A sample of about 1000, tubewells is randomly selected from the population of active, abandoned, replaced and rehabilitated public tubewells in Punjab and the data was entered in the computer input file. The objective of the phase-II was to form the basis for development of statistical analysis methods and to provide initial results statistically relating environmental and well construction feature to deterioration.

Phase-III

Advanced data collection and computerization

On the experience of Phase-I and II full-scale data collection and computerization of public tubewell from all Regions is done in Phase-III.

VI. SOURCES OF DATA

The public tubewells data according to the aforementioned three phases was collected from the following WAPDA and Irrigation Department.

Well Performance Data

SCARPs Monitoring Organization is responsible for monitoring the SCARPs tubewells annually. The performance data is available in the office of Tubewells and Groundwater Monitoring Directorate which is a part of the SCARPs Monitoring Organization.

The data is in the form of ledgers and reports and during the development of data base system these ledgers and reports were borrowed and then returned back after data entry in the computer.

Water Quality Data

Salinity Monitoring Directorate of SCARPs Monitoring Organization has been collecting the water quality data since the installation of SCARPs tubewells. The data is in the form of ledgers and these ledgers were collected

from the above mentioned offices for data entry in the computer. After computerization of water quality data these ledgers were handed over to the Salinity Monitoring Directorate Office.

Well Construction, Well Performance and Well Lithology Data.

The above mentioned data is available in the offices of Design Directorate(Water) Central and SCARPs Monitoring Organization Lahore. The data is lying in the form of ledgers and files. During the computerization of above mentioned data, the ledgers and files were borrowed from the offices of SCARPs Monitoring Organization and Design Directorate (Water) Central and then returned back.

VII DATA COMPUTERIZATION AND CHECKS

The public tubewell data collected was computerized in five input files as already mentioned and this computerization is done by the following method.

The information available in different ledgers and files of different input files are obtained by the data entry operator during the data computerization.

The average daily progress of one data entry operator is about 300 to 350 records which he entered in the computer from ledgers of well performance, water quality, well equipment and well lithology.

In case of well construction file the average daily progress of one data entry operator is about 20 to 25 records. Because of large number of fields. The daily computerized data, data entry operators take the listing of computerized data for that particular day and compare it with the original records contained in ledgers. If a mistake is encountered during the checking phase it is removed and corrected in the computer record. In this ways all the public tubewell data was computerized and stored.

Quality Control and Data Correction Methods

The quality control and data correction method is only applied on the well performance data. To keep a check on the quality of computerized data, the data stored was scrupulously scrutinized and that having questionable validity was discarded from storage files through various filtering techniques. Three files namely original, filtered and processed were made from the performance computerized public tubewell data. Both original and filter data of performance have been stored separately and available in soft and hard copy. The filter files have been used in the analysis of deteriorated tubewells to know the root causes of tubewell deterioration. During the scrutinizing of the performance data many irregularities were found.

The irregularities were checked and corrected manually and through computer programming. Following are the few examples to examine and filter the computerized data in performance input files.

Error Checking

i) To look for duplicate entries in the data base files.

ii) To see if any month/year of data are missing from a series of observations for a given well.

iii) To see and trace the computerized records of a missing tubewell from the list of public wells.

iv) To check the data showing human errors i.e. abrupt rise in the static water level reading for a particular month/year etc.

v) To check the performance data for the preceding years with reference to final acceptance test. It is pertinent to mention here that average method for recording the field data is practiced i.e. short specific capacity test for monitoring the SCARPs tubewells which are subjected to small errors in reading resulting from orifice plate and piezometric tube. Moreover the acceptance test reading may increase in the preceding years because working of a well results in more

development. Keeping this in view acceptance test data to the tune of more than 50 percent with respect to first acceptance test has been discarded and not included during the analysis work.

Filtering Techniques

Series of filtering techniques are applied after debugging the computerized tubewell data to know what percentage of data stored in the input files can be effectively used in the analysis work for instance some of filtering techniques are discussed below:

i) Eliminate the number of years of months in which data was not recorded.

ii) Remove the records having missing field such as static water level and pumping water level etc.

iii) Delete the records of well with no first acceptance test or acceptance test data.

iv) Delete records with any other missing data.

v) Eliminate records giving the following performance parameter readings (Punjab SCARPs) which are not possible.

a) Specific capacity > 300 or Specific capacity < 0

b) Discharge > 3500 gpm or Discharge < 1 gpm

c) Static water level 50 ft.or Static water level < 0

d) Pumping level > 120 feet or Pumping level < 0 feet

e) Drawdown > 100 feet or Drawdown < 2 feet.

VIII. DATA COVERAGE

Although about 13,000 tubewells have been installed in the various SCARPs in the Country with quite a few of these having been replaced, entering on to the data base, their construction data has progressed to include about 7.311 tubewells. The original (as constructed) record of the SCARP tubewells included in the data base under the three files is in Table-5.

As far as the time series record (well performance and water quality) is concerned it covers 12.065 tubewells. The time coverage of the data in the data base is shown in Table-6.

For the replaced tubewells, the data coverage of performance record is in Table-7. This brings out the number of tubewells for which data are available for varying periods of record from 4 to 15 years. The table brings out that the number of tubewells in the record decrease with time which is due mainly to the progressive replacement of the tubewells.

IX. DATA STORAGE

The data base system has included enormous amounts of diverse data ranging from well construction information to water quality and aquifer characteristics. After computerization of all SCARPs tubewells data, it is essential that great care and consideration be given to the Organization of data storage and preservation. Data has been stored on a large number of 1.2 to 1.44 megabyte diskettes. The storage system have the facility for selection of a specific item of data at a specific location and also be exampleable to include new well or new data as they become available.

About 30 high density diskettes have been used to store the 13000 public tubewells data. Three sets of diskettes of each data base file have been made to preserve the data of all SCARPs tubewells. The data of 13000 public tubewells have also been saved on a tape that has sufficient capacity to store all the data of SCARPs tubewells regarding well performance, well construction, water quality, well equipment and well lithology.

Table 1. Public Tubewell data base files.

Field name	Description
	Data in well performance file.
SCARP	Name of Scarp e.g Scarp I, Scarp II.
LOC	Scheme of the Scarp e.g BRW means Beranwala Scheme
WELL NO	Identification Number
SFX	Suffix to the well number e.g A,B,C etc
YY	Years of specific capacity test.
MM	Month of specific capacity test.
ENTRY	A for acceptance and S for subsequent test
PLVL	Pumping level in (ft) from measuring point
WLVL	Static water level in ft.
Q	Discharge during test in gpm.
	Data in Well Lithology File
SCARP	Name of Scarp e.g Scarp I , Scarp II etc
LOC	Scheme of the Scarp e.g BRW means Beranwala
WELL NO	Identification Number
SFX	Suffix to the well number e.g A,B,C etc
DFROM	Depth started,Starting point of the log
DTO	Depth end, ending point of the formation
SAND1	First type of formation
SAND2	Second type of formation

Table 2. Data in Well Construction file.

Field Name	Description
SCARP	Name of the Scarp
LOC	Scheme of the Scarp
REP	This code has been used for replaced tubewells.
CONTRACTOR	This field represent the agency name involved in Tubewell construction.
DRILMETHOD	Type of drilling method RR represent reverse rotary, PC for percussion
DRLHRS	Drilling time in (hours)
COMPDATE	This is the date of Tubewell completion.
GBAGUSED	Gravel bags used around the screen of the tubewells
DEVMTHD	Development method e.g raw hiding or air surging RH represent raw hiding, AS for air surging.
DEVHRS	Development time in (hours)
DEVSAND	Development sand 0 represent free from sand 1 represent traces -1 represent data not available
IEC	Initial electrical conductivity
FEC	Final electrical conductivity
DEVMTHD2	Development method no 2 (Air surging)
DEVHRS2	Development hours of the method no 2 (Air surging)
BOREHOLE	Bore hole diameter in inches
DEPTH	Depth of the well in feet.
HOUSLEN	Housing pipe length in inches
HOUSDIA	Housing pipe diameter

BLKCASDIA	Blank casing diameter in inches (10" diameter of casing)
BLKCASDI8	Blank casing diameter in inches (8" diameter of casing)
BLKCASLE8	Blank casing length of the eight inches diameter.
BLKCASLEN	Blank casing length of the ten inches diameter.
SLTCASDIA1	Diameter of the screen of ten inches diameter.
SLTCASDIA2	Diameter of the screen of eight inches diameter
SLTCASLEN1	Length of the screen of ten inches diameter.
SLTCASLEN2	Length of the screen of eight inches diameter.
HOSMAT	Housing pipe material MS represent mild steel.
SCRMAT	Type of screen material MS: mild steel FG: fiber glass BR: brass PVC: pvc
SCRSLOTW1	Width of the screen of ten inches diameter in inches.
SCRSLOTW2	Width of the screen of eight inches diameter in inches.
SLOTL1	Length of the slot in inches of ten inches screen diameter.
SLOTL2	Length of the slot in inches of eight inches screen diameter
NOSLOT1	Number of slot of the ten inches screen diameter.
NOSLOT2	Number of slot of the eight inches screen diameter.
SCROPEN	Open area in percentage of the screen

SCRORIENT	Screen slot orientation V: vertical slot D:diagonal slot H:horizontal slot
MPAGLEVEL	Measuring point above ground level in ft
SWLBMP	Static water level below measuring point
FATDD	Draw down in feet at the time of first acceptance test.
FATSND	Sand contents at the time of acceptance test. 0 for free from sand 1 for traces
QDESIGN	Design discharge in cusecs
QACTUAL	Actual discharge in gpm.

Table 3. Data in Water Quality file

Field name	Description	Field Name	Description
SCARP	Name of Scarp	PH	PH
LOC	Name of Scarp Scheme	RSC	Residue sodium carbonate
WELLNO	Identification of well number	SAR	Sodium absorption ratio
SFX	Suffix to well no	Q	Discharge
LABNO	Laboratory number	DEPTH	Depth
LABYR	Laboratory year	TEMP	Temperature
SAMPDATE	Date of sample test		
CA	Calcium		
MG	Magnasium		
NA	Sodium		
K	Pottasium		
CO3	Carbonate		
HCO3	Bicarbonate		
CL	Chloride		
SO4	Sulfate		
NO3	Nitrate		
F	Flouride		
CATIONS	Cations		
SIO2	Silica		
FE	Iron		
B	Boron		
TDS	Total dissolved solids		
EC	Electrical conductivity		

Table 4 Data in Well equipment file

Field name	Description
SCARP	Name of Scarp
LOC	Scheme Name
WELL NO	Identification of the well
SFX	Suffix to the well no e.g A,B,C etc
DISCHARGE	Design discharge
DATE	Date of installation of the equipment
PUMP	
MAKE	Name of the Manufacturing company
SERIALNO	Serial number of the pump
BOWLDIAM	Bowle diameter in inches
BOWLALENTH	Length of the Bowle assembly in ft
NOOFSTAGE	Number of stages
DEPTHSET	Setting depth of the bowl assembly
MOTOR	
MAKE1	Name of the manufacturing company.
SERIALNO1	Serial number of the motor
HP1	Horse power of motor
RPM1	Revolution per minute of motor
CONTROL BOX	
MAKE2	Name of manufacturing company
SERIALNO2	Serial number of control box cabinet
HP2	Horse power of the control box.

Table 5. **Status of data availability in database (original record)**

Sr. No.	SCARPs	Schemes	Total No. of wells	Well Construction Computerized data	Well Equipment Computerized data	Well Lithology Computerized data
1	SCARP-I	Beranwala	129	126	127	70
2		Chichokimallian	12	0	10	10
3		Chukarkana	25	0	23	15
4		Hafizabad	321	320	290	225
5		Harse Sheikh	46	45	43	24
6		Jaranwala	133	9	133	80
7		Khanqah Dogran	213	209	210	163
8		Pindi Bhattian	21	6	20	17
9		Sangla Hill	236	232	233	120
10		Shadman	152	89	150	92
11		Shahkot	378	375	283	85
12		Zafarwal	403	390	400	220
1	SCARP-II	Ara	331	331	330	150
2		Busal	248	240	212	0
3		Khadir	213	213	92	213
4		Kot Moman	232	232	230	0
5		Lalian	163	163	160	163
6		Lower Hujjan	51	51	50	0
7		Mona	138	138	137	138
8		Phalia	335	335	100	0
9		Shah Jewana	244	244	0	0
10		Sohawa	249	249	245	0
1	SCARP-III	Alipur	552	541	363	0
2		Kot Adu	523	523	522	0
3		Rangpur	582	549	580	528
1	SCARP-IV	Mangantwala	341	312	311	311
2		Muridke	656	624	622	627
1	SCARP-V	Khairwala	48	33	45	0
2		Satiana	71	0	70	0
3		Shorkot K.P.	101	98	95	57
	SCARP-VI	Allahabad	672	576	0	382
1	SUKH BEAS SCARP	Sukh Beas	101	26	99	26
1	SCARP-VIII	Minchanabad-I	100	32	20	48
2		Minchanabad-II	126			
		Grand Total	8146	7311	6209	3764

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Table 6. Status of data availability in database (time series record)

Sr. No.	SCARPs	Schemes	Total Nos. of Wells	Comput-erized	Period of Constr-uction	Period of Perfor-mance	period of Water Quality data
1	SCARP-I	Beranwala	129	129	1960	1960-1991	1960-1989
2		Chichokimallian	12	12	1960	1960-1988	1961-1989
3		Chukarkana	25	25	1955	1965-1989	1961-1989
4		Hafizabad	321	321	1960	1960-1990	1960-1989
5		Harse Sheikh	46	46	1961	1961-1990	1961-1989
6		Jaranwala	133	133	1960	1960-1991	1961-1989
7		Khanqah Dogran	213	213	1960	1960-1989	1960-1989
8		Pindi Bhattian	21	21	1959	1961-1990	1962-1988
9		Sangla Hill	236	236	1960	1960-1991	1960-1989
10		Shadman	152	152	1961	1961-1990	1961-1989
11		Shahkot	378	378	1961	1962-1991	1961-1989
12		Zafarwal	403	403	1962	1962-1990	1961-1989
1	SCARP-II	Ara	331	331	1970	1970-1990	1970-1985
2		Busal	248	248	1966	1966-1991	1976-1985
3		Khadir	213	24	1965	1965-1989	1967-1985
4		Kot Moman	232	232	1969	1970-1989	1969-1985
5		Lalian	165	165	1963	1963-1989	1964-1985
6		Lower Hujjan	51	51	1966	1966-1989	1976-1985
7		Mona	138	138	1964	1964-1990	1964-1985
8		Phalia	345	345	1946	1966-1990	1972-1985
9		Shah Jewana	251	251	1970	1970-1990	1969-1985
10		Sohawa	261	261	1966	1966-1991	1965-1985
11		Saline Zone	795	725	1978	1978-1990	
1	SCARP-III	Alipur	395	395	1967	1967-1991	1969-1985
2		Kot Adu	523	523	1968	1968-1989	1971-1985
3		Rangpur	582	582	1969	1969-1989	1969-1986
4		Saline Zone	141	135	1977	1977-1990	
1	SCARP-IV	Mangantwala	341	338	1968	1969-1989	1969-1987
2		Murdki	656	656	1967	1969-1991	1971-1987
1	SCARP-V	Khairwala	48	0			
2		Satiana	71	71	1977	1977-1990	1979-1985
3		Shorkot K.P.	101	101	1976	1976-1990	1976-1987
	SCARP-VI	Allahabad	672	666	1977	1977-1990	1976-1987
1	SUKH BEAS	Sukh Beas	101	100	1983	1994-1988	-
1	SCARP-VIII	Minchanabad-I	100	99	1977	1977-1987	-
2		Minchanabad-II	126	126	1979	1980-1987	-
	SIND SCARP		2851	2817	1967	1967-1986	-
	NWFP SCARP		414	407	1973	1973-1987	
1	NON SCARP	Qadirabad	45	45	1979	1979-1989	
2		Rasul Scheme	164	164	1985	1985-1989	
		Grand Total	12430	12065			

Table 7. Period of record for replaced wells

Sr. No.	SCARPS	SCHEMES	Computerized Wells	T/wells after different period			
				4 Years	8 Years	12 Years	15 Years
	SCARP-I						
1		Beranwala	10	9	8	6	1
2		Chichokimallian	9	7	7	7	3
3		Chukarkana	27	19	19	11	7
4		Hafizabad	138	122	114	77	15
5		Harse Sheikh	12	12	9	6	-
6		Jaranwala	32	32	31	19	-
7		Khanqah Dogran	8	7	6	1	-
8		Pindi Bhattian	19	17	16	5	1
9		Sangla Hill	21	20	17	9	1
10		Shadman	59	56	54	38	6
11		Shahkot	34	34	33	21	8
12		Zafarwal	295	272	250	135	16
	SCARP-II						
1		Ara	8	8	7	3	2
2		Busal	5	4	4	1	-
3		Khadir	18	16	13	1	-
4		Kot Moman	4	4	2	1	1
5		Lalian	6	4	3	-	-
6		Lower Hujjan	1	1	1	1	1
7		Mona	3	3	2	1	-
8		Phalia	27	20	9	2	-
9		Shah Jewana	7	7	6	-	-
10		Sohawa	20	19	15	6	1
	SCARP-III						
1		Alipur	73	54	30	10	4
2		Kot Adu	328	13	10	8	7
3		Rangpur	126	49	27	1	-
	SCARP-IV						
1		Mangantwala	137	128	80	10	-
2		Murdki	87	79	39	9	-
		Grand Total	1514	1016	812	389	74

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DEVELOPMENT OF METHODS OF TUBEWELLS REHABILITATION

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DEVELOPMENT METHODS OF TUBEWELLS REHABILITATION

CHAPTER-1

1.1 Introduction

Widespread waterlogging and salinity problems have developed in Pakistan following extensive development of Irrigation in the Indus Plains without adequate provision of drainage in 1960, the Government of Pakistan embarked on a programme to relieve salinity and waterlogging problems through a series of Salinity Control and Reclamation Projects (SCARPs). In these SCARPs tubewells were constructed by WAPDA and later operated by the Provincial Irrigation Department. Approximately Thirteen Thousand public tubewells of various capacities were constructed under these Projects. The majority of them are functioning satisfactory but many have experience rapid deterioration and decline in discharge. Over 1000 tubewells have already been replaced during the last few years and more are indeed of replacement.

Number of studies have been undertaken to determine the causes of and corrective measures for public well deterioration. Despite the extensive efforts the studies have not conclusively isolated the causes of deterioration. The experiment to find out the techniques for rehabilitation of tubewells were carried out from May 1992 to May 1993 on Four number of tubewells in SCARP-IV and SCARP-II by applying the internationally known techniques. Such as mechanical surging, air surging and use of dispersing

agents. This report describes the results achieved on the above mentioned tubewells.

1.2 Scope of Work

Rehabilitation will be carried out by mechanical, chemical and air surging methods:

i) Mechanical Method

Surging with Surge Block.

ii) Chemical Method

Treatment with hexametaphosphate.

iii) Air Surging Method

CHAPTER-2

2.1 Previous Study

Although the problem of tubewell deterioration have been engaging the attention of WAPDA and operating agencies right since mid sixties yet limited amount of work in proportion to the magnitude of investment involved was done on scientific lines to identify causes of deterioration and devising ways and means of their maintenance and rehabilitation.

2.2 Present Study

Under ISM/R, it was proposed that further work relating to this problem be done. Attention was given to evaluating the commonly used technique of surging for the rehabilitation of wells constructed with fiber glass casing. Four number tubewells were rehabilitated in SCARP-II and IV

SCARP-IV	MDK-43	Jan 1992 to May 1992
	MDK-219	May 1992 to Jun 1992
SCARP-II	SO-166	Jan 1993 to May 1993
	SO-178	Mar 1993 to Apr 1993

CHAPTER-3

3.1 Selection Criteria

For the trial, the work has restricted to four number tubewells selected to represent identical design and construction facilities.However to examine the effect of different environments. Four wells were selected where the formation was composed entirely of sand and where clay lenses were also present. Another element considered was the degree of deterioration as it is generally held that well that have not far deterioration can be easily rehabilitated (Ahren's 1975). The Three wells therefore represented a high degree of deterioration (specific capacity reduction of 60 percent) and one low degree of deterioration (specific capacity reduction of about 20 percent).

Four tubewells of 3 cusecs design capacity MDK-43,219 in the Muridke Unit SCARP-IV and SO-178, in the Sohawa Unit of SCARP-II of which SO-166 is of 2 cusecs design capacity were related, which were constructed by one contractor and SO-178, 166 by the other contractor under the same design specifications. Apart from practical considerations, the selection of these wells based on the further consideration that surrounding wells displayed similar behaviour and treatment results might be widely applicable.

3.2 Tubewell Design

The selected tubewells were drilled by the reverse rotary method using 22 inch dia drilling bit and below mild steel pump housing of 14 inch, the casing and screen consisted of 8 inch dia fiber glass pipe. The screen consisted of 1.75 inch long siots (180 per foot length) giving an open area of 8.7 percent with the slot width of 1/16". Screen length was intended to give an entrance velocity of 0.1 ft/sec. for the design capacity. The wells were gravel packed with graded gravel, for which as per specification,D-50 ranged from 10 mm to 12 mm and the uniformity co-efficient (D-60/D-10) was 2.1. The comparative design features of the two tubewells and their performance record is shown in Table-1.

Of the four selected wells, MDK-43 and SO-178, 166 which had clay lenses were badly deteriorated, while MDK-219, having sandy formation materials behaved quite well with only a slight degree of deterioration.

Table-1 COMPARATIVE CONSTRUCTION FEATURES & INITIAL PERFORMANCE

Description	Tubewell Numbers			
	MDK-43	MDK-219	SO-166	SO-178
Drilled depth (feet)	255.00	230.00	190.00	220.00
Well Cased depth(feet)	242.75	220.50	115.00	129.00
Housing length(feet)	54.75	84.75	68.00	78.00
i) Screen length	136.00	129.58	110.00	124.00
ii) Blank	54.83	-	5.00	5.00
iii) Bail Plug	4.0	4.0	4.0	4.0
Lithology (below housing)(feet)				
i) Clay	43.00	-	15.00	15.00
ii) Fine sand	46.00	44.00	150.00	10.00
iii) Med. sand	20.00	64.00	-	-
iv) Coarse	25.00	36.00	20.00	165.00
v) Kanker	-	-	5.00	30.00
Discharge at Acceptance(Cs.)	3.44	4.16	2.6	3.90
Specific capacity gpm/ft. Date of acceptance	119.31	117.59	111.91	135.69
After 4 years	110.13	122.52	97.56	128.88
After 8 years	95.31	114.11	88.88	102.51
After 12 years	46.93	111.21	65.04	55.70
After 16 years	64.68	105.24	61.38	41.00
After 20 years	48.58	97.22	63.00	39.45
After 23 years	43.27	100.00	51.86	35.71
Entrance velocity ft./sc Based on design discharge	0.114	0.120	0.080	0.120
Based on acceptance discharge Cusecs.	0.137	0.158	0.103	0.157

CHAPTER-4

4.1 Treatment Procedures and Methods

The treatments which were tried consisted of mechanical surging with surge block, surging with compressed air and mechanical surging following the introduction of dispersing agent in the well.

To evaluate the effectiveness of the treatments short specific tests were carried out initially before the start of the trials and subsequently after each treatment.

The amount of sand brought in the well and deposited in well bottom was measured prior to and following each treatment to give an idea of the material dislodged. Short specific capacity tests were also carried out 3 months after the conclusion of the trials to determine the effects of the treatments over time. Details of different treatments are described below:

4.2 Mechanical Surging

Tubewells were developed with a vented surge block, 12 feet long and 7 inch dia meter and 400 K.G. in weight. The surge block attached to the drilling line of a percussion rig, was lowered to the bottom of the well (Figure-i). The surge block was lifted 2.5 feet and then dropped, the strokes being repeated twenty times at each setting. The surge block was raised by intervals of 2.5 feet and the process repeated

upto top of casing pipe. Following this treatment the sounding of the well was taken. The process of surging was again repeated starting from the bottom with drops of 3.0 feet repeated 15 times at each setting. Again the well sounding was taken. The deposited material was then bailed out before carrying out a short specific capacity test.

4.3 Use of Dispersing Agent

The well was treated with a dispersing agent, Sodium Hexametaphosphate for deflocculating any material that could not e dislodged by mechanical surging. A total of 100 Kg. of Hexametaphosphate mixed in 150 gallons of water was used in each well. Mixing was done in 45 gallon drums which were heated to a temperature of 100 degree centigrade. The heated mixture was pumped into the well at a pressure of 5 Psi through a 1 inch dia rubber hose pipe starting from the bottom of the well. The mixture was introduced in 5 feet section and dispersed by lowering and raising the house pipe 5 time in each section. The hose pipe was with drawn by 5 feet successively until 1/3 of the mixture was introduced through the entire well. This process was repeated 3 times for introducing the full quantity of the mixture. After the injecting of the total quantity of the mixture it was allowed to stay in the hole for 12 hours. The well was then developed with surge block from top to bottom with 5 strokes of 2.5 feet at intervals of 2.5 feet. The well was sounded after completing the development. The material

deposited during the process was bailed out before carrying out a specific capacity test (Figure-ii).

4.4 Air Surging

Surging of the well with air was done using a 150 Psi 600 cfm capacity compressor. The procedure was that the compressed air was released through 1 inch dia rubber hose pipe starting from the well bottom. While the air was being released the air pipe was raised and lowered by 10 feet for 10 time at each depth setting(Figure-iii). The air pipe was then raised by 10 feet and the process repeated upto the top of the casing. During the treatment the water discharge at the well top was collected in a sand cone to determine the sand content. A sounding of the well was taken 12 hours after the treatment of the well. The material deposited at the well bottom was bailed out before carrying out a short specific capacity test.

4.5 Results

The results of the trials on the tubewells are shown in the table-2,3,4,5 and 6.

The material deposited after the initial mechanical surging was 13 feet in case of MDK-43, 6 feet in MDK-219. 8 feet in SO-178 and 20.5 feet in SO-166. After surging following the use of dispersing agent the material deposited in MDK-43 was 13.5 feet where as MDK-219. No material was deposited and in case of SO-178 and SO-166 4.5 feet and 3 feet material was

deposited. Air surging was carried out only in MDK-219 and this brought in 2 feet of material.

Following the initial surging the specific capacity of MDK-43 increased from 43.25 gpm/feet to 49.71 gpm/feet while in the case of MDK-219 the increase was from 100.27 gpm/feet to 102.14 gpm/feet. Similarly in SCARP-II Unit Sohawa the increase in specific capacity was 22.5 to 41.4, on SO-178 and 32.52 to 52.96 for SO-166. After the use of dispersing agent the increase was from 49.71 gpm/feet to 60.88 gpm/feet in case of MDK-43 while for MDK-219 the increase was from 104.85 gpm/feet to 105.20 gpm/feet and increase for SO-178 was from 41.4 to 41.33. In case of air surging in MDK-219 the increase was from 102.14 gpm/feet to 104.85 gpm/feet and in case of SO-166 the increase was from 52.96 to 53.5 gpm/feet. After 3 months a short specific capacity test was carried out and indicated 57.41 gpm/feet to 106.26 gpm/feet in MDK-43 and MDK-219.

2. Effect and Mech: Surging Material brought in the well feet

Treatment	MDK-43	MDK-219	SO-178	SO-166
After surging with 2.5 feet strokes (feet)	9.5	4.5	4.0	50.16
After 2nd surging with 3.0 feet strokes (feet)	3.5	1.5	4.0	10.00
Total	14.0	6.0	8.0	20.00
After air surging	N.A	2.0	-	-
After surging with dispersing agents	13.5	0.0	4.5	3.00

3. Effect of Mechanical Surging MDK-43 Specific Capacity Changes

	Sp.Cap. gpm/ft	percent increase over per test	Sp.cap. % of A.S.C
Pre-test	43.27	-	36.26
After mechanical surging	49.71	14.88	41.66
After use of dispersing agent	60.88	40.69	51.03
3 month after treatment	57.41	32.67	48.12

4. Effect of Mechanical Surging MDK-219 Specific Capacity Changes

	Sp.Cap. gpm/ft	Percent increase Over per test	Sp Cap. % of A.S.C
Pre-rehabilitation test	100.27	-	85.14
After mechanical surging	102.14	1.86	86.72
After air surging	104.85	4.56	89.03
After dispersing agent	105.20	4.91	89.32
After 3 month	106.26	5.97	90.23

5. Effect of Mechanical Surging SO-178 Specific Capacity Changes

	Sp.Cap. gpm/ft	Percent increase Over per test	Sp Cap. % of A.S.C
Pre-test	22.55	-	16.61
After mechanical surging	41.14	82.44	30.31
After use of dispersing agent	41.33	83.28	30.45
3 month after treatment	105.02	165.72	77.37

6. Effect of Mechanical Surging SO-166 Specific Capacity Changes

	Sp.Cap. gpm/ft	Percent increase Over per test	Sp Cap. % of A.S.C
Pre-rehabilitation test	32.52	-	29.06
After mechanical surging	52.96	62.85	47.32
After air surging	53.50	64.51	47.81

4.6 Discussion

i) Impact on dislodging the fines

The results tabulated in table 2 indicate that the initial surging was effective in dislodging the fines from the gravel pack or the surrounding formations which could be obstructing the flow in the wells. More material was brought in MDK-43 SO-178 and 166 which had clay layers as compared to MDK-219 which has only sandy formation.

The subsequent use of dispersing agent resulted in dislodging of 13.5 ft. of material in MDK-43 and 4.5 feet of material in of case of SO-178 where as MDK-219 it had no effect. This points to the efficiency of dispersing agent where clay is present in the formation. Which is defloculated and permits the fines to be drawn in the well.

Air surging method tried in MDK-219 having sandy formation had same effect in drawing in the fines in the well. But as their treatment was done after the initial surging with the surge block. Its effect can not be independently assessed.

None the less as additional material was brought in. It can be summarized that surging with air may be effective, if not more than mechanical surging. The economics of the treatments should determine in choice of the method.

ii) Impact on Specific Capacity

After the initial mechanical surging the specific capacity of the 4 tubewells improved by 14.88 percent 1.6 percent 82.44 and 62.85 percent respectively in MDK-43,219, SO-178 and 166 with the use of dispersing agent the specific capacity increased by 40.69 percent 4.91 percent and 83.28 percent respectively in MDK-43 and SO-178 has been improved by this method while MDK-219 had no much effect. With the treatments help to increase the specific capacities they were not effective in the restoring the wells to their original conditions. In the badly deteriorated well MDK-43 SO-178 and SO-166 the specific capacity after treatment was only 51 percent. 30.45 percent and 47.81 percent respectively of the acceptance capacity. It would therefore appear that apart from any mechanical blockage there may be other causes which are operative in restricting the flow into the well In the case of MDK 219 almost 90% of acceptance specific capacity was attended but this had only a partial deterioration.

The short specific capacity carried out after 3 months indicates that in MDK 219 it improved by 1% The reduction in

specific of mdk 43 in the short period of 3 months again reinforces the view that other factors possibly biofouling may be causes of the problem.

CHAPTER-5

CONCLUSIONS

The study carried out in the 4 tubewells indicates that the method applied are effectively but it does not improve the efficiency of tubewell completely.

1. The specific capacity of tubewell No MDK-43 SO-178 and SO-166 improved from 43.27 to 60.88 gpm /feet 22.55 to 41.33 and 32.52 to 53.5 gpm/feet respectively the one of the reasons is that presence of clay lenses present in the formation which had effect on well by these techniques.

2. MDK 219 had improved satisfactory by these techniques.

3. Mechanical surging shall help in improving the efficiency in both the cases.

4. Use of dispersing agent has more effect on the tubewell having clay lenses and fine silty material.

5. Air surging can improve tubewell having entirely sand formation.

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ACKNOWLEDGEMENTS

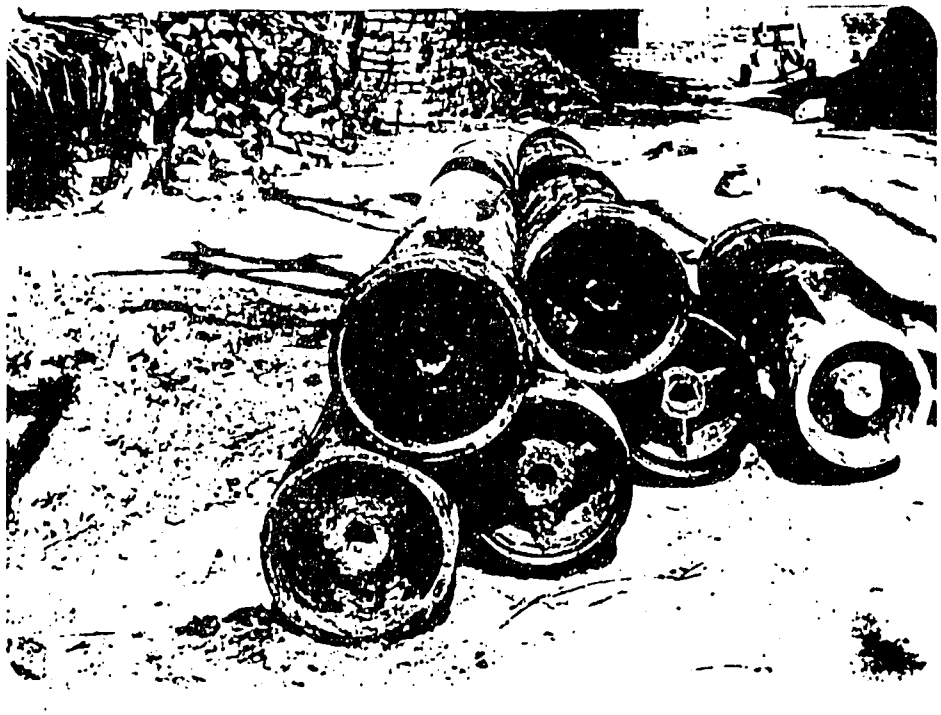
The author express appreciation to the Government of Pakistan and USAID for their financial support of this study. Technical support from USAID University of IDAHO through irrigation and Management Research Projects has been essential IIMI Pakistan Mr M Badruddin for his guidance and Mr Muhammad Ishaq khan Niazi Chief Engineer SCARPs Monitoring Organization WAPDA for providing full support and advise The following staff remained associated with the preparation of this report:

1.	Mirza Muhammad Rafiq	Junior Engineer
2.	Parvez Arif	Junior Geologist
3.	Mr. Munir Ahmed	Stenographer
4.	Mr. Waseem Ahmed	Research Assistant

The report is based on the field work performed by Ghazi Umar Javid Butt Sub-Engineer

BS-166

Condition of column pipes after pulling out for mechanical surging of the tubewell

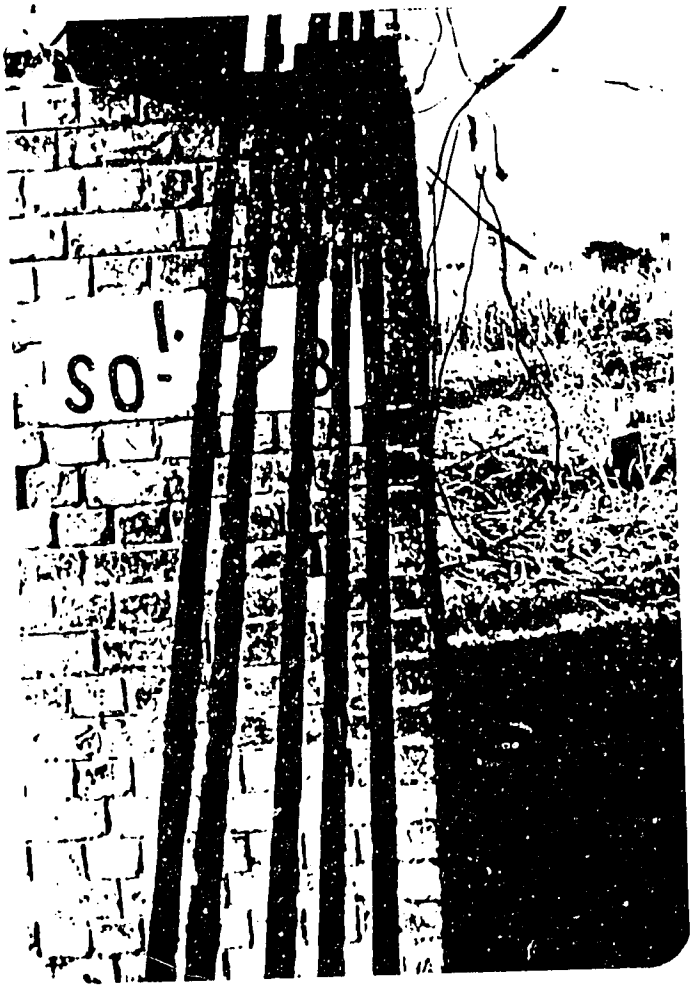


MDK-219

Air surging with air compressor at the rate of 150 Psi pressure. Water being gushed during air surging FIG. 3

BS-178

Condition of shaft before rehabilitation



SO-178

Condition of the bowl assembly before treatment

B

SO-178

Chemical treatment during carried out using sodium Hexametaphosphate

SO-178

Turbid water coming after using Hexametaphosphate

SO-178

Deposited material in tubewell~~s~~ bailed out after mechnical surging. FIG - 2

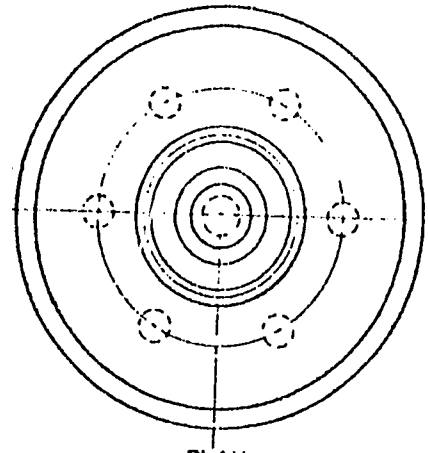
BS-166

Material bailed out after mechanical treatment FIG. 2

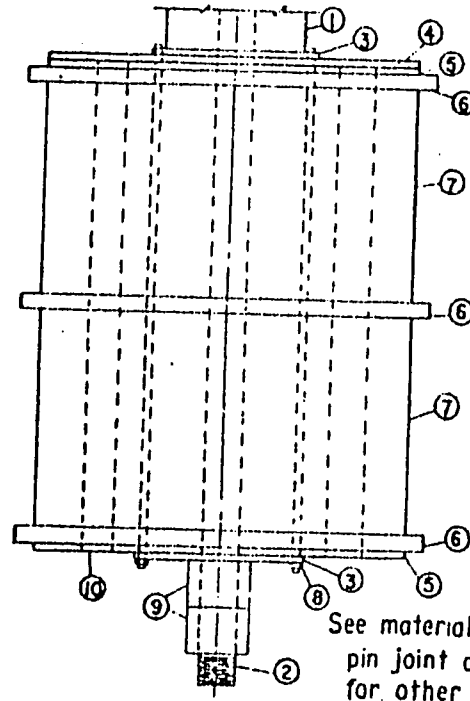
SO-17B

Chemical treatment being carried out using sodium hexametaphosphate

FIG-1



PLAN



See materials list top view, and pin joint and shaft assembly for other dimensions.

FRONT ELEVATION

VENTED SURGE BLOCK FOR 8" SCREEN
(USE 10" DIAMETER LEATHERS FOR 10" SCREEN)

Factors Associated with Deterioration of SCARP Tubewells

Muhammad Memon and Parvez Arif[1/]

ABSTRACT

To investigate possible causes of tubewell deterioration, this study based on the available computer database of SCARP tubewells was undertaken. The average rate of decline in the specific capacity over the eight-year operation was used to characterize the performance of tubewells in different SCARPs. This was correlated with different parameters such as acceptance specific capacity, actual discharge in relation to design, development time, lithology, slot size, screen material, and saline and fresh water tubewells. The analysis concluded that some of the above mentioned parameters have a direct relation to the performance of the tubewells.

INTRODUCTION

WAPDA has installed about 13,000 tubewells of different capacities in various Salinity Control and Reclamation Projects (SCARPs) in the country. These tubewells in many cases experienced a decrease in their discharges soon after their installation. Previous studies by Ahrens (1975) and other consultants, based on field investigations, pointed to a number of causes for tubewell deterioration. Their results were, however, inconclusive mainly because of the limited scope of the studies. After two decades of SCARPs operation, an enormous amount of data is available on their performance. Performance, well construction, water quality, well equipment and lithology data of all SCARPs tubewell have recently been collected and consolidated into a single computer database (Arif, 1990).

To investigate the possible causes of tubewell deterioration, the database was used to establish a correlation between well performance and several other factors (Arif, 1990).

With a more extensive database now developed, the factors in the earlier analysis have been reexamined with several new factors now included.

The objective of this study was to establish, as well as possible, the relationship between well performance and some of the relevant factors pertaining to well design, well construction, well discharge and the well environment.

MATERIALS AND METHODS

Specific capacity, the main parameter in the well performance file, is the basic indicator of tubewell performance. Specific capacity of a well is defined as the yield per unit of drawdown, and expressed as gallons per minute per foot of

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1/ Senior Geologist and Junior Geologist, respectively, SCARP Monitoring Organization, WAPDA

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draw down (gpm/ft). Specific capacity has been computed from discharge and draw down monitored annually in the SCARP tubewells. For this purpose, a short specific capacity test has been performed in each tubewell to get the value of static water level, pumping level and discharge.

For comparison purposes, the specific capacity of tubewells were related to the acceptance specific capacity and expressed as a percentage, the acceptance specific capacity being taken as hundred. The deterioration rate was derived from the time of operation in years to get the annual rate for each tubewell. Computations for this purpose were made by developing a computer program. The deterioration rate after eight years of operation, was used as an indicator of well performance on the following considerations:

1. For this time period the data base was quite extensive and;

2. significant changes in the performance of tubewells are captured during this period.

Previous Work

Previous work on the same subject (Arif, 1990) revealed that:

- Performance of the original tubewells was poorer than the performance of the replaced tubewells.

- Tubewells with high acceptance specific capacity showed poorer performance than the tubewells with low acceptance specific capacity.

- The performance of the brass screen tubewells was better than the performance of the mild screen tubewells (Shahkot Scheme).

RESULTS AND DISCUSSION

For the investigation of the possible causes of tubewell deterioration, the factors that were considered in the analyses of the extended database are discussed below.

Actual discharge in Relation to Design

Tubewells with different design capacities have been installed in various SCARPs in the country. At the time of acceptance, however a number of tubewells were discharging more than the design and some were discharging less than the design capacity. It appears, that for some reason, wells were accepted even though they were producing less discharge than their design.

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The multiple regression analysis earlier carried out (Arif 1990) had shown that actual discharge (Qa) parameter accounted for about 15% of the variation in deterioration rate in SCARP-I, II and III. To test this parameter further, an analysis was carried out by using the ratio between the actual discharge (Qa) at the time of acceptance test and the design discharge (Qd). After calculating the ratio between two parameters, the average value of deterioration rate was related to different Qa/Qd ratio ranges. Figure 1 shows the relationship between the percentage deterioration rate after eight years of operation and the Qa/Qd ratios for SCARPs-I, II, III and IV. The number of tubewells used in the analysis is also shown on the top of bars in Figure 1.

Figure 1 brings out a decreasing trend of deterioration rate as the value of discharge ratio (Qa/Qd) decreases. This implies that entrance velocities through the screen slots exceeding the design criteria may have contributed to the deterioration of the tubewell.

Effect of Initial Specific Capacity

After the tubewells were installed, an acceptance test was done to determine if the wells had been fully developed. In this test, if the criteria for sand content was met, the initial specific capacity termed the acceptance specific capacity was determined through a short specific capacity test.

The multiple regression analysis referred to above showed that 21% to 31% of the variation in deterioration rate was explained by acceptance specific capacity. This acceptance specific capacity is the variable most highly correlated with deterioration rate in all SCARPs and Schemes. To test this further, a larger sample of data was used in the analysis using values of specific capacity more than 150 gpm/ft, 150-100 gpm/ft, 100-80 gpm/ft and less than 80 gpm/ft. For SCARPs-I, II, III and IV, the results are shown in Figure 2. For greater values of specific capacity, going up to 200 gpm/ft, the data for two schemes, Sohawa & Busal, in the SCARP-II were also analyzed and the results are also in Figure 2.

To test this hypothesis, the acceptance specific capacity of the original tubewells which survived the longest period was averaged for SCARP-I to IV, as shown in the table below:

SCARPs	Operation time in Years.	Average Specific capacity (gpm/ft)
SCARP-I	28	76
SCARP-II	20	91
SCARP-III	16	95
SCARP-IV	18	97

Results of this analysis show that the tubewells having a lower acceptance specific capacity, ranging from 80 gpm/ft to 100 gpm/ft have longer lives than

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wells with acceptance specific capacities greater than 120 gpm/ft. (Figure 2). This in turn could be related to the formation characteristics as specific capacity is directly related to the permeability of the formation.

Effect of Development Time on Deterioration Rate

After the tubewells' installation, the wells are developed to provide sand-free discharge. Generally, raw hiding method has been used in most of the SCARPs tubewells. The development time varies from tubewell to tubewell depending upon the formation materials and its relation to the gravel pack.

To know the effect of development time on the performance of the tubewells, Khadir scheme, for which this information was available, was analyzed by averaging the deterioration rate against different development time ranges. The results are shown in Figure 3.

Deterioration rate of the wells which took longer to develop was greater than that of the wells which were developed in shorter periods. This indicates that the deterioration rate may have been influenced by formation characteristics.

Effect of Lithology

In the database, the well lithology file contains the parameter of clay and fine sand. To know the impact of finer formation material (clay and fine sand) on the performance of tubewell, an analysis of the total length of fine sand and clay layers in feet below housing was done via a computer program.

The average value of deterioration rate was calculated and plotted against different ranges of clay layers as shown in Figure 4a. Similarly, the average value of deterioration rate was calculated and plotted against different ranges of fine sand as shown in Figure 4b. In considering these relationships, it should be kept in an mind that the clay layers could also be associated with fine sand and visa versa.

Results as shown in the figure indicate that there are no significant differences in the deterioration of tubewells with or without fine sand and clay.

Slot Size and Deterioration Rate

Different slot size screens were used in the SCARPs tubewell and to know the performance of tubewells with different slot size, the average value of deterioration rate was calculated against different slot size width. Generally 1/16 (0.0625) or 3/32 (0.0938) inches of width slot size have been used in different SCARPs. The results of the analysis are shown in Figure 5.

Slot size of 0.0938 are used in SCARP-I and III while two different slot sizes screen (0.0625-0.0938) inches are used in SCARP-II, IV and Khadir scheme

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in SCARP-II. Wells with the two slot sizes perform identically but in the case of SCARP-IV and Khadir scheme, a higher rate of deterioration was associated with the narrower slot size. This could be due to how the narrow slots are chocked. However other factors, e.g. the relationships to the gravel pack and the formation, must also be considered.

Performance of Different Screen Materials

Four types of screen material, fiberglass, brass, mild steel and polyvinyl chloride, were used in the installation of public tubewells of different SCARPs. The performance of mild steel and brass screen has already been analyzed for the Shahkot scheme (Arif 1990).

To know the performance of other screen materials, an analysis was carried out using the large database. Figure 6 shows that the brass screen preformed the best followed by the fiber glass screen.

Performance of Saline & Fresh Water Tubewells

The performance of saline tubewells was computed with the performance of fresh water tubewells in SCARP-I, II and III after operating eight years. Figure 7 shows that saline water tubewells have less deterioration than fresh water tubewells. The fresh water zone is defined as having Ec up to 1,600 (micro mhos), RSC, 0 to 2.5 and SAR less than 10. Saline water zone is defined as having more Ec up to 2700 (micro mhos), RSC 2.51 to 5.0 and SAR 11 to 18. The analysis indicates that the performance of saline zone tubewells is better than fresh water zone tubewells. This, on the face of it, appears to be anomalous. However, a factor which could explain the difference in the behavior pattern may be the utilization rate of the tubewells, with the saline tubewells operating for shorter period.

CONCLUSIONS

1. Multiple factors are involved in the tubewell deterioration.

2. Tubewells giving discharge more than their design discharge deteriorate rapidly.

3. Low acceptance specific capacity tubewells perform better than high acceptance specific capacity tubewells.

4. Development time is directly proportional to the deterioration rate.

5. The results achieved through the screen material analysis indicates that brass screen performance is the best among the three screens.

6. Presence of clay and fine sand has little impact on the performance of tubewells.

7. Perhaps due to their lower utilization rate, saline tubewells show a better performance compared to fresh water tubewells.

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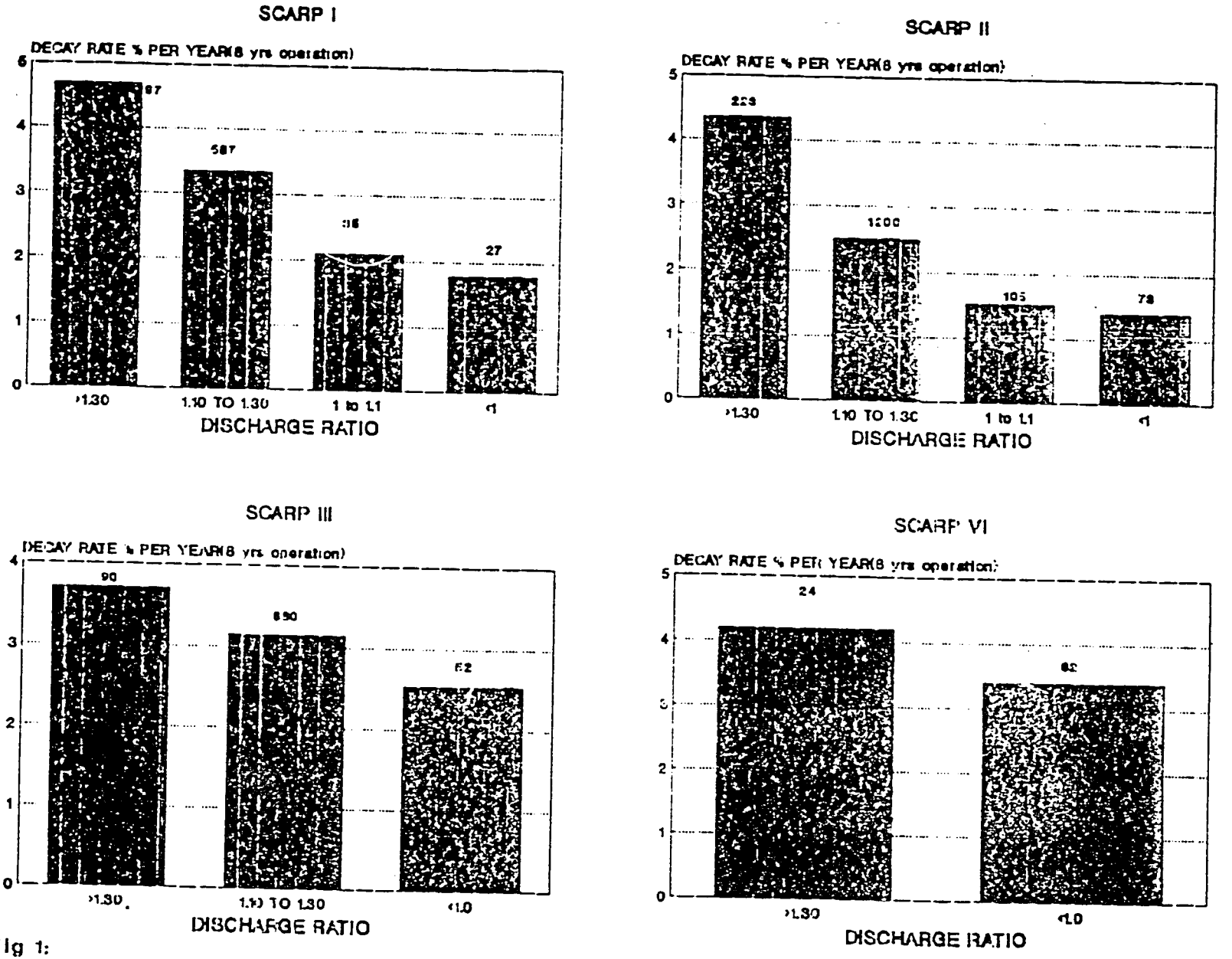

Fig 1:

EFFECT OF DISCHARGE RATIO ON THE PERFORMANCE OF TUBEWELLS

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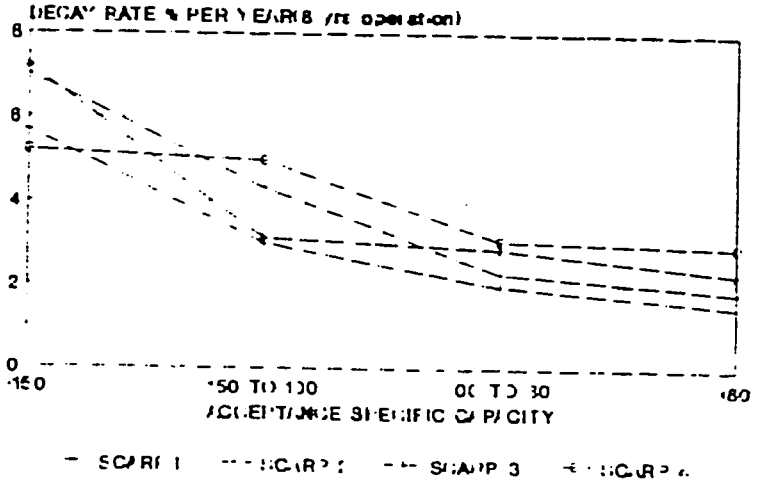

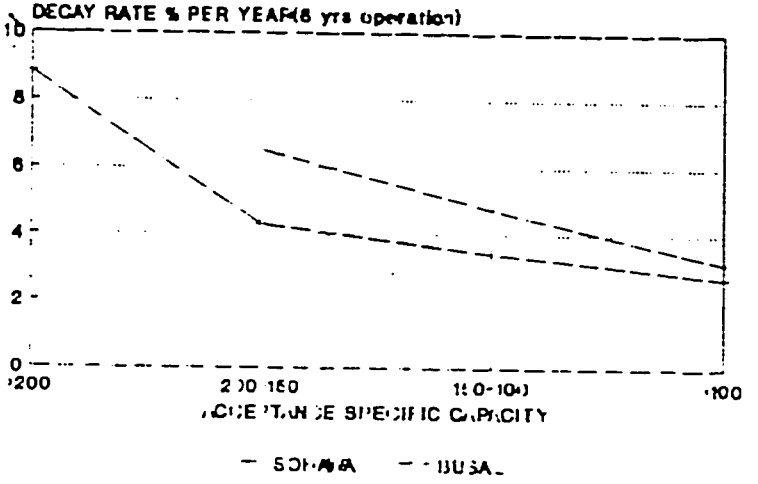

FIG 2: EFFECT OF ACCEPTANCE SPECIFIC CAPACITY ON DECAY RATE

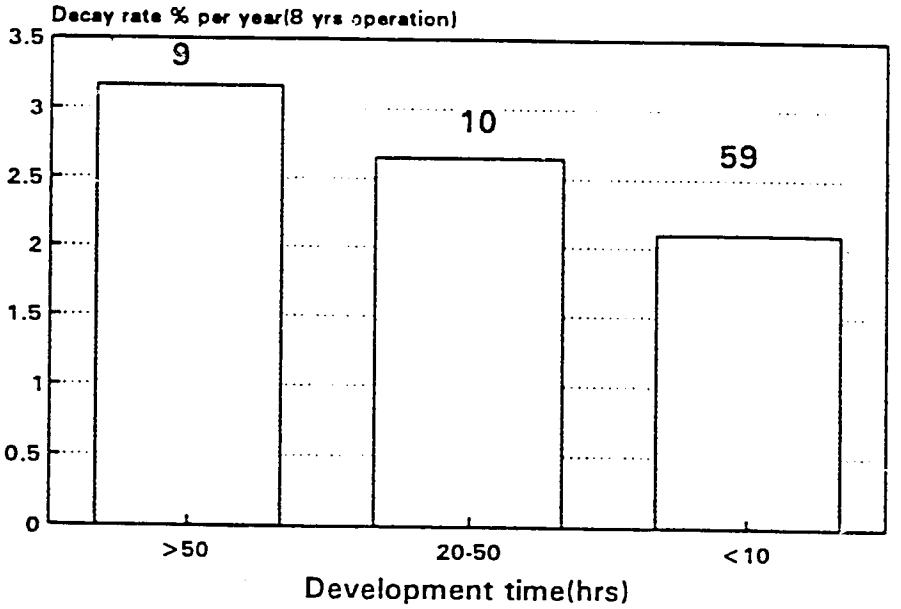

FIG 3: EFFECT OF DEVELOPMENT TIME ON DETERIORATION RATE

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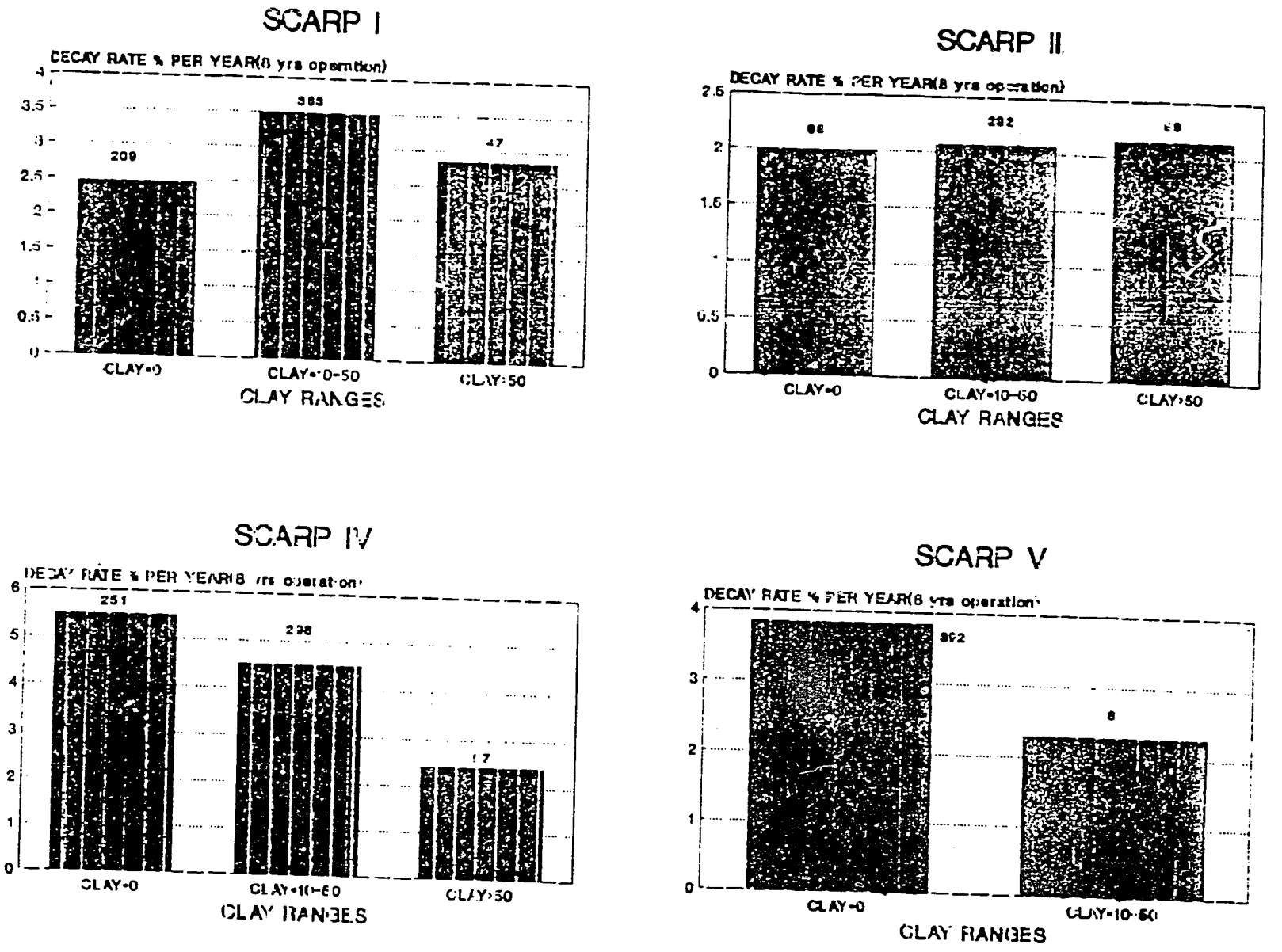


Fig 4a. EFFECT OF CLAY ON THE PERFORMANCE OF TUBEWELLS

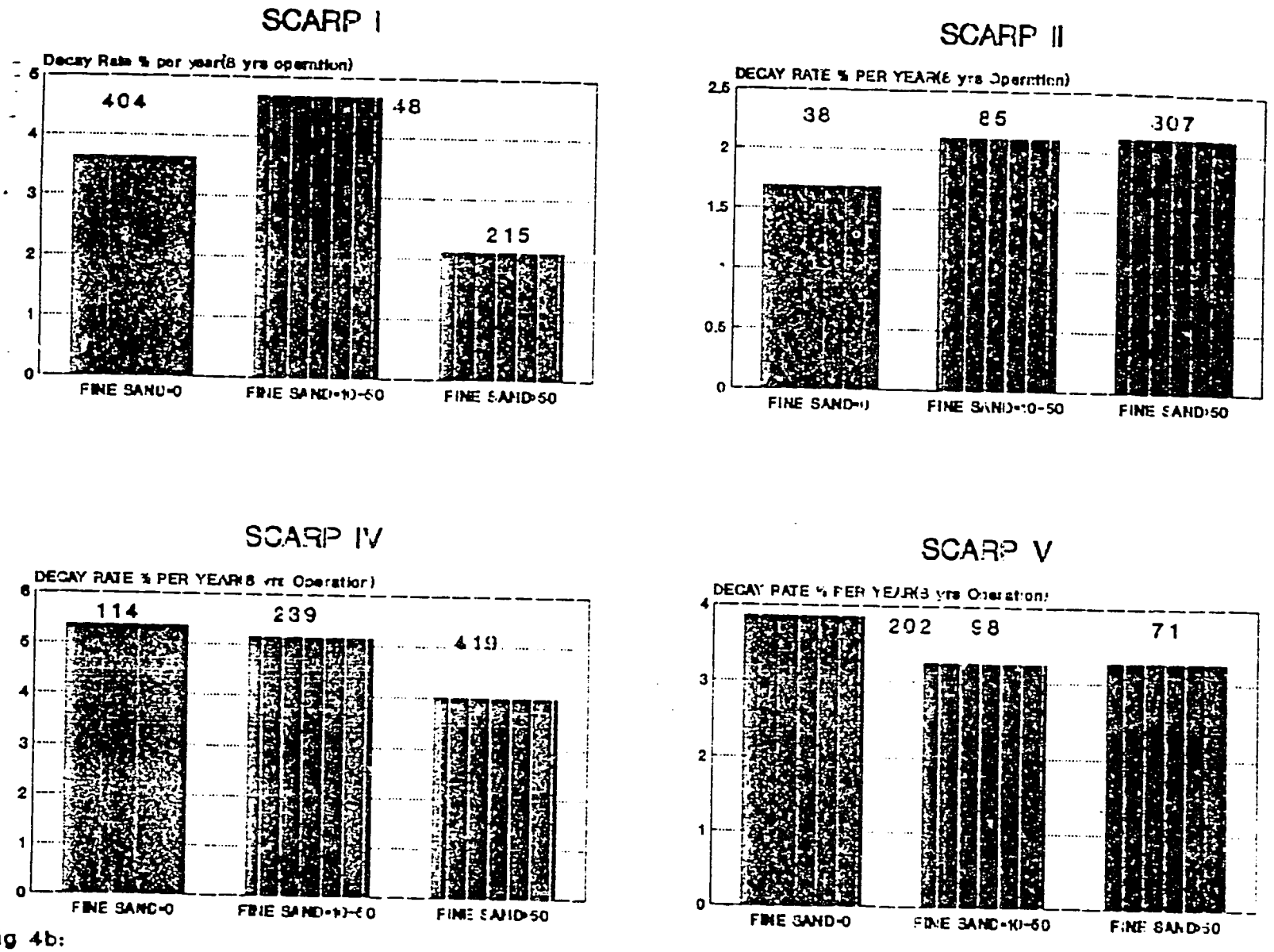
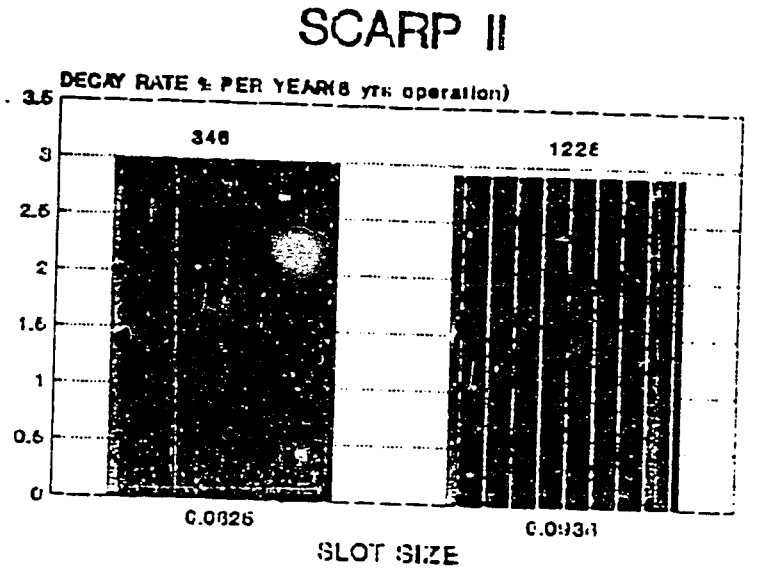
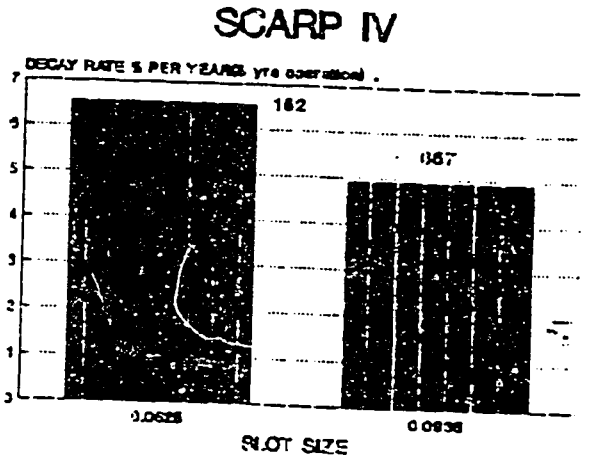


Fig 4b:

EFFECT OF FINE SAND ON THE PERFORMANCE OF TUBEWELLS

60





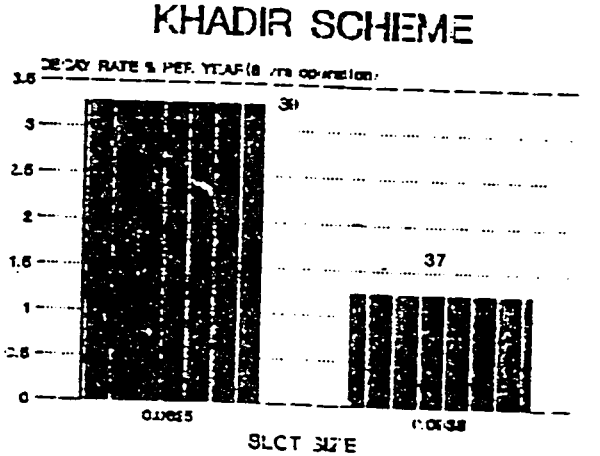
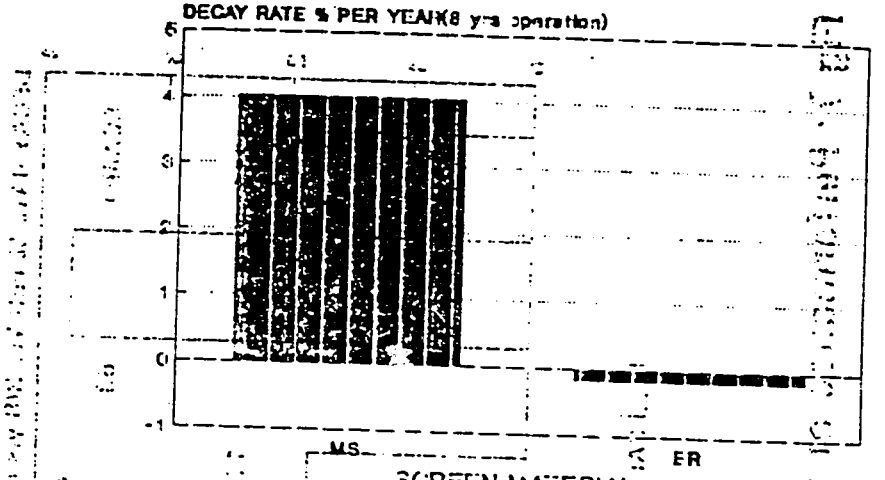
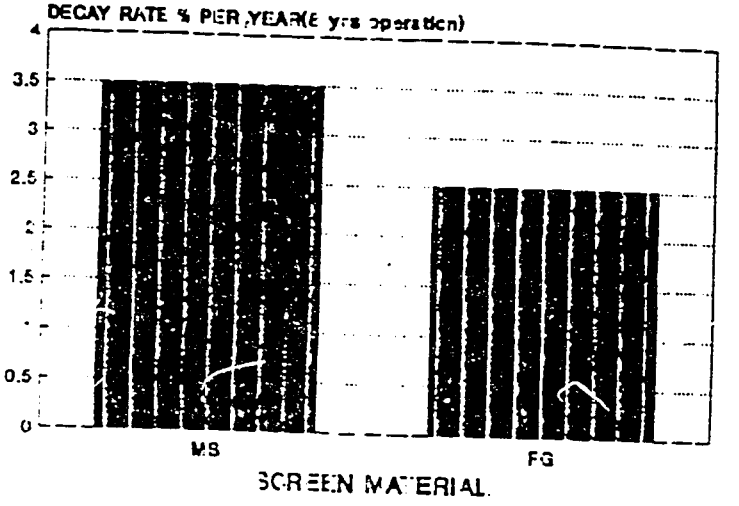


FIG 5: EFFECT OF SLOT SIZE ON DECAY RATE

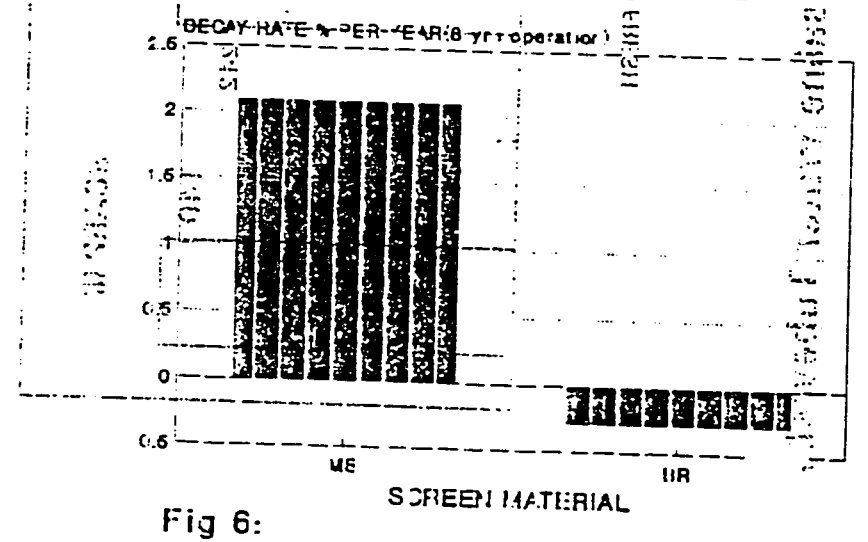
SCARP I



SCARP II



SHAHKOT SCHEME



KHADIR SCHEME

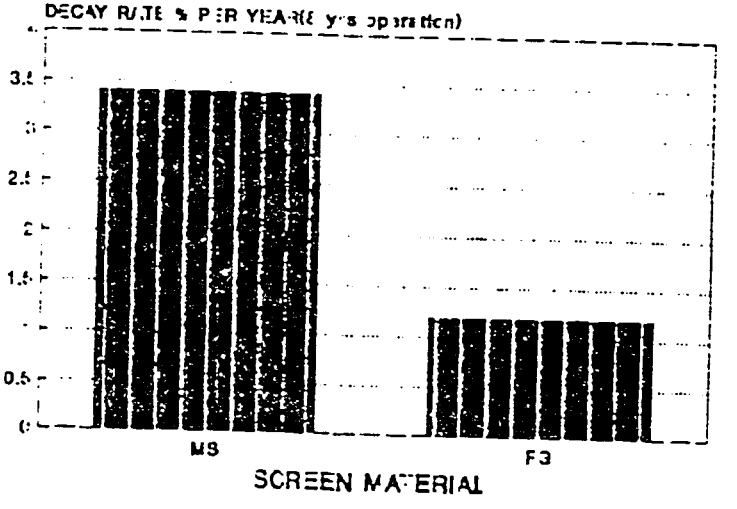


Fig 6:

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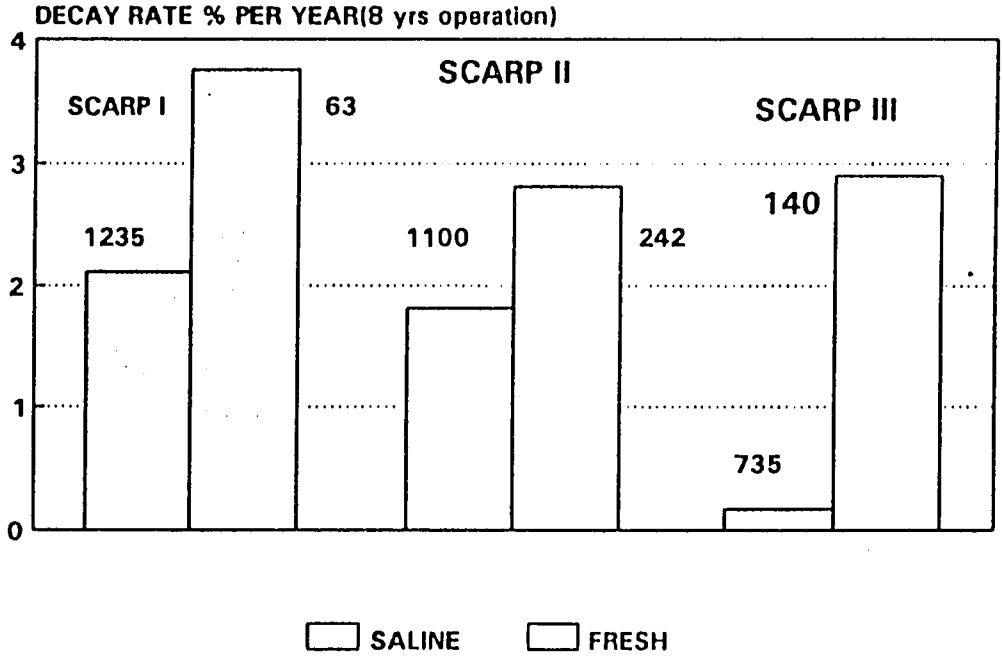

Fig 7: Performance of fresh & saline water Tubewells

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