PAPERS PRESENTED AT THE
SSF/CEP SEMINAR, Nagpur
(India), June 29 - July 1,
1983.

SLOW SAND FILTRATION - AN APPROPRIATE & COST EFFECTIVE TECHNOLOGY FOR SMALL & MEDIUM WATER SUPPLIES IN DEVELOPING COUNTRIES

By

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For presentation at the National Workshop on Slow Sand Filtration to be held at NEERI, Nagpur, during June 29- - July 1, 1983

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INTRODUCTION

Safe water to all by the year 1990 is the goal of the United Nations International Drinking Water Supply and Sanitation Decade. The task ahead will call for enormous increase in construction of water supply facilities particularly in developing countries. The massive investment required to achieve the target underscores the need for innovative and imaginative strategies in planning, implementation and management of public water supply programmes.

Community water supply systems have to be technologically sound, economically viable, socially acceptable and within the local capabilities to operate and maintain. Slow sand filtration has the reputation of being a reliable means of treating polluted waters. The advantages of the process such as its simplicity (of design, construction, operation and maintenance) and ability to accomplish a high degree of purification make it especially appropriate for small and medium water supplies in developing countries. Because slow sand filters require a larger area than rapid filters and are usually cleaned manually by removing top layer of sand, a general misconception prevails among design engineers that they are expensive. This is not, however, always true and for many small water supplies slow sand filters are cost effective. This paper presents a rational approach to the design and construction of slow sand filters, a cost comparison between slow and conventional rapid sand filters and a model for optimal design of slow sand filter system.

BASIC DESIGN CONSIDERATIONS

Design Period

An important decision in planning a new water supply system concerns the design period. The single major constraint in the provision of water supplies in developing countries has been inadequate finances.[1] When money is scarce and interest rates are high, long-range investments are less preferred to investments that bring immediate benefits. Since there is very little economy of scale in slow sand filter construction as shown by cost analysis later, the design period should be short; for example, 10 years. This will help to optimize the long-term investment in water supply and will allow the available money to finance more new projects immediately.

Design Population and per-capita supply

The population to be served during the design period has to be estimated by considering all the factors governing the future growth and development of the community: transportation, agriculture, electrification, education and health services. While several methods are available for population forecasting, no single method will be uniformly applicable to all situations.

A recent study[2] recommends a minimum requirement of 70 lpcd for rural communities where the supply is only through handpumps or central standposts and 90 lpcd when house service connections are provided. The Manual on Water Supply & Treatment[3] recommends an increasing per-capita rate with increasing size of population, 10000 (70-100 lpcd), 10000-50000 (100-125 lpcd), 500000 & above (125-200 lpcd) .

The per-capita demand multiplied by an estimate of the future population gives the total design volume. When considering the design of slow sand filters, it would be more convenient to convert the daily required volume to a design flow Q, the quantity of water to be treated per hour rather than per day, because the daily requirement of water may be treated over a period of 24 hours or just a few hours, which is common in small plants. Thus, for a given daily output, the size of the plant depends on the duration of filter operation .

Rate of Filtration

The traditional rate of filtration adopted for normal operation is 0.1 m/h (2 gph/sq.ft.). Pilot plant studies[4] have shown that it is possible to produce safe water at a rate of 0.2 m/h or even 0.3 m/h. Ofcourse, at these higher rates, the interval between filter cleanings is shortened, but the treated water quality does not deteriorate. The 0.2 m/h rate is considered a maximum desirable rate during those period when some filters are out of service for cleaning or repairs. If only two filter units are built and the normal rate is 0.1 m/h, the overload rate with one unit out for cleaning will be 0.2 m/h, which is acceptable, but the minimum number of units should be two. This recommendation deviates from the general practice in many states in India of providing one extra unit so that the overload filtration rate is kept to 0.1 m/h. A design that does not allow even occasional overload seems to increase the size and cost of the facility unnecessarily .

Continuous versus Intermittent Operation

Given the daily demand, the size of a plant is governed by the effective duration of filter operation. Pilot studies[5] have shown that intermittent filter operation is not desirable. A short time after startup, the bacteriological quality of filtered water deteriorates and becomes unacceptable. Because the purification process is as much biological as physical, the biological organisms do best when conditions are nearly steady. Further, continuous operation over 24 hours obviously requires an area only one third of that needed for intermittent eight-hour operation. The savings in filter construction can pay for storage reservoirs and additional operators.

Number of Filter Beds

To ensure uninterrupted production , a minimum of two filter units should be built irrespective of the plant capacity. Three or more units may be required because the size of each unit can not exceed certain maximum practical dimensions, or three or more units may reduce overload on the filters that are operated when one unit is out of service for cleaning or repairs. Table 1 shows the average and overload filtration rates, depending on the number of filters. It will be shown later that for a given area, the number of filter beds can be increased for higher flexibility and reliability for a marginal increase in total cost of construction .

TABLE 1 - OVERLOAD AND AVERAGE FILTRATION RATES

Number of Filters	Number of Operating Filters	Filtration rate m/hr.
2	2	0.100
2	1	0.200
2	0	0.000
3	3	0.100
3	2	0.150
3	1	0.300
4	4	0.100
4	3	0.133
4	2	0.200
5	5	0.100
5	4	0.125
5	3	0.166

Filter shape and plant layout

Filters may be circular or rectangular. Circular filters are not economical except for very small installations. For a 100 m^2 plant with two filters, the diameter of each filter would be about 8 m. Two rectangular beds arranged in a row would have dimensions of about 8.16 m x 6.12 m . The common wall of the two rectangular units may offset the inherent structural advantages of the circular shape. Rectangular filter dimensions have been determined so that the wall perimeter for a given area is minimal (Table 2) .

TABLE 2 - OPTIMAL SIZE OF FILTER UNIT FOR A GIVEN AREA

Area m2	Two Units			Three Units			Four Units			Five Units		
	l	b	p	l	b	p	l	b	p	l	b	p
50	5.77	4.33	34.62	5.00	3.30	40.00	4.47	2.60	44.70	4.18	2.45	48.96
100	8.16	6.12	48.96	7.07	4.67	56.56	6.32	3.95	63.20	5.77	3.47	69.24
150	10.00	7.50	60.00	8.66	5.71	69.28	7.74	4.64	77.40	7.07	4.24	84.84
200	11.54	8.66	69.24	10.00	6.60	80.00	8.94	5.58	89.40	8.16	4.90	97.92
300	14.13	10.60	84.60	12.24	8.10	97.92	10.90	6.84	109.00	10.00	6.00	120.00
400	16.32	12.24	97.92	14.14	9.34	113.12	12.64	7.90	126.40	11.54	6.92	138.48
500	18.25	13.70	109.50	15.88	10.43	126.40	14.13	8.83	141.30	12.90	7.74	154.80
600	20.00	15.00	120.00	17.31	11.43	138.48	15.48	9.67	154.80	14.14	8.48	169.70
700	21.00	16.20	129.60	18.70	12.34	149.60	16.72	10.45	167.20	15.25	9.16	183.12
800	23.10	17.33	138.60	20.00	13.20	160.00	17.87	11.17	178.70	16.32	9.80	195.84
900	24.50	18.37	147.00	21.21	14.00	169.68	18.96	11.85	189.60	17.31	10.38	207.72
1000	25.80	19.35	154.80	22.36	14.75	178.88	19.98	12.50	199.80	18.24	10.95	218.88
1200	28.30	20.22	169.80	24.50	16.16	196.00	21.90	13.68	219.00	20.00	12.00	240.00
1500	31.60	23.70	189.60	27.38	18.10	219.04	24.47	15.30	244.70	22.35	13.41	268.20
2000	36.50	27.40	219.00	31.62	20.87	232.96	28.26	17.66	282.60	25.80	15.48	309.60

l - length in metres   b - breadth in metres   p - perimeter in metres

Arranging filters in a row maximizes the number of common walls and facilitates construction, operation and maintenance. Filters arranged symmetrically in block on each side of the inlet pipe can also be attractive. Local topography and the placement of pump houses, storage, and other facilities will probably be important in determining the layout. The total area of land covered by filters is not a factor, as it is virtually the same regardless of layout.

Depth of filter box

The elements that determine the depth of the filter box and their suggested depths are free board (20 cm.) supernatant water reservoir (100 cm.), filter sand (100 cm), supporting gravel (30 cm) and under-drainage system (20 cm), with a total depth of 270 cm. The use of proper depths for these elements can reduce the cost of the filter box considerably. It is general practice to adopt a total depth of 3-4 m for the filter box, but use of a 2.7 - m box depth will reduce the cost without adversely affecting efficiency.

Choice of filter sand and gravel

Undue care in the selection and grading of sand for slow sand filters is neither desirable nor necessary. Use of builder grade or locally available sand can keep the cost low. Similarly, rounded gravel, which is often quite expensive and difficult to obtain, can be replaced by hard, broken stones to reduce cost.

ECONOMIC & COST CONSIDERATIONS

Minimum filter cost

The cost of a filter excluding pipes and valves is made up of two components: the total cost for floor, under drains, sand and gravel; and the cost of walls of the filter box.

This cost in general is

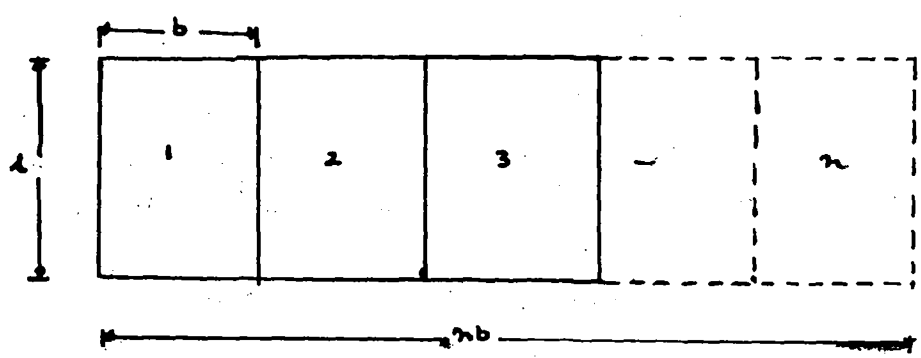
$$C = K_A A + K_p P \qquad \ldots \qquad (1)$$

where A is the total filter bed area in m^2, P the total wall length in m, K_A the cost per unit area of filter bed, and K_p the cost per unit length of wall .

For rectangular filters with common walls, the problem is to minimize C subject to :

$$A = nlb \text{ and } P = 2\,nb + l\,(n+1) \qquad \ldots \qquad (2)$$

where n is the number of filters, b is the breadth, and l is the filter length as shown in sketch below :



The term $K_A A$ is constant for any value of n and any filter shape. Hence, the minimum cost solution is the solution that minimizes P, which is

$$l^2 = \frac{2A}{n+1} \qquad \ldots \qquad (3)$$

and $$b = \frac{(n+1)l}{2n} \qquad \ldots \qquad (4)$$

The equation for b, when re-arranged, shows that $2nb \doteq (n+1)\, l$, or the condition for minimum filter cost is to have the sum of the lengths equal to the sum of the breadths. It can be shown that this is true whether filter units are arranged in a single row or as blocks on each side of a central gallery .

The general expression for the minimum cost is found by substituting Equations 3 and 4 for Equation 1 :

$$C = K_A A + 2\, K_p \left(\sqrt{2A\ (n+1)} \right) \qquad \ldots \qquad (5)$$

A detailed cost estimate based on current (1983) prices (in Nagpur, India, and excluding contractor's profit) for various materials and items of work has shown that the filter bed cost per square metre is Indian Rs. 500 and the wall cost per metre length is Rs. 830 .

Therefore, $K_A = 500$ and $K_p = 830$ the specific cost function (Nagpur, 1983) written in terms of area A is

$$C = 500\ A + 1660 \left(\sqrt{2\ A\ (n+1)} \right) \qquad \ldots \qquad (6)$$

Table 3 gives the costs for filters ranging in total area from 50 to 2000 m^2 . At 0.1 m/h filtration rate and 24-hour operation, this size range corresponds to a range in production of 120 m^3/d to 4800 m^3/d. With a per-capita supply at 70 lpcd, this would serve a population ranging from 1700 to 68000 people. A large percentage of villages and towns in India and other developing countries fall within this population range.

TABLE 3 - COST IN INDIAN RUPEES OF SLOW SAND FILTERS FOR A GIVEN AREA & NUMBER OF UNITS

Area (m2)	INDIAN RUPEES IN THOUSANDS			
	Two units	Three units	Four units	Five units
50	53.75	58.20	62.11	65.66
100	90.66	96.95	102.49	107.50
150	124.80	132.50	139.29	145.42
200	157.50	166.40	174.23	181.32
250	189.29	199.23	208.00	215.92
300	220.42	231.32	240.92	249.60
400	281.32	293.90	304.98	315.00
500	340.92	354.98	367.38	378.58
600	399.60	415.00	428.58	440.85
700	457.58	474.22	488.88	502.14
800	515.[illegible]	532.80	548.47	562.64
900	571.98	530.85	607.48	622.51
1000	628.58	648.87	666.00	681.84
1200	740.85	762.64	781.84	799.20
1400	852.14	875.67	896.41	915.16
1600	962.64	987.80	1009.98	1030.02
1800	1072.51	1099.20	1122.71	1143.79
2000	1181.84	1209.98	1234.76	1257.17

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The cost of operating flexibility

For a given area, the cost of filter media and underdrain is practically the same for any number of filter beds. However, when the number of beds is increased, the cost of construction will increase because of increased wall length. The extra cost to be paid for higher flexibility and reliability is only a fraction of the cost of the least flexible acceptable design, which has only two filters and may often be judged a good investment. The percentage increase in cost with reference to the minimum of two filter units is shown in Table 4 . The table of costs shows that for filter areas upto 2000 m^2, the number of filters can be raised from two to three by spending roughly 2 to 8 per cent more money. Building five units instead of two, costs roughly from 6 to 22 per cent more. The smaller the total area, the greater the additional cost for building more than the minimum of two units. However, it would not be wise to build more units for small areas, as the unit size would become too small for practical construction. Too many filters would also demand greater attention from the operator.

If it is assumed that for a given filter area, the increase in cost to provide a given number of units (against a minimum of two) should not exceed 5 per cent (based on the cost equation $C = 500\,A + 1660\sqrt{2A\,(n+1)}$, the lower limit of area A can be worked out for different values of n. Based on this information and the cost figures given in Table 3, the number of units for a given area, and the cost thereof, have been worked out and presented in Table 5 , which can serve as a ready recokener for a design engineer. It can be concluded that there is no significant cost penalty for making the number of filters greater than two in order to gain reliability and operating flexibility .

TABLE 4 - PERCENTAGE OF COST INCREASE FOR 3,4 & 5 UNITS AS COMPARED TO 2 UNITS ONLY FOR A GIVEN AREA

Area (m2)	Per cent Cost Increase		
	Three units	Four units	Five units
50	8.27	15.56	22.15
100	6.93	13.05	18.57
150	6.17	7.61	16.52
200	5.64	10.62	15.12
250	5.25	9.88	14.06
300	4.94	9.29	13.23
400	4.47	8.41	11.97
500	4.12	7.76	11.04
600	3.85	7.25	10.32
700	3.63	6.84	9.73
800	3.45	6.49	9.24
900	3.29	6.20	8.83
1000	3.16	5.95	8.47
1200	2.94	5.53	7.87
1400	2.76	5.19	7.39
1600	2.61	4.91	6.99
1800	2.48	4.68	6.66
2000	2.38	4.47	6.37

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TABLE 5 - OPTIMAL NUMBER, SIZE AND TOTAL COST OF FILTER UNITS FOR A GIVEN AREA

Area (m2)	Capacity* m /hr	No. of units	L	B	P	Total cost (Rs.x1000)
50	5	2	5.77	4.33	34.64	53.75
100	10	2	8.16	6.12	48.98	90.66
150	15	2	10.00	7.50	60.00	124.80
200	20	2	11.54	8.66	69.28	157.50
250	25	2	12,90	9.68	77.45	189.29
300	30	2	14.14	10.60	84.85	220.42
400	40	3	14.14	9.42	113.13	293.90
500	50	3	15.81	10.54	126.49	354.98
600	60	3	17.32	11.54	138.56	415.00
700	70	3	18.70	12.47	149.66	474.22
800	80	3	20.00	13.33	160.00	532.80
900	90	3	21.21	14.14	169.70	590.85
1000	100	3	22.36	14.90	178.88	648.47
1200	120	3	24.49	16.32	195.95	762.64
1400	140	3	26.45	17.63	211.66	875.67
1600	160	4	25.29	15.81	252.98	1009.98
1800	180	4	26.83	16.77	268.32	1122.71
2000	200	4	28.28	17.67	282.84	1234.76

* At a filtration rate of 0.1 m/hr.

L - Length in metres

B - Breadth in metres

P - Perimeter in metres

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Economy of scale

A general cost model for the filter beds can be written as :

$$C = K(A)^a \qquad \ldots \qquad (7)$$

where 'A' is the total area of the filter beds, K(A) is the cost per unit area of filter bed construction including walls, and 'a' is the exponent that represents the economy of scale factor.

The cost data given in Table 5 has been used to determine the parameters 'K' and 'a' of the function by the method of least squares. The resulting equation is given by :

$$C = 1617\ A^{0.869} \qquad \ldots \qquad (8)$$

Slight changes in the unit cost of filter bed and box wall, from the values of 500 and 830 used to derive Table 5, do not significantly change the value of the exponent 'a' .

At 1980 price level when the unit costs were 350 and 570 respectively, the value of the exponent was 0.857 .

If the exponent were 1, the cost would vary in direct proportion to the area of the filter. If the exponent 'a' is small, there will be little additional cost for building a larger unit. If a=0, the cost is independent of size. Large economies of scale are associated with small values of the exponent. Until the exponent decreases to about 0.6 or 0.7, there is no economic incentive to overdesign. Thus, very little saving is accomplished by increasing the size of the project in order to provide service over a long time into the future. It has been shown[6] that the best economic policy in slow sand filter construction is to use initial design periods of not more than 10 years and to provide for frequent expansion to meet future demand .

Cost comparison between Slow and Rapid Sand Filters

An analysis of comparative costs of conventional rapid sand filters vis-a-vis slow sand filters has been presented in this section. The costs (1983 prices) for conventional plants with treatment flow sheet shown in /Fig. 1 were obtained/ from reputed construction companies in India. Based on a regression analysis of the cost data (Table 6) a model has been developed for cost of rapid sand filters (Fig.2). The costs (1983 prices) for slow sand filters with no pre-treatment have been worked out for various items of civil engineering construction including cost of land. In both the cases, the costs are inclusive of overheads and profit margin. The comparative costs thus obtained for rapid and slow sand filters are given in Table 7 .

It can be seen from the table of costs that the capital cost of slow sand filters is less than that of a conventional plants upto a capacity of 3.0 mld. It is well established that the operation and maintenance cost for slow sand filters is always less than that for rapid sand filters. Therefore, a rational comparison has to be made on the basis of capitalised cost or total annual cost of the two systems. The capital and operation, maintenance and repair (OMR) costs for rapid and slow sand filters of different capacities have been worked out and presented in Table 8, along with the data assumed. The staffing pattern and salary are based on the norms recommended by the Maharashtra Water Supply and sewerage Board (MWSSB). Table 9 shows the capitalised costs for rapid and slow sand filters of equal capacity. From the cost-capacity curves

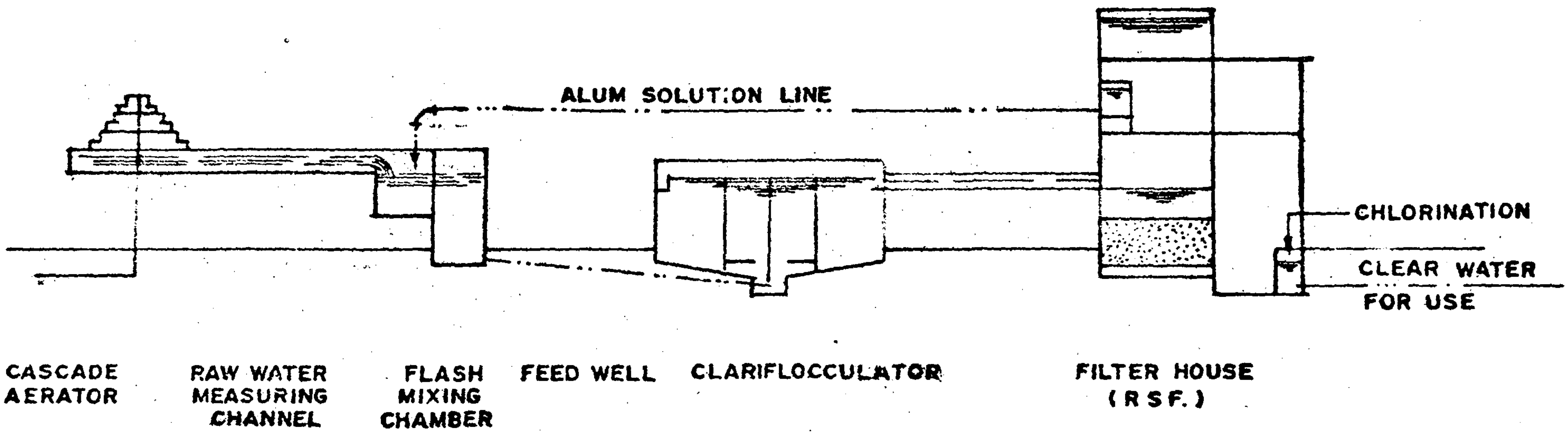

FIG. I – FLOW DIAGRAM OF CONVENTIONAL WATER TREATMENT PLANT

TABLE 6 - COST OF CONVENTIONAL WATER TREATMENT PLANTS (RSF)

Capacity MLD		Cost in lacs (Rs.)
2.26	...	18.55
2.27	...	10.03
2.27	...	10.4
2.72	...	8.77
2.8	...	14.62
3.5	...	8.85
4.5	...	13.18
4.5	...	18.97
4.54	...	12.8
5.5	...	19.15
6.67	...	15.65
6.72	...	14.28
6.81	...	15
9.08	...	18.4
9.08	...	26.49
11.35	...	20.6
13.5	...	35.04
13.62	...	22.8
15.89	...	26.2
18	...	34.09
18.16	...	28
20	...	52.8
20	...	59.11
20.43	...	31.6
22.7	...	33.4
36	...	45.93
42	...	55.19

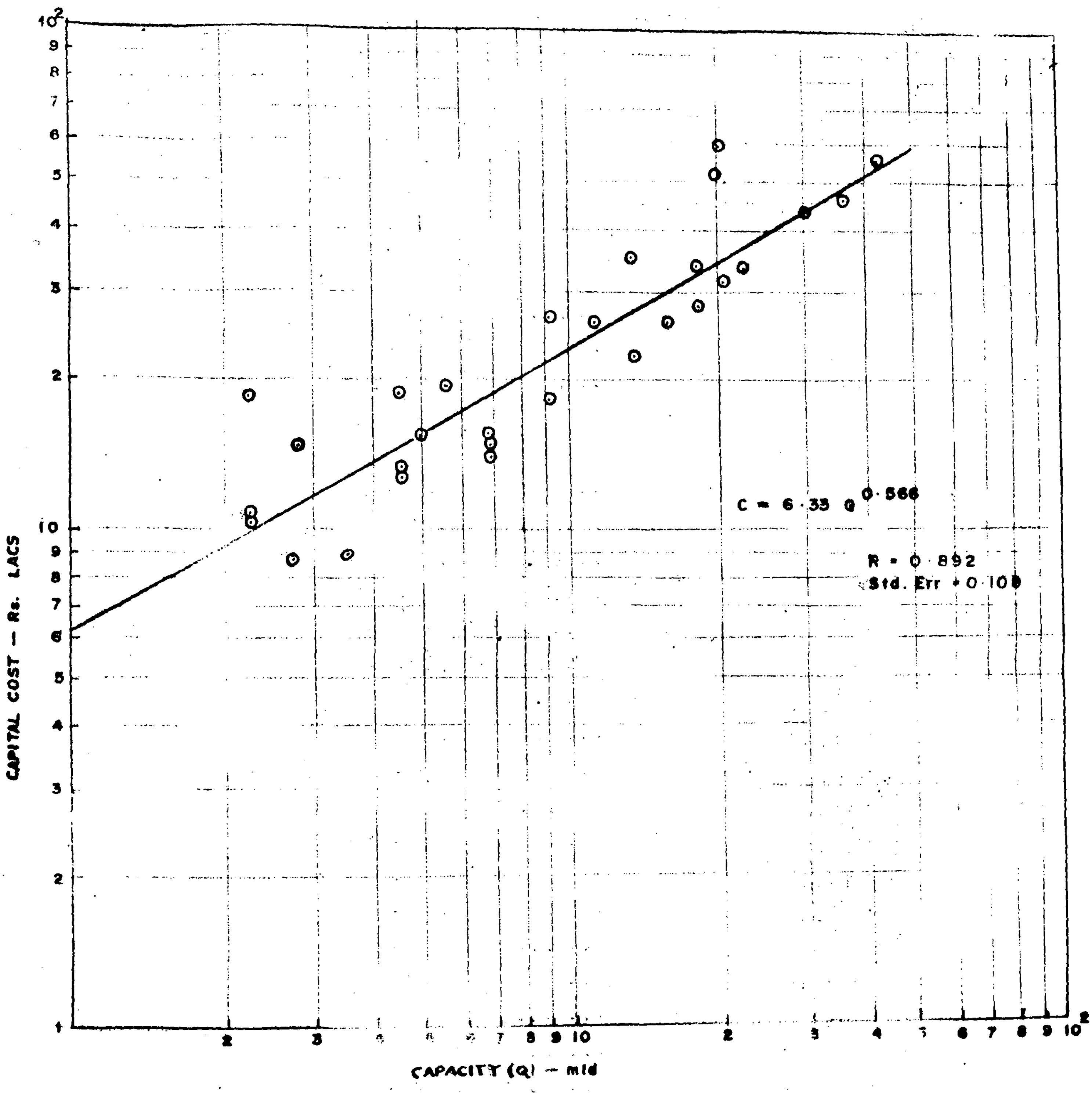

FIG. 2 - COST MODEL FOR RAPID SAND FILTERS

SLOW SAND FILTRATION : HEALTH EDUCATION AND COMMUNITY PARTICIPATION IN THE FOUR PROJECT VILLAGES

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For presentation at the National Seminar on Slow Sand Filtration, Health Education & Community Participation to be held at NEERI, Nagpur, during June 29-July 1, 1983

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It is increasingly recognised that health benefits from improved water supply will not automatically follow unless a desirable change in the knowledge, attitude and practice of the user community is brought about. All water-borne diseases can also be transmitted by any route which permits faecal material to reach the mouth, eg., through contaminated food. Therefore, provision of safe water supply alone by itself can not control water-borne diseases unless the personal, domestic and environmental hygiene are also improved simultaneously. It is against this background that a programme of health education was integrated as an important activity of the slow sand filtration project.

The strategy for the education and participation activities was developed by the Central Health Education Bureau, New Delhi in close collaboration with NEERI, which performed the overall coordination of the national programme as well as with the State Health Education Bureaus in the four participating states of Andhra Pradesh, Haryana, Maharashtra and Tamil Nadu.

Methodology

In general, a uniform methodology was followed in all the project villages. Informations regarding the village, educational requirements of the community, facilities and amenities available etc., were collected through appropriate proformae. For effective planning, implementation, evaluation and follow-up of the health education, advisory and action groups were formulated at various levels. A welfare-cum-health committee was formed at the village level to review and implement the health education activities among the target population .

Orientation training

An orientation training of the community health workers, village head, formal and informal leaders and school teachers was arranged to prepare them to undertake the field work of educating the community. They were trained to organise meetings and deliver information on various aspects of health and disease, water supply, personal hygiene, environmental sanitation at the grass root level. A resource book known as "Health Guide to Workers" was prepared by Haryana State Health Education Bureau, for regular use and reference. In all the project villages, medium of instruction was the respective local language. The course was supported by practical demonstrations, group discussions, charts, models, slides, moviefilms, flashcards and blackboard.

Before and after the training course, the trainees were subjected to written tests to assess their scientific knowledge related to health aspects before and after the training.

Inter-agency meeting :- To ensure uniformity and to facilitate effective coordination, a meeting of representatives of the four participating states was arranged, at Nagpur during July 1978, Public Health Engineers, Medical Officers, and health education field staff from all the four states participated in this meeting.

Educational Activities :- The educational activities comprised of mass meetings, group meetings, individual contacts, exhibitions, screening of movie films, display of posters, mottos, slogans, immunization campaigns, etc. Doctor's visit was arranged periodically to treat the sick and also to discuss and educate the community on health aspects and sanitation. All the project villages have schools and the teachers working there were also involved in educating the community. The teachers were helpful and effective in educating school children about cleanliness, personal hygiene, good habits, common diseases among children, environmental sanitation etc.

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Periodic medical examination of the children was done and the defects and shortcomings were pointed out to them till they were rectified. A variety of educational aids were prepared in local languages and used in all the villages. Recorded dialogues, health songs, celebration of health day, debate and drama for children depicting health topics were part of the campaign to educate the community. In addition, posters, pamphlets, roll charts, models, panels, flash cards, table tops were also used on various occasions.

Movie films were a great attraction in all the project villages. A variety of movie films in the local language were shown to the village audience regularly. The topics covered in these films were : importance of water, cleanliness, solid waste disposal, nutrition, healthy habits, mosquito control, environmental hygiene, dental care, healthy child, malaria eradication, cholera, filariasis, hookworm etc. The films were procured on loan from CHEB and other local agencies for screening. To make the programme interesting, attractive, entertaining and at the same time educative, the scientific films were interspersed with entertaining motion pictures. All such occasions were used to instruct the community to use safe drinking water supplied to them and to use latrines regularly, so that their environment was kept clean and germ free .

Salient Findings

The impact of the education activities on the community was evaluated concurrently and after the termination of the project. Compared to the base-line data regarding the awareness of water-borne diseases, personal hygiene, importance of sanitation etc., the community have shown vast improvements after the educational activity. Majority of the people have taken to regular use of water from slow sand filters, in all the villages. In Borujwada, the only well which provided saltish water is not in use now. The method of storing and handling drinking water have been improved in all the villages. Improvement was also noticed in the status of personal hygiene of adults and children. An appreciable change in the knowledge of the community regarding water-borne and water-related diseases was also noticed with reference to the base-line data in the project villages.

Community Participation

For the success of any developmental activity aimed at improving and enhancing the socio-economic and health status of the community, public support and participation is of paramount importance. This is true also for a water supply project from its planning to implementation and continued operation and maintenance. In the project villages the communities had their share of participation in every aspect of the activity.

Participation in planning and design

During the planning and design of the project, consultations were held with representatives of the villages. They were appraised of the advantages and benefits the community would derive on its implementation, the nature and extent of participation expected from the village people and their commitment for the continued operation and maintenance of the water supply system when handedover. Decisions regarding the source of raw water, location of treatment works, [illegible], location of public stand posts were taken in consultation with the community and satisfying at the same time the engineering requirements.

In Pothunuru, during initial consultations, the Sarpanch (village head) was not in favour of installing slow sand filters for their water supply. This was mainly due to some misunderstanding of the whole concept. Therefore, detailed discussions were held with him and the other leaders during which all their doubts were cleared and the community leaders were fully convinced of the choice of the system. Whole-hearted support, co-operation and participation were readily forthcoming thereafter.

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In Borujwada, the land owners willingly agreed to give away land required to locate the treatment plant at minimal cost .

Participation in Construction

In all the four project villages, participation in construction was in the form of financial contribution. The actual construction was done by contractors.

Village Borujwada was awarded a prize money of Rs. 10,000/- by Zilla Parishad for hundred per cent coverage of the households, with individual sanitary latrines. This money along with another Rs. 10,000/- which they took on loan from the Govt. gave a total contribution of Rs. 20,000/- from village Borujwada. One of the local residents educated upto 10th standard was associated with the various stages of construction and was eventually employed as the operator for the plant. Many of the paid labour were from the village itself.

In Abub Shahar, an amount of Rs. 20,000/- was raised by the community towards their financial contribution to the project.

In Kamayagoundanpatti, the panchayat (local body) obtained a loan of Rs. 3.61 lakhs from LIC towards its share of the construction cost of the plant. The loan with interest was to be repaid by the panchayat from its own income by way of local taxes.

Village Pothunuru also contributed 20 per cent of the total cost of the water supply project.

Participation in operation and maintenance

In Borujwada village, the local person associated with the construction of the plant right from the beginning and therefore familiar with the various units was appointed operator of the plant by the villagers themselves. He was given inplant training by NEERI till he was able to do the routine duties all by himself. The financial contribution of Rs. 50,000/- from the IRC has been kept as a long-term deposit in a bank and the interest money is utilized for meeting the expenditure on routine operation and maintenance of the plant, salary of the operator and repairs and replacements. Since the commissioning of the plant, another local person has also been trained who could look after the plant in the absence of the regular caretaker. As the water supply needs of the community are adequately met in terms of quality and quantity, a sense of responsibility and keen desire to properly operate and maintain the plant in their own interest is evident.

In Abub Shahar and Kamayagoundanpatti, the operation and maintenance of the treatment plant including pumping is looked after by the public health engineering department / water supply board in close co-ordination with the local community .

The treatment plant and the distribution system in village Pothunuru are operated and maintained by the village panchayat staff.

Participation in educational activities

The formal and informal leaders and the prominent people of the villages took part in organizing and conducting the educational activities in all the project villages.

Conclusion

The participation of communities in the four project villages at all stages of planning and design, implementation, operation and maintenance has not only created in them a sense of pride and achievement but also has improved their knowledge regarding the role of clean water, better sanitation and personal hygiene in building up a state of positive health. The strategy for health education and community participation has adequately demonstrated that such activities should form an important ingredient in any health and social development programme for its success. The multidisciplinary approach with the beneficiary community as the target field tested in the slow sand filtration project could thus serve as a model for large scale adoption in future water supply programmes.

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SLOW SAND FILTER BEDS FOR P.W.S. SCHEME AT POTHUNURU IN WEST GODAVARI DISTRICT, ANDHRA PRADESH (INDIA)

By

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For Presentation at the National Seminar on Slow Sand Filtration scheduled to be held at NEERI, Nagpur during 29 June - 1 July 1983

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The Village Pothunuru is situated on the R & B Road from Eluru to Kovvuru (via) Gundugolanu at a distance of 13 kms. from Eluru in West Godavari District, Andhra Pradesh (India). The Population of the village as per 1971 census is 3254 .

The people of this village used to get drinking water from the Godavari River Canal Fed tanks. The people of this village commonly suffered from Amoebeosis and Gastro-enteritis. They also used to complain less resistance to hard labour works.

A Scheme was proposed to give protected water with a per-capita supply of 10 gallons (45 litres) per day by the Andhra Pradesh Panchayati Raj Engineering Department at an estimated cost of Rs. 3.68 lakhs. The scheme envisages filtration of water through pressure filters originally. During execution of the Scheme, it was selected by the "NEERI", Nagpur, for providing slow sand filter units by giving financial assistance of Rs. 50,000/- out of the funds received from W.H.O., International Reference Centre, The Hague, The Netherlands. The P.W.S. Scheme at Pothunuru was selected by "NEERI" for its Rural Development Project which aimed at overall improvement in the health of the people.

... 2

The Slow Sand Filters were designed for a filtration rate of 50 gallons (125 litres) per sq.ft. (0.1 M/hour) per day (24 hours) and 16 hours working. Two filter beds each of size 10.97 M x 7.92 M x 3.0 M (overall depth) to give 33 G.P.M. by each filter, are constructed with the following details.

The alround walls of filter bed are of R.C.C. 40 cms. thick and bottom is provided with 15 cms thick 1: $1\frac{1}{2}$: 3 R.C.C. raft.

FILTER SUPPORT CUM DRAINS

The filter support is prepared out of 20 cms. x 20 cms. x 5 cms. C.C. = 1 : $1\frac{1}{2}$: 3 perforated bricks supported over solid bricks of 20 cms. x 10 cms. x 5 cms. C.C. 1:$1\frac{1}{2}$: 3. 5 nos., of 6 mm dia. perforations are provided in each brick. The filtered water, collected through the perforations along with other gaps in between the brickets, flows through the side drains into a Central Drain of size 30 cms. x 30 cms. The central drain is covered with R.C.C. (1:$1\frac{1}{2}$:3) perforated blocks of 5 cms thickness.

DETAILS OF FILTER MEDIA

		Depth
a) HARD BLASTED GRANITE METAL :		
i) Passing through 25 mm dia. sieve and retained on 20 mm. dia. sieve	...	15 cms.
ii) Passing through 12.6 mm dia. sieve and retained on 6.3 mm dia. sieve	...	10 cms.
iii) Passing through 4 mm dia. sieve and retained on 2 mm. dia. sieve	...	10 cms.
b) COARSE SAND :		
i) Passing through B.S.S. No.14 and retained on B.S.S. No.24	...	10 cms.
c) FINE SAND :		
i) Passing through No.14 sieve and retained on No. 60 sieve	...	100 cms.
TOTAL DEPTH OF FILTER MEDIUM	...	145 cms.

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TABLE 7 - COST OF SLOW Vs. RAPID SAND FILTERS

Capacity mld	Cost in lacs (Rs.)	
	S.S.F.	R.S.F.*
1.0	4.6	6.3
1.5	6.5	7.9
2.0	8.4	9.2
2.5	10.2	10.5
3.0	11.9	11.7
4.0	15.3	13.8
5.0	18.6	15.7
7.0	24.9	19.0
10.0	34.0	23.1
15.0	48.4	29.3
20.0	62.1	34.5

* Based on regression model

...

TABLE 8 - RELATIVE COST OF SLOW AND RAPID SAND FILTERS

(Capital, Annual OMR Cost) Rupees in Thousands

Plant capacity (mld)	Rapid Sand Filter*						Slow Sand Filter**				
	Capital	M & R	Energy	Chemicals	Salary	Total OMR	Capital	M & R	Scraping	Salary	Total OMR
1	630	25.2	0.73	10.9	51.0	87.83	460	9.2	3.12	44.4	56.72
2	920	36.8	1.46	21.8	51.0	111.06	840	16.4	6.25	44.4	67.05
3	1170	46.8	2.19	32.7	51.0	132.69	1190	23.8	9.37	44.4	77.57
5	1570	62.8	3.65	54.5	51.0	171.95	1860	37.2	15.62	44.4	97.22
7	1900	72.0	5.10	76.3	51.0	204.40	2490	49.8	21.87	44.4	116.07
10	2310	92.4	7.30	109.0	51.0	259.70	3400	68.0	31.25	44.4	143.65
15	2930	117.2	10.95	163.5	51.0	342.65	4840	96.8	46.87	44.4	188.07
20	3450	138.0	14.60	218.0	51.0	421.60	6210	124.2	62.50	44.4	231.10

* M & R @ 4 %
Energy @ 4 KWH/MLD (Rs.0.50 / KWH)
Chemical (Alum) @ 30 mg/l (Rs.1,000/MT)
Salary :- Operator 3 nos. @ Rs.550/- P.M.
Attendant 3 nos. @ Rs.450/- P.M.
Helper 2 nos. @ Rs.500/- P.M.

** M & R @ 2 %
Scraping @ Rs.0=50 P /m2 area
Salary :- Operator 3 nos. @ Rs.550/PM
Attendant 3 nos. @ Rs.550/PM
Helper 1 no. @ Rs.500/PM

TABLE 9 - CAPITALIZED COSTS FOR RAPID AND SLOW SAND FILTERS

Rs. in lacs
1 lac = 1,00,000

Plant capacity (mld)	Rapid Sand Filter				Slow Sand Filter			
	Capital	Annual OMR	Capitalised OMR	Total capitalised	Capital	Annual OMR	Capitalised OMR	Total capitalised
1	2	3	4	5=2+4	6	7	8	9=6+8
1	6.3	0.87	6.67	12.97	4.6	0.56	4.30	8.90
2	9.2	1.11	8.43	17.63	8.4	0.67	5.09	13.49
3	11.7	1.32	10.07	21.77	11.9	0.77	5.89	17.79
5	15.7	1.71	13.06	28.76	18.6	0.97	7.38	25.98
7	19.0	2.04	15.53	34.53	24.9	1.16	8.81	33.71
10	23.1	2.59	19.73	42.83	34.0	1.43	10.91	44.91
15	29.3	3.42	26.03	55.33	48.4	1.88	14.28	62.88
20	34.5	4.21	32.04	66.54	62.1	2.31	17.56	79.66

Remarks

Capitalised cost = Capital cost + capitalised OMR cost

$$\text{Cost factor} = \frac{1-(1+r)^{-T}}{r} \qquad r = \text{interest rate : 10 per cent}$$

$$= \frac{1-(1.10)^{-15}}{0.10} = 7.6 \qquad T = \text{design period : 15 years}$$

(Fig.3), it can be seen that slow sand filters are economical upto 8.0 mld. This limit of economical size will further go up if a chemist has to be employed for rapid sand filters. Furthermore, it may be noted that while comparing costs, factors which can not be readily quantified in terms of money should also be given weightage for a more realistic evaluation of alternatives. For example, the quality of product water from a slow sand filter will be less corrosive than chemically treated water, the long term effect of which on the distribution system can not be simply assessed. Similarly the effect on the receiving stream of disposal of wastewater and sludge from waterworks providing chemical treatment is difficult to quantify.

Almost all the villages and towns that still remain to be covered with protected water supply in India and in many developing countries have a population of a few thousands only. Even if regional water supply schemes covering a number of villages are considered, the total population may seldom exceed 1,00,000, for which water treatment by slow sand filtration can prove economical and cost effective.

OPTIMAL DESIGN OF SLOW SAND FILTER SYSTEM

It has been shown that for small and medium water supplies (upto about 8 mld) slow sand filters are economical than conventional rapid sand filters. This section presents a methodology for evaluating various alternatives in slow sand filter system for a given daily demand. The important assumptions made in the design are as follows :

- The system provides for a single step treatment using slow sand filters with no pre-treatment.

- The design filtration rate is 0.1 m/hr.

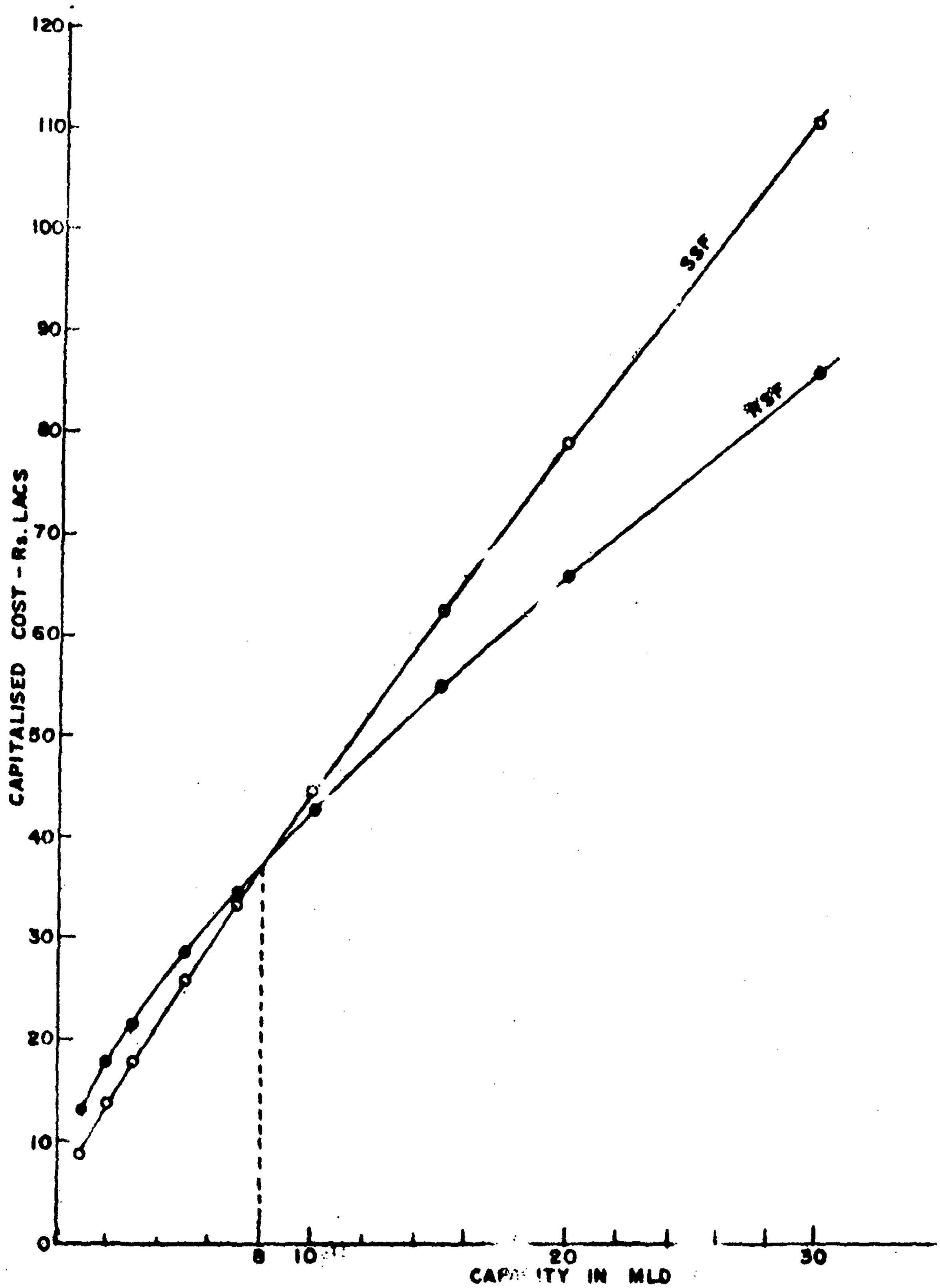

FIG. 3 · CAPITALISED COST FOR SLOW SAND & RAPID SAND FILTERS

- The treatment works are located in the vicinity of raw water source and the raw and filtered water pump houses are so arranged as to facilitate operation & control by one pump attendant.

- The shift timings are :

1st shift	... 6 am to 2 pm
2nd shift	... 2 pm to 10 pm
3rd shift	...10 pm to 6 am

- Water supply is intermittent and the timings are fixed - 6 am to 8 am and 4 pm to 6 pm .

In the light of experience and field practice, five alternatives are evaluated.

<u>Alternative 1</u> :- The filters are designed for 7 hours (one shift) operation from 6 am to 2 pm and so also the raw and clear water pumps.

<u>Alternative 2</u> :- The filters and the pumps are designed to work for 16 hours (two shifts) from 6 am to 10 pm .

<u>Alternative 3</u> :- The filters and raw and clear water pumps are designed for continuous 24 hour operation. The system flow sheet for the three alternatives is shown in Fig. 4 a .

<u>Alternative 4</u> :- The filters are designed for continuous (24 hour) operation while raw water pumping is only for 8 hours divided into two shifts of 4 hours each; 6 am to 10 am and 6 pm to 10 pm. The pumps are designed for a capacity equal to 3 times the hourly output of the filters. The excess raw water is accumulated in a storage tank and fed to the filters by gravity during pump shut down period so as to ensure continuous filtration.

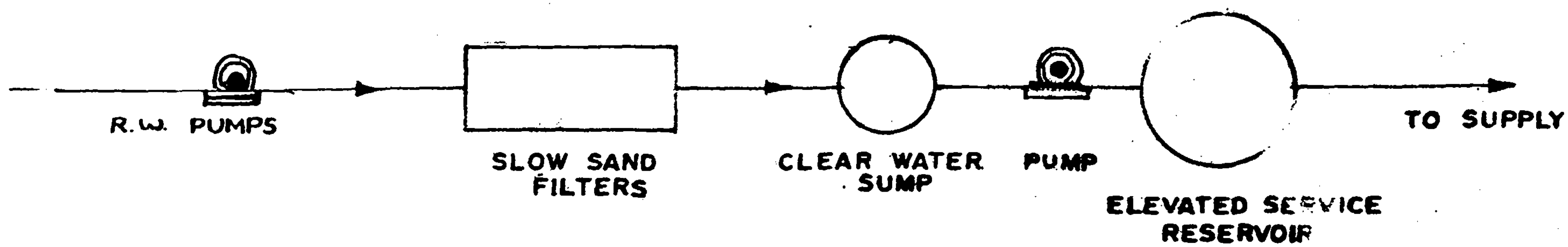

FIG.4a- FLOW DIAGRAM FOR ALTERNATIVES 1, 2, & 3

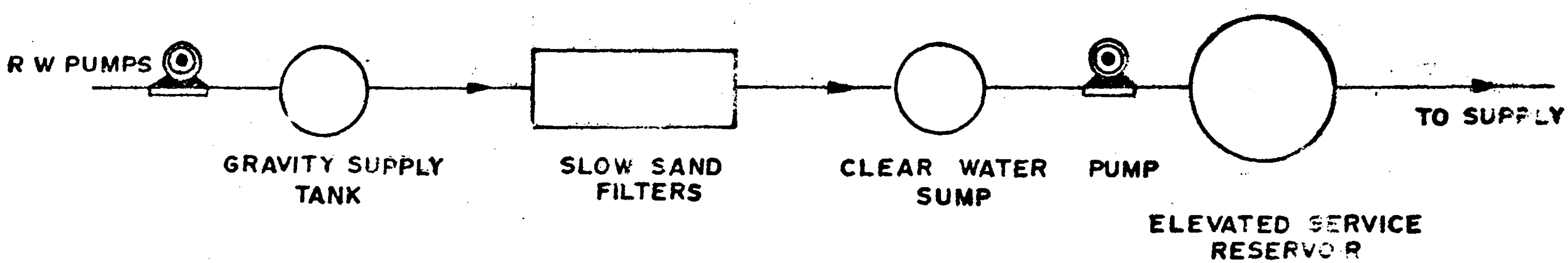

FIG.4b - FLOW DIAGRAM FOR ALTERNATIVES 4 & 5

Alternative 5 :- This is similar to alternative 4 except that raw water pumping is for 16 hours divided into 2 shifts of 8 hours each with a four hour break in between. The flow sheet for alternatives 4 and 5 is shown in Fig. 4 b .

To facilitate comparative cost evaluation, the sizes / capacities of the system components for the five alternatives have been worked out in terms of D, the total daily demand in m^3 and are shown in Table 10 . The cost functions & regression models (based on 1983 prices) are developed for individual components which collectively yield a good estimate of the costs of alternatives under consideration (Table 11). The values of constants and exponents are subject to change with time and place and hence have tobe determined for specific conditions.

The total cost of the system is made up of the cost of civil works, cost of land and the cost of raw and filtered water pumps including standby units. Cost of civil works (CCW) for any alternative can be written as :

$$CCW_n = GSTCST_n + SSFCST_n + CWSCST_n + ESRCST_n$$

where suffix 'n' stands for alternative number.

Cost of Pumps :- $C\,P[illegible]_n = K_5([illegible]_n)^{a5} = K_5(0.0046\,\frac{D.H.}{[illegible]})^{a5}$

Cost of land :- $CSTLND_n = K_6(AREA_n)$

Therefore, total Capital Cost (TCC) = Cost of Civil Works + Cost of Land + Cost of Pumps

$$TCC_n = CCW_n + CSTLND_n + C\,PUMP_n$$

TABLE 10 - SIZES / CAPACITIES OF SYSTEM COMPONENTS

System Component	Alternative 1	2	3	4	5
Gravity Supply Tank - m3 (CAPGST)	-	-	-	$\frac{D}{3}$	$\frac{D}{6}$
Slow Sand Filter - m2 (ASSF)	$\frac{D}{2.4} \times 3$	$\frac{D}{2.4} \times 1.5$	$\frac{D}{2.4}$	$\frac{D}{2.4}$	$\frac{D}{2.4}$
Clear Water Sump - m3 (SCWS)	$\frac{D}{8}$	$\frac{D}{16}$	$\frac{D}{24}$	$\frac{D}{3}$	$\frac{D}{6}$
Elevated* Service Reservoir -m3 (SESR)	$\frac{3}{4} D$	$\frac{D}{2}$	$\frac{D}{2}$	$\frac{D}{2}$	$\frac{D}{2}$

* Based on mass curve

TABLE 11 - COST FUNCTIONS & REGRESSION MODELS FOR SYSTEM COMPONENTS

System Component	Cost Function	Regression Model
Gravity Supply Tank	$GSTCST = K_1 (CAPGST)^{a_1}$	$5549\ (CAPGST)^{0.668}$
Slow Sand Filter	$SSFCST = K_2 (ASSF)^{a_2}$	$1617\ (ASSF)^{0.869}$
Clear Water Sump	$CWSCST = K_3 (SCWS)^{a_3}$	$1035 (SCWS)^{0.785}$
Elevated Service Reservoir	$ESCRCST = K_4 (SESR)^{a_4}$	$6935 (SESR)^{0.668}$
Pumps	$C\ PUMP = K_5 (HP)^{a_5}$	$2266\ (HP)^{0.525}$

A comparison between the five alternatives can be made and the final choice decided on the basis of total annual costs. The total annual cost functions for the alternatives are written as the summation of costs given in Table 12 . Using a computer and substituting appropriate values for the variables (Tables 13 & 14) in the cost functions, total annual costs for plants of capacities 200-5000 m^3/day have been obtained and presented in Table 15 & Fig.5 .

It can be seen from Fig. 5 that alternative 4 (8 hour pumping and continuous filter operation) will provide the least cost solution for plant capacities upto 270 m^3/day . This corresponds to a population of about 3900 with a per-capita supply of 70 lpd. For plants of capacity 270-950 m^3/day alternative 2 which provides for 16 hour operation of both pumps and filters is the least cost solution. For plant capacities greater than 950 m^3/day alternative 3 with 24 hour pumping as well as filter operation will be the cheapest. Experience has shown that non-availability of continuous supply of electric power is one of the major constraints particularly for small plants and that standby power is often not provided for. In such cases alternative 3 is not feasible and therefore the next cheapest has to be selected. For a reliable quality of product water continuous operation of filters is desirable. Alternatives 4 and 5 which ensure continuous filter operation but provide for intermittent pumping, should prove a practical solution though they are marginally more expensive than the least cost alternative.

SUMMARY

The slow sand filters are appropriate and cost effective for small and medium water supplies in developing countries. In the light of recently completed research a rational design of slow sand filters consistent with flexibility and reliability

TABLE 12 - TOTAL ANNUAL COST FUNCTIONS FOR ALTERNATIVES

---

1 Annualized Capital Cost (ACC) @ r % per annum over a period of 'N1' years ... $ACC_n = F(TCC_n)$

$$F = \frac{(1+r)^{N_1}}{(1+r)^{N_1}-1}$$

---

2 Maintenance cost of Civil Works @ r_1 % per annum (DCW) ... $DCW_n = r_1\ (CCW_n)$

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3 Maintenance & Depreciation on pumps @ 'r_2' per annum (DPMC) ... $DPMC_n = r_2\ (C_{PUMP})_n$

---

4 Energy cost @ "r_3" per kwh ... $ENERGY = r_3(kW_n) \times 365 \times Y_n$

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5 Cost of sand scraping @ r_4 per sq.m. area ... $SNDSCR = r_4 \times \frac{ASSF_n}{NS} \times$

NS : No. of scrapings/ year

---

6 Salary of staff*

$$SALARY_1 = 12\ (S_1+S_2+S_3)$$

$$SALARY_2 = 12 \times 2(S_1+S_2) + 12(S_3)$$

$$SALARY_3 = 12 \times 3\ (S_1+S_2)+12(S_2+S_3)$$

$$SALARY_4 = 12\ (S_1 + S_2 + S_3)$$

$$SALARY_5 = 12 \times 2\ (S_1+S_2) + 12(S_3)$$

---

7 Total Annual Cost (TAC)

$$TAC_n = ACC_n + DCW_n + DPMC_n + ENERGY + SNDSCR + SALARY\ n$$

Expressed as cost of water production (CWP_n) per 1000 m^3

$$CWP_n = \frac{TAC_n}{D \times 365} \times 1000$$

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* Refer Table 14 for staffing pattern

TABLE 13 - ASSUMED VALUES FOR THE VARIABLES USED IN THE COST FUNCTIONS

Sr.No.	Item	Notation	Value assumed
1	Cost of land in Rs./m2	K_6	5
2	Total Head on Pumps in metres	H	25
3	Interest rate per year	r	0.12
4	Interest period in years	N_1	25
5	Rate of deprecia-tion & maintenance on civil works per year	r_1	0.02
6	Rate of depreciation & maintenance on pump per year	r_2	0.07
7	Energy charges in Rs./kw	r_3	0.50
8	Scraping charges in Rs./m2 of filter area	r_4	0.50
9	Salary of pump opera-tor in Rs. / pm.	s_1	550
10	Salary of filter attendant in Rs./pm.	s_2	550
11.	Salary of watchman in Rs./pm.	s_3	400
12.	Hours of Raw/Filtered Water Pumping for Alternatives 1,2,3,4 & 5 respectively	Y	8,16,24, 8 & 16

TABLE 14 - STAFFING PATTERN FOR DIFFERENT ALTERNATIVES

Alternative No.	No. of pump operator(s)	No. of filter attendant(s)	No. of Watchman
1	1	1	1
2	2	2	1
3	3	4	1
4	1	1	1
5	2	2	1

TABLE 15 - TOTAL ANNUAL COST IN RUPEES PER 1000 m^3/day

Cap. m3/day	Alternatives				
	1	2	3	4	5
200	1183	1084	1288	1071	1155
500	875	708	748	743	743
1000	727	549	548	599	576
1500	6[illegible]0	486	469	534	506
2000	633	451	426	495	465
2500	607	431	398	469	438
3000	588	413	378	450	419
3500	573	400	362	434	403
4000	561	390	353	424	394
4500	552	381	343	414	383
5000	543	374	335	405	375

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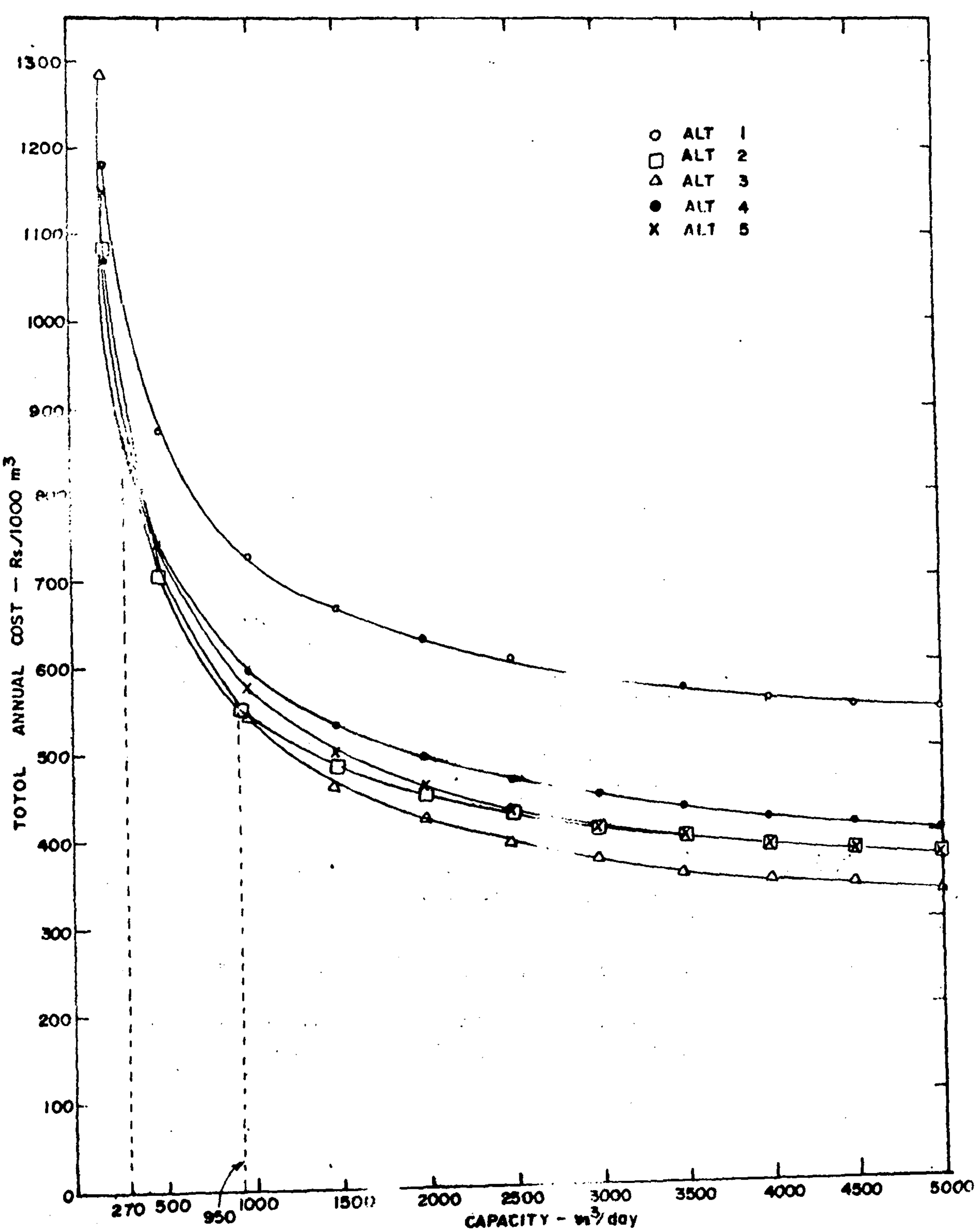

FIG. 5 TOTAL ANNUAL COST VS PLANT CAPACITY

in operation has been discussed. A model for filter cost has been suggested and it has been shown that there is no economy of scale in slow sand filter construction. Cost comparison between slow and conventional rapid filters has proved that for plants of capacity upto about 8 mld, slow sand filters are cheaper. A methodology has been described to facilitate optimal system design for any given daily demand.

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Effective size of the sand used = 0.3 (0.10)
Uniformity coefficient of sand used=2.2 (0.60)

(0.10)

The Godavari River Canal Water is fed into a summer storage tank which will act as a sedimentation tank.

Raw water from the intake well which is situated in the summer storage tank will be pumped into the S.S.Filter beds with 2 H.P. motors. The clear water from the S.S.filter beds is made to pass through "V" notch chambers to the collection well and is pumped to O.H.S.R. of 20,000 gallons capacity after chlorination by using 7.5 H.P. pump sets. From here, the water is distributed in the village through 30 public taps.

EXPERIENCE IN CONSTRUCTION & OPERATION

As far as execution of main structure is concerned, there was not much of a problem except that the shuttering for walls had to be procured and it was felt better to procure them departmentally as the petty contractors in rural areas may not be able to afford such costly items.

For the filter media, the required sieves have been procured by the Department by procuring necessary M.S. Plates and drilling required size holes in them as the meshes available in the market can not withstand the continued use.

The procedure for the operation of the slow sand filters involves only two things, to regulate the flow of raw water into the slow sand filter beds to maintain the constant head of standing water over the filter media and to regulate the flow of clear water from the slow sand filters to the designed discharge.

The first regulation is achieved by having an overflow arrangement by providing an overflow pipe at the required M.W.L. and connecting this pipe into raw water tank.

The second regulation is achieved by employing a "V" notch at the outlet and making a mark on the "V" notch corresponding to the required discharge.

One I.T.I. mechanic is now engaged by the Gram Panchayat for the maintenance of the scheme and the Andhra Pradesh Panchayati Raj Engineering Department is watching the performance of the scheme.

After usage of the filtered water, it is observed that the General health of the public has improved remarkably. No cases of Gastro-enteritis were noticed thereafter. The public have also informed that they are able to stand better for vigorous work.

COST PARTICULARS

The cost of the S.S. filters at Pothunuru works out to Rs. 1,072/- per sq.m. area of the filter bed.

The cost of maintenance of the scheme as observed is Rs. 15,82[illegible]/- during the year 1981-82 and Rs. 19,292/- during the year 1982-83 .

CONCLUSIONS

Keeping in view the easy maintenance procedure and relatively better purification when compared to pressure filters, slow sand filters seem to be the best proposition of purification of waters in rural areas.

This process is also being adopted in Number of villages covered under N.A.P. and other Programmes.

It may be possible to bring down the cost of the structure by adopting suitable designs - such as circular design. The approximate cost with circular design is coming to Rs. 0.40 per litre to Rs. 0.50 per litre against Rs. 0.67 per litre with rectangular designs. If rapid sand filters are adopted, the rate works out higher and operations will be difficult at the village level.

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CHIEF ENGINEER's CONFERENCE
27-28 June 1983 NEERI, NAGPUR.
RECOMMENDATIONS

1. The Conference appreciated the efforts of the Ministry of Works & Housing (CPHEEO) in drafting the Master Plan for the Water Supply & Sanitation Sector for the International Water Supply & Sanitation Decade. While the Conference broadly endorsed the Master Plan as drafted, representatives of some of the State Governments indicated that they have not had time to study the draft in detail and that they would forward their comments, if any, within ten days to the Ministry of Works & Housing. The Conference authorised the Ministry of Works & Housing to finalise the Master Plan Document based on these comments and the deliberations at the Conference.

2. The Conference recommended that adequate financial resources should be provided in the central and state plans for achieving the modest targets of the decade. It was noted that the financial projections in the Master Plan were based on 1980 prices. The actual financial provosions in the VII Plan and the first year of the VIII Plan should take into account the escalation in prices from 1980. The Planning Commission and the State Planning Departments should take particular note of this factor. A minimum of six per cent of the VII Plan outlay should be earmarked for the Water Supply & Sanitation Sector as recommended by the Central Working Group on financial resources to achieve the objectives of the International Drinking Water Supply & Sanitation Decade Programme .

3. The Conference also suggested the introduction of several specific measures to augment the financial resources for the water supply sector. Thus, LIC financing for the sector should be increased and made an additionality to the Plan. Further, LIC financing

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should cover 100 per cent of the project cost, at least in respect of projects costing upto Rs. 100 lakhs. The floating of a lottery to finance atleast the operation and maintenance expenditure was suggested. Cess on land revenue, sales tax, income tax, entertainment tax and increase in octroi rates were also recommended.

4. As regards externally aided projects, the Conference recommended that the entire aid received from the external agency should be an additionality to the state plan. Further, the additionality on account of external projects in the Water Supply & Sanitation sector should flow in full to the sector atleast during the decade period. The customs duty on equipment, received as part of external aid to projects, may be exempted from customs duty, particularly in the case of rural water supply schemes which are intended to benefit the rural poor.

5. The Conference unanimously endorsed the proposal for the setting up of a national level financing institution for Water Supply & Sanitation on the lines of HUDCO & REC. The institution should be set up immediately and should attempt to make available soft loans. State Governments should also set up institutions like Water Supply and Sewerage Boards to enable them to receive loans from the national institution.

6. The Conference noted that the electricity rate for rural water supply schemes was high and recommended that the rate should be brought on par with minor and lift irrigation schemes.

7. The Conference recommended that the centre may appoint a Working Group to study the water rates and collection

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of revenue by local bodies for water supply and sanitation and to suggest suitable norms in this area.

8. The Conference recommended that the principle of supplying water free to the community should be reconsidered and that water supply to any community should be adequately charged for, to make the schemes self-supporting. The objective of full recovery could be attained in stages.

9. The Conference recommended that a Working Group should be set up by the Ministry of Works & Housing with representation for State Governments to prescribe norms for operation and maintenance of water supply and sanitation projects, on the lines of similar norms for high-way projects. Health Ministry to be associated.

10. The Conference recommended that the Ministry of Works & Housing should take necessary steps to create an All India service of Public Health Engineers. The Ministry of Works & Housing may also augment training facilities for inservice engineers . A separate degree course for public health engineers should be introduced in the appropriate educational institutions.

11. The Conference recommended that additional posts should be sanctioned as soon as the workload increases. The sanction should also cover other infrastructure needed, such as vehicles. Procedures should also be streamlined to cover delegation of powers for sanction of projects and efficient implementation.

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PERSONAL INFORMATION FILE

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One of the important aspects, often discussed at conferences, seminars, workshops etc., on User Education, is Personal Information File (PInF). This paper presents a few ideas on PInF based on our own experience as technical writers and also of our interaction with a number of technical writers as users of information.

Research scientists, design and development engineers, technologists, operational and management specialists and such others need to keep themselves abreast of current developments in their own chosen field(s) of activities. For, their functions quite often result in the preparation and production of a variety of documents such as research/technical reports, monographs, treatises, critical reviews, trend reports, project reports and similar others. These activities quite obviously demand very extensive and intensive reading, besides discussions with colleagues and experts. While engaged in the pursuit of a problem, a number of documents relevant to the chosen subject is closely examined and many of them studied at depth, for gathering data, facts, ideas and thoughts. Discussions with peers, experts and others are also sometimes recorded. A good deal of note taking with bibliographical citations of source documents is fundamental to the process of writing and is most essential, in fact, indispensable. Indeed systematic and efficient note taking techniques could considerably contribute to conserving the physical as well as the intellectual effort involved in data gathering. If done properly and systematically, it could eliminate much of frustration in otherwise recalling the required information from an unorganised file at a great effort and time. It can help greatly in the sketching of a preliminary outline of the work being undertaken and subsequently the preliminary drafting. This record of well digested notes grows into a most important reference source for the writer. It has to be maintained with care, accuracy and meticulousness for easy consultation and reference throughout. It has, therefore, to be processed and organised into a file(s) to become a handy and ready tool of reference, lest all the efforts taken in the preparation of notes at various times and for various purposes are likely to be wasted. This file is often called as a Personal Information File. This paper presents a few techniques relating to the creation and maintenance of such files.

Categories of Notes

Depending on the nature of work, the writer is planning to produce, (viz, research paper, technical report, monograph, treatise, etc.), and the notes prepared thereof may be broadly grouped under three categories. They are :

1. Bibliographical references
2. Subject notes
3. Comments

The first category of notes, bibliographical references all those documents that are intensely studied, to be directly used by the author in the text, cited as foot notes, plus others that are relevant to the subject that are to feature eventually in the bibliography. Very often these references are collected at different times from various information products such as current awareness bulletins, indexing and abstracting services, selective Dissemination of information (SDI) notifications, and also while consulting and reading primary literature. These references are surrogates to information and should always contain essential minimum data that will easily and accurately identify the source publications. The usual elements that constitute an entry are ~~author, title, edition, year~~ of publication and pages, for books or similar documents; author, title, host journal title, volume, issue number, year and inclusive pagination for journal - articles; and similar appropriate elements for other types of documents such as patent and theses. It is important to record the bibliographical elements of documents according to a standard format with a keenness on accuracy and attention to details so that there would not be any need to recheck these data at any stage later at the cost of extra time. A number of published standards, including Indian Standard, are available on Bibliographical reference; anyone of them may be chosen and followed consistently.

The second category of notes, viz, subject notes, perhaps the most voluminous, may contain i) Factual data that include statements, numerical data, references to illustrations like figures, graphs, charts, drawings, photographs of designs, etc., with or without annotation; ii) Anstracts of original documents read, extracts or excerpts from original documents; quotations etc., most of which copied verbatim from the sources; and iii) Assimilated and digested notes that the writer records in a condensed form in his own words of ideas contained in the various documents after study/consultation. Obviously a great bulk of notes prepared will fall under this category. Brevity, precision, conciseness and certain amount of uniformity should be the watchwords in the preparation of these notes. It is possible to swell the notes by indiscriminate recordings which will only make the organisation of files and subsequent use very difficult. As far as possible, only digested notes should go into the file and the temptation to copy verbatim from documents should be avoided.

A systematic procedure for recording the notes in a standard format would be worth the time spent. The data may include the following :

1. Date, Time, Place, the Name of the Library where the documents have been borrowed or consulted.

2. Subject Headings, consisting of Keywords or Catchwords.

3. Items of Information :
   a) Factual data
   b) Abstracts, summaries, etc.
   c) Assimilated and digested notes.

4. Bibliographical description of source documents.

5. Indication of the relation of notes prepared to the chapter/section of the work planned.

6. Comments.

The third category of notes reference referred to here as 'Comments' may consist of new thoughts and ideas, criticisms, interpretations and suggestions, clues etc., that frequently occur to the author while reading or thinking. Many ideas may come at seemingly inopportune time - well formed phrases or any idea may come to mind while bathing, at a cinema theatre, at a party or before going to sleep at nights or even while sleeping. Creative ideas do not watch the clock. Often they are as easily forgotten as they occur sometimes effortless. It would be a good practice to put these thoughts in black and white at the earliest possible time and incorporate them in the Personal Information File.

The comments could quite often be fitted into the second category of notes at the appropriate places, registering their identity separately. When these comments cannot be fitted anywhere, they form the third group of notes and must be recorded separately, lest forgotten. The format for recording these may be as follows :

1. Date, & Time
2. Subject Heading
3. Comments which may include :
   i) New thought or idea
   ii) Criticism/ Evaluation/Interpretation,
   iii) A good phrase or a good sentence
   iv) Similar others.
4. Indication of the relation of notes prepared to the chapter/section of the work to be written.

Physical Store of Documents

Apart from the notes assiduously collected and recorded, a number of documents such as books, preprints of journal articles, research and technical reports, drawings, etc., would have been collected by the author over years. Some of these documents may be owned by the author, and would have been perhaps thoroughly read with markings of significant passages and marginal notes. The information marked on the documents or the marginal notes, may be transferred on to the cards/sheets and merged with the files already compiled. Or else an index to files should take care of their retrieval and location. It is important that these should be appropriately dovetailed into the file already built up. The documents themselves need proper arrangement and storage for easy retrieval, particularly when they are too many. A correlation between the arrangement in document store and file organisation would be worthwhile.

Another important component of the Personal Information File is the records of the author's own experimentations or investigations on the problems of his study or research. These may include laboratory notes, with readings and observations of experiments conducted, or data from surveys conducted and such others. These also must be incorporated into the system at appropriate places.

File Organisation

As the information collected in the forms of notes get growing, the organisation of the notes into a file with a meaningful and helpful arrangement of the entries becomes necessary. The three categories of notes and the other parts mentioned above may be organised separately or may be integrated into a single file. The entries are usually arranged under broad subject headings to the extent they meet the writer's requirements. Decisions taken at one stage on the placement of entries should not change unless absolutely necessary, as individual authors tend to change their ideas, views and research pattern as they advance in their work; frequent changes in file organisation would pose problems and cause confusion and hence better be avoided.

The files are organised according to subject headings and sub headings under each chapter. An idea may be discussed in different contexts and hence information on this may be scattered in these files. An alphabetical index of subjects to these files is, therefore, useful, especially when the files grow in size.

Some elementary knowledge of indexing techniques, file structuring and organisation, undoubtedly, come in handy here, firstly in the preparation of the entries containing data elements, and subsequently in the organisations of files and in the preparation of index in a consistent manner. There are a number of good and simple books available on the subject which are listed at the end of this paper.

Physical Form

The physical form in which the information gathered is to be stored and built up into a file is of a considerable significance. An important aspect of a note taking system is that it should be flexible, that is, it should be possible to to add to it at any point without disarranging the older material, and it should also be possible to rearrange the files of notes at will. Keeping this essential requirement in view, notes should be taken on separate sheets, slips or cards so as to be flexible for the purpose of filing. Each piece of information, therefore, should as far as possible contain a complete item or a unitary idea, but when the matter to be noted is too extensive it may be continued on successive pieces and these numbered. Not more than one item should be placed upon a single piece.

There are four types of physical forms :1) the exercise book file/diary/log book, 2) the loose leaf file and 3) the card file, 4) the punch card file.

Exercise Book File

This probably is the most simple system of filing but has many faults. In this system, bibliographic citations, the subject notes, and the comments are entered in an exercise book in three different sections in the sequence of documents read, or pages reserved for each main subject and sub-topic of the subject. There may be difficulties in anticipating the number of pages to be allocated for each and sub-topics in each of them. More than this, the main deficiencies are its inflexibility and difficulties involved in retrieval and location of any information in this file. A thumb nail index of these entries may help the retrieval to a certain extent.

This system may be recommended for writers preparing articles for journals where the notes may not be large and can be handled fairly easily.

The Loose-Leaf File

Here, the notes are entered on separate sheets of paper (A4 size) with index tabs attached to the right hand margin or to the top of the sheet. The tabbed sheets are used as separates between which all notes, entered on to a sheet, are placed. The sheets are arranged alphabetically by subject or systematically arranged by using a code reflecting the structure of the subject. The outstanding advantage of the loose-leaf file is its potability. It is particularly suited to those who have to visit a number of pla ces for collecting information. The loose-leaf file should also have an index to provide easy and quick access to the notes.

Card-Index File

The card index file, the most popular physical form, is similar in conception to the loose-leaf file, but the units of information are entered in cards of sizes 12 x 75 cm or 150 x 100 cm which are sotred in filing drawers or cabinets. Card files have great flexibility. Index cards are easier to file and retrieve than ~~sheets in loose-leaf binders.~~ Potability may not be possible, but may not seriously hamper work.

Punch Card File

Records of items prepared for the three different files can be kept on edge-punched cards. These are similar to index cards but are pre-punched with a series of holes of about 2mm diameter set at a similar distance from the edge of the card and from each other. The holes on all cards in a particular set are in the same position. If that portion of a card between a hole and the edge of the card is removed, the card can be sorted from the rest by placing a knitting niddle or similar object through the file of cards and shaking it. The notched or clipped card will drop out and can be perused. A system of notching can be designed for relating each hole to a particular feature. Thus, the file on bibliographic information, can be sorted out by means of notching, that would represent appropriate subject headings. Similarly, the other files can also be organised by this system. The use of punched cards in India has never been introduced and hence the commercial stationery suppliers do not have the stock to supply these cards nor have they simple mechanism for the physical storage of the file. However, if facilities are available in any institution for specially printing the appropriate stationery and also the simple fabrication required for operating the system, it can be tried. Optical coincidence systems also can be tried wherein the holes representing typical headings are punched in the body of the card which are organised in the blocks of numbers. This system is particularly useful for indexing purposes.

Word Processing

In the western countries, currently the use of computers to manipulate and store personal information files are increasingly possible. Particularly with the advent of Word Processors the possibilities of creating personal information files are becoming common. In India these Word Processing Systems are beginning to be installed in institutions and if access to this equipment is available, experiments can be tried in using this system for Personal Information Files.

Summary

Any serious writing requires a great deal of study and preparation. Most writers interact with the thought and ideas of other writers through their works to widen their own perspective, change and modify the images formed or totally reject. This process is a long drawn process. Any attempt to streamline this process of systematic study and preparation, is worth consideration, as it may help to conserve time and effort. Many here may appreciate these suggestions, if they, in retrospection, view their own predicaments in the past by not caring to organise properly their Personal Information File.

Useful guides

1. ATHERTON, P: Handbook of information systems and services. Paris, Unesco, 1977.

2. FOSKETT, A C: A guide to personal indexes, using edge-notched, uni-term and peek-a-boo cards. Edn. 2. London, Clive Bingley, 1971.

3. FOSKETT, A.C: Subject approach to information. Edn. 4. London, Clive Bingley, 1982

RESOURCE SHARING AND NETWORKING WITH SPECIAL REFERENCE TO WATER INFORMATION IN INDIA

by

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1. GENESIS

Several thousand organizations are engaged, all over the world at regional, national and international level in R & D activities, particularly in the field of Science and Technology alone. These organizations are very active in their respective subject fields and generate a vast amount of new/modified potential information. This ever-increasing volume of information and rate by which it grows, in the form of journal articles, technical reports, conference papers, books and monographs, theses and dissertations, patents and standard specifications etc., has created a publications explosion - an Ocean Like Body, which is uncontrolled and unmanageable. Several measures have been taken for its bibliographical control during the past few decades and now by using most modern techniques for its collection, storage, processing, retrieval and dissemination. But it has not been possible even for the highly developed countries with advanced technological backgrounds and their large libraries, having huge funds at their disposal, to acquire - each and every documents being published in their respective fields of interest and process the same for general distribution. This complexity and helplessness of the nations made it essential to establish international co-operation among the nations of the world and to come closer for the establishment of international information systems. Emergence of concepts, like UNISIST, and their development and expansion of National Information Handling systems into International Information Handling and Dissemination systems, is the result of the same, so as to provide Information Assistance at Universal level. Several United Nations Information Services including that of UNESCO etc., and their sub agencies, are engaged in such programmes at Inter-Governmental level and also helping in national programmes by rendering required assistance.

It is a well known fact that at International level, collaboration and co-operation exists in many activities, in every discipline and profession, then why not in the field of information systems and services. So, one comes to the concept of sharing the resources and networking. This concept implies connectedness, co-operation, resource sharing and other type of relationships at different levels, be it an individual, a group or an institution. There are various types of information networks rising from transfer of information through conferences, seminars, workshops and similar other meetings, to computerised data-based systems. Organizations, in a position to afford, are using both - the man-based systems as well as the machine-based systems which are playing vital role in these networks.

2. EMERGENCE OF THE CONCEPT OF RESOURCE SHARING

During the above mentioned stage of information explosion, concept of resource sharing emerged as a lighthouse in the ocean to guide Librarians, Administrators and Managers of Information Systems and Services to choose the right path. It is just like holding a life belt while drowning. Resource sharing is a need-based concept founded on sound principle of give and take policy. In other words, it says "Share with me and I share with you". It is not the quantum of exchange but real desire to do so and become part and parcel of programme of resource sharing and networking. Some organizations may have little to offer but that may be very valuable and useful contribution in a highly specialised area. Librarians and Information personnel should be willing to share their resources for mutual benefit. Mechanics of sharing could be developed subsequently for effective achievement of goal. Many libraries have been trying to acquire all the material required by their users but rising cost and ever-increasing number of new publications day by day, makes it impossible. Besides this, the budget does not increase in the same proportion, even to meet the increased cost of books and specially of serials such as Journals etc., which are rising exponentially cost-wise in all the areas and specially much more in the field of Science and Technology, where it is estimated that more than 3 million documents are published every year and this number is doubling every seven to ten years. It is also estimated that by the end of the century, several fold increase will be there in the present volume of published literature. In addition to the above, more than 60,000 periodicals and several lakhs of technical reports, patents and other items are also appearing every year.

3. INDIAN SCENE

According to survey conducted by the INSDOC in the year 1969, we have in our country over 900 libraries in the field of Science and Technology alone. After this survey, the number might have increased by a few hundred more, as a number of new research organizations have come up in the field. Each organization has a library with good collection of very specialized nature and subscribe a number of periodicals of interest to their clientele. Such major specialized libraries are under the control of Council of Scientific and Industrial Research, Indian Council of Agricultural Research, Indian Council of Medical Research and Department of Atomic Energy and so on. In addition to this, a number of research organizations are functioning directly under the Ministries of the Government of

India and various other states. But they all have some or other problem. Since emergence of the concept of NISSAT (National Information System for Science and Technology) in 1977, many libraries under CSIR and other organisations have got a shot in the arm in the form of assistance, and have started a number of information centres to cater to information need of their clientele as well as to meet the request of the outside users by becoming a part of National Information Network. In fact, it is anticipated, if everything works out well, NISSAT system may become one day, a largest co-ordinating body in the east for linking the existing and up-coming information systems and services into a national network.

4. BOSLA - AN INDIAN EXAMPLE IN RESOURCE SHARING

Before I proceed further, I may mention here something about an Indian experience in Resource Sharing, which was first of its kind in the country and covering many major aspects of co-operation. It has proved to be a most successful model in resource sharing at local level. In the year 1975 Librarians of Bhabha Atomic Research Centre, Department of Chemical Technology, Bombay University, Indian Institute of Technology, Bombay and Tata Institute of Fundamental Research started meeting each other frequently to discuss and find possibilities of developing closer ties than routine inter-library loan, in the shadow of rising costs of publications and especially of journals etc., and stationary annual budgets of their libraries, but the increasing demands of the users. They wanted to share resources and serve more effectively to the Scientific and Technical communities of their respective organisations. Number of alternatives were examined and discussed in detail. Some of the more pressing areas were identified for co-operation, and a broad agreement was reached on several of them, so as to place the matter for approval of higher policy making authorities of their respective institutions, which was granted.

Thus BOSLA (Bombay Science Librarians' Association) was born in 1975. Now it has 17 libraries of Bombay as its member. In due course more items for co-operation were added. Mechanism to achieve BOSLA goal was worked out and some of the major areas on which we work are as follows:-

1. Effective courier services were introduced on regular basis to obtain and deliver material required. Loan by post was discontinued as some time, it was taking more than a week for local deliveries by post.

2. Any material available in member libraries was loaned without any restrictions.

3. Current subscription of journals were consuming almost 70-80% budget of these libraries. It was decided to loan, last but one issue of some of the selected current journals to other libraries in exchange for a period of one week or so. This

helped not to subscribe (avoid costly duplication) to journals which are useful, but not a must as the same is available with a resource sharing library. Union Catalogue of current journals of member libraries was also prepared to know what is being obtained by others on subscription.

4. Staff members of one library were deputed to other libraries in rotation to learn systems, being followed in the member libraries and also to familiarise with their resources.

5. To train staff members and for improving their efficiency and to discuss problems of mutual interest collectively, it was decided to organise workshops on practical aspects of library administration and have free and frank discussions.

6. Provide extensive reprographic facilities to each other.

7. Exchange of publications issued by their respective organizations and also exchange duplicate issues of journals for completing holdings of other libraries and also distribute unwanted books etc.

8. To avoid duplication of other costly publications, if available in any of the member libraries and not needed frequently as the same could be had as and when requested.

9. Compile computerized journal holdings (back files) frequently as national listing is always taking more time.

5. THE PROBLEM - WATER SUPPLY POSITION OF INDIA

Air and water are most essential for the existence of man, but both are getting polluted due to destruction of trees and indiscriminate use of water. Demand for water is increasing but quality and quantity of usable water is reducing day by day. Water is the key factor for the development and progress of the nation. This fact has been very well accepted by the Scientific and Technical community all over the world. A number of technical meetings, such as Conferences, Seminars, Symposia and Workshops etc., are being held more frequently than on any other subject all over the world, on water problems and related aspects and so generating a huge amount of scientific papers, reports and agreements etc.

Water in India is received mainly through the rains brought by South West Monsoon or from the North-East Monsoon. [illegible] water partly sinks into the ground and mostly runs as surface water-flow in the rivers. The total annual average flow of the rivers is estimated to be in the order of 1,645 thousand million Cubic Meters. Water which sinks into the ground and can be extracted economically is about 2,55,000 Million Cubic meters. The total water thus comes approximately to 1,900 thousand million cubic meters. Some time additional flow of water is there due to melting of snow at Himalayas. This resource could also be considered. Out of this, a portion has to be shared with other countries such as Nepal, & Bangladesh. Lot of precious water flow down to the sea. We can not store all water and therefore utilise only half of the estimated water available. Presently, we store over 15% only. While as we have to have at least half.

There are technological possibilities of creating more water through desalination of saline (Brackish water), cloud seeding, prevention of evaporation from reservoirs. Industrial waste water and sewage flow should be treated and re-used in industries, rather than polluting our rivers by discharging the same into them.

Ours is a mostly agriculture-based country and therefore maximum water is being used for irrigation purposes. Rural and Urban Municipal Water-supply systems also require a good amount of water on priority basis for domestic consumption. Another use is by industries and power production units. Use for navigational facilities and for fishing, wild life and recreation are also to be considered. In our country the greatest problem is erratic availability of water in its different parts. We mainly depend on rain-fall which is very un-even, unreliable and distributed in an irregular way all over the country. One third of the area of our country is arid or semi-arid region.

We can not just sit and watch the situation in vain. Something has to be done. Large scale inter-basin and area transfer of water is most essential. Steps are to be taken early in this direction. Very little work has been done in this regard such as transfer of water into large reservoirs, transfer of water from one reservoir to another and creating a network of large and small connecting canals across the country. Some work in this connection has been done in Rajasthan, Gujarat, Kerala and Hariyana. Various rivers must be inter-linked and surplus water be transferred into deficient areas so as to remove imbalance. "Garland Canal Project" is one such unique proposal by Capt. D.J. Dastur. Pioneering work done by Prof. J.T. Panikar of Indian Institute of Technology, Bombay in the field on abatement of Continental Water Imbalance. These proposals, if implemented, will provide India with safe conservation of monsoon waters, which in turn will provide drinking water, navigational facilities, environmental support and irrigation, which are most basic needs of this vast country so that its 700 million people can look forward with [illegible] hope to live, work and earn their livelihood with human dignity and self-respect.

The visiting UN team during the early 1970's offered the following comments on India's river linking programme:-

> "India's national economy and its development and growth will be confronted with a problem of increasing scarcity of water in the next thirty years. From basic

compilation of future water demands and water yields, it becomes evident that in the year 2,000 A.D. or so, the National Water Grid will be a necessity. No time should be lost to start the very difficult and complex investigations today so that plans will mature and are prepared in due time and the facility will become operative when the need would have come".

We must share the river water within all the states as national resource and should have a clear cut policy on this. Recently, Prime Minister has constituted National Water Council of which she is the Chair-person. We hope, lot of present water problems will be solved by this Council.

I have gone too far on the problem and have to leave detailed analysis to be worked out by the experts of the field and limit myself to resource sharing only. This was highlighted only to show the nature and complexity of the problem.

6. THE SOLUTION - NATIONAL WATER INFORMATION CENTRE

It is extremely difficult to come to the solution of water problems listed above. According to the POETRI "information - in water supply and sanitation like in other fields - is the record of knowledge that mankind has gathered over centuries, at large costs and often at the experience of bitter failures.

Its volume is still growing rapidly, the total amount of relevant data and experience potentially available for beneficial use also expands quickly. The volume of published information is increasing by about 13% per year, or in other words, documented information in the world doubles every 5 to 6 years. This rapid growth has a dramatic impact on both information seekers and information centres everywhere. The effect can be devastating. For information seekers, it means collecting widely scattered documents that might be relevant to their purposes. Scanning through mountains of documents becomes more and more tedious and may soon become an impossible task. To search specific information from huge accumulations of documents is much like searching for needle in a haystack".

Information support is necessary in the form of location, identification, collection of vast amount of data and documents from various sources. Analysing and processing the same in a required form and distributing to users is a highly difficult job. Information relating to water and related problems has to be supplied to Scientists, Engineers, Administrators and Managers of such systems at any cost so as to help in decision making process. This has to be done by creating a very close and reliable network of libraries and information systems and services interested in the field and having confidence in philosophy of resource sharing. Many activities have been enumerated by Library, Documentation and Information Retrieval

Cell (LDIR Cell) of the NEERI (National Environmental Engineering Research Institute). It has done appreciable work in the field of water information. NEERI being located in the centre of the country having a very good infrastructure for information system and services and a number of capable and experienced Scientists and Engineers are working with the organisation, could certainly form a Central Co-ordinating/servicing body for various types of information required by Scientists, Engineers and Technologists working all over the world on water supply and other related problems.

I would, therefore, like to suggest which will also be in the best interest of our country that National Water Information Centre is created with the nucleus already available with NEERI which will have the following objectives:-

i. It will survey all organisations and institutions, engaged in the field of Research and Development and other service activities in the field of Water Resources and Management and maintain their interest profiles and up-date them. (In the Annexure I, I have given a list of broad areas and related subjects based on standard classification system connected with water supply etc. Several institutions all over the country are working on one or more facets, mentioned therein, collecting specialised data and documents and maintaining the same for use by their experts. Steps may be taken to gather information regarding data and publications held by them while surveying).

2. It will act as a Central clearing house of information on water and associated problems.

3. It will locate, collect, classify, store, retrieve, translate, whereever necessary, and disseminate world literature of interest to all the organisations and individuals interested in the same and to those whose profiles are maintained at the centre.

4. It will be a service centre and services of which will be made available to the Librarians, Information Personnels, Managers, Engineers, Scientists and Technologists working in the field of water and associated problems.

5. It will provide all types of documentation services through publications to the above community and bringing to their attention the latest technical information and relevant data for their day-to-day work. This will be in anticipation or on demand.

6. It will maintain closer ties with all the institutions engaged on Research and Development in the field for mutual exchange of publications.

7. It will provide extensive reprographic services to all users and provide copies of the documents of their interest on demand.

8. It will publish periodicals, hand-books, reports, standard data sheets, training mannuals and directories of interest and value to the above community, if required.

9. It will also organise, Lectures, Seminars, Conferences, Workshops and film shows to promote communication of technical information among the specialists as well as information/documentation personnel.

10. It will organise production of films, slides, video tapes and other training material to disseminate information on new technologies/new processes and proper use of water resources.

11. It will act as a National Referral Centre and work as "Information Desk" for Scientific and Technical community.

7. CONCLUSIONS

As already mentioned, water supply system is a very complex and widely distributed all over the country and covers many human activities from all fields. It is now high time to take steps for creation of National Water Information Centre in a very systematic manner, so as to establish network on strong foundations.

In addition to the National Centre, for better coordination and creating a hierarchial network in the sharing of resource and compilation and collection of information at regional level, some of the existing institutions may be given status of regional information centre for Water and Environmental Engineering. The other centres linked with important institutions may be given status of local information unit so as to utilise their expertise in highly specialised area in which they have interest. This will create a regular flow of information both ways, from National Water Information Centre to local units and vice-versa.

It is, therefore, suggested that a panel of experts may be formed to review the situation from all angles and suggest suitable measures to be adopted for fulfilling the objectives mentioned above for such a centre.

ACKNOWLEDGEMENT

I am grateful to the authors/publishers of various sources mentioned at the end of this paper.

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ANNEXURE I

WATER SUPPLY

(Broad Areas and Related Subjects)

1. METEOROLOGY

1.1 Practical Meteorology
(Methods, Data, Forecasts)

1.1.1 Method of observation

1.1.2 Observational data

1.1.3 Meteorological instruments

1.1.4 Weather Forecasts and other applications

1.2 Aqueous Vapour and Hydrometers

1.2.1 Humidity

1.2.2 Evaporation

1.2.3 Condensation and deposits

1.2.4 Fog and mist

1.2.5 Cloud

1.2.6 Precipitation in general (Rain fall)

1.2.7 Special forms of precipitation

1.2.8 Soil moisture and hydrology, Hydrometeorology

1.3 Climatology

2. HYDROLOGY

Surface water

Underground water

3. WATER SUPPLY, TREATMENT, CONSUMPTION AND USE

Urban water supply

Rural water supply

ANNEXURE I (contd)

3.1 Water Resources, Catchment etc.

3.1.1 Rain water and its storage

3.1.2 Spring water, ground water

3.1.3 Surface water from natural and artificial sources

3.1.4 Extraction of water from the atmosphere

3.2 Conveyance of Water

3.3 Storage of Water

3.4 Conveyance of Water from Source to ~~to~~ the Distribution System

3.5 Water Distribution System

Local Networks

3.6 Water Treatment Process

Operations, plants, equipments, water works practice, desalination etc.

3.7 Water Consumption

Water loss and waste prevention

3.8 Pollution of Water Sources and Supply (Causes, prevention and removal)

4. TOWN DRAINAGE SEWERAGE

5. SEWAGE, SURFACE AND FOUL WATER PROPERTIES AND TREATMENT

6. WATER RESOURCES MANAGEMENT (Civil Engineering)

7. IRRIGATION - AGRICULTURE

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National Seminar on Slow Sand Filtration, Health Education and Information Support

NEERI, Nagpur, India
June 29 - July 1, 1983

INFORMATION SUPPORT TO WATER SUPPLY AND SANITATION PROGRAMME IN INDIA - PROBLEMS AND PROSPECTS

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INTRODUCTION

Information is an essential element in problem solving and gainful decision making. It is also a pre-requisite for technology transfer. Present society is organised around information and its utilization. Information is now being regarded as a natural resource, worthy of care, development and management. Any one concerned with water supply and sanitation management must have requisite information readily available. Just as ' Water' is the literal working fluid in a steam cycle, 'Information' is the working fluid for water supply and sanitation development activities. Most of our programmes do not make desired progress because they lack the information edge. Persons involved in activities pertaining to water supply and sanitation are not provided with the means to satisfy their information needs or do not have easy access to information, because they are geographically cut off from information source.

To ignore available information means running a rapidly increasing risk of duplicating, at great efforts and cost,

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of not deriving benefit from the vast amount of already acquired knowledge and experience. We can no longer afford to accept this, least the scarce resources would be wasted at an enormous scale.

Efficient management of water supply and sanitation calls upon to find an optimum solution to convert the abstract into concrete, giving all weightage involved, whether they are in scientific, technical, economical or social fields. All parameters which influence final decision have simultaneously to be taken into account. Available resources are to be converted into meaningful and concrete wealth in the form of service for the benefit of community. Engineer in this field is essentially the Manager of Men, Material, Machinery and Money (The 5 MS). An important input in the management which properly binds these is information. For effective decision making information has to be collected, processed, stored and disseminated for future use. Information is the missing piece because of which our water supply and sanitation activities suffer. Solution to the Rubbic Cube of water supply and sanitation could be easily found, if this information piece is properly placed.

FACETS OF INFORMATION

The term 'information' is used in a wide connotation. Often, the terms 'data' and 'information' are used in the same context. However, we can distinguish between 'Information' and 'Data' as follows :

<u>Information</u> is that which adds to changes or repeats a representation of what is known or believed to be known.

<u>Data</u> has been defined as groups of nonrandom symbols which represents quantities, actions, things. Raw data contributes little to the decision making. Taken separately it has no meaning. Data when processed becomes information.

For our purpose we can divide information in two distinct components, viz.,

I. <u>Data</u>, which is quantified information; and

II. <u>Documentary Information</u> which is recorded and is available in literature.

USERS OF INFORMATION

Users of ' Water Supply & Sanitation Information' can be categorised according to the jobs they are required to carry. The following is the broad categorisation of the users involved in this field :

1. Policy makers in the matters of water supply and sanitation at national and state level
2. Administrators and managers of water supply and sanitation programmes
3. Financial and technical co-operation agencies providing advisory services, funding and sub-contracting
4. Professionals incharge of planning, designing and operating water supply schemes
5. Researchers, scientists and teachers involved in water supply and sanitation
6. Product manufacturers
7. Monitoring and testing personnel

8. Construction agencies
9. Maintenance and operation personnel
10. Field and evaluation personnel
11. Training supervisors incharge of training programme
12. Information personnel

INFORMATION REQUIREMENTS

Information needs vary according to the type of job these personnel are required to perform. It has been observed that the needs vary from person to person, from situation to situation and depends on the environment in which they are placed. However, it has been observed that information needs are identifiable and therefore, amenable to systematic analysis and fulfilment. However, no water tight compartment can be made between the information needs of one category of users from other category. To cite an example, water information is used by the engineers to aid in the interpretation of other information or data newly recorded or in the design of a new piece of equipment or help to solve a technological problem. Planners use it to help make decisions in the matter of water quality, water facilities, and other water matters. Information needs of different categories of personnel are shown in Table I.

Table I - Information Needs of Different Categories of Personnel Involved in Water Supply and Sanitation

Policy and Decision Makers	i)	Demographic, geological, hydrological, meteorological, economic, social and health data which can be supplied by Management Information System (M.I.S.)

	ii)	State-of-art reports
	iii)	Feasibility reports of water supply and sanitation projects
	iv)	Project plans and programmes
	v)	Summary documents of present status and trends in solving specific problems
	vi)	Financial aspects
Designers	i)	Literature on design exercises
	ii)	Manuals
	iii)	Technical reports
	iv)	Latest innovations published in specialist journals
	v)	Conference papers
	vi)	Standards, specifications
	vii)	Process design and data
	viii)	Engineering drawings
Executives & Administrators	i)	Solution to operation, maintenance and repair problems
	ii)	Infrastructure - labour
	iii)	Product information
	iv)	Equipment market
Operators	i)	Practical methods
	ii)	Maintenance and operating manuals
	iii)	Guides
	iv)	Handbooks
	v)	Specifications
Researchers	i)	Articles from journals
	ii)	State-of-Art reviews

	iii)	Bibliographies
	iv)	Trend reports
	v)	Conference papers
	vi)	Theses, dissertations
Product Manufactures	i)	Recent innovations
	ii)	Patents
	iii)	Standards

Typical aspects on which information is required are given in Table II.

Table II - Typical Aspects on which Information is Required (List is only indicative and not exhaustive)

1. Flood loss development
2. Conjunctive ground and surface water resources
3. Chemicals for evaporation suppression
4. Septic tank design
5. Rural latrine design
6. Artificial recharge
7. Bacteriological analysis of water
8. Easy method for determination of residual chlorine
9. Use of pot chlorinators for disinfection of well waters
10. Use of bamboo pipes for water distribution
11. Sanitation facilities at high altitudes
12. Water supply to drought affected areas
13. Standards for drinking water
14. Legislation on water pollution

15. Defluoridation techniques
16. Production of membrane filters
17. Availability of membrane filters
18. Leakage detection equipment
19. Coconut shell as filter media
20. Package water treatment plants
21. Guidelines for operators of water treatment plants
22. How to carry out river surveys
23. Fluoride affected areas in a region

PRESENT SITUATION

The present scene of information support can be summarised as follows :

1) Statistical data useful for water supply and sanitation programmes is usually collected at district level and consolidated at State level. However, it is not collected consistently and systematically. This can be done by developing standard formats. Similarly, linkages need to be established with various bodies which are collecting data relevant to water supply and sanitation. The Central Statistical Organization of Government of India has established a mechanism to collect requisite data. Such a system could be adopted by different States (Fig. 1 describes the statistical system in India). However, this paper is restricted to documentary information only as access to such an information is almost lacking.

2) In the past, the user could himself keep fairly well informed just by reading a limited number of journals

or books. To-day that is no longer possible because the amount of information published is far too considerable. Moreover, the information need extends even beyond what is provided in conventional form of books, journals, etc. and hence, the problem becomes complicated. Besides books, knowledge available in the form of drawings, design, specifications, standards, patents, trade literature, project reports, feasibility reports, design models, is also required.

3) An individual interested in some aspects of water and sanitation management may have a difficult time for obtaining the desired piece of information as it is scattered in different sources.

4) A base of concrete previous experience which can provide the performance information needed to make a rational choice is required. This is possible if there is exchange of experiences. It has been stated that no design starts entirely from scratch and that, in engineering, no design is entirely a simple synthesis of generalized knowledge.

5) Information about the designs and solutions found either in the same state or in neighbouring state is not available. Many internal reports, feasibility reports, reports of successful projects, state-of-art reports in water supply and sanitation are compiled; however, their existence is not known many a times. It is experienced that relevant and potentially useful information pertaining to water supply and sanitation is officially not published and as such not available.

6) Appropriate technologies developed elsewhere have to be utilized and suitably adapted so as to acrue maximum benefit. For example, information about low cost and appropriate solutions available in other developing countries does not reach the actual user in India. Research carried out in India as well as abroad is required to be tried in the field. The advances in research in water supply and sanitation have not been applied in practice as in waste treatment. While there is a lot of talk about simple chlorination devices, distribution systems, low cost sanitation options, very little has been tried in the field. This is probably due to lack of availability of information.

7) Personnel in water supply and sanitation are absorbed in day-to-day problems and lack necessary time to acquire required information. The enormous volume and complexity of literature and urgency of solving immediate problems make it difficult to fully appreciate, identify or acquire for use all the literature that is needed to carry on a comprehensive water programme.

8) Certain sources of technology are utilized while other potential sources are not used at all. A serious handicap to the development of water supply and sanitation programme is the lack of information services for the transfer of technical information.

9) Much useful information is hidden in published literature existing in diversified publications. Finding out relevant information has thus become a tiresome job.

CONSTRAINTS

Following are the major constraints experienced in the free flow of information :

1) Poor or almost negligible information infrastructure is available in most of the Public Health Engineering Departments, with the result that they do not have capabilities for absorbing technical information from external sources and its utilisation.

2) Facilities for documenting the information generated in the State PHEDs and its dissemination are not available.

3) The concept of ' Resource Sharing ' and ' Information Exchange ' has not become popular to the extent desired.

4) Lack of linkages with other centres such as IITs, Universities where the required information is likely to be available.

5) Lack of trained personnel to handle information problems.

6) Users also are not aware of finding out required information.

7) Lack of any provision in the budget for establishing information support programmes.

In this context, one of the recommendations of U.N. Water Conference held in 1977 is of particular interest.

It was recommended that an effective clearing-house mechanism should be developed by strengthening existing mechanism, if available, to provide for the dissemination of selected information concerning all elements of community water supply and sanitation.

ESTABLISHING INFORMATION NETWORK

Mechanism for free flow and transfer of technical information needs to be properly triggered. Documentary information activity has to be rationally conducted in order to achieve efficient transmission of upto-date information pertaining to water supply and sanitation. This can be achieved by :

i) establishing and developing information infrastructure in the form of information units in various states (state focal point) and possibly at district level so that ultimately, a strong national network emerges. The network would help in exchange and transfer of information ;

ii) establishing a national focal point which can act as a National Centre for Water Supply and Sanitation Information which would co-ordinate activities of state focal point and render all possible assistance ;

iii) ascertaining the practical and most pressing information needs ;

iv) organizing information services that are readily and practically accessible to the users ; and

v) developing suitable mechanism for the collection, analysis, storage, retrieval and dissemination of information to support water supply and sanitation programmes.

The following tasks need be taken up immediately :

a) Organising and co-ordinating information services at national level.

b) Preparation of inventories of information requirements, resources and constraints.

c) Planning and establishing information units at state level.

d) Providing orientation training for managing ' information units ' at state level.

e) Offering information support by introducing selected information services.

INFORMATION SERVICES

Following are some of the information services which should be rendered by the National Focal Point. A model information kit has been prepared.

1) Current Awareness Service :

Purpose - To keep the engineers, technicians, management personnel abreast of current developments in the field.

2) Selective Dessimination of Information :

Purpose - To provide pin-pointed and new information based on the interest profiles.

3) Digest Services :

Purpose - To draw attention to solutions found elsewhere for technical problems. The emphasis would be on practicability, cost reduction, simpler techniques and equipment. Similarly, information on measurement, analysis and control methods would be given, besides new applications of materials.

4) Management Information Service :

Purpose - To disseminate current scientific, technical, commercial and techno-economic information from the management point of view.

5) Data Service :

Purpose - To collect in a convenient form and disseminate scientific, technical and techno-economic data on different subjects of interest.

6) News Brief Service :

Purpose - To disseminate general information pertinent to water supply and sanitation which would be of interest to various categories of personnel.

7) Package Information Service :

Purpose - To disseminate information on a specific topic. This also involves re-packaging information, wherever necessary.

8) Bibliographic Service :

Purpose - To provide a list of references on a specific topic by carrying out retrospective search.

9) Document Delivery Service :

Purpose - To provide copies of documents which would be most relevant to the work of engineers and field personnel.

PHASED PLANNING

The task of establishing an information network has to be taken up in phases. It is proposed that the network be established in 4 phases as shown in Table III.

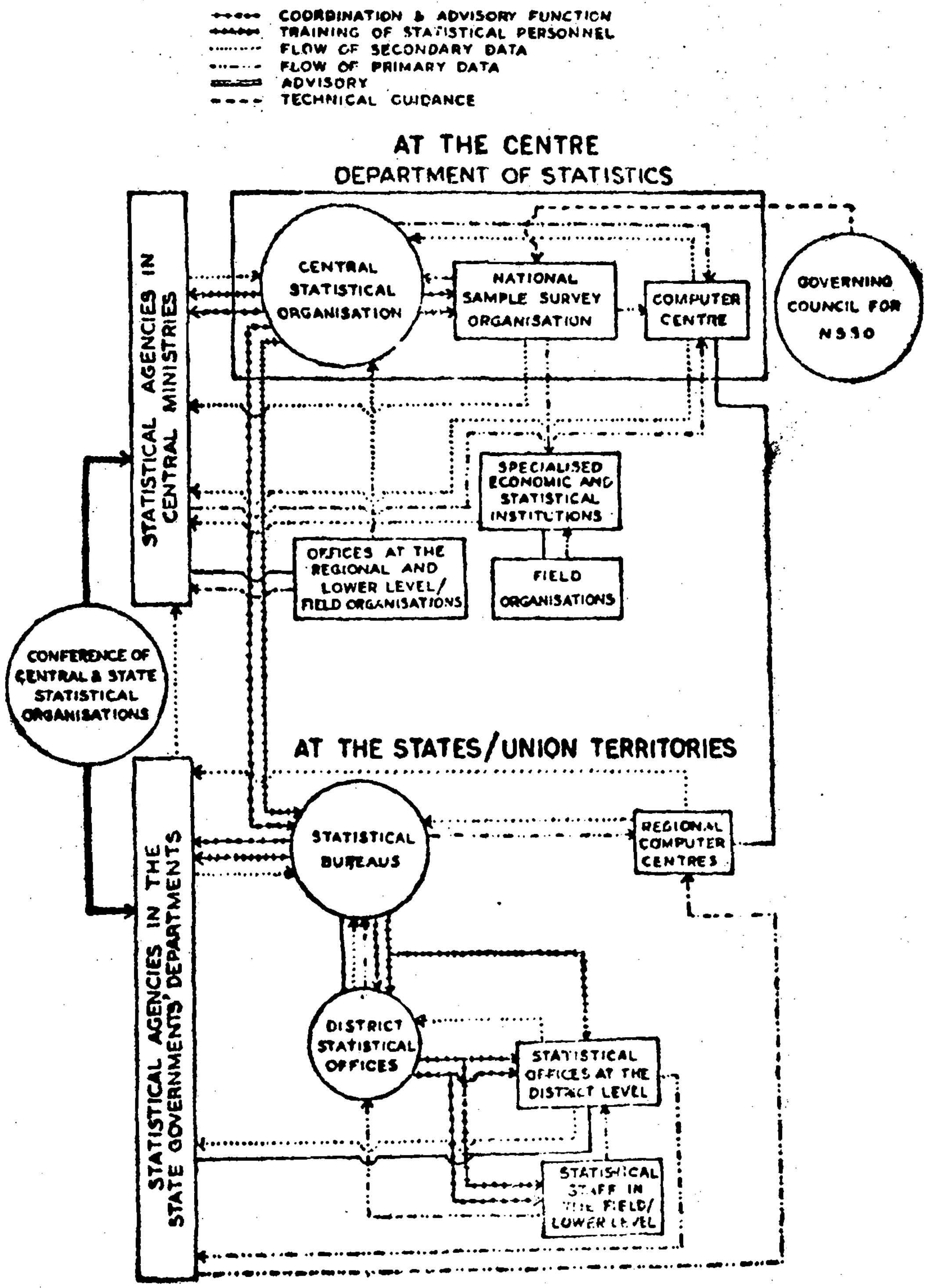
Table III - Phased Programme for Establishing Network

	1983	1984	1985	1986	1987	1988
NPF	xxxxxx	==========	==========	==========	==========	==========
SFP (6 States)		xxxxxxxx	----------	----------	----------	----------
SFP (8 States)			xxxxxxxxxx	----------	----------	----------
SFP (8 States)				xxxxxxxx	----------	----------

xxxxx : Establishment of NPF/SFPs
===== : Support NFP to States (SFPs)
----- : Support SFPs to Districts (Cells)

As pointed out earlier, information support is necessary for the success of the decade programme and major constraints in the free flow and transfer of information could be overcome, if we adopt the proposed plan.

Fig. 1- STATISTICAL SYSTEM IN INDIA



Presented to

National Seminar on Slow Sand Filteration, Community Health Education and Support held at National Environmental Engineering Institute, Nagapur

29th June to Ist July 1983

COMMUNITY PARTICIPATION & HEALTH EDUCATION

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COMMUNITY PARTICIPATION AND HEALTH EDUCATION:

Health Education by itself is nothing, Health Education with programmes is something, Health Education with programmes and people is every thing. This implies the importance of people, their co-operation and participation in accepting the programmes as beneficiaries and receivers of such benefits. Unless the community is convinced that the programmes are planned for their own health, in which they have to play a great role in successful adoption, the end result would not obtain desired success. Therefore, the community as custodian of Health and Health related programmes, must participate effectively so that the programmes meant for them could be implemented to help them.

But the question is how these people participate? There is no magic wand to make people participate and accept. People do participate and shoulder responsibility under the following conditions.

— Full recognition needs to be given to the people among whom programmes are being developed to their needs and interests, and to the social, cultural and economic setting in which they live.

— In developing programmes we must recognise the hierarchy of needs as people see them and find ways of bringing these hierarchies together.

— People for whom programmes are being planned should have a part in the planning, thus making the situation one in which there is planning with, and not for the people.

— It is wise to start with the things that the people themselves see as important and have to come to recognise as their problems.

(......2)

-- It is wise to start with the simple things and within the resources available that people can reach success.

Alma-Ata declaration to obtain Health for all by the year 2000 is a positive step and Primary Health Care approach is a key to attain this goal. The Primary Health Care depends upon community involvement, appropriate technology and multisectorial development. These strategies, in turn, depend upon information and education on Health. Yet, Health Education depends for its effectiveness on community involvement. It is chicken-egg situation. One cannot happen before the other. Do you spend money on creating facilities that people do not want and probably will not use, just so that you can educate people slowly to begin to use them? Alternatively, can you educate in the absence of facilities, untill you have created a consumer demand? Much the same situation arises over the sanitary disposal of excreta. Do you build latrines and hope to educate people to use them, or do you educate people first to demand them? To me, Education and service need to march together neither encroaching on the other, but both providing mutually reinforcing services.

New policies in education for health, therefore, need to spell out commitment to community involvement in particular phase of planning, evaluation and development. "People have the right and duty to participate individually and collectively in planning and implementation of their Health Care" then that right must be supported by policy and that duty must be supported by Health Education.

Safe drinking water supply and environmental sanitation can prevent the occurance of the communicable diseases and community support and participation to change their behaviour to accept the facilities would go a long way to be healthy. Developing wholesome attitude lead to practice, habit formation.

(.....3)

Water is a basic necessity to mankind and people have a urge to use it. They may not be able to differentiate between safe and contaminate water. They may even ignorant of the dangerous consequences of poluted water. Here is the role of Health Education comes into, to change the people towards the direction of accepting safe drinking water. To sustain their change, it is necessary to repeat and reinforce the messages supporting with community organisation, utilisation of local resources, various methods and media and such other things.

Since, Health is a very broad concept, an integrated approach may be thought of. Better water supply and environment should form as a base to prevent water borne diseases, must develop a realistic view, and place as a first line of defence in solving peoples health problems. Health education should serve as a corner stone upon which these programmes should be built.

Community at any cost should notbe ignored if the programmes are to be implemented effectively. Mere thursting on them without their active participation yields no results and bears no fruits. Therefore, community participation and involvement through Health Education process in water supply and environmental sanitation open a new chapter in solving health problems and may be possible to achieve health for all as contemplated in the Alma-Ata declaration.

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OPERATION AND MAINTENANCE CONSIDERATIONS FOR SLOW SAND FILTER PLANTS

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For presentation at the National Seminar on Slow Sand Filtration 29 June - 1 July 1983
NEERI, Nagpur 20.

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OPERATION AND MAINTENANCE CONSIDERATIONS FOR SLOW SAND FILTER PLANTS

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This paper does not attempt to set forth any guidelines as such for the operation and maintenance of slow sand filters. The paper only discusses the general strategy for achieving effective operation and maintenance of SSF plants. Proper operation & maintenance depends on proper management structure, proper selection of O & M staff, staff training, technically sound O & M practices and finally proper supervision and regular monitoring. These aspects are discussed in the paper with particular reference to small slow sand filter plants serving rural communities.

Management Structure

In regard to management strategy, the point for consideration is what agency should manage the operation and maintenance, whether it should be the village council or a state-level organisation such as the PHED. There is a lot to be said in favour of management of village water supply schemes by the concerned villages themselves. But, with SSF schemes, the question arises whether a body with no technical expertise like a village council will be able to manage the operation of the treatment plant effectively. NEERI has been closely associated with a SSF scheme managed by a village council at Borujwada near Nagpur. The experience with the scheme has amply demonstrated that with some degree of technical support from a professional body, the villages can manage the operation and maintenance of SSF schemes quite well.

Staff Requirements

In slow sand filter schemes, the filters themselves require only a very limited day-today operational attention. The operator duties will be only that of adjusting filter outlet valves once daily and making a general check of the functioning of the filters. This should consume very little time. The more one rous duties will be pump operation where pumping is involved, chlorination and distribution system operation. In village SSF schemes, these duties can often be looked after by one operator per shift. The number of shifts would of course depend on design provision, but, generally it will be only a single shift. Irrespective of number of shifts there should be atleast one helper for a scheme. The helper would be required not only for general assistance but also for a temporary substitution of the operator reporting sick.

Selection and Training of Operator

When the village community itself manages the SSF scheme, the operator would naturally come from that community itself. But even when a state organisation is running the scheme, the operational staff should preferably be recruited from the community and in consultation with the community as such step will enhance the cooperation of the community. It will be a good idea to recruit the operator even at the times of construction of a scheme and also associate him with the construction work to some degree or other. The intimate knowledge of the scheme that the operator will gain thereby will help him to fit into his final job smoothly and quickly.

Besides association with construction, the new operator should be given training at the beginning itself so that he may perform his job efficiently. The operator should not be left to pick up the knowledge and skills required for his job by mere exposure to the job. The training of the operator will have to be systematic and formal and will have to be organised at a state level. The curriculum for training of the operator should consist of elementary theory and also of practice. Recently, a guide for training of SSF operation has been published (1) and it could well form the start-off point for designing a meaningful curriculum for the training course.

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<u>Operation and maintenance</u> :

The operation and maintenance of slow sand filters is extremely simple. However, it still requires to be carried out in a technically sound and systematic manner if the filters are to perform satisfactorily. A guideline for Operation and Maintenance [2] has appeared recently as a companion to the Trainer's Guide mentioned earlier.

The check for proper performance of slow sand filters is not merely the clarity of the filtered water but also its bacteriological quality. The latter assumes particular importance in the case of village water supply schemes because in these it is not possible to ensure effective chlorination and the filters will have to form the main barrier against carry-over of harmful bacteria into the supply water. If slow sand filters are properly operated and maintained (they should also have been properly designed and constructed) they should yield a safe water free of <u>E.coli</u> I on a sustained basis.

Some of the O & M defects which affect bacteriological purification in the filters and affect filter performance in other ways may be gone into. One major cause for poor bacteriological purification is the intermittent (part-of-day) operation of the filters. Studies have shown that continuous (24 hr) operation along will yield safe water all the time and that intermittent operation may give filtered water of poor quality at times. Intermittent operation should not therefore be practised.

Intermittent operation has been adopted for small schemes because of the difficulty anticipated for the provision of staff for continuous operation. In gravity schemes, one shift of staff will be sufficient whether the filters are worked for 8 hrs or 24 hrs. They can, therefore, very well be operated continuously.

In pumping schemes, it may be possible to provide only one shift of raw water pumping. In such cases, either a high level storage tank can be providedto hold the pumped water and release it to the filter continuously through a float-controlled outlet allowing the filter to work continuously. Or else, continuous declining rate operation can be adopted. For this the filter is not shut down at the end of the pumping shift but is allowed to function continuously at a declining rate with the supernatant water draining down. It should be noted that the design modalities for declining rate filtration will differ from those for constant rate filtration.

Another major operational defect which affects filter performance is that of feeding raw water into dry filters (at start or after cleaning) without first backfilling them with clear water from adjacent filter beds or other sources. The defect occurs either because backfilling devices have not been provided at all or because the operator is ignorant of the correct procedure or does not appreciate its importance and ignores it.

Neglect of backfilling will cause deep scour of sand at the inlet end. In some filters, the scour has extended even down to the coarse media. With scour of sand, the raw water will continuously short circuit to the outlet and give poor quality effluent. Besides sand scour, neglect of backfilling will cause air binding also which will result in quick filter clogging.

Yet another frequent operational defect is that of not allowing sufficient ripening time after starting new/resanded/cleaned filters. With new/resanded filters, atleast a few weeks of ripening may be necessary even during hot seasons for bacteriological purification to become satisfactory. With cleaned filters, if the cleaning has been done properly, a few days atleast will be required for ripening. During the ripening period, the filtered water will not be of satisfactory bacteriological quality and it will have to be wasted. When the water cannot be wasted due to exigencies it should be chlorinated well before being allowed for supply.

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Still another operational defect frequently noted is that of keeping one filter bed dry as a standby at all times. When filter beds are left dry, the useful bacteria in the sand layers die out and a long ripening period will be required before the bed becomes fully efficient. The strategy should therefore be to keep all the filters working normally. When a filter bed has to be shut down for cleaning, the other filters can be overloaded so that total filter output is maintained. Such overloading may not affect filtered water quality.

Cleaning of Filters

Cleaning of clogged filters is a sensitive maintenance activity. The following are some of the steps required for proper filter cleaning :

(i) The bed to be drained only for 10 cm or so below the sand level and not fully.

(ii) The sand to be scraped only for about 1 or 2 cm depth.

(iii) The scraping to be done as early as possible after step (i) .

(iv) Scraped depth not to be made up with new sand .

(v) Pollution by labourers to be avoided.

(vi) Cleaned bed to be put back into operation as quickly as possible.

(vii) Clean one bed only at a time.

Resanding

As the filters are cleaned and the top layers of sand removed periodically, the sand depth reduces, When the sand depth has reduced by 30 cms, the filters will have to be resanded to maintain filtration efficiency. It should be noted that resanding will be required only after several years of operation (3 years or more) .

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Resanding is a critical work. In many plants, it is being carried out by emptying the entire filter contents, screening and regrading the mixed-up media, making good any losses, washing the media clean and relaying them. The work becomes a major operation and requires considerable labour. This mode should be avoided.

Filter resanding can be carried out much more simply quickly and efficiently by what is called the throwing over method[2]. In this, the top 3 cm of sand is scraped off and the next 30 cm of sand is removed and stored. A layer of sand 30 cm is now placed in the filter and then the 30 cm layer removed earlier is put back on top. This process will reduce re-ripening time of the filter and also reduce labour and cost.

In resanding, the question arises whether for making up the sand depth,altogether new sand should be used or the sand left from previous scrapings should be used after cleaning. The answer will depend purely on the cost of new sand including its cleaning and the cost and effort of cleaning and storing old sand for reuse. If scraped sand is to be reused, it should be cleaned before it is stored. Sand cleaning can best be done in small plants by hosing on a sandwashing platform[2]. Any sand washing operation will cause loss of fines and change the Effective Size and Uniformity Coefficient of the sand. This factor weighs against reuse of old sand after cleaning.

Both filter cleaning and resanding will be labour consuming. The regular staff will not be able to cope up with these works and additional casual labour will have to be employed.

Supervision

The operation and maintenance of SSF schemes is a technical activity and the need for formal technical

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supervision of such activity is obvious. In village SSF schemes, there may not be any one locally who can supervise the operator technically. But, when the scheme is managed by a state-level organisation, there will be periodical supervision by the technical superiors visiting the plant. Such an arrangements should be provided also for schemes run by the villages themselves. The supervising authority in this case would naturally be the state-level organisation which planned and built the plant.

If supervision is to be fruitful, it should be done systematically. The supervisor should visit the plant at specific periods and he should check the working of the scheme against a formal check-list. The supervisor's observations with suggestions should be recorded and brought to the notice of both the operator and his administrative superior.

Supervisory visits should preferably coincide with the cleaning of filters. Resanding itself should ofcourse be carried out only under the supervisor's direct guidance.

Water Quality Monitoring

When a water treatment plant is installed, it is necessary to check whether the plant is performing properly. Such check will help to identify deficiencies in design and operation which can be rectified in the particular plant and avoided in future plants.

The check on plant performance can best be done by monitoring the treated water quality. Monitoring the water quality is also necessary for giving an assurance that safe water only is being supplied to the consumers.

In a SSF scheme, the most essential parameters for analysis will be turbidity, residual chlorine and bacteriological quality, particularly the Coliform and E.coli I counts.

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Turbidity of the filtered water can be checked by the operator against prepared standards or atleast qualitatively. Turbidity of raw water can easily be measured using a turbidity tape. Residual chlorine tests can also be done by the operator easily. These tests should be done daily and the observations should be recorded and counter-checked by the supervisor during his visits.

In regard to bacteriological testing there are several constraints in our situation such as lack of laboratories, lack of adequate handling capacity in available laboratories and also long distances which may involve unacceptable delays between sampling and testing.

Taking into account the existing constraints, any frequent bacteriological testing will be quite difficult in village SSF schemes. However, what can and should be done is to test the bacteriological quality before starting the supply from new and resanded filters and also seasonally during the regular functioning of the plants. Atleast some of the sampling for bacteriological testing should coincide with the supervisor's visits. The bacteriological test report should reach not only the operator but also the supervisor.

Records

Records have to be maintained in water supply schemes so as to provide information on the performance of the filters, provide a check on the work of the operating staff and also provide data for planning future expansions and improvements. In village SSF plants, the operator will have to attend to several duties. Therefore, the records he is asked to maintain should be minimum .

The records should cover daily hours of raw water and clear water pumping, daily energy consumption, daily plant output, periodical loss of head, rate of filtration, and quantities of chemical used and history of filter cleaning (date of shutdown, date of refilling, date of restart of supply) and resanding. In order to be able to record the daily output, there should be a meter on the supply main from the waterworks.

Conclusion

Some of the considerations that should go into the operation and maintenance of slow sand filter plants, particularly small village SSF plants have been described above.

In the design of small SSF schemes, special care must be taken to make operation and maintenance, simple and least labour-consuming. This requirement arises from the fact that such plants will have meagre staff and there will be only limited provision for technical supervision.

References

1. Guidelines for the Operation and Maintenance of Slow Sand filtration Plants in Rural Areas of Developing Countries - Traiser's Guide, IRC Water & Sanitation Centre, Rijswijk, the Netherlands, January 1983 .

2. Guidelines for Operation and Maintenance of Slow Sand Filters, IRC Water & Sanitation Centre, Rijswijk, The Netherlands, January 1983 .

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RESEARCH AND DEMONSTRATION PROJECT

ON

SLOW SAND FILTRATION

RECOMMENDATIONS OF NATIONAL WORKSHOP

HELD IN NAGPUR DURING APRIL 11-13, 1983

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PREAMBLE

In the context of the International Research and Demonstration Project on Slow Sand Filtration, a Workshop was organized jointly by NEERI & IRC, The Netherlands in April 1983. An expert group consisting of research scientists, engineers and public health officials from government department as well as non-governmental agencies discussed the latest findings of the project. Recommendations were made concerning the technological issues involved in water supply systems with special reference to slow sand filtration, economic analysis, public health and health education aspects and information support.

RECOMMENDATIONS

- At national and state level, intersectoral and inter-disciplinary approach to planning and implementation of water supply and sanitation projects is essential. Greater interaction especially between the Public Health Engineering Departments and public health agencies is crucial and should be strengthened to maximise the benefits from such programmes.

- Provision of water supply alone may not improve the health status and quality of life of the people in the village. It may even result in worsening of the situation leading to health hazards if appropriate drainage and sanitation facilities are not provided.

- Decision for selection of water supply system should not be based only on the initial cost of construction. Operation and maintenance cost and the availability of skilled labour should also be taken into consideration and suitable provision made at the planning stage itself. Economic analysis of SSF plants not involving pre-treatment has shown that they are cost effective for populations upto 1,15,000. In the context of the Decade programme, this simple technology adopted in certain regions of the country should be further promoted for wider application in other regions.

- An evaluation programme of existing SSF plants in the country will prove useful to further identify missing links in the existing construction, operation and maintenance practices and to develop suitable rehabilitation plans.

- The central organisations for co-ordinating and promoting water supply and sanitation as well as health education programmes at national and state levels are inadequate and need to be strengthened to facilitate achieving the 'Decade' target.

- At the time of revision of the Ministry of Works & Housing Manual on Water Supply and Treatment (1976) the text on slow sand filtration, including operation and maintenance aspects should be elaborated in the light of recent developments and findings.

- In the curricula of professional courses at all levels, in-depth technical information on simple technologies of water treatment such as SSF, related community education participation aspects should be incorporated so as to provide a better appreciation of problems in implementation, operation and maintenance.

- Information support to allow better planning and implementation of water supply and sanitation programmes is inadequate or lacking. It is essential to establish appropriate information cells at state and national levels.

- States should take urgent steps to establish training centres for water treatment plant operators to ensure effective operation and maintenance of assets already created and to be created during the Decade Programme. These centres should be equipped with necessary facilities including demonstration water treatment plants. It is necessary to develop job specifications on the basis of which training manuals can then be prepared for plant operators and supervisors of water supply systems. Such manuals should be adapted to meet specific local requirements and translated into local languages by the states. The support of international agencies such as WHO and the International Reference Centre (IRC) in the Netherlands may be sought for this purpose.

- There is an immediate need to formulate a suitable system of certification of treatment plant operators and also to encourage local talents who can manage village level water supply systems.

- Very low priority is given to water quality surveillance and existing water quality testing facilities at state levels are totally inadequate. There is an urgent need to strengthen the laboratory facilities at state level and establish such laboratories at district level. Concurrently development of simple equipment for monitoring water supplies at low cost is necessary to promote this activity .

- The introduction of a community water supply in a village could be more smooth if adequate understanding and communication are achieved between the people and the water supply agency. This would avoid undesirable effects such as a higher demand for facilities than can be satisfied by the agency, poor village support for operation and maintenance etc. A liaison unit attached to the water supply agency would prove effective.

- Health education should be an integral part of water supply programmes to bring about changes in the community's practice in relation to water use, hygiene and sanitation and should be planned in conjunction with the community.

- Local persons from the community with appropriate training are best suited to provide health education to others. The village health guide, where present, should play a pivotal role.

- Whilst men, women and children should all be reached by health education in relation to water, women should be most actively involved as prime users of water and being in a key position to influence the family health practices.

- While creating new water supply facilities, a viable long term strategy has to be evolved to meet the future Operation and Maintenance costs. Community self-reliance should be the ultimate goal.

- NGOs which are apolitical and have greater flexibility than Government institutions can play an important role in the promotion of water supply & sanitation programmes. Familiarization and orientation of government staff with the innovative approaches of NGOs through exchange of experience and field visits would be valuable.

- The needs especially in the field of health are such that they can only be met by a coordinated effort. Mobilization of all resources and agencies is required.

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