GENERAL INFORMATION

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IRC 15: SSF

SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

GENERAL INFORMATION FOR PARTICIPANTS

Accomodation

A block booking has been made on behalf of the participants at the Centraal Hotel, Lange Poten 6, The Hague, tel.nr. 070 - 469414, cable Cenho, telex nr. 32000.
All rooms are with bath, shower and toilet. Lounges, restaurant and bar are available.

Travel

When arriving at Schiphol (Amsterdam-Airport) the best way to travel is by KLM-coach to The Hague, where you get off at the Central Station. There taxi's are available.

Registration

Registration will be on Sunday 21th of November from 16.00 p.m. to 18.00 p.m. at the Centraal Hotel. Then you will receive your per diem, conference documents and other relevant information.

Venue

The meeting will be held in the offices of the International Reference Centre in Damsigt Building, Nieuwe Havenstraat 6, The Hague(Voorburg), The Netherlands, nearby the Ministry of Public Health and Environmental Hygiene.
The opening is scheduled for 09.30 a.m. on Monday 22th of November.
You will be picked up at your hotel at about 09.00 a.m.

Social engagement

On occasion of the meeting, participants will be invited to enjoy dinner together, on Monday 22th of November at the Corona Hotel in The Hague.
On Thursday 25th of November there will be cocktails after the combined meeting with the Advisory Group.

Excursion

A trip to the Amsterdam Municipal Waterworks is planned on Wednesday 24th of November.

Dress

Social engagement will require informal dress only.
In November the weather is normally fairly cold so it is advisable to take some warm garments with you. Because of the ever present possibilities of rainfall in Holland, an overcoat may be very useful.

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IRC 15: SSF 19761130

SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

LIST OF PARTICIPANTS

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MONNEY, J.G.	University of Science and Technology Civil Engineering Department Kumasi
BOATENG, Dr. J.W.	Ghana Water and Sewerage Corporation P.O. Box M 194 Accra

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ABDULLA, A.	Sudan Gezira Board Barakat (Wad Medani)

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LERT CHAINARONG,	Ministry of Public Health Community Water Supply Division Bangkok

OBSERVERS

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SOLEMAN, M.A.A.	Consultant

SECRETARIATE

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KERKHOVEN, P.	Project Leader WHO International Reference Centre for Community Water Supply
REINDERS, Miss Conny	Project Secretary
PUTMAN, Miss Yvonne	Secretary

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

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ABDALLA, A.	Sudan Gezira Board Barakat (Wad Medani)

THAILAND

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LERT, C.	Community Water Supply Division Department of Health Ministry of Public Health Devaves Palace Bangkok

OBSERVERS

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STORM, Drs. G.	Ministry of Foreign Affairs Directorate of International Technical Assistanc Muzenstraat 30 The Hague The Netherlands
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SECRETARIATE

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REINDERS, Miss Conny	Project Secretary
PUTMAN, Miss Yvonne	Secretary

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

DRAFT

TENTATIVE ANNOTATED AGENDA

SUNDAY, November 21

16.00	Registration at Central Hotel Issue of Conference Documents

MONDAY, November 22

09.30 - 10.30	Opening Session
10.30 - 11.00	Coffee break
11.00 - 12.30	Presentations (2)
12.30 - 13.30	Lunch (will be held at Building B)
13.30 - 15.00	Presentations (2)
15.00 - 15.30	Tea break
15.30 - 17.00	Presentations (2) Summary main issues
19.30 - ----	Dinner

TUESDAY, November 23

09.00 - 10.30	Daily report Monday Presentation and discussion on interim reports Introduction Working Groups (phase I)
10.30 - 11.00	Coffee break
11.00 - 12.30	Working Group (phase I)
12.30 - 13.30	Lunch break
13.30 - 15.00	Working Group (phase I)
15.00 - 15.30	Tea break
15.30 - 16.30	Working Group (phase I)
16.30 - 17.00	Plenary Working Group reports presented by the chairman Summary main issues

WEDNESDAY, November 24

09.00 - 10.30	Daily report Tuesday Plenary / discussion on results Working Group (phase
10.30 - 11.00	Preparation of items for Advisory Group meeting
11.00 - -----	Departure for excursion to Amsterdam Waterworks *(Lunch offered by the Amsterdam Municipal Waterworks)*

THURSDAY, November 25

09.00 - 10.30	Advisory Group meeting III
10.30 - 11.00	Coffee break
11.00 - 12.30	Continuation Advisory Group III
12.30 - 13.30	Lunch break
13.30 - 15.00	Continuation Advisory Group III
15.00 - 15.30	Tea break
15.30 - 16.30	Continuation Advisory Group III
16.30 - 17.00	Presentation IRC-film "Water: a global care"
17.00 - 18.00	Drinks (will be held at cantine Damsigt Building)

FRIDAY, November 26

09.00 - 10.30	Daily reports Wednesday and Thursday
10.30 - 11.00	Coffee break
11.00 - 12.30	Finalization discussions on results phase I / recommendations, priority allocation
12.30 - 13.30	Lunch break
13.30 - 15.00	Presentation and discussion on general programme proposal for phase II
15.00 - 15.30	Tea break
15.30 - 17.00	Continuation discussions on proposal for phase II Summary of main issues

SATURDAY, November 27) SUNDAY , November 28)	no arrangements

MONDAY, November 29

09.00 - 10.30	Daily report Friday Presentations of proposal for phase II by representatives of Project Managing Committees (3)
10.30 - 11.00	Coffee break
11.00 - 12.30	Presentations of proposals for phase II by representatives of Project Managing Committees (3)
12.30 - 13.30	Lunch break
13.30 - 15.00	Task group sessions, a specific part of programme phase II
15.00 - 15.30	Tea break
15.30 - 16.30	Continuation task group sessions
16.30 - 17.00	Plenary / task group reports presented by chairman Summary of main issue

TUESDAY, November 30

09.00 - 10.30	Daily report Monday
10.30 - 11.00	Coffee break
11.00 - 12.30	Discussion on recommendations and allocation of priorities for implementation of programme for phase II of the project
12.30 - 13.30	Lunch break
13.30 - 15.00	Continuation discussion of programme phase II
15.00 - 15.30	Tea break
15.30 - 16.00	Closing session
16.00 - -----	Drinks

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

GENERAL OBJECTIVES

1. to report on the activities and results of the first phase of the slow sand filtration project.
2. to review and discuss in detail the technical aspects of the programme of investigations of the first phase.
3. to indicate gaps in the current knowledge with regard to the performance of slow sand filtration under local conditions in developing countries.
4. to formulate recommendations for further applied research and field investigations.
5. to formulate design-criteria for slow sand filtration plants in rural areas of developing countries.
6. to review the proposed general programme of activities for the second phase of the slow sand filtration project.
7. to present the various proposals of the Project Managing Committees for participation in the second phase.
8. to agree on a coordinated approach of the implementation of the programme for this phase of the project.
9. to consult on the integration of the various programmes of work for the second phase and to agree on priorities and initial arrangements on the basis of an internationally coordinated collaboration programme.
10. to formulate recommendations for further studies and activities in the context of the programme for the second phase.

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

INVITATION FOR A JOINT DINNER

The undersigned wishes to participate in the joint dinner on Monday, November 22nd at 19.30 hrs at the Corona Hotel, Buitenhof, The Hague.

NAME: ....

I do/do not request a vegetarian menue.

Please return to the Secretariate ultimately Monday morning November 22nd, during coffee break.

WORKING DOCUMENTS PHASE I

who international reference centre for community water supply

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W.O. I-1

SLOW SAND FILTRATION PROJECT

TENTATIVE EVALUATION OF PHASE I

1 NOVEMBER 1976

SUMMARY

1. GENERAL OBJECTIVE SLOW SAND FILTRATION PROJECT

The general objectives of this internationally coordinated research and demonstration project is the promotion of the application of slow sand filtration for biological treatment of drinking water in rural areas of developing countries.

2. DERIVED OBJECTIVES FOR THE FIRST PHASE OF THE PROJECT

- to make an inventory and to evaluate existing knowledge and experience on the slow sand filtration process.
- to obtain additional data regarding the performance of the process under local conditions by means of applied research in the developing countries themselves.
- to stimulate the internal cooperation and to improve the organizational infrastructure in the field of water supply in the participating countries, notably to promote a direct transfer of results of the applied research to be brought in practice.

3. PROGRAMME FOR THE FIRST PHASE OF THE PROJECT

The programme for the first phase of the project contains the following categories: field investigation on existing installations, applied research on pilot installations, literature studies and additional organizational activities. The major part of these activities is being carried out by research institutes in six developing countries: Ghana, India, Kenya, Pakistan, Sudan and Thailand. The institutes involved have built pilot installations on which applied research is being carried out. Next to this, a rough inventory of existing slow sand filters, either on national or on regional scale has been made, and a few selected installations have been studied in more detail. Locally available literature has been collected and studied.

Also, so called Project Managing Committees have been established, that guard the progress of the project in the various countries and in which, next to the research institutions national and local governmental authorities participate.
The IRC takes care of the initiation, coordination and support of the various activities and stimulates the internal exchange of information on the project, contacts are established with several persons, waterundertakings, institutes and organizations in various countries.

4. PROGRESS OF THE PROGRAMME FOR THE FIRST PHASE OF THE PROJECT

a. GHANA - University of Science and Technology, Kumasi
Three standard pilot units and a pre-sedimentation installation have been constructed. The major part of the investigations will be rounded off before December 1st, 1976. In the meantime, the preliminary results have been reported to the IRC by means of an interim report (October 1976). This also goes for a more detailed study of a few existing slow sand filter installations in Ghana. The Project Managing Committee is functioning reasonably well.

b. INDIA - National Environmental Engineering Research Institute, Nagpur
Three standard pilot units have been constructed. Investigations have been rounded off in the beginning of November. Statement of results by means of a progress report (April 1976) and an extensive interim report (August 1976). The final report is expected before the end of November. Studies on pre-filtration techniques are still progressing. An extensive inventory has been made of existing slow sand filtration plants in India. On a few installations more detailed research is being carried out. The Project Managing Committee is functioning satisfactory.

c. KENYA - University of Nairobi, Nairobi
Three standard pilot units have been constructed. A fourth filter is under construction. Before 1st December 1976 the major part of the investigations will be rounded off. Reports come in by means of an interim report (November 1976). An extensive regional inventory of existing slow sand filter installations in 20 African countries is being made. The Project Managing Committee is functioning well.

d. PAKISTAN - Institute of Public Health Engineering and Research, Lahore
Field investigations on existing installations in the Punjab-province are being carried out as well as laboratory research for suitable pre-treatment methods. A proposal for the construction of a complete pilot installation is being discussed. A Project Managing Committee will be formed in the near future.

e. SUDAN - University of Khartoum, Khartoum
Three standard pilot units have been constructed. The programme of investigations will be rounded off after 1st December 1976. The preliminary results have been reported in an interim report (November 1976). An extensive study on existing slow sand filter installations has been carried out. The Project Managing Committee is functioning reasonably well.

f. THAILAND - Asian Institute of Technology, Bangkok
Five standard pilot units and two pre-filters have been constructed. The investigations have been rounded off by the end of August 1976 and results have been stated by means of a final report (October 1976). An inventory on existing slow sand filter installations has been made and a detailed investigation on a few complete plants carried out. The Project Managing Committee is functioning satisfactory.

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IRC 15: SSF W.D. I - 3

SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT I - 3

Presentation of activities and results of the programme of investigations for phase I of the Slow Sand Filtration project, as carried out by the University of Nairobi

Nairobi
Kenya

by

Mr. J. Gecaga

November 1976

SLOW SAND FILTRATION IN KENYA

Summary:

The Slow Sand Filtration Project in Kenya is a joint venture between:

1) Ministry of Health
2) Ministry of Water Development
3) City Council of Nairobi
4) Departments of Civil Engineering and
   Community Health,
   University of Nairobi

1. PILOT PLANTS

1.1	Standard Pilot Plants:	These are three in number; two are downward flow, one is upward flow.
1.11	Construction	: Material: carrogated iron sheets. Size: diameter 1.3 m height 1.845 m
1.12	Sand	: Hazens effective size - 0.65 mm Uniformity coefficient - 1.38
1.13	Filtration rate	: 0.1 m/hr for all filters during first run.
1.14	Filter run	: upward flow - 64 days downward flow(1) 55 days (2) 68 days
1.15	Chlorination	: All filters were dosed with calcium of lime to give a residual of 10 mg/l chlorine before the start-up.
1.16	Algae growth	: Uncovered filters had an aboundant growth of filamentous green algae. Covered filters had brown mobile algae and other non-pigmented species.
1.17	Pre-treatment	: Next runs will be preceded by pre-treatment units made out of fibre glass. We propose to use sisal fibre and coarse aggrate in the tanks
1.2	Other Pilot Plants	: Purpose is to experiment on various materials for construction purposes rather than process parameters
1.21	Mud blocks filters	: 780 x 780 mm square 700 mm high
1.22	Wooden filter	: 500 x 500 mm square 700 mm high

2. Survey of existing filters in Kenya. These are approximately 26 and relevant data is provided in interim report. Table 2.3

3. Survey of Existing filters in neighbouring countries. Information was received from Malawi, Maviities, Seychelles, Tanzania, Uganda, Zambia

4. Conclusion:

   1. More data is required from the Pilot Plants before we can recommend any design criteria

   2. Information on existing slow sand filters in Kenya and other Eastern and Central African countries shows more attention should be given to operation and maintenance of slow sand filters than previously envisaged.

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT I - 5

Slow Filtration as a low-cost Water Supply System for small villages

by

Dr. Nguyen Cong Thanh

November, 1976

SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd – 30th NOVEMBER 1976

SLOW FILTRATION AS A LOW-COST WATER SUPPLY SYSTEM FOR SMALL VILLAGES

N.C. Thanh
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Asian Institute of Technology
Bangkok, Thailand

November, 1976

SUMMARY

The paper reviews slow filtration process in its application to treat tropical surface waters for village community water supply. The study was carried out by using local materials (sand, burnt rice husk, coconut fibre) in different combinations to make up series-filter and dual-filter systems. The results of study at two levels of raw water turbidity (in the regions of 50 and 100 JTU) and two filtration rates are presented. High turbidities in raw water and higher filtration rates rapidly clog filter beds, rendering filter runs shorter. Coconut fibre as pre-treatment filter showed remarkable potential to remove the gross turbidity in raw water and produced satisfactory effluent for subsequent polishing treatment by sand or burnt rice husk. In series-filtration system, the combination of coconut fibre - burnt rice husk was much superior than that of coconut fibre - sand in terms of length of filtration duration. In dual-media filtration system, significant filter run was obtained with the combination coconut fibre - burnt rice husk, the only objection was the development of an unacceptable odour after a certain period of operation. The dual-media filter made of burnt rice husk overlying sand revealed to be a reliable water treatment and no odour development was depicted in this type of filter. Cost estimation shows that the initial costs incurred in the construction of the series-filter system is 25 percent higher than in the case of the dual-media filter system, as a result of the extra construction cost of the roughing filter box and the capital cost of a pump with higher power rating. The monthly operating costs are not significantly different between the two systems.

SLOW FILTRATION AS A LOW-COST WATER SUPPLY SYSTEMS FOR SMALL VILLAGES

I INTRODUCTION

It is well recognized that an effective water supply system should provide water to the greatest number of people at the lowest cost, in a steady and reliable manner. Functional design of systems should be directed by these principles for effective operation of water supply systems in developing countries. Complex and expensive methods of water supply are inappropriate for many rural areas. High cost technology imposes high demands for operation and maintenance on local organization and skills, and in many rural areas the population is unable to make use of the technology available.

For rural areas in developing countries, slow sand filtration seems to be the most suitable single treatment process for surface water and may be very efficient when combined with chlorination (and sedimentation if necessary). It is less complicated, can suffer more abuse and still produce high-grade water and, where land is not a limiting factor, usually requires less investment. Where suitable qualities of sand are not available, it is possible to develop and use other local materials, such as burnt rice husk, coconut fibres, pea gravel, etc. One problem in applying slow-rate filtration to turbid surface waters in tropical regions is that the suspended silt quickly blocks the filter. However, a slow filter can be maintained in good working condition in spite of excessive turbidity (particularly inorganic turbidity) which causes rapid clogging of the filter surface, necessitating frequent cleaning. Where the raw water source contains high amounts of turbidity and algae, pre-filter (coconut fibre or pea gravel, horizontal-flow coarse-material pre-filtration) can be used to remove most of the turbidity and algae before the water passes through a slow sand filter (or burnt-rice-husk-filter) for polishing and removal of remaining impurities.

This paper reports the results obtained in a study[1/] conducted in order

1/ THANH, N.C. and PESCOD, M.B. (1976) Application of Slow Filtration for Surface Water Treatment in Tropical Developing Countries, Research Report No. 65, Asian Institute of Technology, Bangkok, Thailand.

to assess:

(i) The performance of a slow sand/burnt-rice-husk filter and its ability to function in combination with a coconut fibre filter (series-filtration system).

(ii) The performance of a dual-media filter (coconut fibre in the upper layer and burnt-rice-husk filter in the lower layer, in the same filter box.

(iii) The performance of dual-media filters, made of burnt-rice-husk or coconut fibre overlying sand.

The criteria for the evaluation of filter performance were the quality of treated water in terms of turbidity and coliform removal and the duration of filter runs based on the observation of head-loss development. Raw water turbidity and filtration rates were considered as independent variables.

II METHODS OF INVESTIGATION

2.1 Source of Raw Water

The raw water source under study is typical of tropical surface waters. Under normal conditions, the turbidity of this surface water ranged from 25 to 50 JTU. Fluctuations in turbidity were particularly marked during rainy days when runoff from the surrounding area carried silt and soil into the canal. In a later stage of this study where raw water turbidity was in the region of 100 JTU, the muddy bottom of the canal was artificially scoured in order to induce higher levels of turbidity for experimental needs.

2.2 Filter Systems

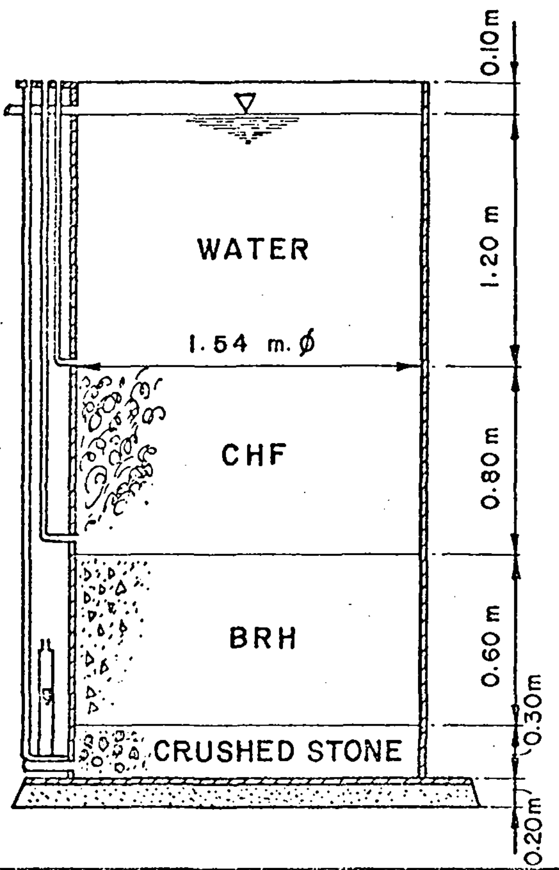
Two systems of filters were designed for the experimental study of dual-filtration and series-filtration. The dual-filtration system as shown in Fig. 2.1, consisted of one single filter box filled with coconut fibres overlying burnt rice husks. Starting from the bottom, the internal depth of the dual media filter was as follows:

Crushed stone underdrain	0.30 m
Burnt rice husk	0.60 m
Coconut fibre	0.80 m
Supernatant water	1.20 m
Freeboard above supernatant water level	0.10 m

In the later stage of study in the region of 100 JTU of turbidity in raw water, a minor change was made in the internal arrangement of the dual-media filter box, which was as follows:

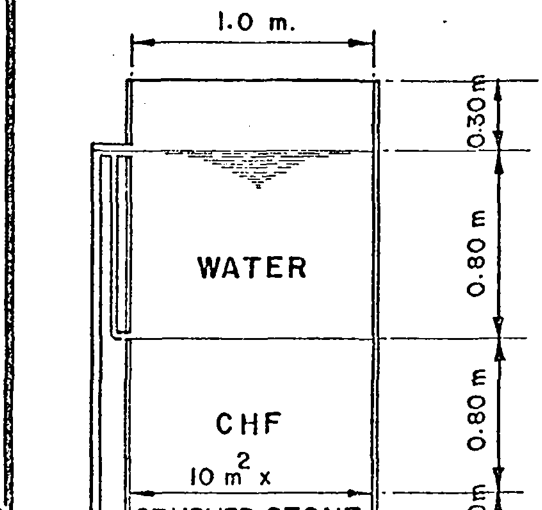
Crushed stone underdrain	0.30 m
Bottom layer of sand/burnt rice husk	0.60 m
Top layer of burnt rice husk/coconut fibre	0.80 m
Supernatant water	0.60 m
Freeboard above supernatant water level	0.70 m

The reduction of the supernatant water head from 1.20 m to 0.60 m was designed in an attempt to minimize the residence time of water in the filter



Scale : 1 : 30

FIG.2.1 DUAL- MEDIA SYSTEM



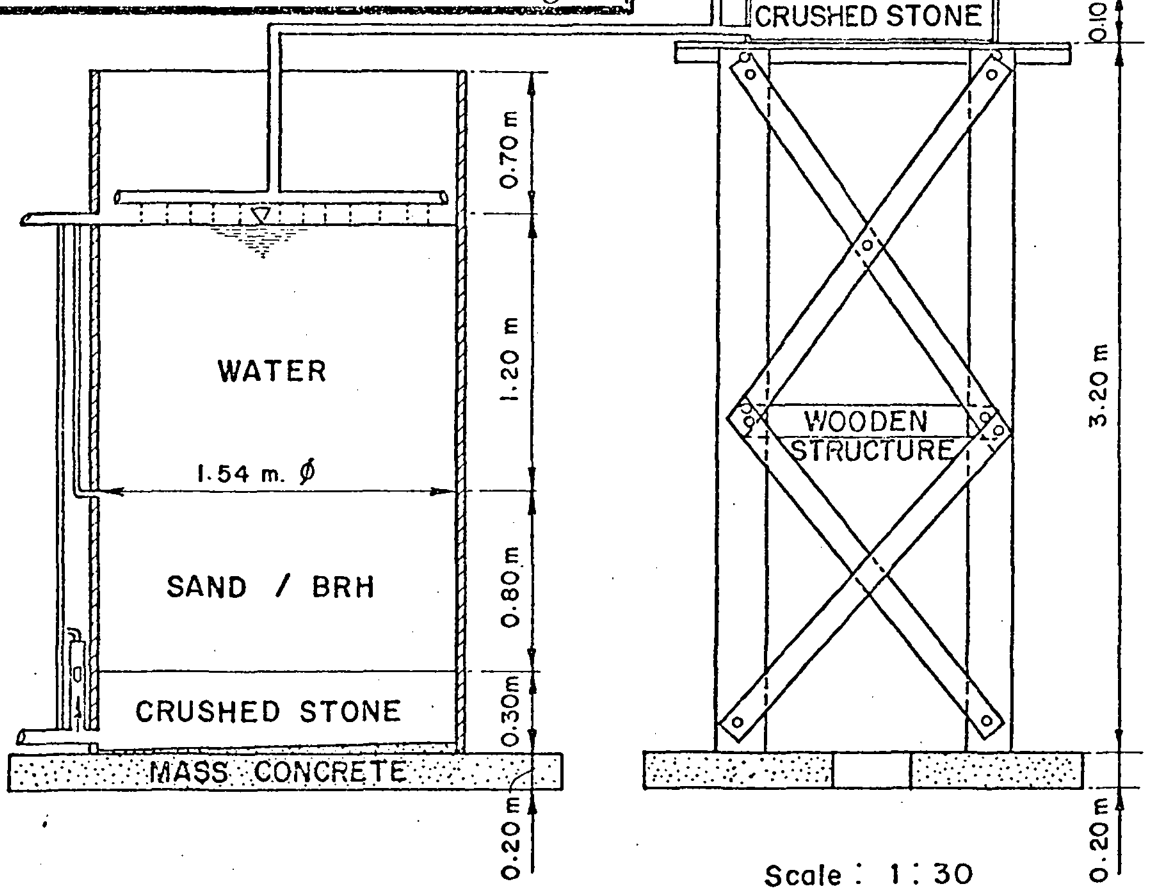


FIG. 2.2 SERIES–FILTER SYSTEM

box and accordingly the development of anaerobic conditions in the dual-media filter. The series-filtration system consisted of a pre-filter packed with coconut fibre and mounted on a 3.20 m-high wooden frame, and coupled with a sand or burnt-rice-husk filter. A series filter set-up is shown in Fig. 2.2. The pre-filter was made of 0.32 cm-thick galvanized iron sheets and measured 1 m x 1 m x 2 m. The internal depth of the box was the sum of the following depths, starting from the bottom:

Crushed stone underdrain	0.10 m
Coconut fibre	0.80 m
Supernatant water	0.80 m
Freeboard above supernatant water level	0.30 m

The polishing sand/burnt-rice-husk filter was made of three 1 m-long, 1.54 m I.D. concrete sewer pipes. The arrangement inside the filter box was as follows:

Crushed stone underdrain	0.30 m
Sand/burnt rice husk	0.80 m
Supernatant water	1.20 m
Freeboard above supernatant water level	0.70 m

2.3 Filter-Media Characteristics

Coconut fibres, before being used, were soaked in water for at least 24 hours and rinsed 3 or 4 times to remove organic colour originating in the fibre structure.

From the results of sieve analyses, presented in Fig. 2.3, burnt rice husks were found to have a relatively high non-uniformity coefficient (U = 5.9) compared with sand (U = 2.3), but the effective size was almost the same in both cases (E = 8.3 x 10^{-2} cm for sand and 9 x 10^{-2} cm for burnt rice husk). For the purposes of this study, stock sand and stock burnt rice husk were used so that the relatively high expense of careful grading was avoided. Burnt rice husk is composed of about 90 percent silicon dioxide, 6-7 percent oxides of magnesium, calcium and iron and the remaining 3-4 percent is organic matter.

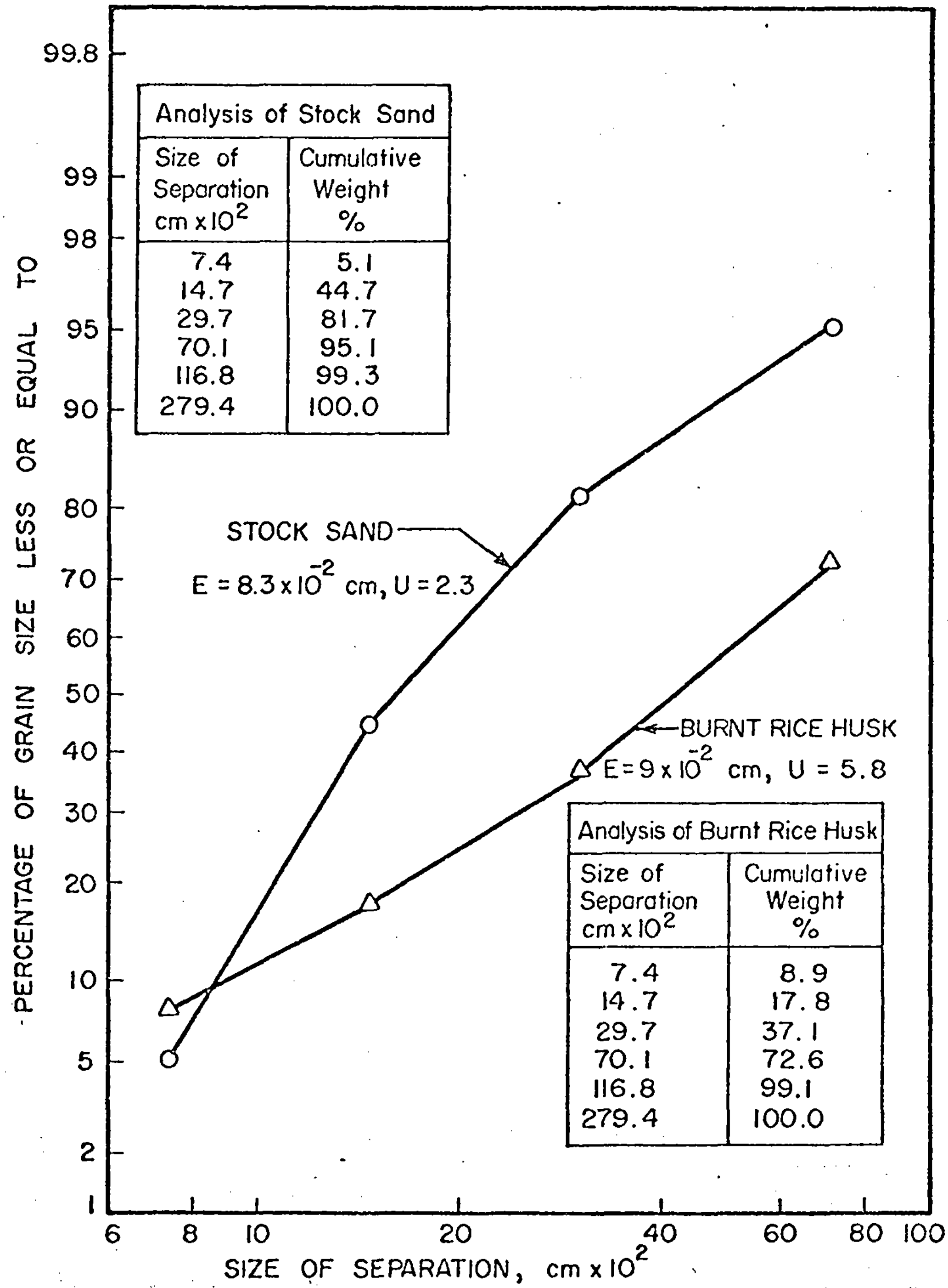


Fig. 2.3 Sieve Analysis of Stock Sand and Burnt Rice Husk.

2.4 Filtration Run and Filter Cleaning

A filtration run was interrupted when the bed resistance (sand and burnt rice husk) had increased to such an extent that the outlet regulating valve was fully open. The head loss measurement was also an indication of blocking development and imminence of the end of a run.

To clean the roughing filter beds, water was completely drained off from the filter box and coconut fibres were manually removed and discarded. New coconut fibre stock, previously soaked in water for 24 hours, was used to repack the filters.

The cleaning of sand and burnt rice husk filter beds was carried out by manually scraping off the surface layer to a depth of 1-2 cm in the case of sand and 2-3 cm in the case of burnt rice husk since it was observed that the suspended solids and colloidal matter were deposited to a greater depth in the latter medium due to the porous nature of the burnt rice husks. Cleaning of the bed in the dual-media filter was achieved by scraping off the biological layer to a depth of only 1 cm or less because the penetration of suspended particles into this type of filter was less than in other types of filter system mentioned.

III RESULTS AND DISCUSSION

This study has been carried out in two stages where raw water turbidity was in the regions of 50 and 100 JTU and filtration rates of 0.1 and 0.2 m^3/m^2 h, respectively, were maintained in the slow filters, and 1.5 and 0.5 m^3/m^2 h, respectively, in the roughing filters. The quality, in terms of turbidity, of the raw water and effluents from roughing filters and slow filters, was monitored daily. Head loss build-up in the slow filters was recorded regularly because it served as a criterion in concluding a filter run. Head loss development in the roughing filters, although negligible, was also recorded for reference. The bacteria contents of the raw water and the final treated waters were determined in the forms of total coliforms, faecal coliforms and Streptococcus faecalis. All analyses were carried out according to Standard Methods [1/].

3.1 Filtration Study at Raw Water Turbidity in the Region of 50 JTU

During this stage of study, the variations of turbidity in raw water and in the effluent from the roughing filter are shown in Fig. 3.1a. The values plotted represent averages of 5-day values. Raw water turbidity varied from 25 to 45 JTU during 108 days of continuous operation, while the average value of turbidity in the effluent from the pre-filter was about 12 JTU, denoting a 63 percent removal efficiency. It can also be noticed that, during the first 48 days of operation, the turbidity of the water produced by the pre-filter was relatively stable and seemed to be independent of the raw water turbidity. As operation progressed and clogging became important, the pre-filter gradually lost its stability and its performance became raw water turbidity dependent. And yet coconut fibre filter exhibited considerable potential to tolerate raw water turbidity changes and still produced an effluent satisfactory for subsequent treatment by slow sand and burnt-rice-husk filters.

Head loss development is an important parameter in filtration since it announces the conclusion of filter runs. Fig. 3.2a records the head loss

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1/ Standard Methods for the Examination of Water and Wastewater, AWWA, WPCF (1971).

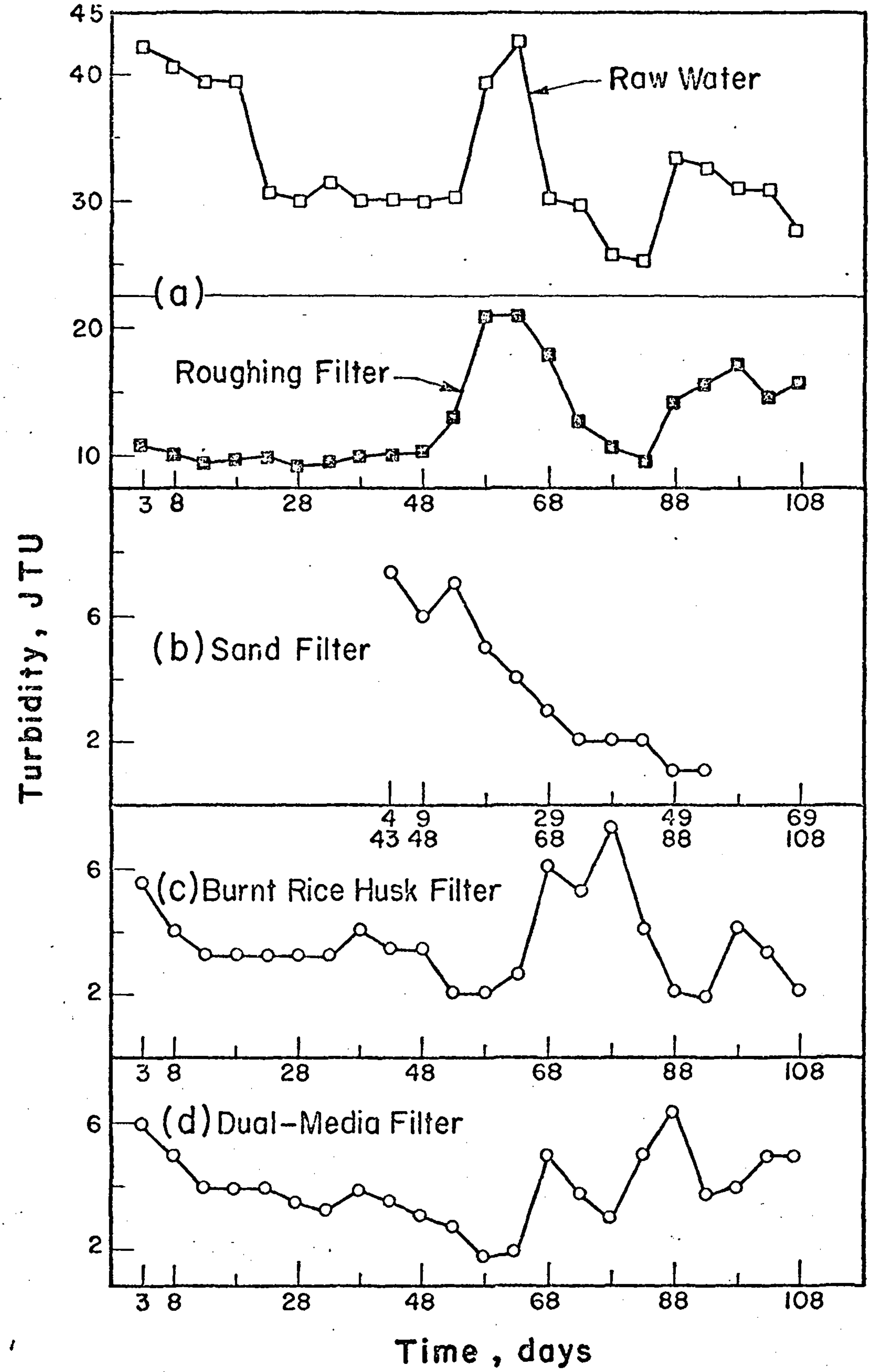

Fig. 3.1 Turbidity of Raw Water and Effluents of Different Filters
(Raw Water Turbidity ≃ 50 JTU)

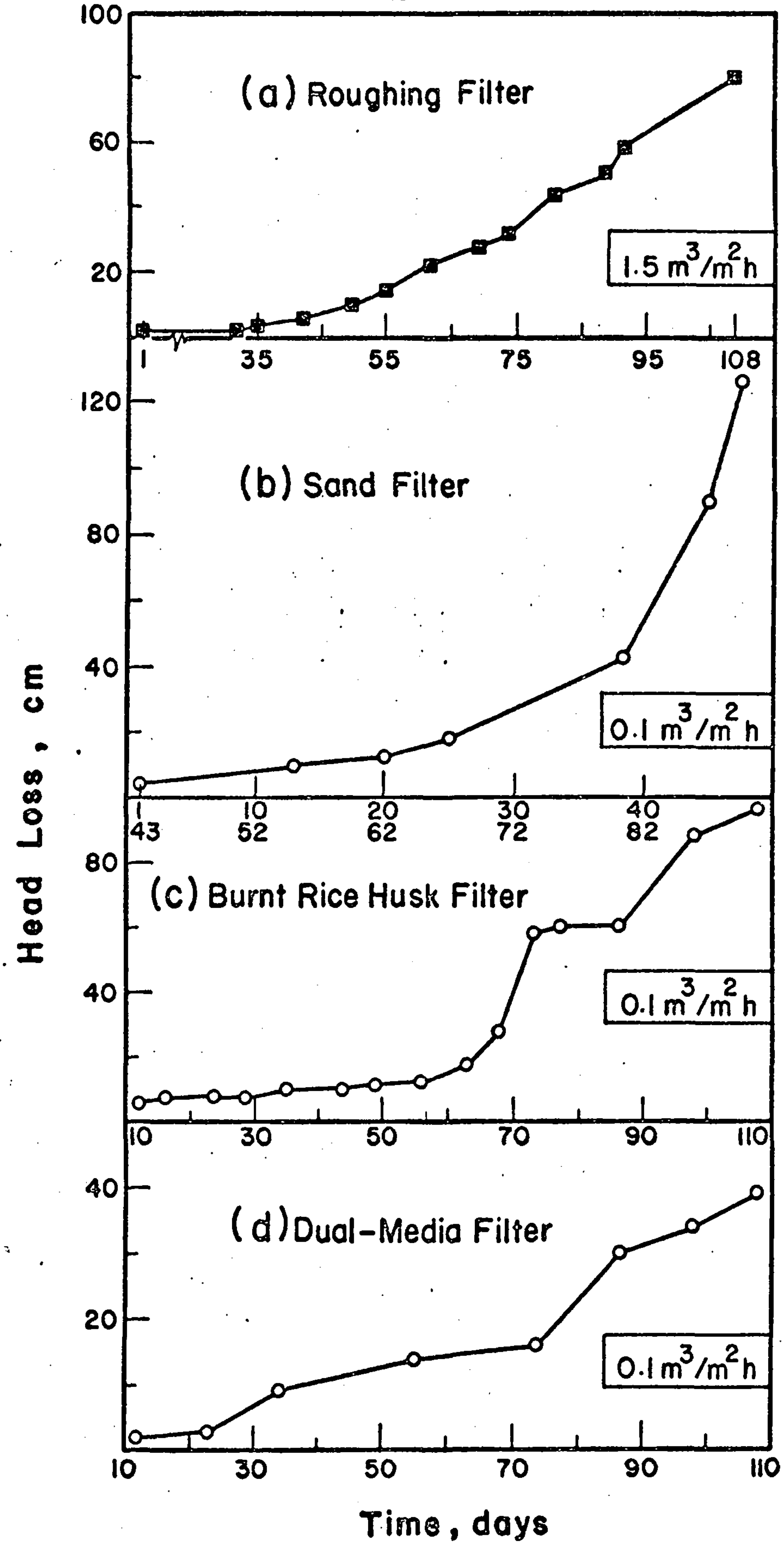

Fig. 3.2 Head Loss Development in Different Filters
(Raw Water Turbidity ≃ 50 JTU)

build-up across the coconut fibre filter. It is seen that the total head loss after 108 days of continuous operation was only 80 cm, at an approximate rate of 1 cm/day, if linear extrapolation is applied. For a head loss limit of 1.20 m and continuous filtration rate of 1.5 m^3/m^2 h, the interval between recharges of new coconut fibres would be of the order of 4 months. There is good reason to anticipate that, at filtration rate as low as 0.5 m^3/m^2 h, a longer filtration rate could be expected as it will be seen in the later stage of study.

The effluent turbidity from the sand filter in the series-filtration system was relatively good (1 to 8 JTU) at flow rate of 0.1 m^3/m^2 h, as it can be seen from Fig. 3.1b. The turbidity of the final treated water appeared to be of little importance in the conclusion of a filter run. Burnt-rice-husk filter also produced an acceptable quality (2-10 JTU) for the rural population, as shown in Fig. 3.1c. With regard to this aspect, burnt-rice-husk filter and sand filter are very competitive in their performance.

On the other hand, burnt-rice-husk filter performed better than sand filter in terms of head loss development at filtration rate of 0.1 m^3/m^2 h, as recorded in Figs. 3.2b and 3.2c. Burnt-rice-husk filter developed a head loss of 97 cm after 108 days of continuous operation, averaging a head loss rate of 0.9 cm/day, whereas in sand filter, head loss reached 1.20 m after 40 days of continuous filter operation. From experimental data, it is evident that filtration duration of burnt-rice-husk filter is three times longer than that of sand filter, at least within the range under study.

The dual-media filter was directly supplied with raw water at a filtration rate of 0.1 m^3/m^2 h. Fig. 3.2d shows the head loss build-up in this filter as time progressed. It can be seen that the development of head loss across the filter bed occurred smoothly, with a very low build-up rate up to 70 days and then a gradual increase at an average rate of 0.7 cm/day. If linear extrapolation and a maximum head loss of 1.20 m are applied in this situation, a continuous filter run of 7 months duration could be contemplated. Hence, in this study it was found that the dual-media filter (coconut fibre-burnt rice husk) gave longer filtration runs than the series-filter for the same raw water. This may have been a result of coconut fibres overlying the burnt-rice-husk bed not only serving as pre-treatment to remove the gross turbidity in the raw water, but also distributing the remaining smaller particles uniformly over the burnt-rice-husk layer for further polishing filtration. As a result of this action, particles of impurity could penetrate deeper into the polishing bed resulting in slower development of head loss throughout the system and a better quality treated water. Fig. 3.1d illustrates the quality in terms of turbidity of the treated water from the dual-media filter. Effluent turbidity, ranging from 2 to 6 JTU during the whole course of continuous operation (108 days), could be considered to be suitable for rural consumption.

However, an unacceptable odour was noted in the effluent from the dual-media filter after 3 months of continuous operation. Concomitant tests on dissolved oxygen in the effluent (shown in Table 3.1) revealed the absence

Table 3.1 - Dissolved Oxygen Content (mg/l) in Raw and Filtered Water (Raw Water Turbidity in the Region of 50 JTU)

Run Duration, Days	Date	Influent Water	Roughing Filter 1.5 m^3/m^2h	Sand Filter 0.1 m^3/m^2h	Burnt-Rice Husk Filter 0.1 m^3/m^2h	Dual-Media Filter 0.1 m^3/m^2h
6	20/11/75	7.4	6.2		5.4	5.5
11	25/11/75	7.8	6.8		5.4	5.6
17	1/12/75	7.6	6.2		5.5	5.2
23	7/12/75	8.2	6.2		5.5	5.6
29	13/12/75	7.8	6.3		6.0	5.7
35	19/12/75	6.5	5.5		5.5	5.5
39	23/12/75	-	-		-	-
43, 1	27/12/75	7.0	5.5	5.5	6.0	5.5
50, 8	3/ 1/76	7.0	6.0	5.6	5.5	5.8
53,11	6/ 1/76	6.5	6.1	5.1	5.7	3.5
98,56	20/ 2/76	5.2	3.8	3.4	3.4	0
101	23/ 2/76	4.0	4.0	3.5	3.0	0
103	25/ 2/76	4.5	3.5	3.6	3.1	0
105	27/ 2/76	4.1	3.0	3.2	3.9	0
108	1/ 3/76	4.3	2.4	3.3	4.0	0

of this parameter in spite of the excellent clarity of the water. The development of anaerobic conditions can be explained as having been due to the extended detention time of the water in the filtration unit, which was 29 hours at a filtration rate of 0.1 m^3/m^2 h for a total water depth of 2.9 m. It is believed that organic matter in the raw water was deposited in the filter bed and incurred depletion of dissolved oxygen in the water during its degradation process. In practice it would be necessary to conclude a filtration run as soon as odour occurred and proceed to filter cleaning. Also shown in Table 3.1 are the results of the dissolved oxygen content in filtered waters from the series-filtration units (sand and burnt rice husk). Short residence time of water in the roughing filter (coconut fibre), helped by aeration between the roughing filter and the polishing filter, prevented the occurrence of anaerobic conditions in the final treated water.

From the microbiological standpoint, the general conclusion is that neither series-filters nor dual-media filter could completely remove coliform bacteria from the raw water, as illustrated in Figs. 3.3, 3.4 and 3.5. This deficiency would tend to limit the application of these simple systems in the provision of treated water to rural populations if the bacteriological international drinking water standards are strictly applied. However, considering the present situation in many rural communities, where water from polluted surface sources is carried over long distances and used directly, any significant improvement in service and water quality could be expected to have a beneficial impact on health. This does not mean that reasonable efforts should not be made to supply a good quality safe water, but costly attempts to meet international standards are unnecessary and wasteful in Asian developing countries. It is then suggested that a much improved quality water which is convenient and acceptable to villagers is preferable to an absolutely safe water which villagers reject in favour of their traditional contaminated supply. In many rural situations, acceptability is a more important criterion than bacterial quality, as indicated by the coliform standard, and WHO international drinking water standards should be applied with discretion. The series-filters and dual-media filter significantly improved the bacterial quality of the raw water, as the efficient removal of faecal coliforms and S. faecalis proved, and would provide

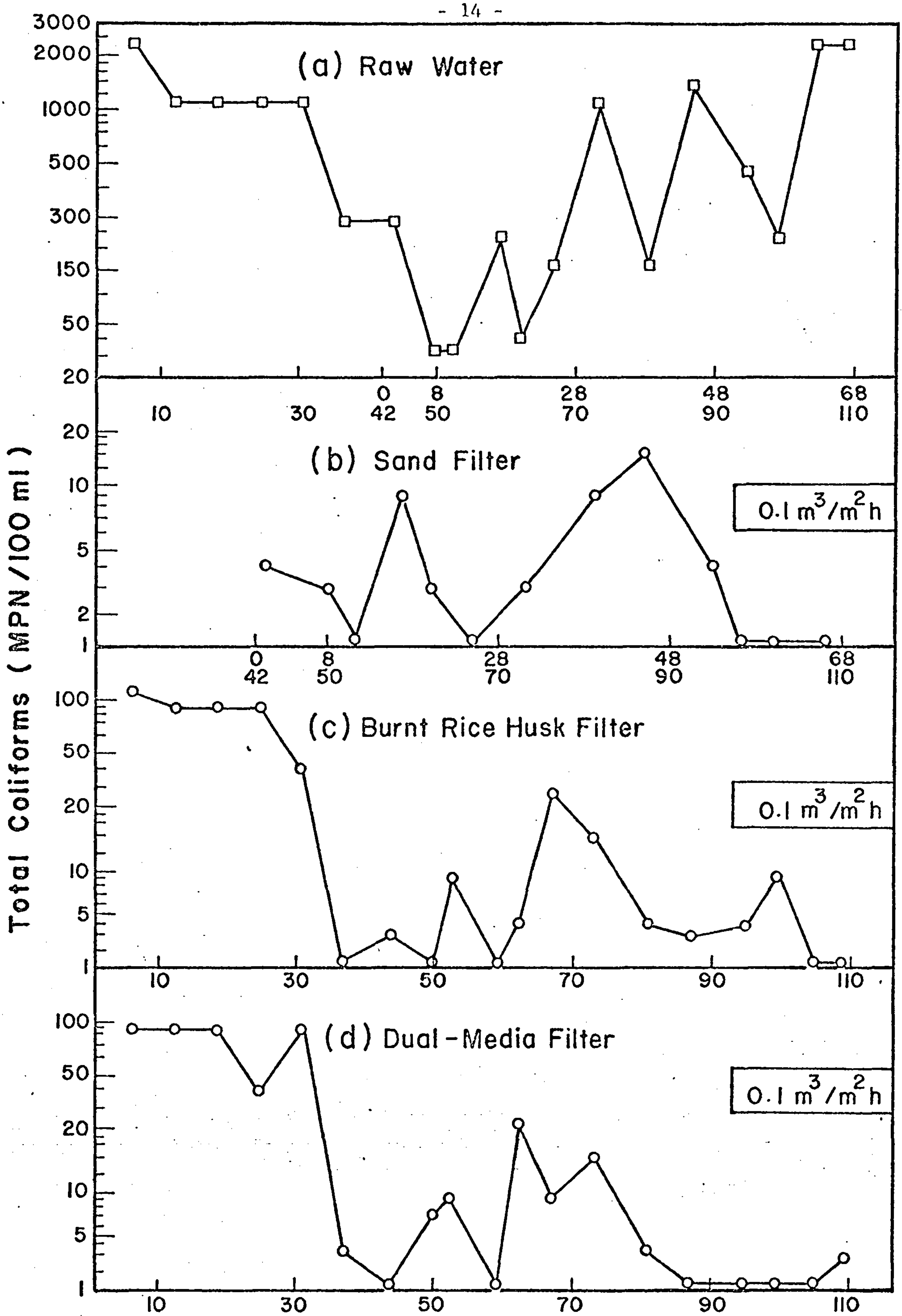

Fig.3.3 Results of MPN Tests for Total Coliforms
(Raw Water Turbidity $\simeq$ 50 JTU)

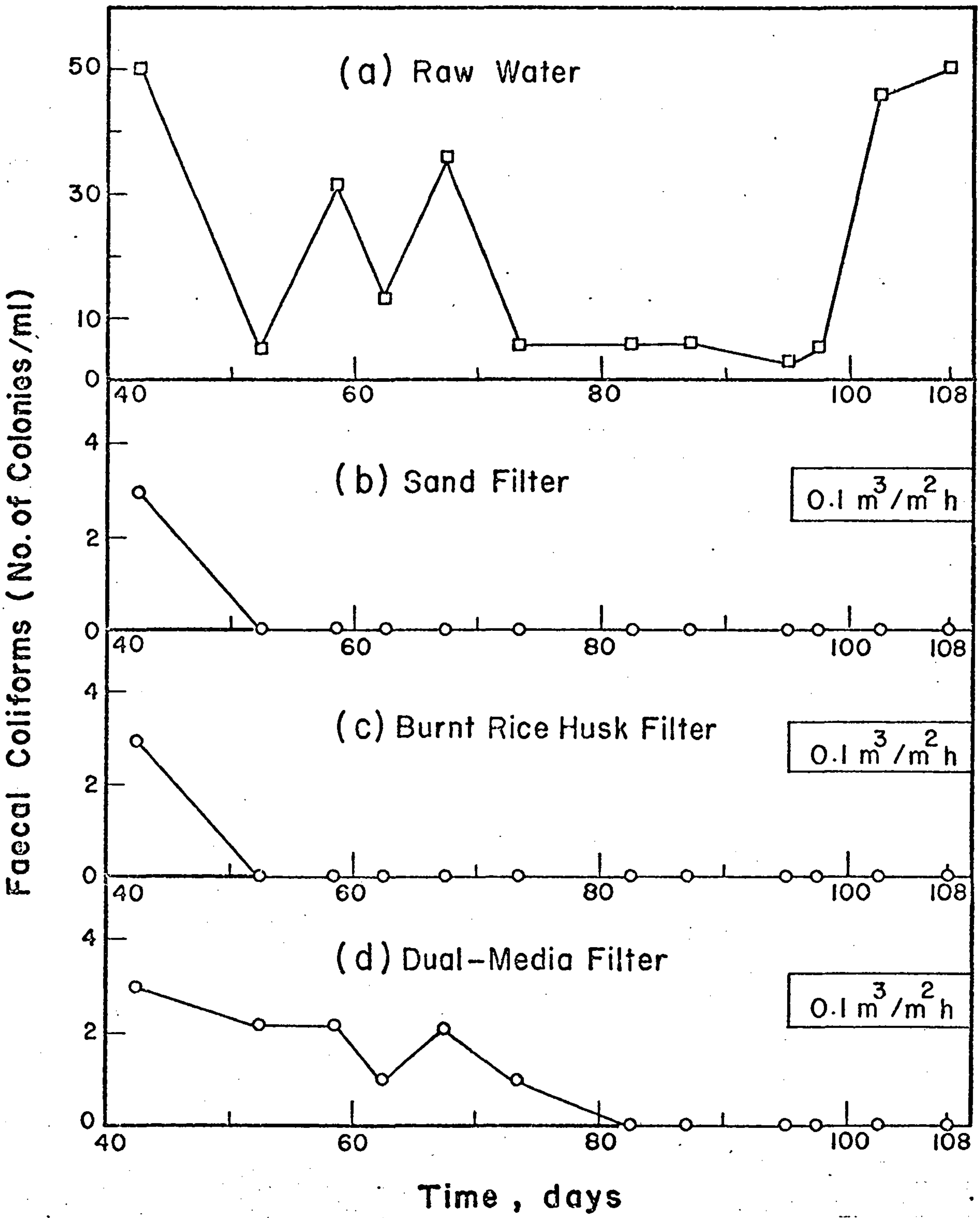

Fig. 3.4 Result of Faecal Coliform Plate Count Tests
(Raw Water Turbidity ≃ 50 JTU)

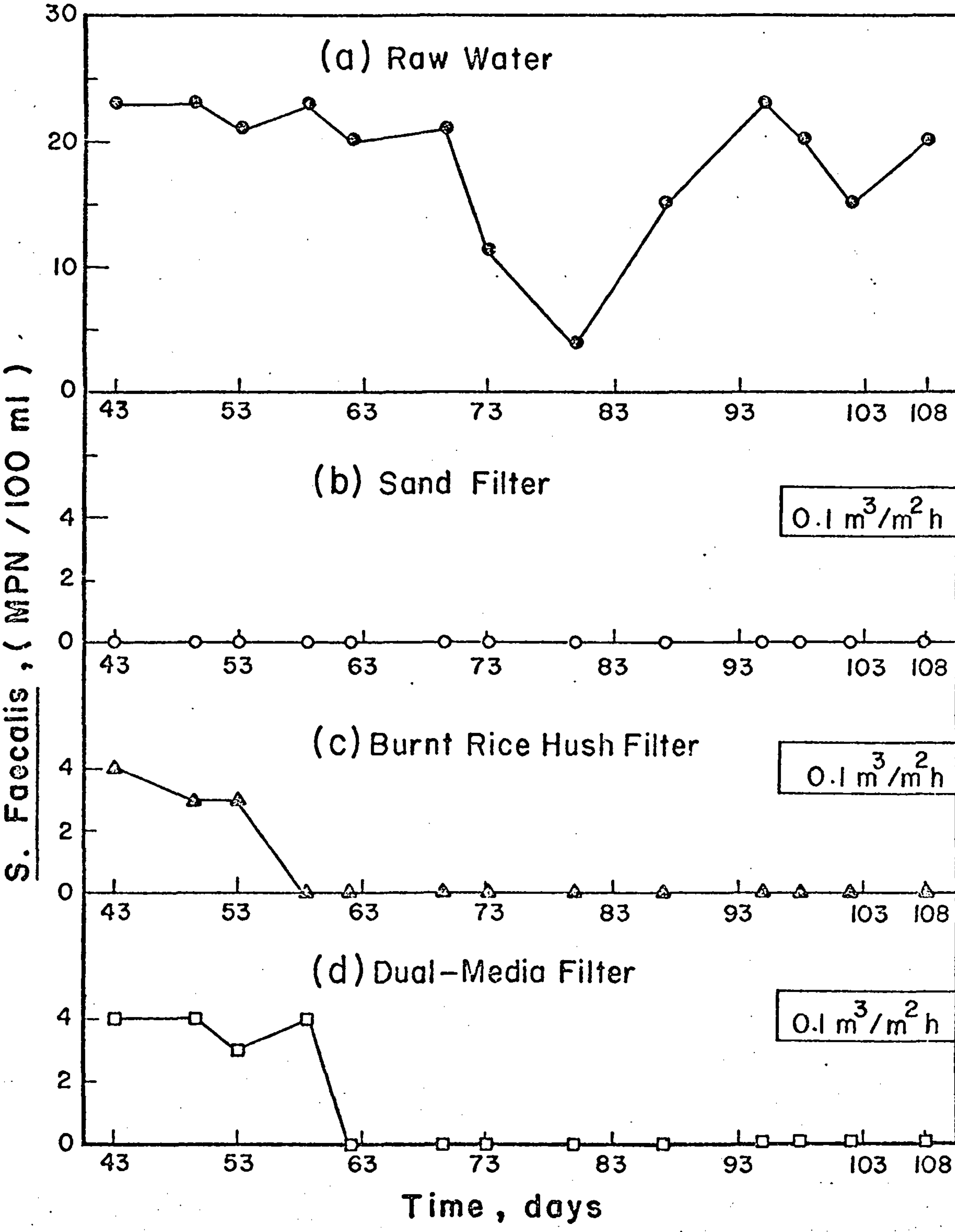

Fig. 3.5 Results of Streptococcus Faecalis MPN Tests
(Raw Water Turbidity ≃ 50 JTU)

a high degree of health protection to rural people now exposed to unprotected water supplies.

3.2 Filtration Study at Raw Water Turbidity in the Region of 100 JTU

This stage of study included two series-filters (CF-SAND; CF-BRH) and three dual-media filters (CF-SAND, BRH-SAND, CF-BRH)[2/], all operated at a filtration rate of 0.2 m^3/m^2 h. This experimental design was intended to provide an overall picture of the performance of different types of filters in supplying village water supply needs, and also to compare the results of this part of study with those of the first stage study where the raw water turbidity was in the region of 50 JTU and the filtration rate of 0.1 m^3/m^2 h was maintained in the filters. For the purposes of this study, artificial stirring of the muddy canal was applied to maintain the turbidity level of about 100 JTU.

In this part of the study, the roughing filter was operated at 0.5 m^3/m^2 h. In spite of wide fluctuations in raw water turbidity, as shown in Fig. 3.6a, the behaviour of the coconut fibre filter was remarkably consistent, exhibiting considerable potential to absorb turbidity "shock loading" and produced an effluent relatively constant and satisfactory for subsequent slow-filtration treatment by sand and burnt rice husk. Fig. 3.6a also shows that the average turbidity in the effluent of the roughing filter ranged from 10-30 JTU, for a raw water turbidity range of 40-140 JTU, denoting an overall turbidity removal of 75 percent. Fig. 3.7a records the head loss build-up across the roughing filter bed. It can be seen that the head loss after 40 days of continuous operation was only 20 cm, at a rate of about 0.5 cm/day. If linear extrapolation is applied for a maximum head loss of 1.20 m a continuous filtration run of 8 months duration at a filtration rate of 0.5 m^3/m^2 h could be contemplated, compared to 4 months duration extrapolated in the previous study at lower raw water turbidity but at higher filtration rate.

Also shown in Fig. 3.7a is the head loss build-up in the sand and burnt

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2/ CF = Coconut Fibre; BRH = Burnt Rice Husk

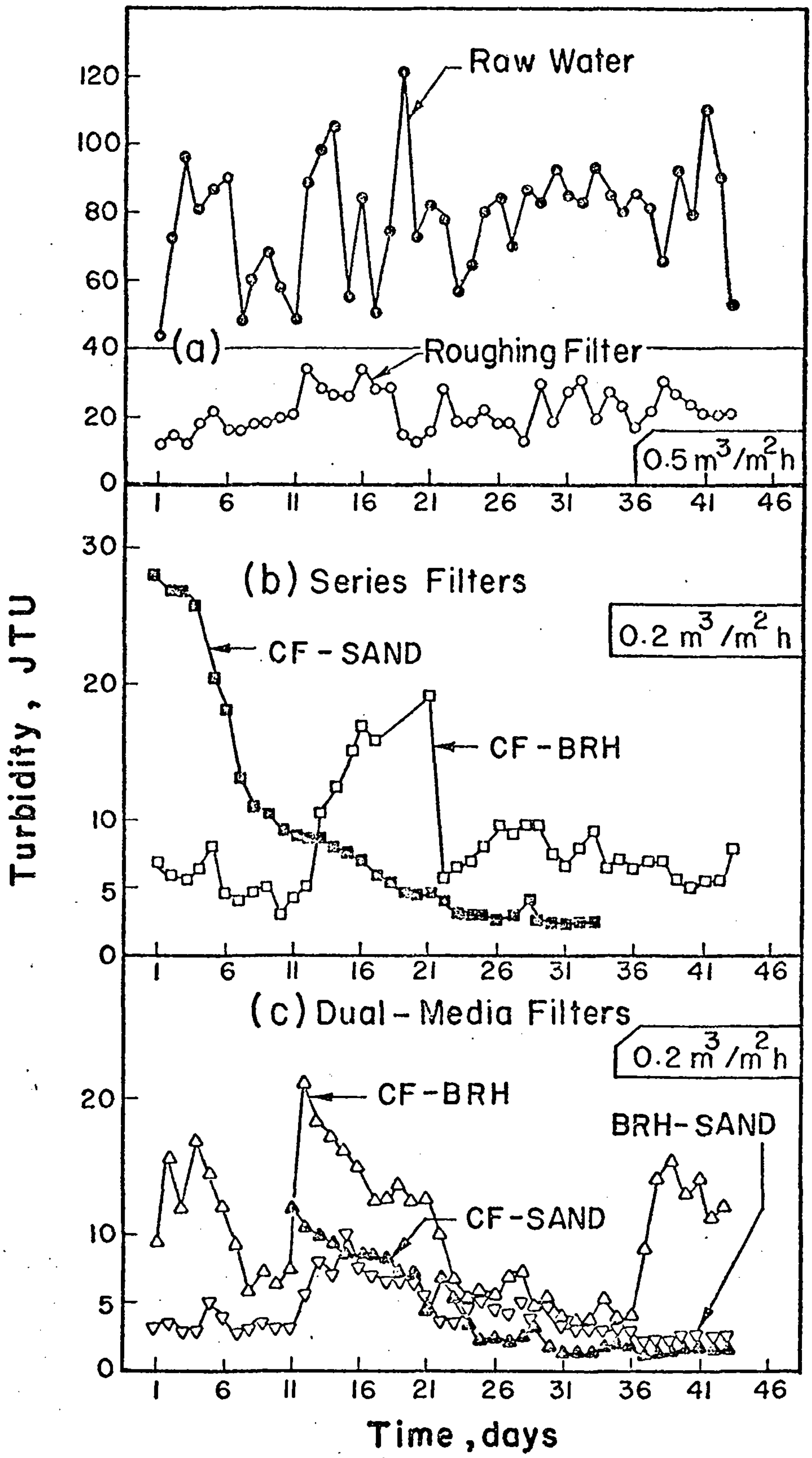

Fig. 3.6 Turbidity of Raw Water and Effluents of Different Filters
(Raw Water Turbidity ≃ 50 JTU)

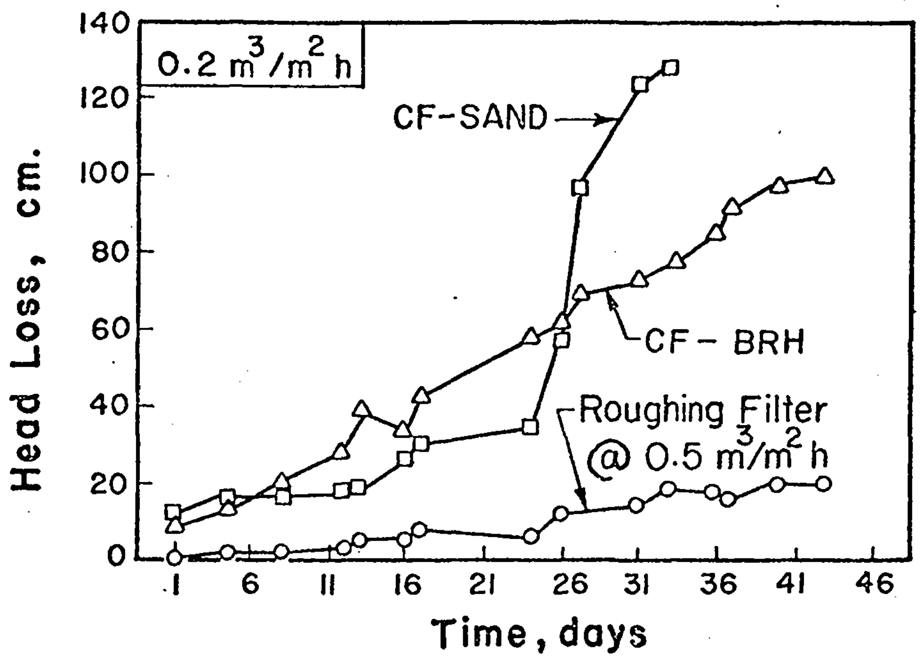

Fig. 3·7a Head Loss in Series-Filter Systems
(Raw Water Turbidity ≃ 100 JTU)

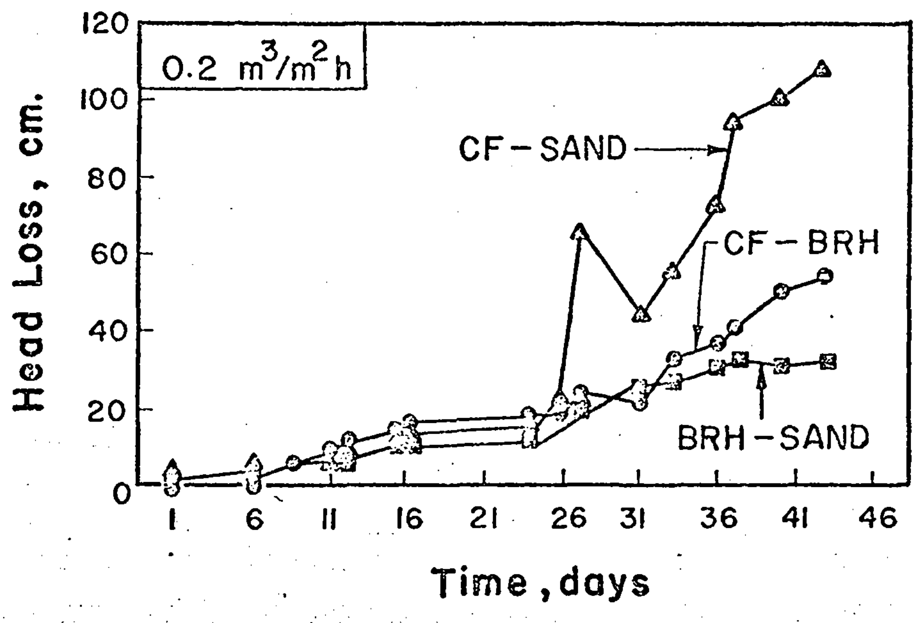

Fig. 3·7b Head Loss in Dual-Media Filters
(Raw Water Turbidity ≃ 100 JTU)

rice husk filters of the series-filtration systems. The sand filter developed a gradual head loss at the rate of 1.12 cm/day which was disrupted after 24 days of operation. The run was terminated after one month of filter operation, which is about half of filter run accomplished in the earlier stage of study. Turbidity removal varied inversely with head loss build-up and, after 10 days of filtration, pure water was obtained. In series-filters system, it was observed that sand filter always produced better and more consistent final water quality than burnt-rice-husk filter, but exhibited shorter filter runs.

For the same level of raw water turbidity and at filtration rate of 0.2 m^3/m^2 h, the burnt-rice-husk filter in the series-filtration system developed head loss at a lower rate than the sand filter, as also depicted in the previous stage of study. The head loss rate was approximately 2.3 cm/day, indicating a continuous filtration duration of 50 days, which is half of what was achieved in the study where raw water turbidity was in the region of 50 JTU at lower filtration rate. In Fig. 3.6b, it can be seen that the water produced from the burnt-rice-husk filter was, in general, of acceptable quality for village needs in terms of turbidity, except in some circumstances of excessive turbidity in the raw water during rainy days when runoff from the surrounding area carried silt and soil into the raw water source.

Variations in the combination of different media to form dual-media filters (e.g. burnt rice husk-sand, coconut fibre-sand, coconut fibre-burnt rice husk) were also examined in this part of study in an attempt to look into a wider range of alternatives for treatment of tropical surface waters to cope with the needs of village community water supply. In terms of head loss development in filter beds, the three dual-media followed a similar path of low head loss build up at the beginning of operation, as it can be seen in Fig. 3.7b. After 26 days of continuous operation, the coconut fibre-sand showed a breakthrough in head loss forcing the shutdown of this unit after about 45 days of filtration duty. On the other hand, the water produced from this filter was of very good clarity and constant quality. From a practical standpoint, this type of filter exhibited longer filtration duration than its counterpart series-filter. At this stage, it is appropriate to bring up a general comment on the performance of the sand filter coupled with coconut fibre in a series-filter system or dual-filter system. In both cases, this filter arrangement is not very attractive for village community water supply as far as head loss build-up is concerned. The filter has a rapid rate of head loss resulting in short filter runs, which are not convenient for village needs because of the requirement for frequent filter cleaning. However, this type of filter can produce a good quality and relatively safe water.

If the combination of coconut fibre and sand is not so practically attractive, the dual-media filter made up of burnt rice husk overlying sand seems to be a reliable alternative for tropical surface water treatment. This filter developed a slow rate of head loss, as recorded in Fig. 3.7b. After 40 days of continuous operation the head loss only reached 40 cm (about 1 cm/day). If linear extrapolation is applied for a permissible head loss of 1.2 m, a continuous filtration run of 4 months could be contemplated. Added to this, the quality of the treated water in terms of turbidity was excellent, as can be seen in Fig. 3.6c.

The dual-media filter made of coconut fiber overlying burnt rice husk exhibited a head loss rate of 1.8 cm/day after 26 days of continuous operation. The total run duration could be estimated to be approximately 2½ months if a total head loss of 1.2 m was permitted, compared to 7 months duration in the previous stage of study at lower raw water level and slower filtration rate. Recorded turbidity in the treated water, as shown in Fig. 3.6c, was not stable but still fluctuated within the limits of acceptability for village needs. The objection to this type of filter (coconut fibre and burnt rice husk in the same filter box) was the development of a disagreeable odour in the treated water after a long period of operation, as can be seen in Table 3.2. This situation has already been mentioned for the same kind of filter when the study at raw water turbidity level 50 JTU was carried out but the phenomenon did not occur for any other filter type.

With regard to the microbiological aspects of water quality as shown in Figs. 3.8, 3.9 and 3.10, all the treated waters still contained relatively high numbers of total coliform organisms, rendering them unsuitable for village domestic consumption if bacteriological international drinking wa-

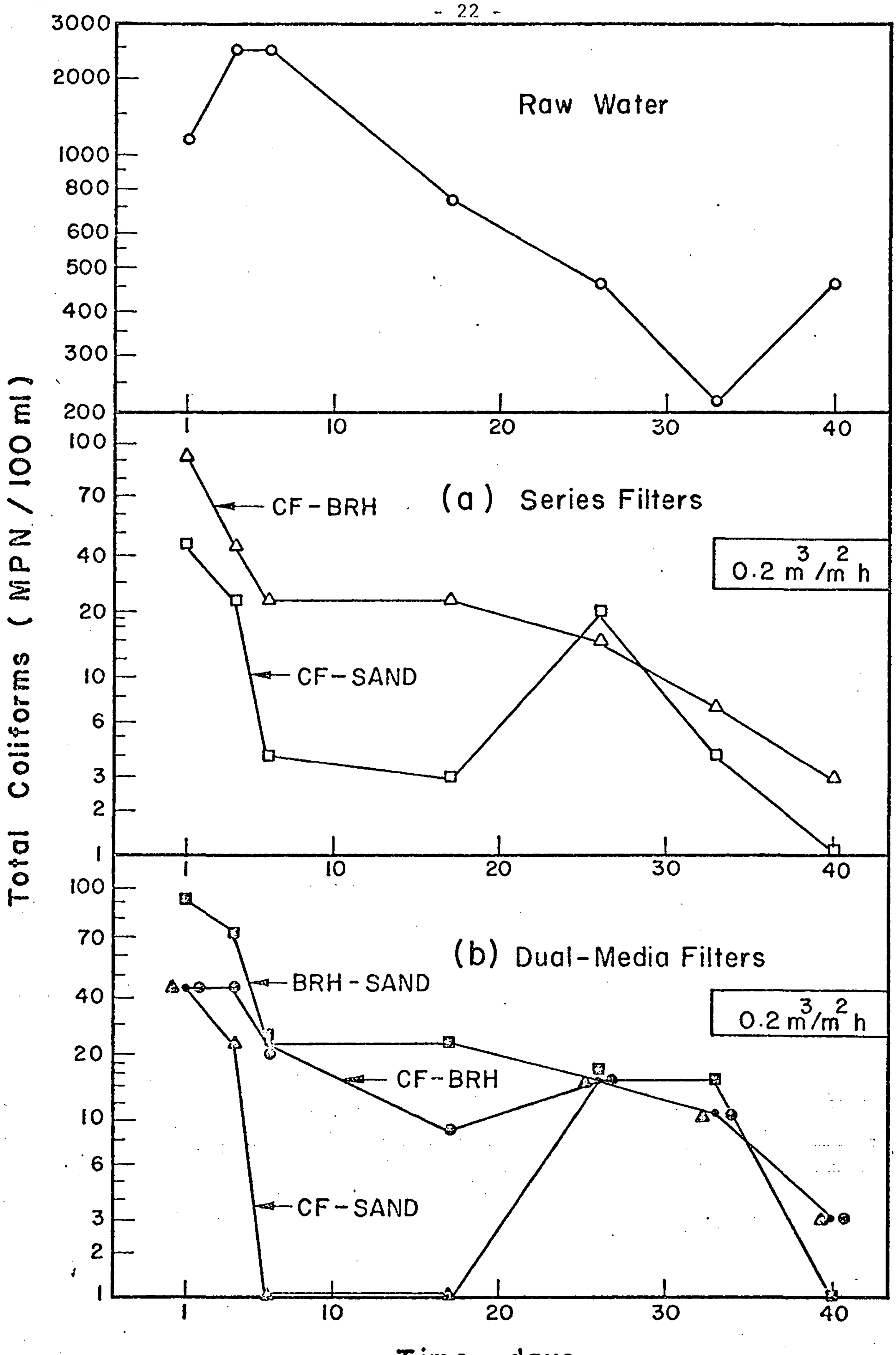

Fig. 3.8 Result of MPN Tests for Total Coliforms
(Raw Water Turbidity — 100 JTU)

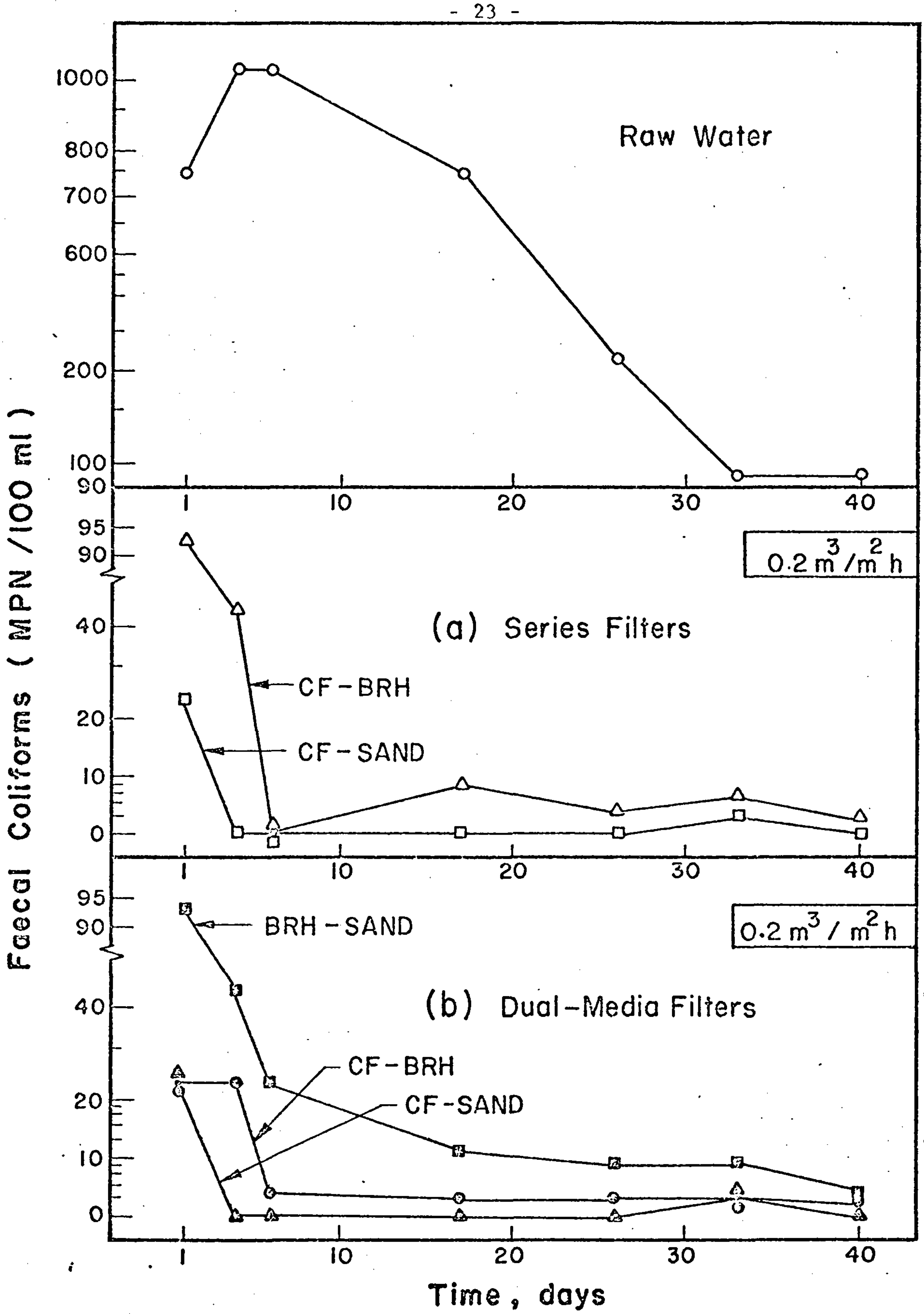

Fig.3.9 Results of Faecal Coliform MPN Tests
(Raw Water Turbidity ≃100 JTU)

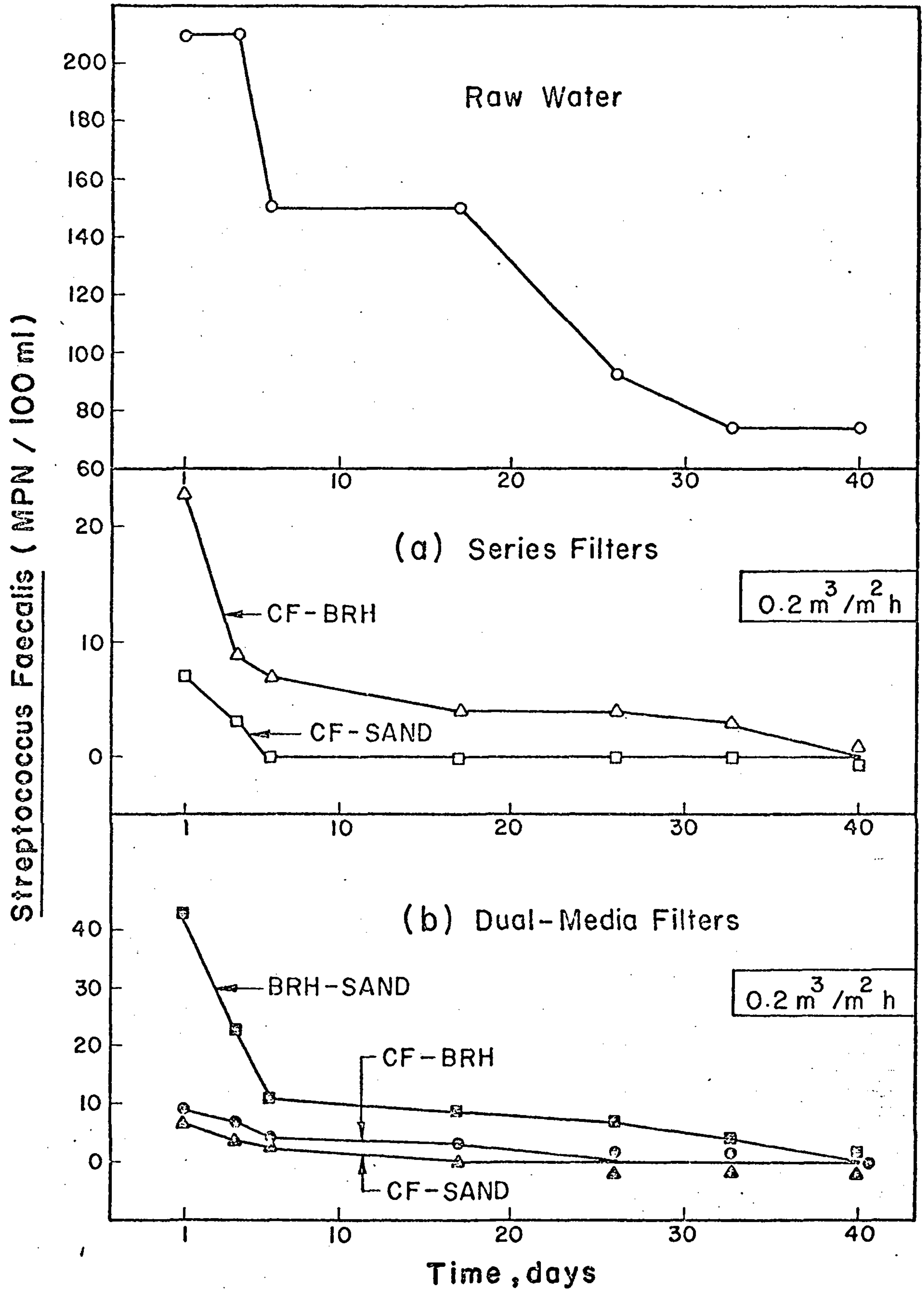

Fig. 3.10 Results of Streptococcus Faecalis MPN Tests
(Raw Water Turbidity ≃ 100 JTU)

ter standards are rigidly applied. However, considering the number of coliform microorganisms in the raw water and the situation where the rural population has been using unsafe waters for decades, it may be stated that the final treated water could be considered suitable for the purposes of village community needs, requiring a certain relaxation of WHO standards for drinking waters. Moreover, negligeable numbers of faecal coliforms and S. faecalis in the treated water and, as filtration progressed their absence in the treated water provides a certain degree of security against epidemic outbreaks.

Table 3.2 - Dissolved Oxygen Content in Raw and Filtered Water (Raw Water Turbidity in the Region of 100 JTU)

Run Duration, Days	Date	Influent Water	Roughing Filter	BRH-Sand (Dual)	CF-BRH (Series)	CF-Sand (Series)	CF-Sand (Dual)	CF-BRH (Dual)
1	26/4/76	6.7	3.9	4.1	4.0	-	3.4	2.1
4	29/4/76	5.3	4.0	4.7	4.1	4.6	3.1	2.7
5	30/4/76	6.8	4.6	4.3	4.8	3.5	-	3.0
12	7/5/76	5.2	4.6	4.1	4.5	-	-	2.9
24	19/5/76	5.8	4.5, 2.4	4.8	4.0	3.1	3.7	3.2
26	21/5/76	4.6	4.3, 3.7	4.5	4.3	4.9	3.7	3.0
31	26/5/76	6.4	4.5, 3.6	4.9	4.7	3.8	3.4	2.5
33	28/5/76	6.1	4.2	4.5	4.5	-	3.5	0.6
38	2/6/76	5.2	5.1, 2.4	4.6	4.4	3.6	3.3	0
40	4/6/76	5.4	4, 2.5	3.6	4.5	3.6	3.3	0

IV APPRAISAL OF DIFFERENT FILTER SYSTEMS

4.1 Treatment Alternatives for Tropical Surface Waters

From the results of this investigation, it is considered important to bring the efficient treatment alternatives for tropical surface waters into relief and to make a trade-off among these alternatives. Considering the range of turbidity in the raw water under study (which also reflects the quality of many tropical surface waters), four alternative systems could be favourably considered, as shown in the diagram of Fig. 4.1.

Alternative A is a series-filter system composed of coconut fibre as a roughing filter and burnt rice husk as a polishing filter. It has already been demonstrated that coconut fibre, through its fibrous configuration, exhibited remarkable potential in retaining impurities in water and also absorbing turbidity "shock loading" to produce a relatively consistent effluent satisfactory for subsequent polishing treatment. At a raw water turbidity level of about 100 JTU and filtration rate of 0.5 m^3/m^2 h, the average turbidity in the effluent of the coconut fibre filter was about 25 JTU, showing an overall turbidity removal of 75 percent. At this filtration rate, head loss development through the filter bed was slow and, as a result, a continuous filtration run of about 8 months could be contemplated, if linear extrapolation for a maximum head loss of 1.2 m is applied. The burnt-rice-husk filter in this system plays the role of a polishing filter, and removes the residual turbidity in the effluent from the roughing coconut fibre filter to produce a final water acceptable for village consumption. The length of operation of the burnt-rice-husk filter depends upon flow rates and, to some extent, the turbidity of raw water. On the basis of the results obtained, there is reason to believe that, at a raw water turbidity level of about 100 JTU and filtration rate of 0.2 m^3/m^2 h, a continuous filter run of 2-3 months could be expected. It is logical to anticipate that a longer duration, perhaps about four months, could be achieved at a lower level of raw water turbidity.

Alternative B is a dual-media filter consisting of coconut fibres compactly spread on a bed of burnt rice husk. Recorded results on performance

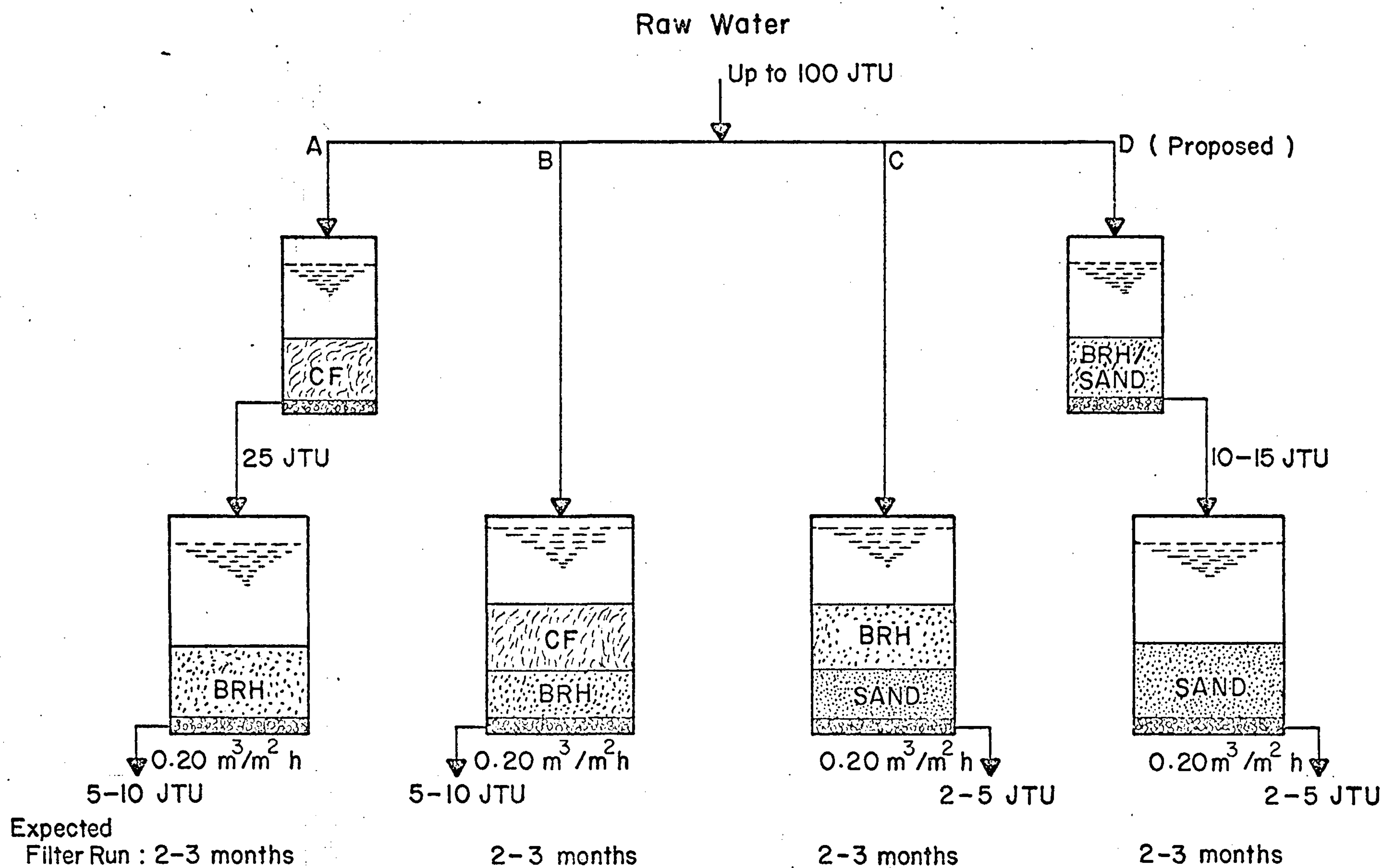

Fig. 4.1 Treatment Alternatives for Tropical Surface Waters

of this type of filter indicated that the length of filter run depended upon raw water turbidity and filtration rate. At a turbidity level of about 50 JTU in the raw water and filtration rate of 0.1 m^3/m^2 h, a continuous filter run of seven months could be extrapolated. At a higher level of turbidity, of about 100 JTU, and filtration rate of 0.2 m^3/m^2 h, only a 2½ months run duration was obtained. It has been observed that, in spite of the acceptable quality of treated water in terms of turbidity and the relatively long filter run, a disagreeable odour was detected after a long period of filter operation. It is suggested, therefore, to adopt a filtration rate to hinder the occurrence of this odour, which can be detected organoleptically or by dissolved oxygen determination. Based on the results of this study, it is pertinent to adopt a filtration rate of 0.2 m^3/m^2 h for a raw water turbidity level of about 100 JTU, and a continuous filter run of 2 to 3 months could be expected. In practice, operation would be disrupted at the first sign of odour in the system.

Alternative C is also a dual-media filter consisting of a burnt-rice-husk bed overlying a sand bed. This combination of filter media proved to be a reliable water treatment system for village community water supply. Head loss rate was relatively slow giving a fairly long filtration period. The treated water was of excellent clarity and no odour was detected during the period of 43 days of continuous operation. However, this type of filter is inconvenient in operation due to the cleaning process involving removal of the whole burnt-rice-husk bed before the top layer of the sand bed can be removed. This mode of cleaning is troublesome and time-consuming. On the other hand, it is counterbalanced by the lower height to reach by comparison with the series-filter system, which may make the cleaning operation easier. On the basis of the findings of this study, a series-filter system using the media of alternative C could also be designed. The roughing filter could consist of either burnt-rice-husk or coarse sand, and the polishing filter would be fine sand, represented as alternative D in Fig. 4.1. However, a higher construction cost will be incurred if this treatment alternative is adopted. It is proposed that further investigations are necessary before a valid conclusion can be reached on this last alternative.

There is a need to apply the WHO International Drinking Water Standards with discretion as far as rural water supply is concerned. Considering the present situation in many rural communities where water from polluted surface sources is used without treatment, any improvement in facilities and water quality would have a beneficial impact on health. This policy does not necessarily mean that reasonable efforts should not be made to supply a good quality safe water, but costly attempts to meet international standards are inappropriate and wasteful. Acceptability is another important criterion to consider in village water supply. If an acceptable quality could be preserved with simple continuous treatment and source protection, the risk of transmission of water-borne disease will have been markedly reduced even if final disinfection is not incorporated to provide absolute safety.

4.2 Trade-Off Between Different Filter Systems

In order to make a judicious choice of filtration system to be adopted in a given circumstance, it is appropriate to delineate the trade-off among different filter systems and, more specifically, between series-filtration and dual-media filtration systems. From the operational point of view, the series-filtration system and the dual-media system have their own advantages and disadvantages. More power is needed to lift raw water to a higher head in the case of the series filter but the cleaning process can be carried out separately in the roughing filter and polishing filter without disturbing the whole system. It is advisable to apply an uniform distribution of the effluent from the roughing filter over the surface of the polishing filter, otherwise shorter filter runs would result. In the dual-media filter, the coconut fibre, or any other material playing the same role, has to be removed from the filter box before the burnt rice husk or sand can be cleaned, which is time-consuming and requires labour. However, the advantage of the dual-media filter is that less power is used in pumping raw water to the filter.

Both series-filter and dual-media filter systems are likely to have applications depending upon local conditions in villages and economic considerations. Table 4.1 summarizes total initial cost and monthly running costs of these systems. It should be noted that cost estimates do not include the construction cost of a storage tank. These estimates show that the initial costs incurred in the construction of the series-filter system is 25 percent higher than in the case of the dual-media filter system. This is because of the extra construction cost of the roughing filter box and the capital cost of a pump with higher power rating. However, the monthly operating costs are not significantly different between the two systems or between one treatment alternative and another and represent an average cost of 5 US¢ /month per person, using either gasoline or electricity.

Table 4.1 - Comparative Initial Costs and Running Costs of Different Filter Systems

Item		Alternative A CF-BRH (Series)	Alternative B CF-BRH (Dual)	Alternative C BRH-SAND (Dual)	Alternative D BRH-SAND (Series)
Capital cost		1,005	757	757	1,005
Operating cost, $/month	gasoline	60	68	54	57
	electricity	54	57	51	51
Population served		250	250	250	250
Operating cost, $/cap-month	gasoline	0.24	0.27	0.22	0.23
	electricity	0.22	0.26	0.20	0.20
Operating cost, $/family of 5/month	gasoline	1.20	1.34	1.09	1.14
	electricity	1.09	1.29	0.99	0.99

CF = Coconut Fiber BRH = Burnt Rice Husk

In conclusion, from an economic point of view it is more attractive to choose a dual-media filter system than a series-filter system. Out of the four treatment alternatives suggested, alternative C, which is a dual-media filter consisting of burnt rice husk and sand, seems most appealing and has the greatest potential for treatment of tropical surface waters in rural areas.

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT I - 6

TENTATIVE REVIEW
OF ACTIVITIES AND RESULTS
OF PHASE I

THE HAGUE, November 1976

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0. INTRODUCTION

The WHO-International Reference Centre has developed a research and demonstration programme for promoting the application of slow sand filtration for the treatment of drinking water in developing countries.

The project has been divided in two phases. The first phase includes pilot plant studies, field investigations on existing plants, literature studies and additional organizational preparatory activities for the second phase. The second phase is to demonstrate the ability of slow sand filtration by full-scale village demonstration filter plants. The major part of the work is carried out by the participating institutions, while the IRC is performing the coordination of the project.

- University of Science and Technology, Kumasi, Ghana
- National Environmental Engineering Research Institute, Nagpur, India
- University of Nairobi, Kenya
- Institute for Public Health Engineering Research, Lahore, Pakistan
- University of Khartoum, Sudan
- Asian Institute of Technology, Bangkok, Thailand

Furthermore, two institutions are partly involved in this project;

- CETESB, Sao Paulo, Brazil
- Middle East Technical University, Ankara, Turkey

PART I

PILOT PLANT STUDIES

1. UNIVERSITY OF SCIENCE AND TECHNOLOGY OF KUMASI, GHANA

The investigations in Ghana will mainly be directed to:

- The performance of a slow sand filter in relation to the quality of the raw water and concerning the removal of organic matter turbidity and specific bacterial contaminants.
- The effect of different filtration rates, shading and seasonal variation of the water quality.
- Literature studies and field investigations on the performance of existing slow sand filter installation in Ghana.

A first progress report has been submitted, to which reference is made (1).

1.1 Pilot plant studies

The investigations are being carried out at two locations: Owabi Water Works and Kuwamu.

Owabi:

The pilot plant consists of three filters of 1.5 m diameter. The details of the pilot filters are shown on Annex 1.

Raw water is derived from a reservoir formed by impounding the river Owabi. The water has an iron content of 5-15 mg/l and a turbidity in the range of 10-50 units.

The overall objectives of the studies are mainly:

- Investigation of the effect of media size, shading and filtration rate, especially on:
  - . ripening period
  - . length of filter run
  - . removal of organic matter, turbidity, coliforms, colour, iron.
- Comparison of the performance of slow sand filter with rapid sand filter.
- Identification of algae content in raw water, filtrate and scrappings from filter beds.

The initial study was, however, limited to:

- Effect of filtration rate on the ripening period, filter run and removal of organic matter, turbidity, coliforms, colour, iron and cercariae.
- Algae identification.

The first progress report deals with the results obtained during the period September 6th - October 6th, 1976.
The filtration rate was kept at:

v = 0.1 m/h for filter No. 1
v = 0.2 m/h " " " 2
v = 0.3 m/h " " " 3

The experimental period is too short to draw firm conclusions. The difference in initial head losses at the different filtration rates is remarkable: the rates of initial head losses for filtration velocities of 0.3 m/h and 0.2 m/h are five times and three times the rates at 0.1 m/h.
Theoretically the initial head loss is directly proportional to the velocity. So the head loss at 0.3 m/h should be three times that at 0.1 m/h.
It may be in this case caused by extra resistance, not of the filter bed itself but of the under-drainage system; this has to be investigated.

Kuwamu:
Kuwamu, situated about 50 km North East of Kumasi, has a water treatment plant, which only comprises coagulation followed by sedimentation and chlorination. So a filtration is not included. It was therefore decided to carry out experiments on comparison of the installed treatment process with slow sand filtration.

A standard filter of 1.5 m diameter has been built from sandcrete blocks. The filter bed consists of a 1 m layer of fine sand (E.S. = 0.25 and U.C. = 2.0) supported by a 0.15 m layer of 3 mm gravel. The supernatant water depth will be about 1.3 m.

The experiments are likely to begin in November 1976.

1.2 Household slow sand filter

It is the intention to carry out experiments on a single unit filter suitable for an individual household. The unit consists of two parts in series: filter and reservoir for filtrate, as shown on Annex 2.
The filter sand and gravel used are the same as for a slow sand filter.
The average draw-off is assumed to be 200 l/day, with a peak flow of about 4 l/min.

The investigations will be directed to:

- Effect of filtration rate and shading on length of filter run, removal of organic matter, turbidity.
- Algae identification.

1.3 Existing slow sand filter installation

In the aforementioned first progress report (1) a description of the only slow sand filter installation in Ghana, the Winneba Slow Sand Filter Plant, is given.

The treatment scheme comprises:
Coagulation with Alum and sedimentation followed by slow sand filtration.
The raw water source is the river Ayensu.

The filtration rate was originally at 0.17 m/h, but over the years it has increased to 0.59 m/h, which is high for slow sand filtration.
No data on chemical analysis of the raw water and filtrate are given.

Furthermore, another plant is described, the Weija filter plant, of which the slow sand filters have been replaced by rapid sand filters.

1.4 Conclusions

The reviewed period is too short to draw conclusions about the performance of the pilot filters. It is recommended to further investigate the initial head loss at different filtration rates. More details of the filter material itself should be measured (sieve analysis).

2. NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE, NAGPUR, INDIA

The NEERI directs the studies mainly towards:

- The performance of a slow sand filter and its ability to function in relation to the quality of raw water with regard to turbidity and organic matter content.
- The effect of different filtration rates, shading and seasonal variations of water quality and temperature.
- Simple pre-treatment methods of turbidity reduction by sedimentation or primary roughing filtration through a coarse medium.
- Optimization of construction, operation and maintenance of small slow sand filtration systems, taking into account the local circumstances and thus including the possible utilization of indigenous materials.
- Literature studies and field investigations to collect available data and information on the design, construction, operation, performance and maintenance of slow sand filter installations in India.
- Preparation for the technical and organizational aspects of the second phase of the project: the demonstration phase.

2.1 Pilot plant studies

The investigations are being carried out in a pilot plant, consisting of three reinforced concrete pipe filters, each of 1.65 m diameter and 2.5 m in height, filled with sand from the Kanhan river. As raw water source, a nearby lake, Ambazari, was selected for the experimental studies. This lake functions also as one of the sources of water supply to the city of Nagpur.

The results, obtained thus far, have been laid down in two reports:

- Quarterly progress report, January-April 1976 (2)
- Interim report, August 1976 (3).

Reference is made to these reports.
The details of the pilot plant are shown on Annex 3.

The programme of investigation is as follows:

Stage 1 : Effect of filtration rate

2 : Shading experiments

3 : Intermittent operation

4 : Filter material experiments

In the period January-April 1976 the effect of filtration rate has been studied. The filters were operated at respectively 0.1, 0.2 and 0.3 m/h velocity. The results obtained are described in the aforementioned first quarterly report (2).

On Annexes 4 and 5 the %-removal of turbidity and C.O.D. are given. The mean values are:

Turbidity:	Filter No. 1 = 71%	(v = 0.1 m/h)
	Filter No. 2 = 78%	(v = 0.2 m/h)
	Filter No. 3 = 82%	(v = 0.3 m/h)

C.O.D. :	Filter No. 1 = 51%
	Filter No. 2 = 48%
	Filter No. 3 = 52%

The average filter output during the reviewed period is:

$F_1 = 109\ m^3/m^2$

$F_2 = 147\ m^3/m^2$

$F_3 = 117\ m^3/m^2$

The coefficient of permeability (k) of the clean filter bed is about:

$F_1 = 34,7$ m/d

$F_2 = 34,2$ m/d

$F_3 = 30,2$ m/d

The raw water had a turbidity in the range of 1.5-4.2 FTU, with a maximum of 6.5 FTU. In all cases the filters produced a filtrate generally free from E-coli and with a turbidity of less than 1 unit.

From April 1976 till June 1976 the shading experiments (Stage 2) were carried out. Filter No. 1 was covered by placing sheets of teakply directly on the top of the filter. Filter No. 2 was open to sky, acting as control reference filter. Filter No. 3 was partly shaded by placing sheets of teakply on a framework of angle irons, erected 60 cm above the top of the filter. The two sides (East and West) were also covered so as to exclude direct sunlight into the filter.

The filtration rate was kept at 0.1 m/h during the period April 21st - end of May and at 0.2 m/h during the month of June 1976. The results of the experiments are reported in the interim report (3).

The mean values of the %-removal of turbidity, C.O.D. and $KMnO_4$-value are (see Annexes 4, 5 and 6):

	Turbidity	C.O.D.	$KMnO_4$
F_1	79%	59%	55%
F_2	83%	66%	54%
F_3	85%	64%	58%

The filter outputs are:

	v = 0.1 m/h	v = 0.2 m/h
F_1 in m^3/m^2	124	95
F_2 "	149	71
F_3 "	124	95

There is also a difference in the coefficient of permeability k of the clean filter bed at the different filtration rates ($k = \frac{v.l}{z}$; v = filtration rate, l = filter depth., z = head loss).

k-value	v = 0.1 m/h	v = 0.2 m/h
Filter 1	k = 42.1 m/d	k = 27,5 m/d
Filter 2	40,3	38,0
Filter 3	31,0	22,4

Although the study about shading was of limited duration, the following can be concluded:

- All filters produced a good quality filtrate.
- The covering of filters has no significant influence on the length of filter runs.
- The dissolved oxygen content of the filtrate from shaded filters is more or less constant. The filtrate of "open to sky" filters has a marked difference in d.o.-content at day and night. This may be due to photosynthetic activity and biomass respiration.
- The shaded filters produced a filtrate of satisfactory bacteriological quality.

  The filtrate of the open to sky filter was of unsatisfactory bacteriological quality. This may be caused by decay of dead tadpoles and frogs in the filter.

Conclusions

The experiments have been carried out with a raw water of rather good quality (turbidity 1-6 FTU). The performance of the pilot filters is considered to be good: the filtrate is of satisfactory bacteriological quality.

The shading of filters has no significant influence on the length of filter runs, but it can be expected that it will reduce algae growth and also uncontrolled contamination from the open sky.

In the course of the experiments the initial head loss of the cleaned bed at the same filtration rate tends to increase. Also during the second stage the initial head losses are not in proportion to the filtration rate, which was to be expected. This is to be further investigated.

2.2 Field studies at Umrer Plant

As a part of the first phase programme, field investigations on an existing slow sand filter installation were carried out. The slow sand filters at Umrer have been chosen for this purpose.

Umrer is a small town in the Nagpur district, situated about 50 km South-East of Nagpur.
The treatment scheme, as recommended by NEERI after detailed study, comprises slow sand filtration of water from a nearby irrigation canal. The raw water is being stored in tanks prior to filtration. The plant has a capacity of 2.6 mld. On Annex 7 a flow scheme of the Umrer Plant is given.

A study of the performance of the filter installation has been made during the period March-June 1976 and the results are given in the interim report (3).

The horizontal area of the two storage tanks is 55 x 25 = 1375 m^2 each. At a raw water inlet capacity of Q = 115 m^3/h the overflow rate is:

$$So = \frac{115}{2 \cdot 1375} = 0.08 \text{ m/h}$$

$$\text{Detention time } t = \frac{6800}{115} = 59 \text{ hours}$$

The filters are designed for a rate of v = 0.17 m/h. The mean filtrate output is Q = 81 m^3/m^2 filter. It may be noted that during the period February-May 1976 the highest output was achieved.

The main observations are:

- Storage of raw water results in substantial reduction of coliform (around 60%) and turbidity (25-75%).
- The raw water from the canal had a turbidity in the range of 5-35 FTU and the settled water of 2-15 FTU.
- The filter produced a good quality filtrate with a turbidity less than 1 unit and free from E-coli.

2.3 Inventory on slow sand filters

An inventory on slow sand filter plants in India is being made. Details of 73 plants have been collected up to mid 1976. These are given in the interim report (3). From the data available the following frequency distribution according to various parameters can be derived:

Population range	up to 1000	4%
	1000 - 2000	11%
	1001 - 5000	33%
	5001 - 8000	21%
	8001 - 10000	10%
	> 10001	21%
Source of water	canal	82%
	river	11%
	stream, impounded reservoir	7%
Pre-treatment	nil	3%
	plain sedimentation	66%
	plain sedimentation + alum coagulation during monsoon	31%
Filtration rate	0.10 m/h	96%
	0.17 m/h	1%
	0.20 m/h	3%

2.4 Conclusions

The study of NEERI, both on pilot scale and on existing filter installation, has proven that slow sand filtration of a raw water with a relatively good quality (turbidity $\leqslant$ 10 FTU) will give a reliable, potable filtrate. If the turbidity is higher, a pre-treatment seems to be advisable, such as plain sedimentation or a roughing filtration. The shading experiments are too short to come to final conclusions. However, similar experiments, carried out at the Metropolitan Water Board (London) show that shading successfully inhibited algae growth, but did not result in increasing of length of filter runs (4).

3. UNIVERSITY OF NAIROBI, KENYA

The University of Nairobi will investigate mainly:

- The performance of a slow sand filter in relation to the quality of the raw water with regard to turbidity and organic matter content.
- Simple pre-treatment methods such as turbidity removal by sedimentation or primary roughing filtration through a coarse medium without addition of coagulants.
- The implementation of public health baseline studies in some villages in Kenya, proceeding the introduction of slow sand filters.

A pilot plant, consisting of three identical pilot filters, made from corrugated iron sheet, has been erected. The first filter has been in operation since June 19th. Filter 2 will be covered and Filter 3 is planned to be operated in counterflow.

The first results of Filter 1, over the period June 23rd - August 8th, show that the filter is not yet ripened. The colour of the effluent is lower than the influent, but on the other hand the turbidity is after filtration higher than before.

The first progress report on the experiments has been submitted. Furthermore, information and data about the performance of the existing slow sand filter installation are being gathered.

Recently also a second interim report has been received. Unfortunately results not yet included in this review.

4. INSTITUTE OF PUBLIC HEALTH ENGINEERING AND RESEARCH, LAHORE, PAKISTAN

The IPHER will investigate the following items:

- suitable pre-treatment systems
- field investigations on existing pre-treatment and slow sand filter installations
- literature study

A report about experiments on high-rate tube settlers has been submitted (7).

5. UNIVERSITY OF KHARTOUM, SUDAN

The University of Khartoum will investigate during the first phase the following items:

- The effect of different filtration rates, shading and different filter material.
- Discontinuous operation.
- Simple pre-treatment methods.

A pilot plant is being installed, consisting of four pilot filters of 1.5 m diameter.
The experiments started on October 1976, the first results will be reported soon.

6. ASIAN INSTITUTE OF TECHNOLOGY, BANGKOK, THAILAND

The A.I.T. has directed its investigations towards the following items:

- The performance of a slow sand/burnt-rice husk filter and its ability to function in combination with a coconut fibre pre-filter (series-filtration).
- The performance of a dual medium filter (coconut fibre and burnt-rice husk).
- Comparison of the above-mentioned filtration systems.

The study was mainly to determine the influence of raw water turbidity and filtration rates on the quality of treated water (turbidity, coliform removal) and the duration of filter runs based on the observations of head loss development.

The experiments have been carried out in a pilot plant consisting of in total seven filters. The raw water source is a canal near the Regional Engineering Research Centre of the A.I.T. Under normal conditions the turbidity of this water ranged from 25-50 JTU.

The studies are described in two reports:

- progress report d.d. March 1976 (5),
- final report d.d. July 1976 (6),

on "Application of slow sand filtration for surface water treatment in tropical developing countries".

The series-filtration system consisted of two pre-filters (R_1 and R_2), each coupled to two polishing filters (F_1, F_2, F_3, F_4). The pre-filters were made of iron sheets and measured 1 m x 1 m x 2 m. Filter material: shredded coconut fibre.
The polishing filters were made of concrete sewer pipe, with 1.54 m diameter. The dual medium filter (F_5) was of the same design as the other four polishing filters.

Stock sand and burnt-rice husk were used as filter material. The characteristics were as follows:

	Effective size	Uniformity coefficient
Stock sand	$E = 8.35 \times 10^{-2}$ cm	U = 5.8
Burnt-rice husk	$E = 9 \times 10^{-2}$ cm	U = 2.3

A sieve analysis of these materials is shown on Annex 8.
Design details of filters are given in Annexes 9 and 10.

The experiments started with investigations with different turbidity levels at filtration rates ranging from 0.1 to 0.6 m/h.
On Annex 11 the flow diagram of the filter runs and the operating conditions are shown.

The results are described in the progress report. Although the duration of the study was limited to a short period (9-12 days) some general conclusion may be drawn from this exploratory filtration study:

1. A coconut fibre roughing filter can produce a filtrate acceptable for subsequent treatment by sand and burnt-rice husk filters.
2. The final treated water turbidity was more or less independent of raw water turbidity and flow rates. The head loss development, which is related to raw water turbidity and flow rate will govern the length of the filter run.

The follow-up study was divided into two stages:
Stage A : raw water turbidity level at 50 JTU,
Stage B : raw water turbidity level at 100 JTU,
with the emphasis on the duration of filter run and the bacteriological quality of the effluent.

Stage A - Raw water turbidity 50 JTU (November 76 - March 76).

Two series-filtration and one dual-filtration systems were investigated at the following rate of filtration:

	v =
Roughing filter R_1 (coconut husk)	1.5 m/h
Polishing filter F_1 (burnt-rice husk)	0.15-0.2 m/h
" " F_2 (burnt-rice husk)	0.1 m/h
Roughing filter R_2 (coconut husk)	1.5 m/h
Polishing filter F_3 (sand)	0.15-0.2 m/h
" " F_4 (sand)	0.1 m/h
Dual-medium filter F_5 (coconut fibre - burnt-rice husk)	0.1 m/h

The results are given in full detail and discussed in the final report (6). The main conclusions are:

- Coconut fibre can be used for roughing filtration purposes.
- The polishing filters produce a filtrate with a turbidity in the range of 2-8 JTU.
- The length of the sand filter run is about three times that of the burnt-rice husk filter.
- The dual-medium filter produced after 3 months running a filtrate with a bad odour and smell.
- None of the filters could completely remove coliform bacteria.

Stage B - Raw water turbidity 100 JTU (April 76 - June 76).

In this stage of study two series-filtration and three dual-medium filter systems were investigated. The operating conditions were as follows:

	v =
R_1 - coconut fibre	0.5 m/h
F_2 - burnt-rice husk	0.2 m/h

	v =
R_2 - coconut fibre	0.5 m/h
F_2 - sand	0.2 m/h
F_1 - burnt-rice husk + sand	0.2 m/h
F_4 - coconut fibre + sand	0.2 m/h
F_5 - coconut fibre + burnt rice husk	0.2 m/h

The final report deals with fully detailed results and observations. Reference is made to this report.

The same results were obtained as for the Stage A study.

Final conclusions

Coconut fibre can be utilized for primary filtration purposes. A series-filtration system and a single dual-medium filtration system have their pros and cons, but the series filtration is to be preferred in view of reliability of treatment (two stages) and cleaning purposes.

PART II

GENERAL DESIGN CRITERIA

7. BASIC PROCESS DESIGN CRITERIA

Slow sand filtration is the oldest, effective method for purifying contaminated surface waters. Particularly its ability to remove pathogenic bacteria, makes this process appropriate for purification of drinking water, especially in cases where a simple, reliable treatment scheme is to be chosen and where high technical skilled operation and maintenace staff may not be available.

The mode of action in a slow sand filter is not a matter of simple straining, but rather a complex process of physical, boi-chemical and microbiological actions. The purification of the water does not take place only at the surface of the filter bed, but also for some distance below.

Van de Vloed (8) has given a clear description of the method of purification, he distinguishes three layers in the filter:

- the "schmutzdecke"
- the autotrophic zone
- the heterotrophic zone

each consisting of its own components of anorganic and organic kind and having its specific purification effect. In this respect the rate of filtration and the filter medium is of great significancy.

Filtration rate

The rate of filtration is mainly in the range of v = 0,1 - 0,3 m/h. For each plant the rate shall be chosen after pilot plant studies, with due regard to the raw water quality.

There is a trend to increase the rate of filtration. This is only acceptable when there is an extensive pre-treatment and the slow filters have just only a polishing function.

It is yet obvious that at higher filtration rate the biological purification effect will decrease due to the shorter contact time in the filter.

For the SSF-project second phase it is recommended to keep the filtration rate in the range of v = 0.1 - 0.2 m/h.

Filter bed

In general any stable, granual filter material can be used but in almost all cases sand is applied. Sand is inert, durable and widely available. It shall be free of contamination, foreign matter when using a filter medium. It is not strictly necessary to have a graded sand, but the following specifications shall be met:
effective size: 0,2-0,4 mm
uniformity of coeffecent: $<$ 2,5
The total thickness of the layers in which the purification takes place (the autotrophic and heterotrophic zone) is about 0.6-0.7 mm. Therefore the minimum bed depth shall not be less than 0.7 mm.
The filter bed shall preferably be of 1.2 - 1.4 mm thickness.

Shading

To control the algae growth shading of filters against direct sunlight is to be considered. Experiments show that the shading has no significant influence on length of filter run, but it prevents excessive growth of algae and contamination of the supernatant water layer.

Raw water

The raw water shall be of a good quality (turbidity $<$ 10 FTU). A pre-treatment (e.g. plain sedimentation, rough filtration) may be used to reduce turbidities and to improve the raw water quality.

Mode of operation

The slow sand filter will be submerged operated. Intermittend or non-submerged operation is regarded as too complicated for practise in the rural areas in developing countries.

8. CONSTRUCTION DESIGN PARAMETERS

The following deisgn parameters shall be considered:

- number of filters

  At least two, preferably more, filters shall be designed

- filter area:

  The filter shall have not a too small working area in order to reduce the effect of short circuits during filtration on the effluent quality

  Minimum size: 200 - 300 m^2

- supernatant water

  the layer shall be 0.90 - 1.30 m

- filter bed

  the initial depth: 1.20 - 1.40 m

- underdrainage system
- filter basin
- filter operation
  - inlet
  - outlet
  - drainage
  - cleaning
- total arrangement and site lay-out

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7. First Progress Report, August 1976, Institute of Public Health Engineering and Research, Lahore, Pakistan.

8. Comparison between slow sand and rapid filters, Dr. A. van de Vloed.

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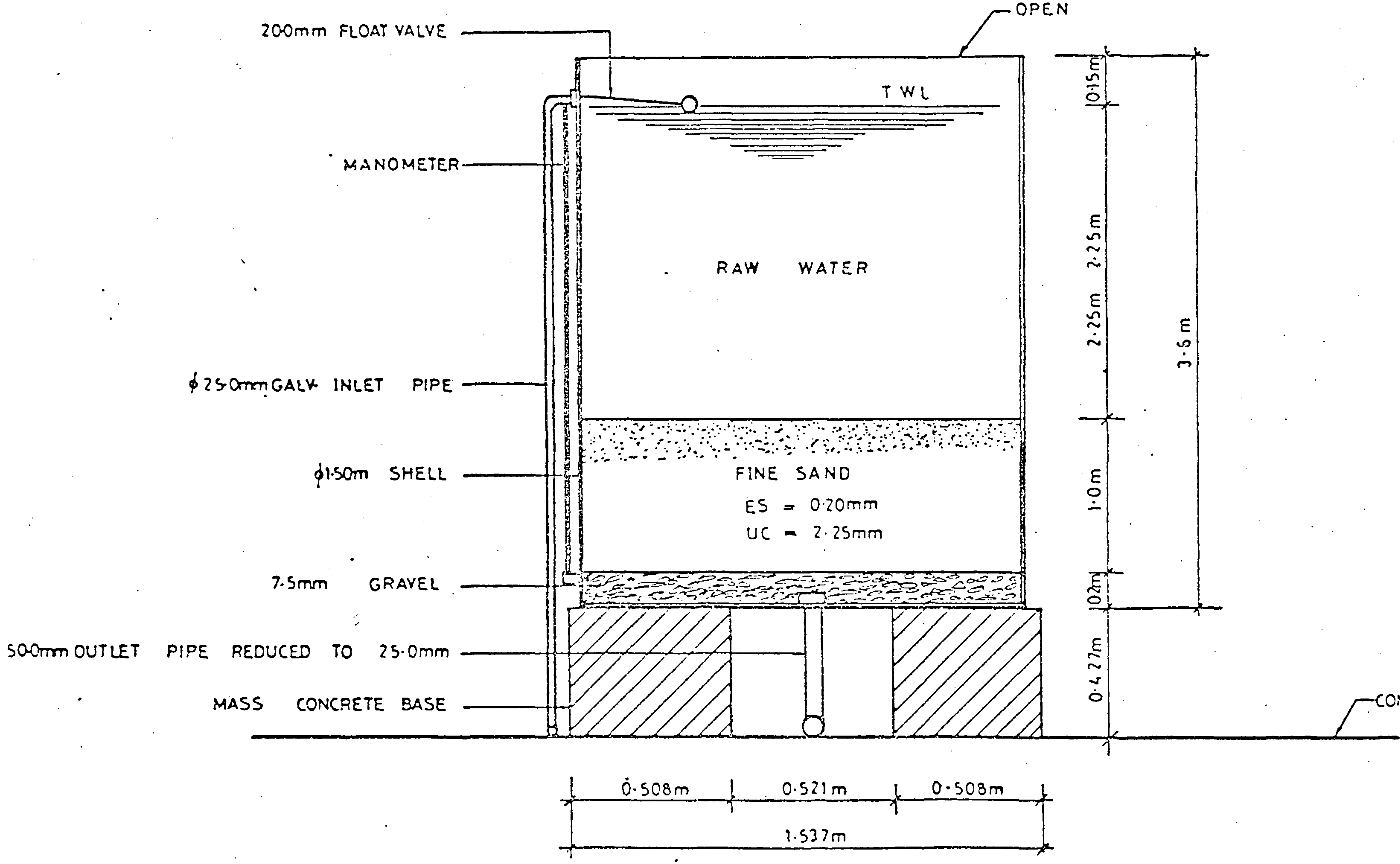
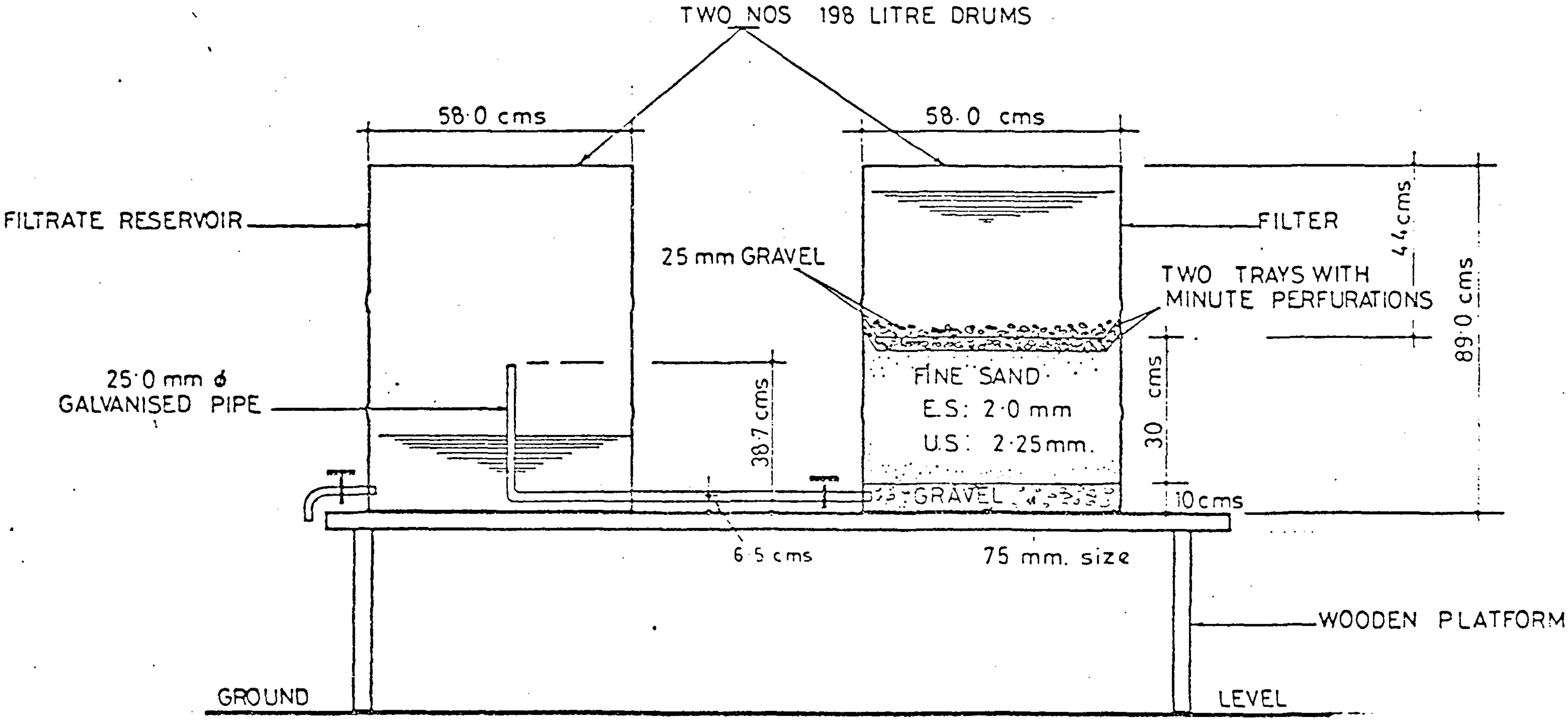
University of Science and Technology
Kumasi, Ghana.



STANDARD FILTER ARRANGEMENT

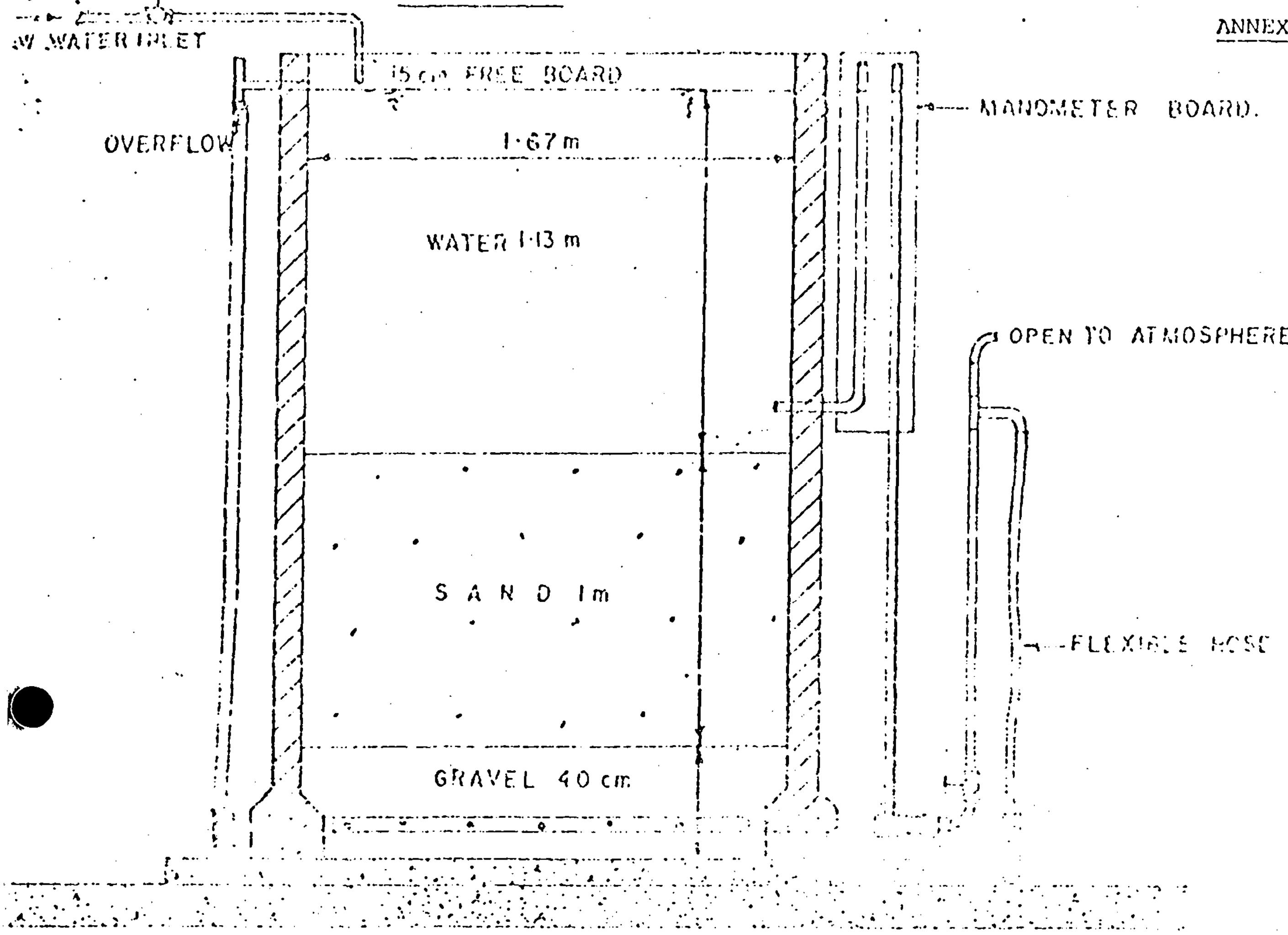
ANNEX 1

HOUSEHOLD FILTER UNIT

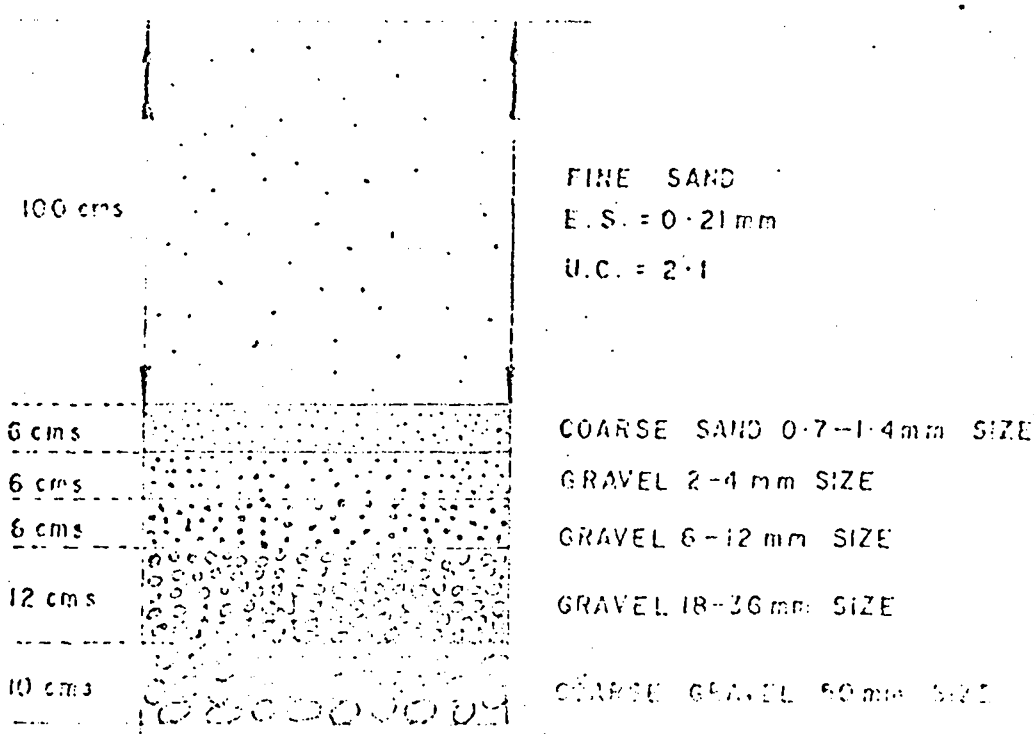


NEERI-Plant

ANNEX 3



FILTER SET UP



MEDIA DETAILS

Parameter: Turbidity

Date		Raw water	F1		F2		F3		Mean values
		FTU	FTU	removal %	FTU	removal %	FTU	removal %	% removal
Jan.	1	1.7	0.48	42	0.83	51	0.71	58	
(week no.)	2	1.85	1.0	46	0.95	49	0.73	61	F1 = 71.1%
	3	2.35	1.15	51	0.92	61	0.67	71	F2 = 78.4%
	4	6.5	0.97	85	0.67	90	0.77	88	F3 = 82.5%
Feb.	5	6.35	1.0	84	0.72	89	0.65	90	
	6	4.15	0.59	86	0.66	84	0.37	91	
	7	1.7	0.65	62	0.46	73	0.3	82	
	8	1.6	0.63	61	0.52	68	0.39	76	
March	9	2.0	0.65	68	0.47	77	0.43	79	
	10	2.2	--	--	0.48	78	0.41	81	
	11	2.4	0.61	75	0.39	84	0.31	87	
	12	1.5	0.62	59	0.43	71	0.34	77	
	13	1.75	0.59	66	0.46	74	0.4	77	
April	5	2.3	0.57	75	0.51	78	0.4	83	
(date)	14	1.4	0.54	61	0.35	75	0.3	79	
	21	0.95	0.48	49	0.62	35	0.32	66	
	26	1.15	0.50	57	0.53	54	0.42	63	
May	3	1.4	0.60	57	0.45	68	0.53	62	
	10	1.6	0.45	72	0.33	79	0.31	81	F1 = 79.3%
	17	1.6	0.44	73	0.21	87	0.21	87	F2 = 83.4%
	24	2.1	0.47	78	0.37	82	0.35	83	F3 = 84.9%
	31	1.55	0.27	83	0.29	81	0.2	83	
June	7	3.1	0.57	82	0.43	86	0.33	89	
	14	2.5	0.35	86	0.34	86	0.35	86	
	23	1.9	0.36	81	0.32	83	0.28	85	

Filtration rate:

Jan. - April : F1 = 0.1 m/h
F2 = 0.2 m/h
F3 = 0.3 m/h

April - end May: F1, F2 and F3 = 0,1 m/h

June : F1, F2 and F3 = 0.2 m/h

Parameter: C.O.D.

Date		Raw water	F1		F2		F3		Mean values
		mg/l	mg/l	removal %	mg/l	removal %	mg/l	removal %	% removal
Jan.	1	8.6	7.2	16	7.4	14	7.4	14	
weekno.	2	5.6	2.0	64.3	1.8	67.8	2.2	60.1	
	3	8.45	5.1	39.6	5.45	35.5	6.2	26.6	F1 = 51.4%
	4	10.5	4.6	56.2	6.4	39.1	5.9	43.8	F2 = 47.9%
Feb.	5	7.7	2.9	62.3	1.9	75.3	1.8	76.6	F3 = 51.8%
	6	9.2	3.8	58.7	3.8	58.7	4.2	54.3	
	7	7.0	2.3	67.1	3.1	55.7	2.3	67.1	
	8	10.1	4.8	52.5	3.4	66.3	5.8	42.6	
March	9	--	--	--	--	--	--	--	
	10	6.8	--	--	5.5	19.1	5.65	16.9	
	11	9.4	3.6	61.7	7.4	21.3	4.65	51.1	
	12	8.55	8.0	6.4	8.0	6.4	7.95	7.1	
	13	8.8	4	54.5	3.7	57.9	3.6	59.1	
April	5	7.0	2.5	64.3	2.1	70.0	2.7	61.4	
(date)	14	5.6	3.6	35.7	1.6	71.4	2.1	62.5	
	21	7.9	2.2	72.2	2.6	67.1	2.7	65.8	
	26	8.7	3.3	62.1	4.5	48.3	6.9	20.7	
May	3	8.4	1.9	77.4	2.1	75	2.3	72.6	F1 = 59.3%
	10	9.8	3.9	60.2	1.7	82.6	3.0	69.4	F2 = 65.6%
	17	8.7	4.1	52.9	3.3	62.1	4.5	48.3	F3 = 63.8%
	24	12.6	3.9	69.1	3.9	69.1	3.1	75.4	
	31	8.2	4.4	46.3	3.1	62.2	2.9	64.6	
June	7	8.4	5.0	40.5	3.1	63.1	4.1	51.2	
	14	6.0	3.6	40.0	2.2	63.3	2.2	63.3	
	23	8.8	2.4	72.7	3.2	63.6	3.2	63.6	

Filtration rate:

Jan. - April : F1 = 0.1 m/h
F2 = 0.2 m/h
F3 = 0.3 m/h

April - end May: F1, F2 and F3 = 0.1 m/h

June : F1, F2 and F3 = 0.2 m/h

Parameter: $KMnO_4$ - value

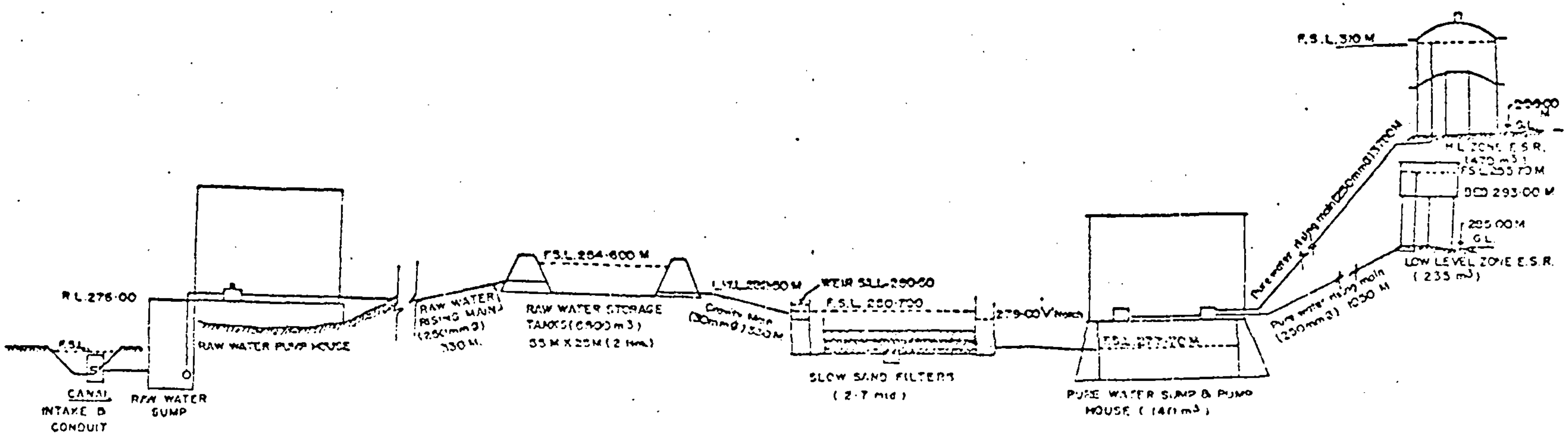
Date		Raw water	Filter 1		Filter 2		Filter 3	
		mg/l	mg/l	removal %	mg/l	removal %	mg/l	removal %
April	21	0.56	0.23	59	0.23	59	0.28	50
	26	0.67	0.34	49	0.32	52	0.30	55
May	3	0.65	0.30	54	0.20	69	0.30	54
	10	0.85	0.40	53	0.40	53	0.25	71
	17	0.75	0.35	53	0.40	47	0.35	53
	24	0.70	0.30	57	0.40	43	0.30	57
	31	0.85	0.40	53	0.30	53	0.30	65
June	7	0.85	0.60	29	0.45	47	0.60	29
	14	0.70	0.30	57	0.30	57	0.30	57
	23	0.80	0.30	63	--	--	0.30	63

Mean value % removal:

Filter 1 = 55.3%

Filter 2 = 54.1%

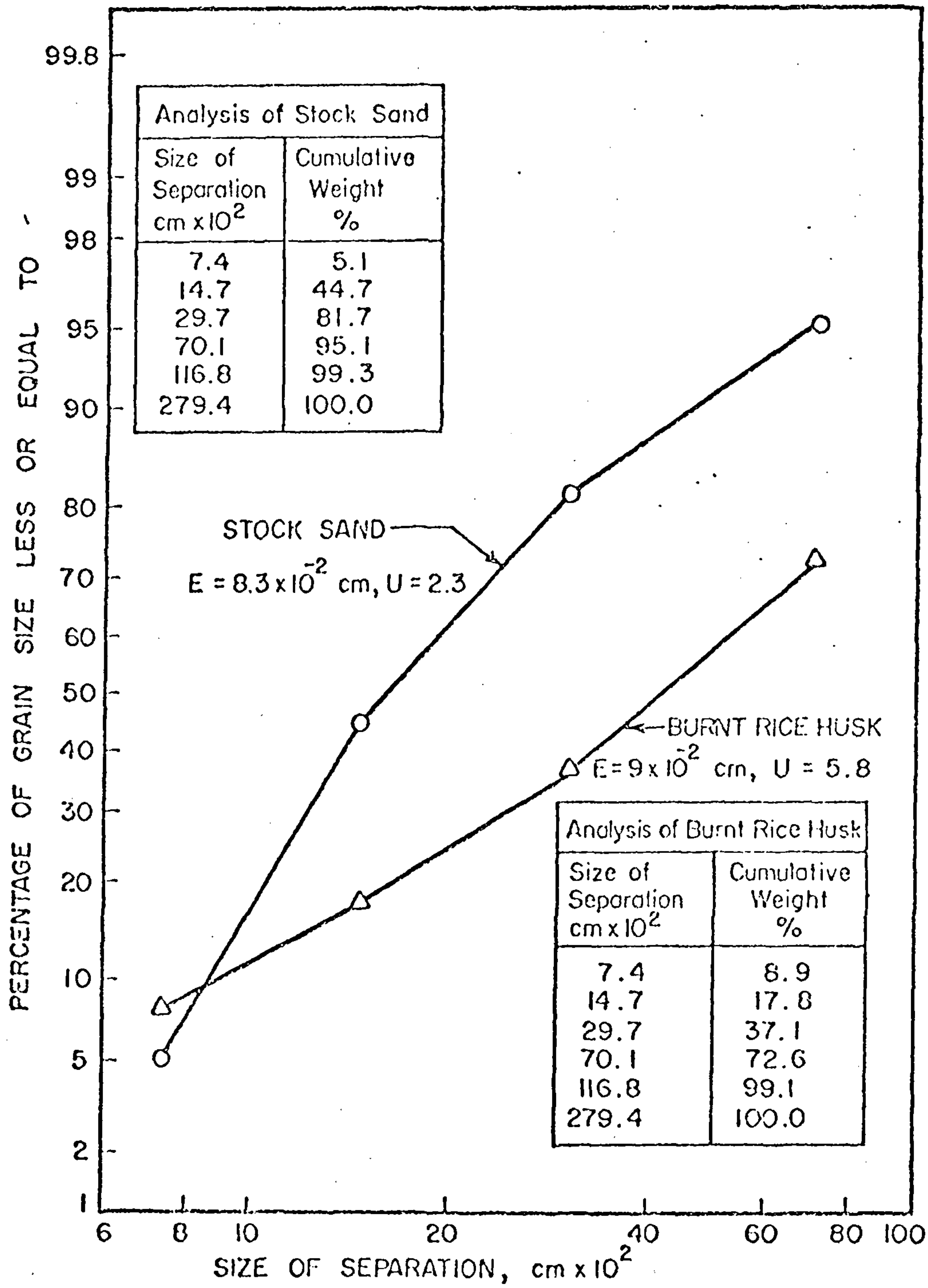
Filter 3 = 58.3%



UMRER WATER SUPPLY SCHEME

(FLOW SHEET)

ANNEX 7

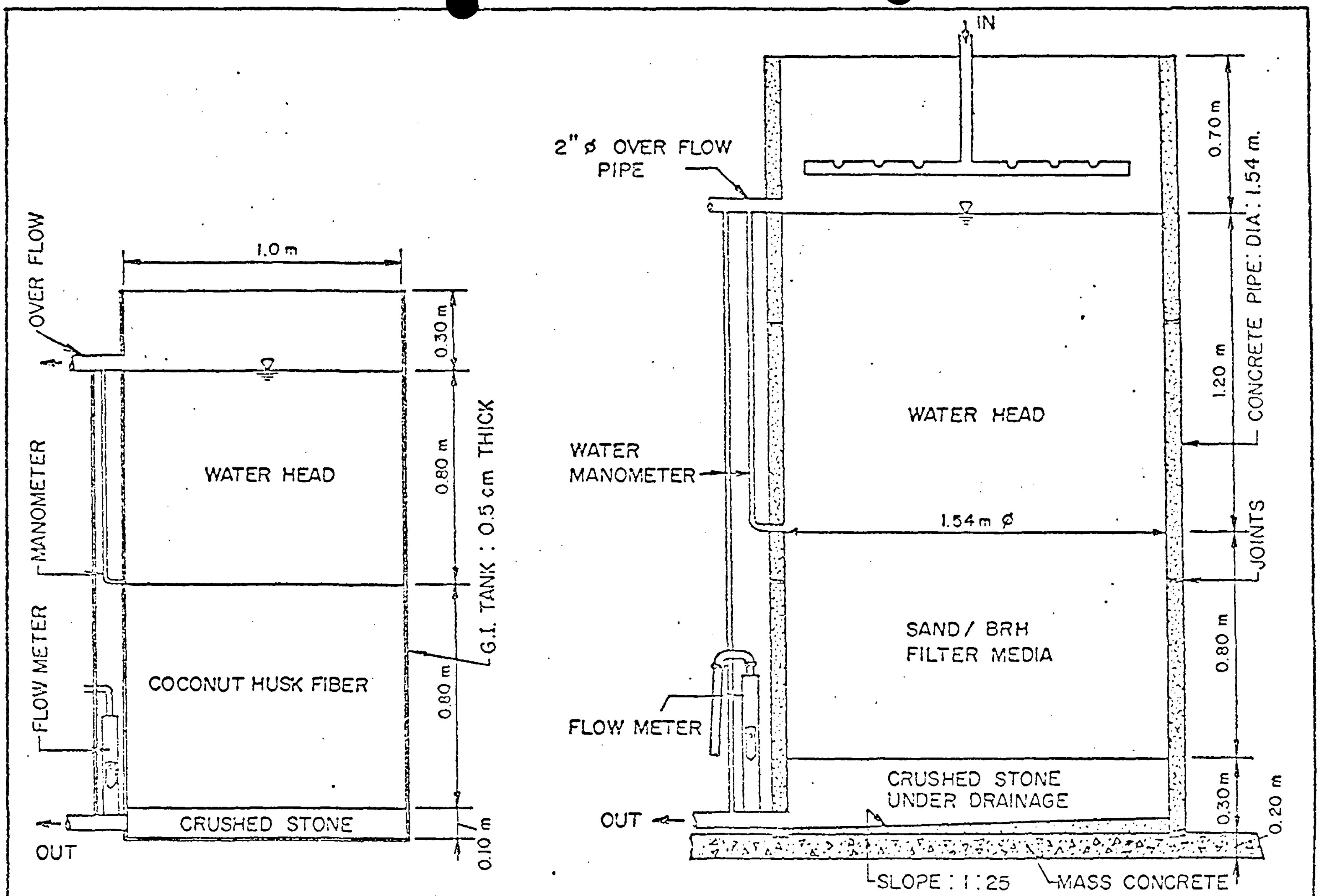


Analysis of Stock Sand	
Size of Separation cm x 10^2	Cumulative Weight %
7.4	5.1
14.7	44.7
29.7	81.7
70.1	95.1
116.8	99.3
279.4	100.0

Analysis of Burnt Rice Husk	
Size of Separation cm x 10^2	Cumulative Weight %
7.4	8.9
14.7	17.8
29.7	37.1
70.1	72.6
116.8	99.1
279.4	100.0

Sieve Analysis of Stock Sand and Burnt Rice Husk.

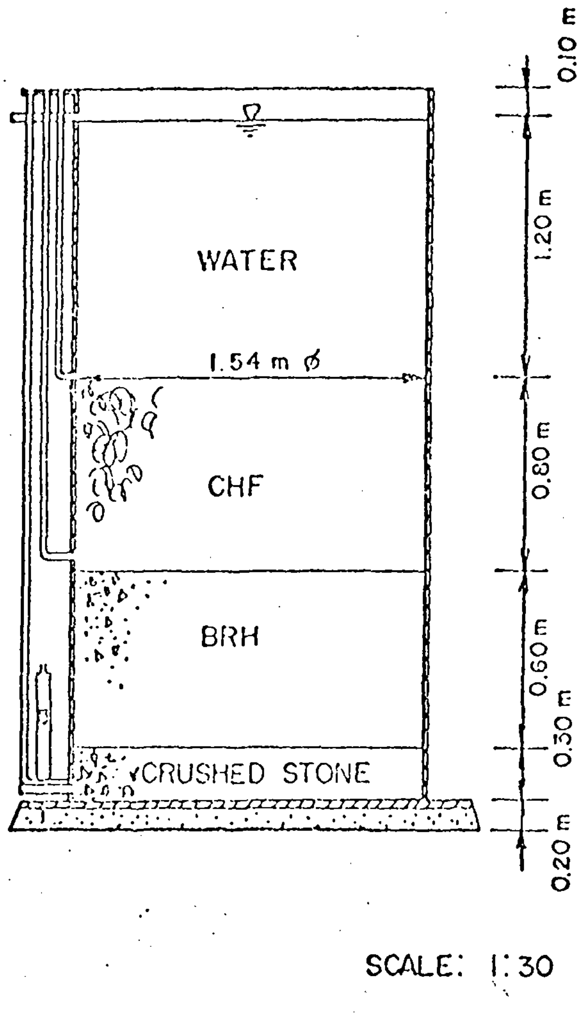
Asian Institute of Technology
Bangkok, Thailand



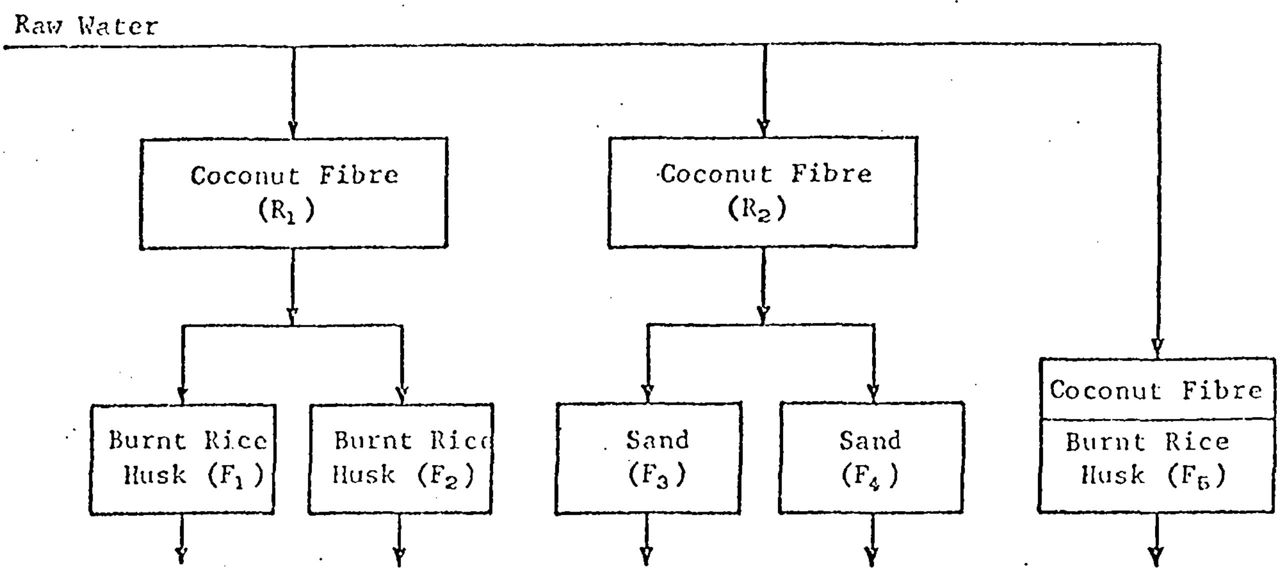
ROUGHING FILTER (TYPICAL)
SCALE 1:50

POLISHING FILTER (TYPICAL)
SCALE 1:50

TYPICAL DETAILS OF SERIES FILTER



DUAL-MEDIA FILTER



Flow Diagram of Filter Systems

Operating Conditions for the Reported Study

Level	Run No.	Raw Water Turbidity Average, JTU	Filtration Rate, m^3/m^2-h						
			Roughing Filter R_1	Rice Husk F_1	Rice Husk F_2	Roughing Filter R_2	Sand F_3	Sand F_4	Coconut-Rice Husk F_5
I	1	50	1.5	0.2	0.1	1.5	0.2	0.1	0.1
	2		4.5	0.6	0.4	4.5	0.6	0.4	0.5
	3		3.5	0.5	0.3	3.5	0.5	0.3	0.3
II	1	100	1.5	0.2	0.1	1.5	0.2	0.1	0.1
	2		3.0	0.4	0.3	3.0	0.4	0.3	0.3
	3		4.5	0.6	0.5	4.5	0.6	0.5	0.5
III	1	150	4.5	0.6	0.5	4.5	0.6	0.5	0.5
	2		3.0	0.4	0.3	3.0	0.4	0.3	0.3
	3		1.5	0.2	0.1	1.5	0.2	0.1	0.1

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SLOW SAND FILTRATION PROJECT

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WORKING DOCUMENT I - 7

Guidance to Working Groups

phase I

GUIDANCE FOR WORKING GROUPS PHASE I

I. Subjects working groups phase I

The basic process criteria and subsequent the subjects for the working groups may be divided into 5 main categories:

1. Raw water quality
2. Pre-treatment
3. Shading/algae
4. Physical aspects
5. Mode of operation

II. Subdivision subjects working groups phase I

When discussing the mentioned categories of basic process criteria, the working group may consider to cover at least the following subjects.

1. Raw water quality

- turbidity
- suspended matter
- microbiological pollutants
- organic pollutants
- colour
- iron/manganese

2. Pre-treatment

- plain sedimentation
- high-rate settling
- roughing filtration
- horizontal-flow coarse-material pre-filtration

3. Shading/algae

- shading
- algae growth (raw water, supernatant, sandsurface)
- maturing

4. Physical aspects

- sand specification
- height filterbed
- height supernatant
- filtration rate
- filtration and head loss

5. Mode of operation

- constant rate/constant head filtration
- discontinuous operation
- intermittent operation

III.Suggestions for composition working groups phase I

It is suggested to have two working groups A and B

Working Group A (room 505)

Dr. Beshir
Dr. Boateng
Mr. Lert
Mr. Paramasivam
Mr. Waweru
Mr. Tjiook

Working Group A is requested to review the basic process criteria of the category 1, 2 and 3.

Working Group B (room 117)

Mr. Abdalla
Mr. Gecaga
Mr. Ingawale
Mr. Monney
Dr. Thanh
Mr. Soleman

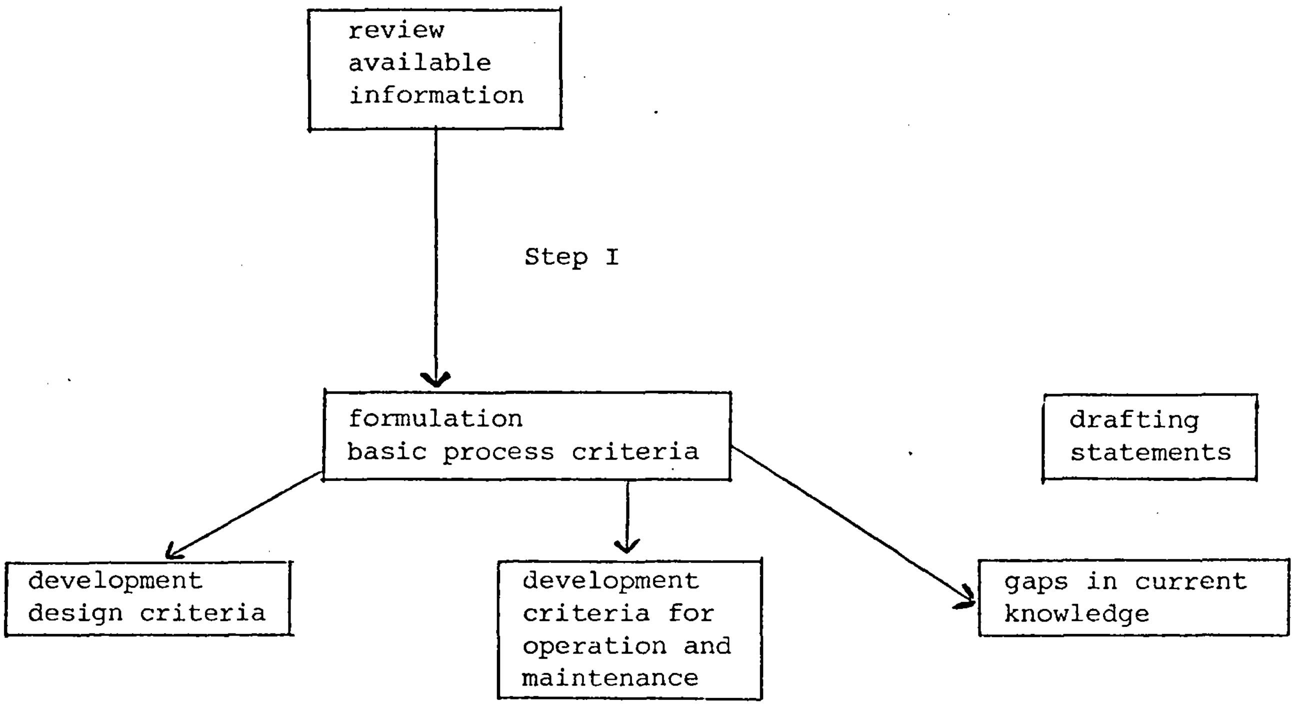
Working Group B is requested to review the basic process criteria of the categories 4 and 5.

IV. Terms of reference working groups

1. to thoroughly review and discuss the selected technical subjects of the programme of investigations of phase I as brought forward in the presentation of Monday and as indicated at item II.
2. to review the available information such as:
   - specifications of subjects (W.D. 8)
   - tentative review of results (W.D. 6)
   - presentations of results phase I (W.D. 1 - 5)
   - interim reports participating institutions (background-papers 1 - 8)
   - additional backgroundpapers (nos. 10 etc)
   - literature (see B.P. 9 + display)

   as well as current knowledge and own experiences.
3. to compile all relevant information per subject and to agree on the formulation of basic process criteria
4. to draft clear and comprehensive statements on the selected basic process criteria.
5. to develop constructional design criteria for slow sand filtration and suitable pre-treatment installation.
6. to develop criteria for opertion and maintenance
7. to indicate gaps in the current knowledge
8. to identify and list the technical limitations of the application of slow sand filtration in rural areas of developing countries.

V. <u>Outline of Programme for Working Groups</u>



Continuation: Guidance for Working Group phase I

VI. Development of constructional design criteria (see IV.5)

Following the basic process criteria as formulated in II, relevant parameters and criteria for construction, operation and maintenance may be derived, taking into account a number of additional aspects.

Working Group B is requested to review the constructional design criteria, covering at least the following subjects:

- number of filters;
- size of filters; shape and arrangement of basins;
- sand bed: initial depth, minimum depth;
- depth of supernatant water;
- filter bottom and underdrainage;
- construction filterbox; materials;
- filtercontrol system (constant rate, constant head);
- control well, weir, valve;
- pre-treatment installations;
- clear-water well.

VII. Development of criteria for operation and maintenance

Working Group A is requested to review the criteria for operation and maintenance, covering at least the following subjects:

- regulations for operation and maintenance (manual);
- quality control effluent;
- indicators for cleaning (quality, quantity);
- intervals of cleaning;
- method of cleaning;
- drainage;
- scraping and sand - replenishment;
- pre-treatment;
- energy source.

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WORKING DOCUMENT I - 8

Specification of subjects of the Programme of Investigations

7. Experiments to find the optimum height of the filter bed will only be necessary under specific conditions, for instance in case an alternative filtering material is used instead of sand. In general the height of the sand bed should be 1.00 - 1,50 m, preferably 1,20m but in any case not less than about 0.8 m.

7.+ 8. If it is anticipated that the quantity of specified sand will be a problem in the second phase of the project, i.e. the realization of a village pilot plant, it is acceptable to experiment with different specifications for the top layer as this is the most critical part of the sand bed with reference to the specifications. In this connection it may be considered to experiment with a filter bed, consisting of a lower part of rather coarse sand, possible ungraded, or gravel (60 cm) and a top layer (30-50 cm) of well selected fine sand.

7. Most of the institutes are interested in studying the influences of various heights of the sand bed. Not only with regard to minimizing the necessary amount of sieved sand but also with a view to optimizing the height of the construction and thus reducing the initial costs. Studies on minimizing the height of the filter bed should include a consideration of the different bio-degradation processes in the three major zones, i.e. the supernatant water, the sand surface and within the depth of the column.

A study on minimizing the height of the filter bed should include a consideration of the different bio-degradation processes in the three major zones, i.e. the supernatant water, the sand surface and within the depth of the sand column.

8. Experiments with different gradings of sand do not have a very high priority. The advised characteristics for a standard laboratory pilot unit are: E. S. = 0.15 - 0.35 mm and preferably U.C. $\leq$ 2.0. Experiments with "builders grade sand" may also be considered. The top layer (0.30 - 0.50 m) is the most critical part of a slow sand filter with reference to the sand specifications.

If the quantity of specified sand turns out to be a problem, it is acceptable to make use of different specifications for the top layer and the lower part of the filter. As the quantity of sand requisited for a laboratory pilot units is rather small it is not likely that this problem will arise in the first phase. However, in the second phase, this problem may occur in relation to the village pilot plant.

10. The filtration rate recommended is 0.1 m3/m2/h. Experiments will be carried out in the range between 0.1 and 0.5 m3/m2/h, depending on several circumstances, such as the filtering materials used. The effect of changes in the filtration rate during the filtration process may also be part of the experiments. Otherwise the rate should be a constant as possible.

11.+ 12. After pointing out once more the difference between suspended matter content and turbidity, it was decided to insert the suspected matter content as number 11 and to place the turbidity as number 12 on the list, while organic matter (12) is delected.

The suspended matter content of the raw water used as influent of the slow sand filter will prove to be one of the most important factors involved in the study of the optimum performance of the filtration process. The experiments will be done with water from the nearest surface water source. As far as slow sand filtration is concerned, the acceptable turbidity level will be about 4 FTU. Pre-treatment systems should be able to cope with turbidity levels up to 20-40 FTU, at least for short periods of extremely high turbidity, for instance during monsoon.

14. There was consensus about the usefulness of a study on the effectiveness of the slow sand filtration process for the removal of specific microbiological contaminants like cercarine or bilharzia. It may also be considered to include other studies of this kind (cysts) in the second phase of the project.

16. Under certain circumstances the influences of algae growth will turn out to be a limiting factor in the optimum performance of a sand filter.

Regular harvesting is still the simplest method to cope with this problem, but there was not unanimity in the Group on the adequacy of this method. Some algae are needed for the oxygen content. Investigations of algae types was suggested.

The influence of algae growth is considered as a possible limiting factor in the opitmum performance of a slow sand filter. Growth and type of algae present in the supernatant water will be studied.

17. Shading against direct sunlight is regarded as a good preventive method to control the algae growth. The influence of shading on filter performance may be studied by comparing the performance of shaded filters and non-shaded filters.

The difference between the influence of only light and direct sunlight on the growth of algae in the supernatant water, will be investigated by also studying the performance of a completely dark filter, not receiving any light at all.

18. Intermittent operation, in which case the filter bed is not continously submerged, but the sand surface is periodically dryed up is regarded as too complicated to be practised in rural areas in developing countries.

However it may be useful to experiment with intermittent operation of the filters under certain circumstances. For instances in the case of high suplhate or organic matter content and anaerobic conditions.

20. Anticipating on the possible methods of practising slow sand filtration in the second phase of the project, it may be useful to study the influence of discontinuous operation on filter performance.

Several ways of discontinuous operation may be distinguished. In practise, filters are often operated for several hours per day, varying from 3 to 12 hours or are used as household filters and operated following the fluctuation in the demand for water during the day.

25.- 28. In view of the possible considerable turbidity levels which can be expected in phase II, it might be useful also to experiment with some simple pre-treatment techniques in order to lower the suspended matter load of the raw water before it is supplied to the slow sand filter.

However, keeping in mind rural circumstances, coagulations is out of the question.

26. The period for extended settling may vary from 1 - 2 days to 1 week. Storage is added to this item.

28. It was suggested to insert in the Programme of Investigations the principle of horizontal-flow coarse-materials pre-fitration which is a combination of settling and filtration. Biological improvement of the water quality may be expected. It seems to be very promising pre-treatment alternative in connection with the slow sand filtration process.

With a view to the possible considerably high turbidity levels which may be anticipated in the second phase of the project, it may be considered to investigate the effectiveness of horizontal-flow coarse-material pre-filtration, under local conditions. This combination of settling and filtration seems to be suitable pre-treatment method in connection with the slow sand filtration process. It may be reqarded as a kind of roughing filter.

28. Much interest was expressed in the principle of horizontal-flow coarse-material pre-filtration. All participating institutes intend to study this "roughing filtration" method in combination with slow sand filtration. Also the possibilities of applying local materials as

30. Some participants will investigate possibilities for the development of alternative roughing filters by making use of local filtration materials such a crushed stones, coarse sand, gravel, diatomaceous earth, chips of wood, charcoal, coconut husks, straw, etc.

38. A full-sieving curve is regarded as the optimum presentation of the specifications of sand used.

43. The measuring of the turbidity will be standardized as much as possible. The possibility of measuring the "filterability" of the water was also discussed, but it was considered not to be an adequate method.

Turbidity should preferably be measured with a Hack Laboratory Turbidimeter model 2100 A and the data will be presented in standardized turbidity unit (FTU = JTU).

50. The amount of dissolved oxygen may be important in relation to taste and odour problems. If the oxygen content is measured this should be done twice a day, with the understanding that the first measurement should be carried out early in the morning. Temperature of the influent and possibly also of the effluent, should be recorded.

54.- 56. Both influent and effluent quality will be investigated regularly. MPN-tests will be used to determine standard coliform bacteria and EMB-test for E.coli. The incubation has to be carried out at 37^{o}C on an agar-agar basis.

59. The type of algae in the supernatant water as well as in the filter effluent will be studied.

81. Investigations on the quality of the raw water that will be used as influent of the village pilot plant have a very high priority. This should be properly studied during a whole hydrological year.

88. The design of a Village Pilot Plant is regarded as a logical consequence of the studies mentioned above. One of the most important design criteria will be the necessity of simple operation and maintenance of the plant.

Criteria on behalf of the design of a village plant will be developed, while also a tentative design of the Village Pilot Plant will be prepared.

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SLOW SAND FILTRATION PROJECT

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WORKING DOCUMENT 1 - 9

Report of Working Group A

Tuesday, 23rd November 1976

I RAW WATER QUALITY

1. TURBIDITY (Standard Methods, 14th edition p. 132)

   It is appropriate to have a standardized unit for turbidity measurement; NTU is recommended. The group realizes that actually suspended solids should be measured instead of turbidity. But it is more practical to measure the turbidity of the water.

   When working with conventional flowrates and sand specifications and filter runs not less than one month, the level of turbidity of the water to be filtered should be less than 10 NTU. When the turbidity exceeds 10 NTU for a longer period, suitable pre-treatment is recommended.

2. SUSPENDED MATTER (Standard Methods, 14th edition p. 94)

   It is more accurate, to measure the total suspend solids content. This parameter may be the decisive one when evaluating the performance of slow sand filters. It is recommended that the settleable solids content should be as low as possible in order to have reasonable filterruns.

3. MICROBIOLOGICAL POLLUTANTS

   (bacteria, viruses, cysts and worms)
   According to experience (India) slow sand filtration can cope with E.Coli concentrations up to 2400. No maximum has been determined with regard to the bacteriological pollution of the raw water. Slow sand filtration removes viruses more efficiently than E.Coli.

4. ORGANIC POLLUTANTS

   Experience shows that slow sand filters can treat efficiently a raw water with organic pollution expressed as COD up to 40 mg/ltr. No maximum has been found in literature. BOD as an expression of organic pollution is considered not desirable in view of its limitations.

5. COLOUR

   Natural biodegradable organic colours can be efficiently removed by slow sand filtration.

6. IRON AMD MANGANESE

   Normally occuring concentrations of Fe and Mn up to 2 ppm can be removed by slow sand filtration. For higher concentrations, pre-treatment is advisable.

II PRE-TREATMENT

If settleable solids content is high and turbidity exceeds 10 NTU, plain sedimentation should be recommended because of its reliability and simplicity. The roughing filtration, horizontal flow pre-treatment and high rate settling may be considered as alternatives, although not enough experience and information are available. Further research should be encouraged in order to evaluate their potential possibilities.

III SHADING / ALGAE

Shading is not regarded as an important parameter with regard to filter performance. It affects the type and content of algae in the supernatent water as well as the dissolved oxygen content. Available information and experience indicates that shading reduces the content of algae by inhibiting its growth. It is expected that shading increases the initial ripening period. (The findings of the group are in agreement with the report of MWB).

VII DEVELOPMENT OF CRITERIA FOR OPERATION AND MAINTENANCE

The group realizes the need for an operational manual for slow sand filter operators, and such manual should contain:

A. I - Definition of:

slow sand filtration process; ripening period; headloss; filterrun, etc.

- brief description of the slow sand filtration process
- elements of the slow sand filter
- how to start and commission a slow sand filter
- normal operation of the filter
- draining + scraping the filter
- resanding of the filter
- restarting of the filter

II Laboratory facilities available and how to use them

III Routine control tests

B. Quality Control of influent:

- Turbidity should be determined once a day and it should not exceed 10 NTU for any prolonged period. It should be noted that slow sand filters can stand higher turbidities (up to 50 NTU) for short periods (about 3 days).
- Colour is to be determined when need arises.
- Dissolved oxygen should be determined as frequent as the bacteriological quality.

BACTERIOLOGICAL QUALITY

The frequency of the determination of E.Coli is related to the number of people. E.Coli measurement could be carried out by a central laboratory.

INDICATORS FOR CLEANING

Maximum filter resistance (heas loss) or detoriation of the quality of the effluent.

METHOD OF CLEANING

A provision for drainage of supernatant water to waste should be located just above the sand bed. Manual scraping is recommended in view of the availability of labour. The minimum depth of sand bed should not be less than 80 cm. Sand depth to be scraped should be about 2 cm.

PRE-TREATMENT

If turbidity exceeds 10 NTU for a longer period, suitable pre-treatment, such as plain sedimentation, roughing filtration, highrate settling or horizontal-flow filtration etc., should be considered.

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WORKING DOCUMENT I - 10

Report of Working Group B

Tuesday, 23rd November 1976

IV PHYSICAL ASPECTS

1. SAND SPECIFICATION

- Sand specifications: ES 0.2 - 0.3 mm; UC ∠ 2.5.
  The sand should be clean and preferably free from organic matter.
- Under certain circumstances also the use of sand with a higher ES may be considered.
- Specification of sand is dependent on the raw water quality.
- The raw water to be filtered should preferably have a turbidity of less than (10 - 15) NTU.
- Natural unsieved sand can be used if its grading complies more or less with the above mentioned specifications.

2. HEIGHT OF THE FILTER BED

It is well known that the biological and chemical purification takes place in the top 40 - 50 cm. It is therefore desirable that the initial total height of the filter bed be at least 1 meter.

3. HEIGHT OF SUPERNATANT WATER

The principal function is to maintain a constant head of water above the filter medium, thus providing the pressure to carry the water through the filter. The supernatant height should be at least 1 meter.

4. UNDERDRAIN SYSTEM

So as to collect the filtrate equable from the filter area, an underdrain system should be at least 0.3 meter deep and should be made of appropriately graded material. The underdrain system also has a supporting function.

5. FILTRATION RATE

The filtration rate should be maintained in the range of 0.1 - 0.2 $m^3/m^2/h$.At higher filtration rates, the penetration of impurities is higher and the duration of the filter run is reduced.

6. HEAD LOSS

The final head loss should not exceed the height of the supernatant water, so as to avoid negative pressure in the filter bed. The filter is to be cleaned when the head loss reaches this level, or when the quality of the filtered water deteriorates considerably.

V MODE OF OPERATION

- A slow sand filter should be operated in a submerged condition.
- It is desirable to aim at continuous operation of a slow sand filter. However, in rural areas where water supply is often discontinuous, discontinuous operation can be acceptable. In case of continuous operation, a clear water storage tank is required.
- The duration of discontinuous operation should preferably not be less than 8 hours per day.

VI DEVELOPMENT OF CONSTRUCTIONAL DESIGN CRITERIA

1. NUMBER OF FILTERS

At least two filters should be constructed so as to ensure a continuous supply of water. They should be operated simultaneously.

2. NUMBER OF FILTERS

   Dependent on demand and rate of filtration.

3. SHAPE OF BASINS

   This can be circular or rectangular. However, a rectangular tank is easier to construct. If the tank is to be constructed of red bricks or masonry, a circular tank can be used.

4. ARRANGEMENT

   Rectengular tanks may have a common partition-wall, thus reducing the construction costs.

5. SAND DEPTH

   Initial - 1 meter, with a minimum of 60 cm.

6. DEPTH OF SUPERNATANT WATER

   1 meter

7. FILTER BOTTOM AND UNDERDRAINAGE

   30 cm depth; use can be made of crushed stone or gravel.
   The underdrainage system can be constructed of bricks, precast concrete slabs or of porous concrete.

8. CONSTRUCTION OF FILTER BOX

   Masonry, bricks, natural stones; plain concrete; reinforced concrete; ferro-cement.
   Materials which are degraded by water or which have a detrimental effect to water, should not be used (e.g. mud-blocks, some types of timber).

9. FILTERCONTROL SYSTEM

   In order to maintain a constant flow rate, the outlet should be provided with a valve. The level of the outlet should not be lower than the top of the sandbed.

10. CLEANING

    The filter should be constructed in such a way, that it is easily accessible for cleaning and maintenance.

11. PRE- TREATMENT ALETRNATIVES

    Plain sedimentation, roughing filtration (straining); suitable local materials (e.g. coconut fibre) may be used; horizontal pre-filtration through coarse material.

12. CLEAR WATER WELL

    - size depends on demand. A capacity of one day demand is common practice.
    - should be covered.
    - should be located near the filter.
    - should be constructed from the filtered water.
    - there should be enough ventilation.

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

BACKGROUND DOCUMENTS PHASE I

Reports Project Participating Institutions (Folder II)

1. First Progress Report (October 1976) by Department of Civil Engineering
   University of Science and Technology, Kumasi, Ghana

2. Quarterly Progress Report (April 1976)
   National Environmental Engineering Research Institute, Nagpur, India

3. Interim Report (August 1976)
   National Environmental Engineering Research Institute, Nagpur, India

3a. Annex to Interim Report (August 1976)
   National Environmental Engineering Research Institute, Nagpur, India

4. Interim Report (October 1976)
   University of Nairobi, Nairobi, Kenya

5. First Progress Report (August 1976)
   University of Engineering and Technology, Lahore, Pakistan

6. Interim Report (November 1976)
   University of Khartoum, Khartoum, Sudan

7. Progress Report (March 1976)
   Asian Institute of Technology, Bangkok, Thailand

8. Final Report (September 1976)
   Asian Institute of Technology, Bangkok, Thailand

Additional Background Documents (Folder I)

9. Preliminary list of references on Slow Sand Filtration and
   Related Simple Pre-Treatment Methods

10. Filtration of water and waste water
    Professor K.J. Ives

11. Comparison between slow sand- and rapid filters
    Dr. A. van de Vloed

12. The removal of viruses by Slow Sand Filtration
    Thames Water Authority, London, England

13. Slow Sand Filtration
    Copies from 44th and 45th Report of the Metropolitan Water Board, London

14. Guidelines for Waterworks Technical Management
    Japan Water Works Association

15. Optimization of Surface Water Treatment by a Special Filtration Technique
    Dr. O.R. Kuntschik

16. Design of Water Treatment Plants Part III
    Dr. A.G. Bhole

17. In Defense of Slow Sand Filters
    S.V. Belsare

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT I - 12

MAIN ITEMS RESULTED FROM WORKING GROUP DISCUSSIONS AND TO BE PRESENTED TO THE ADVISORY GROUP

I. LEADING SUBJECTS OF PROGRAMME OF INVESTIGATIONS OF PHASE I

According to the programme of investigations as carried out for the first phase of the Slow Sand Filtration Project and as an outcome of working groups discussions, the participants of the first meeting of institutions participating in the Slow Sand Filtration Project would like to consult with the Advisory Group the following subjects:

1. The performance of a slow sand filter in relation to the quality of the raw water and especially concerning the removal of turbidity, organic matter and specific bacterial contaminants.

2. The performance of a slow sand filter in relation to the type and specifications of the filter material.

3. Optimization of the filtration rate in relation to the raw water quality, the filterbed composition, the duration of the filterrun and the desired quality of the effluent.

4. Alternatives for operation of slow sand filters in developing countries.

5. The effect of shading on the performance of a slow sand filter and especially on the algae growth in the supernatent water.

6. Simple pre-treatment methods for the reduction of the turbidity of the raw water.

7. Optimization of the construction, operation and maintenance of small slow sand filter plants, taking into account the local circumstances in rural areas of developing countries.

II. MAIN ITEMS TO BE PRESENTED TO ADVISORY GROUP

1. THE PERFORMANCE OF A SLOW SAND FILTER IN RELATION TO THE QUALITY OF THE RAW WATER

1.1 SUSPENDED MATTER AND TURBIDITY

Although, with reference to the performance of a slow sand filter, the suspended matter content of the raw water would be a more relevant parameter than the turbidity, it is more feasible to measure the turbidity of the water, especially in rural areas of developing countries. It is appropriate to have a standardized unit for turbidity measurement; NTU is recommended.

When working with conventional flow rates and sand specifications and filter runs not shorter than one month, the level of turbidity of the water to be filtered should be less than 10 NTU. Slow sand filters can stand higher turbidities (up to 50 NTU) for short periods. When the turbidity of the raw water exceeds 10 NTU for a longer period, suitable pre-treatment is recommended.

1.2 ORGANIC MATTER

The results of the pilot experiments indicate that slow sand filters can purify raw water with an organic matter content expressed in COD up to 40 mg/ltr. in an efficient way. In literature no maximum has been found. Further applied research is recommended in this connection. BOD as an expression of organic pollution is not considered desirable in view of its limitations.

1.3 MICROBIOLOGICAL CONTAMINANTS

The results of the pilot experiments tentatively indicate that slow sand filters can cope with E.Coli concentrations of 2400 +. No maximum has been determined with regard to the bacteriological pollution of the raw water. It is recommended to further investigate the effectiveness of the slow sand filtration process with regard to the removal of specific microbiological contaminants. Recent research at the Thames Water Authority, England, has shown that the E.Coli removal is a conservative indicator for the removal of viruses in slow sand filters.

2. THE TYPE AND SPECIFICATION OF FILTERMATERIAL

In general any inert, granular filter material can be used. In almost all cases sand is applied. The sand should be clean and preferably free of organic matter. Sand specifications:

effective size 0,2 - 0,3 mm
uniformity coefficient $<$ 2.5

Under certain circumstances also the use of sand with a higher effective size may be considered. Tentative results show that builders grade sand (E.S. $\approx$ 0.4) will give good results.
Natural unsieved sand may be used if its grading complies more or less with the above mentioned specification.

Some experiments have been carried out with burnt rice husk as filter medium instead of sand. The mechanical strength of burnt rice husk is limited and in manually scraping problems may be anticipated.

About the effectiveness of coarser material (E.S. up to 0.7) more investigations are desirable. Tentative results indicate that turbidity removal and bacteriological efficiency are not always sufficient.

3. FILTRATION RATE

The filtration rate should be in the range 0.1 - 0.2 m^3/m^2/hr.

Higher rates of filtration are only acceptable in combination with an extensive pre-treatment system. In that case slow filters have a polishing function.

4. MODE OF OPERATION

Slow sand filters should be operated in a submerged condition. Intermittent operation, in which case the filter bed is not continuously submerged, but the sand surface is periodically dried up, is regarded as too complicated to be practiced in rural areas of developing countries.

It is desirable to aim at continuous operation of a slow sand filter. In case water supply is only provided during some hours of the day, discontinuous operation can be acceptable. Several ways of discontinuous operation may be distinguished. In practice, filters are often operated for only a few hours per day; the duration should preferably not be less than 8 hours per day.

The preliminary results of the studies on discontinuous operation indicate that there is no average effect on the quality of water.

Slow sand filters should be operated with a constant flow rate and a constant level of the supernatant water. In order to maintain the constant flow rate, the outlet should be provided with a valve. The level of the outlet should not be lower than the top of the sand bed.

5. THE EFFECT OF SHADING ON FILTER PERFORMANCE AND ALGAE GROWTH

Under certain circumstances the influences of algae growth will turn out to be a limiting factor in the optimum performance of a sand filter.
Regular harvesting is still the simplest method to cope with this problem, but this method may not be adequate under all circumstances. Some algae are needed for the oxygen content.

Shading against direct sunlight is regarded as a good preventive method to control the algae growth. It affects the type and number of algae in the supernatant water as well as the dissolved oxygen content. Available information indicated, that shading reduces the content of algae by inhibiting its growth.

With regard to filter performance, shading is not regarded as an important parameter. The influence on the duration of the filterrun is not significant. An increase of the initial ripening period may be expected.

6. SIMPLE PRE-TREATMENT METHODS FOR TURBIDITY REDUCTION

With a view to the possible considerably high turbidity levels which may be anticipated in the second phase, experiments regarding simple pre-treatment systems are considered necessary in the context of the project.

Keeping in mind the circumstances in rural areas of developing countries, coagulation is considered to be beyond the scope of the project. Particularly plain sedimentation, roughing filtration and horizontal-flow course-material pre-filtration are considered useful alternatives in view of their reliability and simplicity.

Experiments with coconut-fibre roughing-filters indicate that turbidity reduction up to 80% is possible, with an acceptable duration of the filterrun. After clogging this kind of filter media is put to waste. It is recommended to carry out similar experiments with alternative materials for roughing filtration.

The system of the horizontal-flow coarse-material pre-filtration seems to be a very promising alternative in connection with the slow sand filtration process. Although some information is already available, more research is considered to be necessary.

7. OPTIMIZATION OF THE CONSTRUCTION, OPERATION AND MAINTENANCE OF SMALL SLOW SAND FILTERS

7.1 HEIGHT OF THE FILTERBED

Optimization of the height of the sand bed is recommendable with regard to reducing the initial costs and the necessary amount of filter sand. A study on minimizing the height of the filter bed should include a consideration of the different bio-degradation processes in the three major zones, i.e. the super-natant water, the sand surface and within the depth of the sand colums. As the main biological and chemical purification takes place in the top 30 - 50 cm., the minimum height of the sand should not be less than about 0.50 m.
The initial height of the sand bed should in general not be less than about 0.75 - 1.0 m.

7.2 NUMBER, SIZE AND SHAPE OF FILTERS

It is recommended to have at least two filters constructed, so as to ensure a continuous supply of water. The filters should be operated simultaniously.
The filter shall not have a too small working area in order to reduce the effect of short circuits during filtration on the effluent quality. For conventional slow sand filters, constructed from reinforced concrete, a minimum size of about 40 - 50 m^2 is recommended. However in rural areas of developing countries smaller filters, e.g. circular corrugated iron filters, may be practised.

The shape of slow sand filters may be circular or rectangular. In general a rectangular tank is easier to construct. When more filters are constructed rectangular tanks may have a common parti-sion-wall, which will reduce the construction costs. If the slow sand filtration is constructed from red bricks, masonry or corrugated iron, a circular shape may be used.

7.3 CONSTRUCTION MATERIALS

Masonry, bricks, natural stones; plain concrete; reinforced concrete; ferro-cement.
Materials which are degraded by water or which have a detrimental effect to water, should not be used (e.g. mud-blocks, some types of timber).

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT II - 1

Outline of Programme for the Second Phase

+ Annexes

by

International Reference Centre for Community Water Supply
Voorburg, October 1976
The Netherlands

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SLOW SAND FILTRATION PROJECT

OUTLINE OF PROGRAMME FOR THE SECOND PHASE

DRAFT

C O N T E N T S

A N N E X E S

1. INTRODUCTION

" Slow Sand Filtration is an art rather than a science "

Following a special priority recommendation from the meeting of Directors of Institutions collaborating with the WHO/ International Reference Centre for Community Water Supply, held in Bilthoven in April 1973, the IRC has developed an internationally coordinated research and demonstration programme to promote the application of slow sand filtration for the purification of drinking water in developing countries. Slow sand filtration is a simple, efficient and reliable method for the biological treatment of water and is most appropriate for application in developing countries. On the basis of international collaboration, a programme for applied technical research and investigations as well as for the demonstration of the process under local conditions, has been developed and is carried out by various participating institutions in developing countries. In this context, demonstration relates to the suitability and appropriateness of slow sand filtration for developing countries from both technical and social-economic points of view. In addition to this, the programme also aims at demonstrating the approach and set-up of the programme itself.

The programme is divided into two phases.
In the first preparatory phase applied research on pilot filters, field investigations on existing plants, literature studies and additional organizational activities are carried out as a preparation for the second phase of the project. This work is done by six participating institutions, on a joint basis, while the international coordination of the various activities is performed by the IRC. This first phase of the project is financed by the Directorate for International Technical Assistance of the Netherlands Ministry of Foreign Affairs.

The purpose of the second phase of the project is to further develop the possibilities of applying and practising slow sand filtration in developing countries. Therefore several full-scale village demonstration plants will be constructed in rural villages, under various local circumstances. These plants will be used for demonstration purposes and further investigations under local conditions. In this connection, much attention will be paid to local circumstances of a non-technical nature, such as social, cultural and economic factors, which could hamper the optimal performance of the plant. Towards the end of the project, several seminars will be organized to transfer know-how and experiences and to promote the application of slow sand filtration. Eventually, the village demonstration plant will be put under full control of the local population.

In a logic and functional way, the programme for the second phase follows the results of the first phase of the project. The main elements of this programme are: continued applied research and investigations, transfer and exchange of know-how and experiences, the demonstration of the appropriateness of the system and the preparation of effective follow-up programmes. The programme of activities of phase II is set up on the basis of national and international cooperation and is developed following the idea of the 'integral approach'. This indicates that a number of activities of a more general and structural nature are grouped around the central, technical subject: slow sand filtration. Formulated the other way around, the central theme is wrapped in a series of supporting activities of a motivational and informative nature. This approach has lead to the devdopment of a series of objectives that are all interrelated to a considerable extent. Other characteristic elements of the programme are the implicit self-generating-effect and the built-in dissimination of the results. This secures an adequate spreading of the outcome of the project in several countries and in a very early stage.

As self-reliance of the rural population, with regard to water supply and sanitation is the ultimate aim of the programme, people concerned will be actively involved in the implementation of the programme. In this connection, priority is given to the development of local capabilities, leadership and responsibilities, as well as to the improvement of the national and local infrastructure in the field of water supply and sanitation.

It is intended to interlink this programme with other programmes of the IRC or other international organizations. In this connection one may think of the present and future activities of the Ad Hoc Working Group on Rural Potable Water Supply, their integrated international programme on the acceleration of the development of water supply and sanitation in rural areas and the operational programme on global exchange of information in the field of water supply and sanitation, as well as of the overall training programme of the IRC.

This second phase of the project may be regarded as a practical preparation for future large scale implementation programmes, which hopefully will follow up this demonstration project. The project will be a demonstration to the developing countries and a demonstration of the developing countries at the same time.

2. OBJECTIVES

The general objective of the programme is to promote the application of slow sand filtration for biological treatment of drinking water in developing countries.

For a better understanding of the background and the scope of the programme, it may be useful to distinguish basic objectives, long-range objectives and the actual short-term objectives of the programme. Some of the objectives are purpose and mean at the same time.

Actually, the basic objectives may be regarded as descriptors of the ideological concept of the programme; consequently, they are of a more fundamental character:

- to improve the public health and social-economic situation and thus the well-being of the people in developing countries.
- to promote a self-generating autonomous development process, ultimately leading to self-reliance, by creating local capabilities and stimulating the use of local resources in the field of water supply and sanitation in developing countries.
- to further the international collaboration, particularly the international exchange of information, between the developing countries in the field of water supply and sanitation.

The long-range objectives indicate the projected targets of the programme. It is expected that the implementation of the programme will considerably contribute to the fulfilment of these targets and derived objectives. The most important long-term objectives are:

- to create awareness regarding the suitability and possibilities of slow sand filtration on local, national, regional and international level.
- to promote the development of national plans for community water supply and sanitation programmes including the application of slow sand filtration and preferably integrated in multi-sectoral development programmes.
- to contribute to the improvement of the national infra-structure in the field of water supply and sanitation in the developing countries concerned.
- to generate interest from both national and international organizations for large scale implementation programmes on slow sand filtration.
- to demonstrate the feasibility of the overall approach of the slow sand filtration programme, which may be characterized by the following elements: international collaboration, development of local resources and capabilities and promotion of autonomous development and self-reliance.

The short-term objectives profile the actual intentions of the programme of activities and are directly related to the substantial results to be obtained in the contractual period:

- to develop a process for the preparation of drinking water by adopting and improving the slow sand filtration system to tropical conditions and local circumstances in developing countries.
- to investigate the possibilities for a suitable pre-treatment system
- to develop and improve appropriate design criteria for the construction of various slow sand filtration plants and suitable pre-treatment installations and that are directed to simple operation and maintenance.
- to gain experiences with experimental village demonstration plants installed at selected sites to make people concerned familiar with the phenomena and the ins and outs of the slow sand filtration process.
- to prepare a series of guidelines on the design, construction, operation, maintenance and management of small slow sand filtration plants in developing countries.
- to demonstrate the suitability and appropriateness of slow sand filtration for developing countries from both technical and social-economic points of view.
- to show the public health and social-economic impact of the introduction of a dependable water supply in rural villages.
- to develop an appropriate methodology for the introduction of a water supply in rural communities in developing countries.

In addition to these groups of objectives also intermediate targets are distinguished. These targets are directly related to the respective steps of the programme of activities, viz.: preparatory activities, realization of village demonstration plants, testing of operation, demonstration and follow-up. The accomplishment of the intermediate targets will be reviewed regularly at the planned meetings of the institutions participating in the project and at the meetings of the Advisory Group.

3. POLICY AND APPROACH

The aformentioned objectives of the programme are interrelated to a considerable extent. This leads to a more or less interwoven policy that could be characterized by the following keywords: international collaboration, transfer and exchange of knowledge, orientation on local cicumstances, optimal use of local resources, development of capabilities, appropriate technology, applied research, education, training, community motivation, local involvement and responsibility, demonstration, autonomous development and self-reliance.

This interwoven over-all policy is a direct consequence of the IRC's methodology for the programme development, which is often referred to as 'integral approach'. This term indicates that a variety of multy-disciplinary activities of a more structural nature are grouped around a central technical subject. In this programme the central theme : slow sand filtration, is wrapped in a series of supporting activities of motivational, educational and informative nature, such as transfer of appropriate information and know-how, basic public health education, training of an operator and motivation of executives, professionals and consumers. The 'integral approach' also refers to the integration of the various elements of the programme, viz. 'the preparation of the soil', the actual introduction of the water supply into the village and the demonstration and follow-up. The main purpose of this approach is to secure that several related technical and non-technical problems and constraints are taken into account in developing a programme.

Collaboration is also an important element of the programme. The aim is to foster a spirit of cooperation among those active in the field / throughout the world; to avoid duplication and wasted efforts and to overcome the main obstacles by concerted action. For that reason, both international cooperation and internal collaboration will be intensively promoted. The direct national and international exchange of information, knowledge, ideas and experiences among all participants in the project may highly contribute to an effective implementation of the programme The intensification of the internal collaboration among research workers, field engineers, govermental executing agencies and policy makers may lead to an improvement of the national infrastructure in the field of water supply and sanitation.

Another basic element of the policy is that most of the actual work is to be done by national and local people in the developing countries themselves. In this context it will be stimulated, that the participating countries take the lead in the implementation of the project and will accept primary responsibility for the progress. Of course, unimpeded IRC's responsibility with regard to the overall guidance and progress control. The role of the IRC is to initiate stimulate and coordinate the implementation of the various parts of the programme and to provide technical guidance and support. On request also assistance will be given, through direct advice or by means of consultants. The IRC will step back as soon as specific activities can be taken over at national or local level, thus promoting self-reliance.

/ of slow sand filtration

Another essential element of the programme is the orientation on the local circumstances, possibilities and constraints. The making optimal use of local resources in terms of know-how, experiences, inventiveness, manpower, labour, materials, energy, and finance will be stimulated. The allocation and application of these resources may lead to a more socially appropriate approach.

Appropriate technology is a pre-requisite for this programme and therefore the applied research will be directed to the actual needs. In applying basic engineering principles, much attention will be given to the local circumstances and resources. This may contribute to realistic solutions that reach actual needs, original and innovated techniques and simple operation and maintenance of the slow sand filtration plants.
Local involvement, community participation and self-help development will be promoted as much as possible. This is to stimulate the autonomous development to self-reliance. In this connection also the creation and further development of personal and institutional capabilities is regarded as an important factor in the set-up of a self-generating programme.

Local programmes on the promotion of slow sand filtration should preferably be integrated in the national or local planning for overall development. For that reason, it will be investigated whether it is possible to interlink the introduction of slow sand filtration with activities in other development sectors, such as agriculture, irrigation, roads, electricity, housing or the development of small industries, etc.
This programme on slow sand filtration will be most successful when it is integrated into a multi-sectoral development programme and can thus contribute to the overall development, through the entrance of water. This multi-sectoral approach may provide a good opportunity to actually show the impact of an improved water supply system on the local and national social and economic development.

Summarizing, the main policy items are: integrated approach, international and internal collaboration, local orientation, demonstration and motivation and the integration in national plans. It is the ultimate aim of this policy to make the slow sand filtration project a self-generating activity.

4. GENERAL DESCRIPTION OF THE PROGRAMME

In the second phase of the slow sand filtration project several full-scale village demonstration plants (VDPs) will be set up in rural areas of developing countries. This will be done on the basis of the results and experiences acquired in the first phase of the project. After a guided introduction of the new drinking water supply into the selected communities, further applied research on these installations will be carried out under local conditions. In addition to the technical aspects, much attention will be paid to local circumstances of a non-technical nature such as cultural and socio-economic factors which might hamper the optimal performance of the plant. At the same time, these village plants will be used for demonstration purposes. The suitability of the process as well as the advantages and disadvantages of the various ways of applying and practising slow sand filtration will be demonstrated to those concerned and interested. In this connection we may think of: local authorities, chief engineers, research workers and policy makers from governmental organizations involved in rural water supply and sanitation. Eventually, the village demonstration plant will be put under full control of local population.

As transfer of knowledge and experience is an essential element of this programme, many activities are related to information, education training and demonstration. Also various activities are directed to the improvement of the local and national infrastructure in the field of water supply and sanitation. Most of these activities are very much inter-related.

In this chapter a general description of the programme is given; detailed information of the respective activities of this programme is given separately (Annex A). The Programme of Activities clearly reflects the division of the programme in four main groups and an additional group: preparatory activities, realization of village demonstration plants, testing of the operation, demonstration, follow-up and general activities. This division will be followed in further outlining the programme.
The Programme of Activities of Phase II (annex 1) clearly reflecs the division of the programme in four main groups an an additional group: preparatory activities, realization of village demonstration plants, testing and demonstration, follow-up and general activities. This division will be followed in further outlining the programme.

4.1 PREPARATORY ACTIVITIES

The programme starts with selecting and consulting participants for the second phase of the project.
Following this,a project managing committee (PMC) will be established in each country. These committees will consist of representatives of both national and local governments, universities or research institutes and local executing agencies. This stimulation of the internal collaboration is considered to be of crucial importance to a successful implementation of the programme. The various Project Managing Committees may play an important role in contacting and motivating other authorities and agencies involved, as well as in establishing and improving the local infrastructure and thus in developing local capabilities in the field of planning, administrating and managing water supply support programmes.

In order to realize an optimum contribution from the participating countries in developing and setting up the programme, the various participants will be consulted about their ideas with respect to the execution of the programme. This will particularly be useful for the development of the Programme of Investigations for further applied research on both experimental pilot units and on the village demonstration plants. Formal letters of agreement will be drafted according to the results of these consultations; these letters will cover the contents and arrangements concerning the participation in phase II of the slow sand filtration programme.

Several studies preceeding the realization of the village demonstration plant are planned in the preparatory stage. The selection of rural villages and a proper location in these villages for the set-u of demonstration plants will be done in close cooperation with the authorities concerned. Various local circumstances will be thoroughly studied and the possibilities for active community participation will be investigated. Following this, a design will be made for a complete water treatment plant, fitting in the local environment and meeting the actual needs of the village. Finally, a local contractor will be approached and necessary funds will be allocated.

Before the actual construction of the Village Demonstration Plant starts, a series of activities are planned 'to prepare the soil in which the seed will grow '.The major elements of these activities are: information, education, training and motivation. They will be directed to various levels, such as the national and local governments, the local executing agencies, the village-leader and the future consumers. The main constituants of this series of activities are:

1. the creation of local interest and the stimulation of active community participation;
2. the transfer and exchange of information in an appropriate way anc at an appropriate time;
3. a basic public health education programme for the villagers;
4. the preparation of a series of draft guidelines on design, construction, operation, maintenance and management of several types of slow sand filtration plants in developing countries;
5. the preparation of a manual for the local plant operator in the local language;
6. the set-up of a training course for the local plant operator;
7. the allocation of funds for the implementation of the various activities and
8. various other motivating activities.

Community participation is essential for the development, operation and maintenance of a water supply. Education of the local community may contribute to a better understanding of their own reponsibilities in this field.Training activities will deal with both technical and administrative aspects and will especially be directed to the middle and lower echalons. These'preparations of the soil activities' are considered as an essential element of the integral approach that characterizes this programme.

4.3 TESTING OF THE OPERATION AND DEMONSTRATION

In this stage of the programme, the testing of village demonstration plants will be continued. At the same time local, nationa- and regional demonstration activities will be set up to make acquired experiences public knowledge. Appropriate information packages have to be developed for this purpose. Written information in the local language as well as audio-visual presentations will be prepared. Also the possibilities of making use of programmes on radio and television will be investigated.

At the end of this stage, evaluation studies on both the public health and socio-economic situation are planned. In this connection, endeavours will be made to show the impact that the new water supply has on the socio-economic development of the communities concerned.

As part of the demonstration, several publications are to be prepared. After an evaluation of the preliminary results of the programme, the operator manual and training course and the basic public health education programme will be improved. The same goes for the series of guidelines on design, construction, operation, maintenance and management of the plants. Finally, it will be considered to summarize relevant information in a handbook on slow sand filtration for developing countries.

Towards the end of this stage, seminars will be organized to transfer experiences and results and to encourage the application of slow sand filtration on a larger scale. Both professionals and policy makers will be informed about the effectiveness, suitability and reliability of this drinking water purification process.

Eventually, the village plants will be put in the hands of the local population. This taking over of the equipment, the actual responsibility, and the care for operation and maintenence by the villagers will be done gradually and in close cooperation with the local government.

4.4 FOLLOW-UP

Follow-up is related to several matters, such as the generation of interest for large scale implementation programmes in several countries and the adoption of slow sand filtration projects in national development programmes.

Endeavours will be made via national and international organizations to allocate funds necessary for extensive follow-up programmes. Support will be given to the organization of seminars and the set-up of permanent demonstration and training centres will also receive encouragement. Possibilities will be investigated for the dissimination of the resulting information, on a larger scale. The evaluation of the organizational aspects of the project may probably lead to the development of a methodology for project development.

4.5 GENERAL ACTIVITIES

The exchange of information on various aspects of the programme is a continuous activity. The same goes for the literature studies and the development of clearing-houses for information on slow sand filtration and related subjects.
Through these activities the slow sand filtration programme may be inter-linked with the operational programme for global exchange of information in water supply and sanitation.

Some of the pilot experiments started in the first phase, will be continued. Also the continuation of some other parts of the Programme of Investigations of phase I, such as field investigations and literature studies will be considered. These activities may provide useful information and technical backing for the set-up of new activities in this second phase.

5. ORGANIZATION, STAFFING AND FINANCE

A basic element of the programme is the idea that the major part of the work is to be done by nationals in the developing countries. The Project Managing Committees have the responsibility for the formation of the local staff and will see to it that the planning and implementation of the various activities is carried out, accordir to the over-all programme of work.

The IRC will function as the nexus of a network of collaborating institutions, operating in 8 different countries. In each of these participating countries, formal contacts will be established with two or three national and/or local organizations assembled in the Project Managing Committee. The contact with the national government will go through the Ministry in question (water, health, development).

The difficulties under which many government departments work are fully appreciated; in almost every case, funds and skilled staff are inadequate, organizational problems are acute and in some cases a multiplicity of government agencies dealing with water supplies add to the complication.
As a result, the operational staff, professional, administrative and sub-professional, are barely able to meet their day to day demands and have no opportunities for research and development work which might, in the long term, materially improve the efficiency of their efforts.

The manpower requirement, both qualitatively and quantatively will depend on the programme of work to be carried out in the country concerned. In all cases, the appointment of a central programme coordinator by the Project Managing Committee is regarded as a necessary condition for an optimal coordination of the various activities in the country concerned. This coordinator will also be responsible for regularly convening the Project Managing Committee and for the collection and dissimination of the relevant information. A full-time assignment would be prefered for this managing function.

The letters of Agreement for the implementation of phase II of the slow sand filtration project will be based on the WHO standard contract form. The legal personalities that formally enter the Agreement, will bear the primary responsibility for the progress of the programme. In addition to this, there will also be a joint responsibility of the Project Managing Committee based on the obligatory character of the collaboration amongst the various institutions participating in the programme in each countr Therefore, a specific paragraph will be incorporated in the letters of Agreement, emphasizing this joint responsibility and the inetrnal collaboration.

The general policy concerning the financial aspects of the programme is based on the objective to mobilize indigenous capital resources as much as possible and to have the financial assistance from the side of the IRC completed by cash contributions from both national governments and from the villages concerned. Also with regard to this aspect, an optimal local involvement is regarded as an integral target of the programme. As to the construction of the Village Demonstration Plant it is the aim to obtain the major part of the capital funds from within the country. Both national and local agencies as well as the villages concerned should contribute to the construcion costs.

Constructing a water supply system is one thing, the operation and maintenance of it is another. For that reason, a clear plan for local financing of recurrent costs of service is required. The village should normally agree to pay the major portion of the future operation and maintenance costs, thus enabling the implementing institutions to secure the service on a longer term. This accepting the future financial responsibility is one of the purposes of the promotion of community involvement. Failure to make a reasonable contribution to these costs raises sufficient doubts about the village motivation and input to suggest that it be excluded from the programme. However, in this connection it should be mentioned again that the social and economical situation differs very much from country to country and from village to village.

In the later stages of the programme the possibilities will be investigated for international funding of large scale implementation programmes.

It is the intention of the IRC to start the implementation of the second phase of the slow sand filtration project as from December 1976.

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ANNEXES TO

OUTLINE OF PROGRAMME FOR THE SECOND PHASE OF THE SLOW SAND FILTRATION PROJECT

Annexes:

PROGRAMME OF ACTIVITIES PHASE II

9 months

I. PREPARATORY ACTIVITIES

selection of participants
establishing project managing committee; contacting and motivating national and local authorities
consultations on programme of work and organizational arrangements
development programme of investigations for further applied research on both experimental pilot units and village demonstration plants.
letterof agreement - phase II
village demonstration plant pre-investment studies
- selection location
- allocation funds
- complete designs
- contractor

preparation of the soil activities
- set-up guided introduction method: education and motivation
- transfer and exchange of appropriate information
- basic public health education programme
- creation of local interest, participation and involvement
- preparation of draft guidelines on design, operation, maintenance and management
- preparation manual for plant operator in local language
- preparation and start training course for plant operators
- allocation of national and local funds
- various other motivational activities

base line studies in location selected

6 months

II. REALIZATION VDP

continuation of preparation of the soil activities
promotion and guidance community participation
construction VDP
on-the-job-training operator
testing and applied research on VDP following programme of investigations

6 months

III. DEMONSTRATION AND TESTING

continuation testing and applied research programme
continuation training-on-the-job
improvement manual
improvement draft guidelines
demonstration: audio-visual (local, national, regional and international)
preparation of various publication (guidelines and Handbook)
planning and set-up of seminars
further contacting national and international organizations with regard to the development of large scale implementation programmes
transfer of VDP to villagers

3 months

IV. FOLLOW-UP

organization seminars
set-up training courses and centres
expert meeting to review and evaluate the programme
development national programmes to introduce the construction of SSF in national development programmes in rural water supply and sanitation
allocation funds from national and international organizations
project evaluation

V. GENERAL ACTIVITIES

Literature studies
information exchange
clearing house function

EXPLANATION ON SOME ELEMENTS OF THE PROGRAMME OF ACTIVITIES

1. SELECTION AND CONSULTATION OF PARTICIPANTS

The selection and consultation of participants will be the first step of the implementation of the second phase of the slow sand filtration project. In selecting participants, the following criteria may be applied:

- satisfactory participation in the first phase of the project
- local conditions suitable for the application of slow sand filtration
- serious interest in the idea of integral approach and the demonstration character of the programme and thus in activities like motivation, training, education and international exchange of information
- possibilities and propects for adequate follow-up of the project, such as the set-up of large scale implementation programmes, preferably integrated in multi-sectoral development projects
- possibilities for the integration of present and future activities in

In addition to this it is intended to select the countries in such a way, that various geographical and climatological conditions are represented (plain and high lands, land and sea climate, desert, arid monsoon,or rainy areas).

Both for the purpose of selecting participants following the above criteria and for the further working out of the programme, extensive consultations are indispensible. In consulting the potential participants, several aspects will be discussed, such as: the general programme of activities, the possibilities for participation, the local programme of work, the establishment of a project managing committee, the development of a national infra-structure in the field of water supply and sanitation and the possibilities for the allocation of national or local funds.

Both reseach institutes and governmental authorities will have to be consulted with regard to the implementation of the activities planned for the second phase. Sometimes responsibilities of both kinds of organizations may overlap or are not precisely defined. With regard to this matter all institutes and organizations involved should be willing to prevent organizational problems in the future.

2. PROJECT MANAGING COMMITTEE

In each country participating in the programme, a Project Managing Committee (PMC) will be established. Representatives of both national and local governments and universities or research institutes will form the core of the committee. Next to them, representatives of the local executing agencies and additional advisers may also participate in the committee.

It may be considered to also include representatives of the communities concerned. The composition of the group may differ from country to country, depending on the social and cultural circumstances. The members of the project managing committees are supposed to contact and to inform each other regularly and the committee will meet officially about six times a year.

The main prupose of the establishment of project managing committees is to promote and to improve the collaboration between governmental authorities, ministries, universities, research institutes and executing agencies water supply and sanitation. An adequate collaboration within the country is considered to be a basic pre-requisite for an effective planning and coordination of the various activities and a necessary condition for a successful implementation of the project in the country concerned. This collaboration is very important with regard to optimizing the input in the programme from the side of the country itself.

The project managing committee will have an integral responsibility for the organization of the planned activities as well as for the staffing and the progress control of the programme. The group will also see to it that other national and local authorities concerned are informed and consulted and that the allocation of national and local resources and the development of a collaborative format for the implementation of various parts of the programme is worked out. In this connection it may turn out to be necessary that the responsibilities for the implementation of specific contractual commitments be divided between some of the institutions participating in the committee, related to their respective fields of competence and action. It is well recognized that in establishing a project managing committee and in promoting a spirit of collaboration as indicated above, a variety of social-cultural and professional constraints may have to be surmounted. However, it is considered worth trying, the more so as strong support in the legislative and executive branches of governments is essential in accomplishing the long-range programme objectives.

3. LETTERS OF AGREEMENT

The results of the aforementioned consultations form the basis of the letters of Agreement between the IRC and the national entities and collaborating institutions in the participating countries. It is anticipated that for a successful inplementation for phase two, firm agreements have to be made with both the research and development institutes and the national and local governmental agencies. It has to be investigated whether more than one contract is necessary or desired. This will vary from country to country and is very much depending on the division of tasks and responsibilities within the Project Managing Committee. In general it may be stated that the division of tasks need to be clearly defined to avoid duplication, competition and confusion of functional responsibilities. The various letters of agreement will be based on the World Health Organization standard contract form with the exeption of some slight deviations in the general conditions and completed with some supplementary conditions. An elaborated statement on investigations and other technical services will form an integral part of the Agreement.

4. SELECTION OF VILLAGES

The selection of communities and locations for the set-up of Village Demonstration Plants is the responsibility of the project managing committee. In developing criteria for this selection, various elements determining the scope of the programme will be taken into account. The actual selection will be made in close cooperation with the national authorities and local agencies concerned. Consensus in the project managing committee on both the criteria for selection and the suitability of the villages selected as well as on the feasibility of the planned activities is of utmost importance. It is intended to aim at different types of villages and towns in rural areas with populations ranging from 500 to 10.000. This will lead to a variety of designs of village demonstration plants. The IRC has a final say in the selection of the villages.
In selecting the villages it should be well recognized that the communities will not be equally receptive to public water supply, often due to differences in the degree of development already attained.
Experience from many countries indicates that water supply systems are better maintained, less abused and have a higher level of financial performance if the villages to be served are selected because they express a real interest in having a new or improved system. In general terms, a good sense responsibility for the water supply system is an important condition for effective community involvement and should consequently be one of the criteria for selection.
Also, the possibility of having the introduction of the water supply system integrated into a multi-sectoral development project would be a positive factor in the process of selecting a suitable demonstration location. Especially the combination with the development of an irrigation scheme will be encouraged.

5. DESIGN OF VILLAGE DEMONSTRATION PLANTS

On basis of the preliminary design criteria developed and the experiences acquired during the first phase, several plants, including pre-treatment, biological treatment and distribution devices will be designed. With a view to the research and development character of the programme it is most desired to have a broad scope with regard to the technical aspects of the design. This scope is determined by the various possible ways of applying and practising slow sand filtration and the operational alternatives. The various technical factors and physical variables influencing the design as well as the resulting embodiments are reviewed in a structured scheme of interrelations. It is expected that the natural conditions and local circumstances will turn out to be decisive factors in the development of an appropriate design. In this connection much attention will also be given to making optimal use of local resources and indigenous material. The development of a number of different designs for various capacities is anticipated:

- a single unit household filter,
- a river bed system with a handpump,
- a set of filters installed on the river bank, equiped with a simple and suitable pre-treatment system,
- a small but complete treatment plant including pre-treatment, slow sand filtration, mechanical pumping, storage and distribution, and
- a complete plant consisting of more pre-treatment and filtration units suitable for adequate and reliable water supply for a small town of about 10.000 inhabitants.

The design should be compatable with the availability of materials and equipment required for operation and maintenance of the plant.
In general community water supply development programmes should be planned to provide adequate quantities of safe water to meet all the needs of the population 24 hours a day throughout the year, in order to satisfy basic public health requirements. Whereas water for domestic use is the principal goal, the provision of water for cattle and local industries is of substantial importance to economic and social development and will contribute to the fiscal viability of the water utility.

6. PREPARATION ON THE SOIL ACTIVITIES

Information, education and motivation are essential elements of the 'preparation of the soil' and the 'guided introduction' of the new water supply provision into the villages.

Motivation is not an independent element of the programme. It is an essential and integral constitutent of the preparation of the soil and it forms the basis of various programme activities. It is means and purpose at the same time. It can only be brought about indirectly; for instance through a series of activities that have a motivating impact.

The main objective of such activities is to create a stronger sense of responsibility for the village water supply system. In this project, the motivation of the future consumers will be stimulated, among other things, by means of the transfer of appropriate information to the villages, a basic public health education programme, including related socio-economic apects and the promoting of community participation; these are all inter-related activities.

The transfer of appropriate information is to be regarded as part of the overall activity on information exchange which is an integral part of this project on slow sand filtration. In general, the selected transfer to the community of appropriate information on various aspects related to the realization of the village demonstration plant is considered to be essential to the motivation of the villagers as well as to the social acceptance of the system, and the promotion of local involvement. The preparation of such information will be the shared responsibility of the national project managing committee, the local agencies involved and the IRC.

A basic public health education programme on village level is to be prepared,preferably by the local health agency, and implemented in the community before the actual start of the construction of the village demonstration plant. The purpose of such a programme is to provide the villages concerned with the necessary background information on the relations that exist between the proper use of clean water and the individual and the community health situation. Following this, the expected beneficial influence of drinking treated water, that is reliable from a bacteriological point of view, will be indicated and explained to future consumers of the filtered water.
It will be considered to carry out a similar information programme on socio-economic aspects related to the use of purified drinking water, either in combination with the health education, or separately. In this connection, it will be investigated whether it is possible to make use of audio-visual information transfer methods in addition to printed matter.

Community participation will be encouraged and promoted, as much as possible, and with regard to all aspects of the realization of the village demonstration plants. It may be considered to set up a local project committee for the planning and progress control of the various activities to be inplemented. Representatives of the community will be invited to participate in this committee. Optimal use of local resources in terms of know-how, experience, labour and materials may also play a stimulating role. The allocation of some financial support to the project from the community itself, may considerably contribute to the local interest and involvement in the project. The same goes for the recruitment of the future plant operator from the village concerned.
Of course, self-help and thus the social and economic independence is regarded as the ultimate goal. However, when operating in different parts of the world at the same time, it should be well recognized that there are numerous interpretations of the idea and several ways of practising self-help as well as many gradations of community involvement.

7. CONSTRUCTION OF VILLAGE DEMONSTRATION PLANTS

A number of village demonstration plants, varying from one to three, will be set up in different parts of each country that participates in the project. The variety in designs and the call for locally appropriate technology will lead to a broad scala of construction alternatives. Simplicity and solidity will be the main criteria for the appropriateness of the construction.

The construction of the plant provides a good opportunity to visualize the input from the country itself. Optimal use will be made of local resources in terms of know-how, experience, labour, materials and finance, while the import of parts will be restricted to the bearest minimum. All actual work will be carried out by nationals; local engineers and contractors will be brought in and, if desired, also the assistance of a national consultant will be asked for.
And, of course, the actual participation from the villagers is considered to be the most important counterpart activity, with regard to the construction of the village plant.

8. PUBLIC HEALTH AND SOCIAL-ECONOMIC STUDIES

Next to the technical suitability of the slow sand filtration process, the effect of the introduction of the water supply on the well-being of the villagers is an important element in demonstrating the appropriateness of the system. The improvement of the individual and public health situation and the social and economic development are the main indicators of the possible impact of the system on the standard of living of the community.

For that reason, it is intended to set up impact studies on these two subjects, A profile of the community in terms of its social, cultural and economic organization is to be compiled, preceeding the implementation of the water supply scheme. Therefore a public health base-line study, if possible in combination with a socio-economic base-line study, will be carried out in the communities concerned. Follow-up and evaluation studies on both subjects are to be carried out at the end of the programme. Comparison of the results of both series of investigations may give an indication of the impact that the supply of treated water may have on public health situation and on the socio-economic development of a community.

It is evident that in developing and carrying out these studies, the cooperation of national and local health authorities and rural development specialists is indispensible. And, of course, also a sociological or anthropological advisor should be involved in these studies.

9. TRAINING ACTIVITIES

The need for trained manpower in community water supply continues as a critical problem in most of the developing countries. For that reason, training should be an integral and substantial part of all technical development programmes. As failures in water supply schemes are often caused by poor operation and maintenance and inadequate management, training efforts should especially focus on these items. There is a decided need for on-the-job training of semi-skilled labor, sub-professional supervisory personnel, professional personnel and administrative personnel. As far as this project on slow sand filtration is concerned, the training and education components will be mainly directed to the lower and middle echelons.

The training-course for the local operator of the village demonstration plant will be directed to imparting the skills that are specifically necessary for operation, maintenance and management of slow sand filtration plants as well as some craftmen skills in the field of piping, masonry and mechanics. In addition to printed information, such as an operators manual, preferably in the local language, also audio-visual course material will be used. And, of course, practical training on existing installations and/or equipment will form part of the programme. It is intended to train several operators and other skilled workers at the same time, thus enabling them to acquire feeling for collaboration and to gain experience in transfering to each other information related to the construction, operation and maintenance of a slow sand filtration installation. Therefore use could be made of local school facilities.

The establishment of training activities on a larger scale, in the later stages of this programme, will require assistance in planning the programme and training the local faculty and staff. In this connection it is considered to interlink the training components of this programme with IRC's over-all pro-ramme on training of water works personnel and if possible, also with activities of other inetrnational organizations operating in this field.

10. REGIONAL DEMONSTRATION SEMINARS

Extensive demonstration activities are planned in later stages of the programme. The very purpose of these activities is the creation and stimulation of the awareness that the application of slow sand filtration may considerably contribute to solving drinking water problems in various parts of the world. Especially the suitability and appropriateness of the system for application in rural areas is to be demonstrated. Therefore regional demonstration courses will be set up.

In addition to this, the need for local training programmes for operators, technicians and craftsmen will be emphasized. As future manpower requirements call for a broad spectrum programme, also training in the field of management and administraion will be stimulated. The development of demonstration and training facilities within the individual countries is considered to be a basic requirement for the creation of local capabilities.

The Village Demonstration Plants will play an important role in making acquired experiences and know-how public knowledge. The same goes for the series of guidelines on construction, maintenance and management of slow sand filtration plants. Also more specific means to transfer the available information may be used. Audio-visual presentations and programmed instructions are considered to be useful tools.
In this connection use will be made of slides, pictures, sketches and, if possible, also of films.

Through these seminars also policy makers and local authorities will get informed on the possibilities of slow sand filtration in rural water supply and will be motivated to consider the development of large scale implementation programmes.

11. MEETINGS OF INSTITUTIONS PARTICIPATING IN THE PROJECT

Two international meetings of representatives of the Project Managing Committee are planned for the second phase of the project. The main purpose of these meetings is to optimize the exchange of information on various aspects of the project. Participants will report on the progress made, compare and coordinate their activities with the programmes of the other participants and consult together on specific elements of the over-all programme.

At the same time these meetings provide good opportunities for strengthening personal contacts. This is considered to be very important, especially with regard to the desired intensification of mutual contacts, the stimulation of international collaboration and the promotion of an effective exchange of information directly between the participating countries during the whole project.

12. EXPERT MEETINGS

It is intended to organize some expert meetings in the context of this programme on the promotion of slow sand filtration. Those involved in research and development work on the larger slow sand filtration plants in Europe will be invited to attend this meeting: to review their work carried out in the recent past, to exchange views on the ins and outs of operating a slow sand filter and to coordinate their future work.
The actual reason for organizing these meetings is the expectation that much information with difficult access may be brought about. This information on operation, maintenance and management of slow sand filtration plants will be of the highest technical level. The resulting material will be made available to the project participating institutions, while publication of interesting findings will be encouraged.

13. FUNDING FOR FOLLOW-UP

Following the creation of interest for large scale implementation programmes on slow sand filtration in several countries, also the allocation of funds for these programmes is to be generated. Therefore various local, regional, national and international organizations will be approached. In this connection sound results of a successful research and demonstration project will be very valuable.

14. LITERATURE STUDIES

The literature survey on slow sand filtration and related simple pre-treatment methods will be continued during the whole programme. A preliminary list of references has already been prepared during the first phase and in collaboration with several institutions. This list only includes officially published references and it is recognized that, next to these, a lot of not officially published material like internal reports, case studies, notes from field trips, correspondence, drawings etc., are available in the field. As the slow sand filtration project focuses on practical solutions rather than on theoretical problems, this kind of information will be of great value. Therefore the survey will be specifically directed to making available difficult accessable material. Finally, the results of the survey will be presented in the form of a selected and annotated bibliography.

15. INTERNATIONAL EXCHANGE OF INFORMATION

The promotion of international exchange of information on slow sand filtration and related subjects is a permanent activity in this programme. Next to the institutions directly participating in the project, many other national and international organizations operating in the field of water supply and sanitation will be involved in this action.
In general, the developing countries do not have any basic data for planning national programmes or for designing individual projects. Therefore it is planned to start the collection, analysis and distribution of data and to set up clearing-house centres on slow sand filtration and related subjects in several countries as aoon as possible. In future these centres may function as national and regional information seedingcores, thus embodying the generating character of this project.

It will be considered to interlink these information exchange activities with the operational programme for global exchange of information in water supply and sanitation. At present this programme is in development at the IRC by order of the Ad Hoc Working Group on Rural Potable Water Supply.

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT II - 2

Presentation of proposal for the programme of work for phase II in Ghana

by

Mr. J.W. Boateng

PROPOSAL FOR PHASE II

1. SELECTION OF VILLAGES

The Project Managing Committee, which comprises representatives from the Ghana Water and Sewerage Corperation and from the University of Science and Technology Kumasi, has five villages in view. These villages are within 32 kilometers radius of the University. However, the Committee has the intention to only select two of the villages, because this will facilitate effective supervision and monitoring of the demonstration plants and of the existing pilot plants in Owabi. The villages that would be selected, have a population of 3,000 each with a plant capacity of 135 m^3/day.

2. FINANCE

The selected villages should be situated within the National Water Plan, as this will make the financing and the implementation of the project much easier. In this way it will be possible for the Central Government to finance the construction of the plant and the distribution network. The operation and maintenance of the system will form part of the normal functions of the Ghana Water and Sewerage Corporation. In this regard, the Ghana Water and Sewerage Corporation will have to appoint staff to work on the project on a full time basis.

3. DESIGN

The demonstration plants will be jointly designed by the Ghana Water and Sewerage Corporation and the University of Science and Technology Kumasi. The design criteria will be based on the results obtained so far from phase I of the Slow Sand Filtration Project. The design together with the estimated cost will have to be ready by 31st March, 1977, so as to enable the estimations to be included in the Ghana Water and Sewerage Corporation budgetary allocation for the fiscalyear beginning 1st July, 1977.

4. CONSTRUCTION OF VILLAGE DEMONSTRATION PLANTS

Although we recognise the concept of community participation in the construction of the plants, experience has shown that whenever this approach is adopted, the project will no doubt be delayed because of organizational problems. Secondly, once the local people have participated in the project, they are generally of the opinion that water services provided by the Ghana Water and Sewerage Corporation should be free of charge and this attitude makes the water rate collection very difficult.

5. FOLLOW-UP

Although the demonstration plants will be run and maintained by the Ghana Water and Sewerage Corporation staff on a full time basis, the Project Managing Committee will follow up with the monitoring and the observation of the performance of the plant.

6. OTHER ACTIVITIES

a. Apart from the two demonstration plants proposed above, we also intend to install a third plant of the same capacity at an existing rapid gravity filter plant for comparative study. This third plant will be located in Koforidua, which is 75 km of Accra.

b. Household Sand Filter: experiments are being carried out on household slow sand filters at the University of Science and Technology and it is hoped that by the time that phase II will start, design criteria will have been established to allow demonstration units to be installed in selected homes.

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT II - 3

Presentation of the Proposal
of the Programme of work for
phase II of the Slow Sand Filtration Project

in India

by

Mr. R.T. Ingawale

INTRODUCTION

It would not be out of place if at the outset, I say something about my country and also about the Government of Maharashtra having relevance to the subject under consideration. As you all know the provisions of safe water supply has received due attention since indenpence in India and the outlay provided for this went up from Rs. 49 crores in the first Five Year Plan to Rs. 438 crores in the 4th Five Year Plan. Much large outlay is expected to be spent in the 5th Five Year Plan. Our of 2,921 towns in India 1,674 towns are expected to have been provided with piped water supply by the end of Fourth Plan. In the Rural Section out of total number of 5,67,169 villages, 1,52,475 villages are classified as difficult ones, out of which 28,830 villages have been provided with piped water supply.

Coming to the State of Maharashtra which has an area of 3,70,762 Sg. K.M. and population of 5.04 crores (1971 census). There are 222 Municipal councils and 5 Corporations having a total population of about 149.69 lakhs. Except 3 or 4 Municipal Councils out of the above, others have been provided/ are being provided with piped water supply schemes. The left over 3 or 4 schemes refered to above are also likely to be taken up and completed in the Fifth Five Year Plan. It could thus be said that the entire urban area is almost covered with the facility of piped water supply. In case of Rural section out of 35,851 villages, 8,400 villages have been classified as difficult ones. By March 1974 about 2,400 villages were provided with water supply arrangements. The balance villages are expected to be covered in a Fifth Five Year Plan i.e. March 1979. On an average the present annual outlay is of the order of about 20 crores for water supply and sanitation.

For water supply the source is surface water (either flowing or impounded) and underground water. When surface water is used the same is treated either with rapid sand filters or slow sand filters process and supplied after chlorination. The underground water is tapped by providing an open well or by providing infiltration works where the conditions are suitable for the latter.

It would thus be seen that the programme which we are considering today is part of our activity and as such we can take a very active part therein, in collaboration with WHO-IRC, The Hague and NEERI, Nagpur.

OBJECTIVES OF PHASE I AND II

This meeting is for the appraisal of the Phase I of the project and the observation taken on Slow Sand Filters which are in existence at present. The conclusion drawn out of these observation are to be demonstrated by constructing village plant in the participating countries. This demonstration will include continuation of the observation on these new plants to see whether they collaborate with the observation already taken on the existing ones. The other material benefit of these village demonstration plants would be a point of study of phase II of the project.

SELECTION OF LOCATION FOR VDP

Under phase II of the Project preparatory activities are to be started immediately after this meeting. As for India so far three states have been chosen for constructing V. D. P.'s for phase II. Other states if considered for inclusion would also be considered for constructing V. D. P.'s

The preparatory activities are spread over a period of 9 months. It was decided by the Project Managing Committee in India that certain broad criteria may have to be laid down by WHO-IRC for selection of these demonstration plants, though of course it was unanimously decided that the selection of location should be left to the participating countries. The follwoing would be some of the criteria for deciding upon the selection of the V. D. P.'s.

1. The plant should be in Rural area and the present population of village may be within the range of 500 to 10,000.

2. If the source is a surface water, the turbidity of water should not be above 50 ppm.

3. If conditions are favourable for providing infiltration works, then river works and the purification works could be combined in the combined drawal arrangement and the scheme with such an arrangement would also fall under the criteria for acceptance as V. D. P. in Phase II.
4. Any other special criteria for selecting particular village for the VV V. D. P. as deemed necessary for the participating countries.

ALTERNATIVE TO PROPOSALS

It may not be out of place if we deal with the situation in brief as to where the infiltration works are usually provided. In India and, in particular in Maharashtra, most of the rivers excluding the big ones are not perennial. The flow in the river dries up sometime in February/March. At the same time some of the rivers have got sandy bed with depth ranging from 3 to 10 Ft. This sandy bed holds substantial quantity of underground water, which, if drawn is likely to be sufficient for community water supply on the banks of such rivers. The only alternative to have more reliable source of water supply for such places would be to provide a storage impounded on these rivers. But such proposals are very costly and beyond the means of the villages making the scheme infeasible in regard to the criteria laid down for taking up a particular scheme as Rural Water Supply Scheme. It is in such situation that we avail of the underground storage of water available in the sandy bed which suffices for the summer period of about 3 - 4 months. This type of system also brings down the cost of the scheme from the capital outlay point of view and also from the maintenance point of view.

The study of slow sand filters is taken up because of its simplicity and efficiency and because the same may prove to be an economical way of providing purification works for a small community.

PROPOSAL FOR THE CONSTRUCTION OF THE V. D. P.

For the location of the VDP in Maharashtra a village called Burjwada (about 40 KM from Nagpur) is tentatively selected. The Project Managing Committe has carried out necessary survey and investigations and it is found that the scheme could be formulated to fit into phase II programme with infiltration works in the river Kolar which is flowing by the side of the village. The details of this scheme would be as per enclosed sheet.

Even though this village has been selected for providing a VDP, it is not certain that the State Government would approve it finally.

In India the State Governments where these VDP's will be constructed are well equipped with organisations to construct such scheme and as such the construction part wouldbe left very conveniently to the concerned Government.

INFORMATION COLLECTION

On construction of the V. D. P.'s it is proposed to continue the testing and applied research programme in these VDPs. One of the main intentions of this project is to have an involvement of the local people. Even the State Governments in India have the same view. However, having constructed these VDP's it would be desirable to employ personnel who would run VDP and at the same time take observation at least for a period of two years so as to know the realisationof the programme. The experience shows that the water supply systems when handed over to concerned community are not maintained up to the expectations and in particular the data collection is alway lacking. As such it is felt that the cost of such personnel should be met with from the project funds for the period of first two years of their construction. There would be only one person who would be able to run the pumps and at the same time take observations as contemplated under the project. During this period of two years he may also train the local personnel who would then take over the installation for further running and also for collection of further data.

BORUJWADA VILLAGE WATER SUPPLY SCHEME

PRINCIPAL FEATURES

1. GENERAL :-

i) NAME OF VILLAGE :- BORUJWADA.

ii) TAHSIL & DISTT. :- SAONER. IN NAGPUR (INDIA)

2. POPULATION & POPULATION FORECAST :-

CENSUS OF	(1971)	- 597 SOULS.
PRESENT STAGE	(1976)	- 672 SOULS.
IMMEDIATE STAGE	(1991)	- 933 SOULS.
ULTIMATE STAGE	(2006)	-1315 SOULS.

3. RAIN FALL :- AVERAGE - 1073 MM.

RATE OF WATER SUPPLY :-

70 LITRES/HEAD/DAY IN ALL THE 3 STAGES.

WATER REQUIREMENT :-

PRESENT STAGE	(1976)	- 0.047 MLD.
IMMEDIATE STAGE	(1991)	- 0.065 MLD.
ULTIMATE STAGE	(2006)	- 0.092 MLD.

5. SOURCE :- KOLAR RIVER.

6. PROPOSED WORKS :

(1) JACK WELL :-

(i) LOCATION :- ON THE LEFT BANK OF THE RIVER KOLAR NEARLY 50KM.AWAY FROM THE VILLAGE BORDER.

(ii) SIZE :- 4.0 M DIA AND 7.6 M.DEPTH.

(iii) MASONRY :- C.R.STONE MASONRY II SORT.

(2) INSPECTION WELL :-

i) DIA :- 1.5 M.
ii) LOCATION :- IN THE RIVER BED,8 M.LONG.
iii) MASONRY :- C.R.STONE MASONRY II SORT.

(3) INFILTRATION GALLARY :-

i) DIA :- 450 MM DIA R.C.C.SLOTTED PIPE.
ii) LENGTH :- 8 M.

(4) PUMPING MACHINERY :- 2 BHP SUBMERSIBLE PUMPS - 2 NOS.(ONE WILL BE STAND BYE)

(5) RISING MAIN :-

DIA AND TYPE :- 80 MM.Ø CI 'LA' CLASS.
LENGTH :- 100 M.

(6) E.S.R. :- CAPACITY.-~~XX~~,35,000 LITRES WITH 5.5 M.STAGING HT.

(7) DISTRIBUTION SYSTEM :- 80 MM. DIA A.C.PRESS,PIPES.- CLASS-I- 215 M.

NO.OF STAND POSTS :- 3 NOS.

(8) MISCELLANEOUS WORKS :-

i) CHLORINE DOSING :- WITH GRAVITY FEED B.P.SOLUTION APPRATUS.
ii) CONTROL ROOM :- A TIN SHED STRUCTURE OF 2 X 2½ M.SIZE LOCATED ABOVE HFL NEAR JACK WELL.

DHOTE/*

ADYAL VILLAGE WATER SUPPLY SCHEME

PRINCIPAL FEATURES

1) GENERAL

i) NAME OF VILLAGE :- ADYAL.
ii) TAHSIL & DISTRICT :- BHANDARA- BHANDARA (INDIA)

2) POPULATION & POPULATION FORE CAST.

CENSUS OF (1971) :- 7,496 SOULS.
PRESENT STAGE (1973) :- 8,000 SOULS.
IMMEDIATE STAGE (1988) :- 9,500 SOULS.
ULTIMATE STAGE (2003) :-11,000 SOULS.

3) RAIN FALL : AVERAGE :- 1326.00 MM.

4) RATE OF WATER SUPPLY :- 70 LITRES PER HEAD PER DAY.
DAILY WATER REQUIREMENT

PRESENT STAGE (1973) :- 0.56 MLD.
IMMEDIATE STAGE (1988) :- 0.625 MLD.
ULTIMATE STAGE (2003) :- 0.77 MLD.

5) SOURCE :- WAINGANGA RIVER.

6) PROPOSED WORKS

1) JACK WELL :
i) LOCATION :- ON THE LEFT BANK OF RIVER WAINGANGA.
ii) SIZE. :- 60 M. DIA AND 20.0 M. DEPTH.
iii) MASONRY :- C.R.STONE MASONRY IIND SORT.

2) INSPECTION WELL :- 2 NOS.
i) LOCATION :- IN THE RIVER BED.
ii) SIZE :- 2.5 M.DIA & 4.0 M. DEPTH.
iii) MASONRY :- C.R.MASONRY IIND SORT.

3) INFILTRATION GALLERY
i) DIA :- 450 MM.DIA R.C.C.SLOTTED PIPE.
ii) LENGTH. :- 100 METRES.

4) INTAKE WELL
i) LOCATION :- ON THE LEFT BANK OF WAINGANGA RIVER.
ii) DIA. :- 2.50 M.DIA & 5.0 M DEPTH.
iii) MASONRY :- C.R.MASONRY IIND SORT.

5) CONNECTING PIPE.
i) DIA. :- 200 MM. C.I.
ii) LENGTH :- 200 M.

6) PUMPING MACHINERY
DEEP WELL TURBINE PUMPS COUPLED TO AN ELECTRIC MOTOR OF 20 B.H.P. - 2 NOS.
(ONE WILL BE STAND BYE)

7) RISING MAIN :
i) DIA AND TYPE :- 200 MM.DIA C.I.CLASS-IA.
ii) LENGTH :- 1740 M.

8) SERVICE RESERVOIR.
i) GROUND SERVICE RESERVOIR.
ii) CAPACITY :- 2,80,000 LITRES.
iii) MASONRY :- C.R.MASONRY.

9) DISTRIBUTION SYSTEM.
i) C.I.PIPES :- 3,829 RMT.
ii) A.C.PRESSURE PIPE CLASS-I :- 4,154 RMT.
iii) STAND POSTS :- 12 NOS.

10) DISINFECTION
SIMPLE CHLORINATION DEVICE AT G.S.R.OF GRAVITY FEED
B.P.SOLUTION APPARATUS.

who international reference centre for community water supply

postal address: p.o. box 140, leidschendam, the netherlands
office address: nw havenstraat 6, voorburg (the hague)
telephone: 070 - 69 42 51, telegr.: worldwater the hague, telex: 33604

SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT II - 4

Slow Sand Filtration Project

Proposal for participation in the second phase of the project

by Nelson N. Waweru

Environmental Health Division

Ministry of Health - Kenya

SLOW SAND FILTRATION PROJECT

(Kenya Component)

PROPOSAL FOR PARTICIPATION IN THE SECOND PHASE OF THE PROJECT.

By Nelson N. Waweru

ENVIRONMENTAL HEALTH DIVISION

MINISTRY OF HEALTH - KENYA

In Consultation and on behalf of the Kenya Project Management Committee.

1. INTRODUCTION:

From 1960 - 1972, under the Environmental Sanitation Programme the Ministry of Health with assistance from WHO/UNICEF designed and completed approximately 560 Small Rural Water Supplies in various parts of the country each serving populations ranging from 500 - 2500. Owing to the urgent need for water supply in the rural areas most of the supplies were developed without treatment devices. However it was programmed to introduce Slow Sand Filtration plants into these schemes as a second phase development and a considerable number of these filters has already been completed while a few are presently under construction.

The Environmental Sanitation programme succeeded in making most of the rural population aware of the importance and advantages of permanent piped water supply with consequent development of several water supplies on Self Help basis not withstanding the demand for clean and wholesome water supply. We therefore have great potential and possibilities for the application of slow sand filters in Kenya and hence our interest and active participation.

2. PHASE II ACTIVITIES.

The components of this programme comprises of:-

(a) The programme of investigations

(b) Basic Public Health and Socio Economic surveys.

(c) Selection and location of village demonstration plants.

(d) Health Education and motivation.

(e) Design and construction.

(f) Funding of village demonstration plants.

(g) Training Local operators.

(h) External funding requirement.

(a) The programme of investigations. The Department of Civil Engineering University of Nairobi will continue to monitor the experimental pilot installations at Kabete water works and carry out further studies of the existing slow sand filters in the country in collaboration with the Ministries of Health and Water Development and Nairobi City Council in order to build up adequate and conclusive data necessary to determine the design criteria etc. for our future village demonstration plants.

(b) Basic Public Health and Socio Economic Surveys. The Department of Community Health - University of Nairobi will carry out this survey whose main objective is to determine whether the introduction of a slow sand filter to a rural water supply will have a favourable effect (impact) on the health of the population served. A base line study of water associated diseases in the area selected will be carried out at different seasonal conditions (at the end of dry season and at the beginning of the rains) prior to the installation of the slow sand filter. A similar (follow-up) survey will be carried out after one year of the commission of the filter during the same months to give comparable results. Owing to the interdependence of infection and malnutrition a clear understanding of the nutritional status of the sample population will also be investigated. It is felt that follow up surveys should be carried out for longer periods of more than a year to cover possible epidemics during the study period.

(c) Selection and location of Village Demonstration plants. Preliminary investigations into the possibilities of the installation of the demonstration plants have already been carried out in two schemes namely Kiaria in Kiambu District, and Kisekini in Machakos. We propose to construct our first Demonstration plant in Kiaria for the following reasons:-

1. About 80% of the population covered by the scheme is served with water through individual connections.
2. The ecological and economic situation is favourable for the public health survey.
3. The control and study group for the survey are in the same ecological area and hence favourable for the health and socio economic survey.
4. The population density is also suitable for the survey.
5. The project is within a reasonable distance from Nairobi and is easily accessible to the scientists carrying out relevant investigations.
6. There is a strong and active self help committee.

Kisekini water scheme is not suitable for the installation of the village Demonstration plant since the population served is presently very small. However, plans are vigorously underway to augment the source and extend the water to cover greater population and it is certainly a potential area for realistic studies and investigations on slow sand filtration. Kisekini population will be served with communal stand pipes and it will offer good comparable studies with Kiaria where individual connection supply system is preferred.

We are in the process of determining other sites for the Demonstration plants and we shall communicate our recommendations to the IRC for necessary comments and advise.

(d) Health Education and motivation. Following the preliminary health survey, the Ministry of Health in collaboration with the Ministry of Housing and Social

Services will carry out a health education and motivational campaign in order to provide the population in question with the necessary information on the advantages and relationship between utilisation of clean water and health. It is strongly felt that such campaign will enlighten them and provide an incentive for community participation which is considered essential for the success of the programme.

(e) Design and Construction. Arising from the conclusions drawn from our investigations of the pilot plants and the existing filters and any other relevant information from elsewhere we propose to design slow sand filters suitable to the local conditions and circumstances. We intend to hire competent locally available contractors to construct the filters. In order to maintain the spirit of Community participation, unskilled manual labour is expected to be provided by local people.

(f) Funding of Village Demonstration plants. Self help(community involvement) is a way of life in Kenya and we do not expect to encounter problems in motivating the community to participate fully to the programme.

Notwithstanding the community participation and involvement, we are fully conscious of their financial capabilities and their capacity to raise funds and while they may be willing to contribute towards the projects it may take considerable time to generate substantial amounts for the constructional works to commence. Unskilled manual labour from the community is certain but we cannot estimate the financial contribution that could arise from the community.

(g) Training Local Operators. Our thoughts in this programme are similar to the suggestions made by the IRC. When the filters are completed the local people will select a person of their choice for the maintenance and operation training and we shall take the responsibility of providing the necessary skills.

We have had preliminary discussions with UNICEF on this subject and they are willing to assist us in this respect.

(h) External funding requirement. In addition to our request for the filter construction funds we also require additional funds for the basic public health and socio-economic studies. The details of these estimates are shown in Appendix I.

CONCLUSION.

Owing to the great possibilities and potentialities of the application of slow sand filters in this country we are anxious to proceed with the second phase and to exchange information and experiences with the other project participating countries.

As the future development of the project to a large extent will depend on the activities and results of the second phase and in view of the encouraging results we have already received in our first phase, we are determined to put all that is within our capacity to sail the programme to success and we are sure that with the existing spirit of collaboration and international co-operation we shall succeed.

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT II - 5

Demonstration Full-scale Slow Sand Filters in Sudan

by

Mr. A. Abdulla

Sudan Gezira Board

Barakat

Sudan

PHASE II : DEMONSTRATION FULL-SCALE SLOW SAND FILTERS IN SUDAN

by Mr. A. Abdulla

LOCATION:

It is highly recommended to carry out the programme of phase II of Sudan in the Gezira area. The reasons for this choise are:

1. The area is near to Khartoum and the members of the Working Group will have no difficulty in visiting it for carrying out tests and for supervision purposes;
2. Surface water is available all the year round in the Gezira area from irrigation canals.
3. Gezira villages are in need of potable water supply and this is why an extensive programme of providing water supply has been going on in the area for over 25 years.
4. Local building materials and artizans can easily be made available in the area for construction.

As for location within the Gezira area, I suggest that two villages in the North-Western part of the Gezira be chosen for the project for the first reason listed above. The choice of the two villages is expected to be fairly easy, taking into consideration the probable sizes wanted.

CONSTRUCTION:

1. Materials:
   The best type of design is assumed to make use as much as possible of the available local materials and hence the use of reinforced concrete together with red bricks will be feasible. Sand, gravel and bricks can be purchased from the surrounding locality whereas cement and reinforcement steel can be purchased from Khartoum. The only items that may be difficult to find on the local market may be the pumping units and the over-head storage tanks. The possibility of local fabrication can be looked into or otherwise importation from outside the country may be inevitable.

2. Method of construction:
   Three methods of construction are adopted by us in the Gezira area for construction, namely:
   a) by contract where the contractor provides all materials and labour;
   b) direct labour;
   c) a combination of the two, where the emplöyer provides the materials and the contractor provides the labour and the implements.

   For many reasons we found it better in the remote areas like the suggested areas to adopt the first method, that is by contract. Therefore I would recommend this method.

SOCIOLOGICAL:

Villages in the Gezira have a good deal of education and knowledge and they have their local councils, societies, groupings and social clubs. These can be useful in many aspects of the project, e.g.

1. running of the filters;
2. data education;
3. cleaning and maintenance;
4. to help in the construction by providing labour.

Rural Water Supply Division
Department of Health
Ministry of Public Health
Bangkok
Thailand
Mr. L. Chainarong

Preliminary Survey

Village ....Klang.... Amphur ....Muang.... Province ....Patumthani....

1. Houses ....100.... Population ....500....

2. Present Water Usage

Source ....River.... For ....Drink. & Other....

Source .... For ....

Source .... For ....

3. Raw water source to be used for water supply

✓River Canal Reservoir Deep Well

Others ....

3.1 Capacity of the source ....enough through the year round.

3.2 Qualities of raw water

Turbidity ✓High Medium Low

Odor Yes ✓No

Colour ....Gray Brown....

Taste ....No....

algae Yes ✓No

Other singnificant impurities ....–....

....

4. Area available for plant construction ....✓....M^2

5. Villagers interested in obtaining water supply ✓High Low

6. Any contribution from village

6.1 ....Land....

6.2 ....

6.3 ....

Social and Economical Studies

1. Highest school level in the village, grade ....12..........

2. Distance to the nearest 12th grade school ....–..........km.

3. Villagers vocation

Rice Growing ....20......... %

Farming ....1......... %

Trading ....25......... %

Government Officer .....50..... %

Labor ....4......... %

Average yearly income .....20,000.....baht

4. Building and Facilities

Water Supply	Yes	✓No
Electricity	✓Yes	No
School	✓Yes	No
Health Office	Yes	✓No
Mill	Yes	✓No
Temple	✓Yes	No

5. Local administration .....✓.....

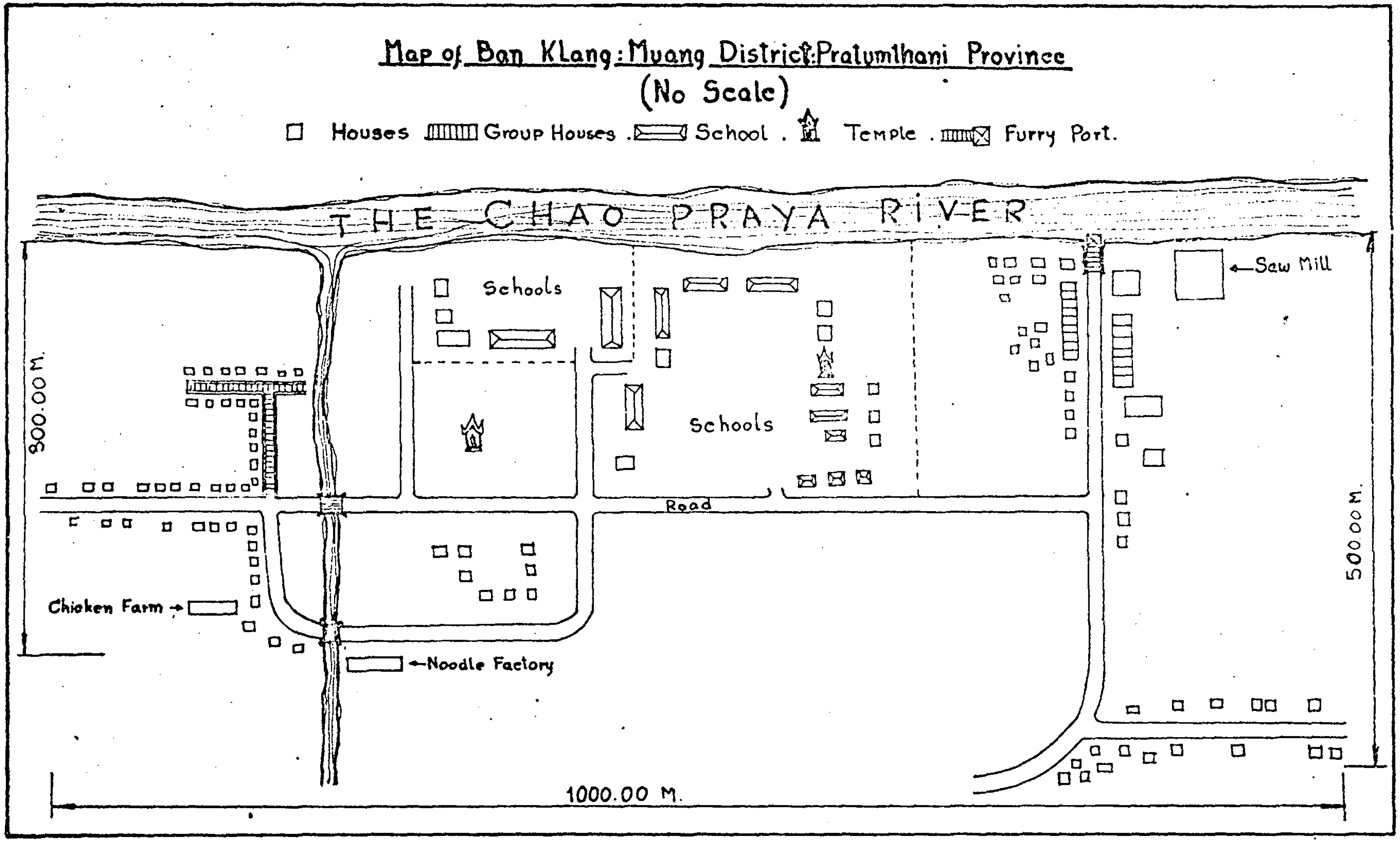
chief Village Head

Committee .....✓.....

....

....

....


Map of Ban Klang: Muang District: Pratumthani Province
(No Scale)
Houses
Group Houses
School
Temple
Furry Port.
THE CHAO PRAYA RIVER
Schools
Schools
Saw Mill
300.00 M.
500.00 M.
Road
Chicken Farm
Noodle Factory
1000.00 M.

Preliminary Survey

Village ....Pai Nong.... Amphur ....Nakorn Laung.... Province ....Ayudhaya....

1. Houses ....215........ Population ....1,253........

2. Present Water Usage

   Source ....The Pasak River.... For ....Drinking & consumption....

   Source ....Rain.... For ....Drinking....

   Source .... For ....

3. Raw water source to be used for water supply

   River ✓Canal Reservoir Deep Well

   Others ....

   3.1 Capacity of the source ....

   3.2 Qualities of raw water

   Turbidity ✓ High Medium Low

   Odor Yes No

   Colour ....Red..

   Taste ..Tasteless........

   algea ✓Yes No

   Other singnificant impurities ....–........

   ....

4. Area available for plant construction ....400 - 500........ M^2

5. Villagers interested in obtaining water supply ✓High Low

6. Any contribution from village

   6.1 ..any contribution..

   6.2 ..can be negotiated..

   6.3 ....

Social and Economical Studies

1. Highest school level in the village. grade ......1 - 7......

2. Distance to the nearest 12th grade school ......30......km.

3. Villagers vocation

   Rice Growing ......10...... % knife small industry 80%

   Farming ......-...... %

   Trading . ...5...... %

   Government Officer ......2...... %

   Labor ......3...... %

   Average yearly income ..4,000 - 6,000...... baht

4. Building and Facilities

Water Supply	Yes	✓No
Electricity	✓Yes	No
School	✓Yes	No
Health Office	✓Yes	No
Mill	Yes	✓No
Temple	✓Yes	No

5. Local administration ......✓......

chief Village Head

Committee Mr. Banyat Kamori

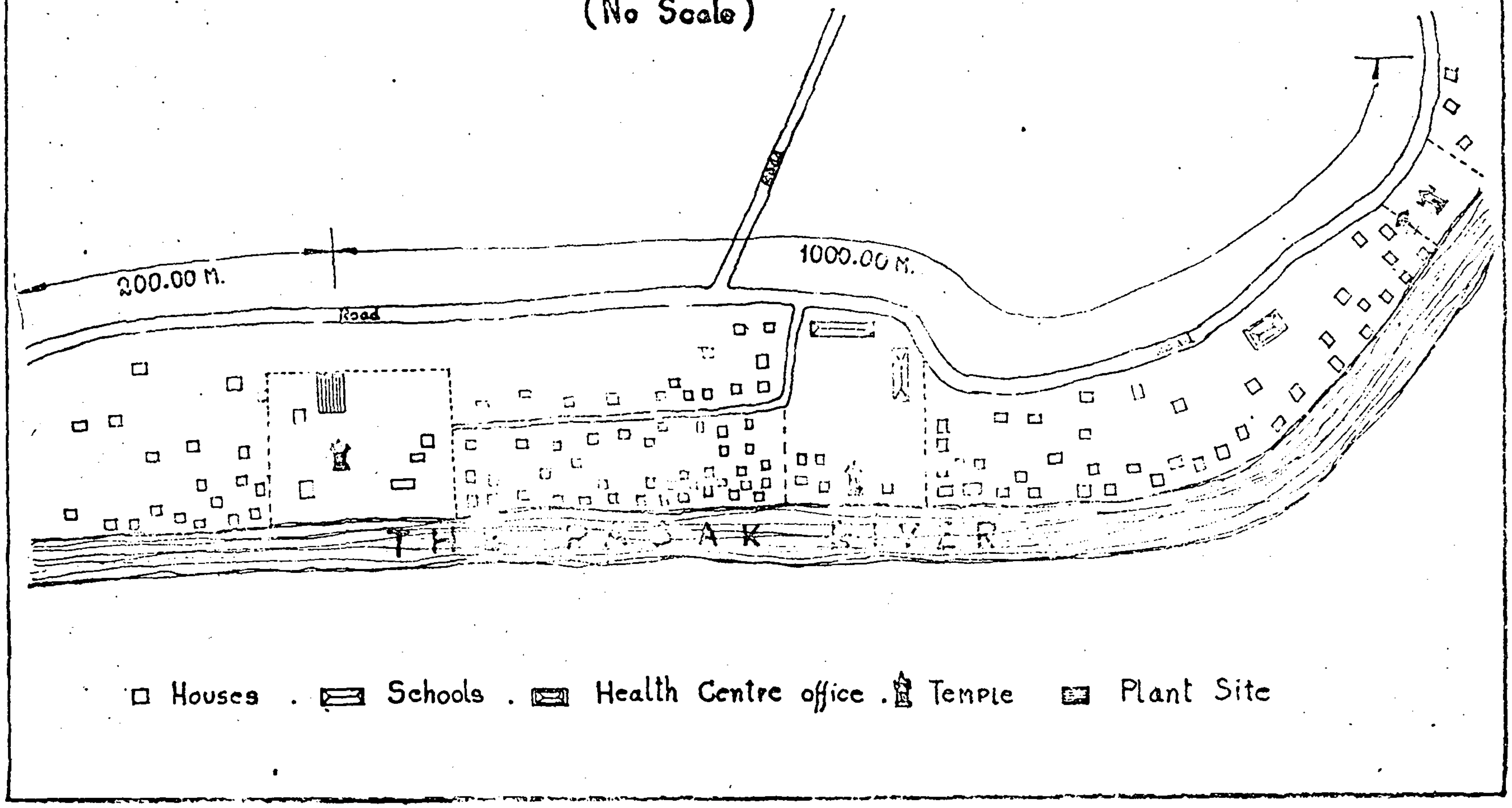
Mr. Tongdee Chalermwat

Policeman : Mr. Somphan Pathison

Policeman : Mr. Prasith Suthipram

Map of Ban Pa[illegible] : Nakom Lueng District : Ay[illegible] Province

(No Scale)



Preliminary Survey

Village ....Koke Toom.... Amphur ....Muang.... Province ....Lopburi....

1. Houses ....501.... Population ....2500....

2. Present Water Usage

   Source ....Rain.... For ....Drink....

   Source ....Deep Well.... For ....Use (High Hardness)....

   Source .... For ....

3. Raw water source to be used for water supply

   River   Canal   ✓Reservoir   Deep Well

   Others ....

   3.1 Capacity of the source ....9,000,000 M^3....

   3.2 Qualities of raw water

   Turbidity   High   Medium   ✓Low

   Odor   Yes   ✓No

   Colour ....light green....

   Taste ....NO....

   algea   ✓Yes   No

   Other singnificant imprities ....–....

   ....

4. Area available for plant construction ....OK.... M^2

5. Villagers interested in obtaining water supply   ✓High   Low

6. Any contribution from village

   6.1 ....30,000....

   6.2 ....

   6.3 ....

Social and Economical Studies

1. Highest school level in the village. grade ....7.........

2. Distance to the nearest 12th grade school ....24..........km.

3. Villagers vocation

40 .... %

Farming ....90.......... %

Trading ....20.......... %

Government Officer .....15.......... %

Lobor ....5.......... %

Average yearly income ...30,000...........baht

4. Building and Facilities

Water Supply	✓Yes	No
Electricity	✓Yes	No
School	✓Yes	No
Health Office	✓Yes	No
Mill	✓Yes	No
Temple	✓Yes	No

5. Local administration ....Sanitary District.......

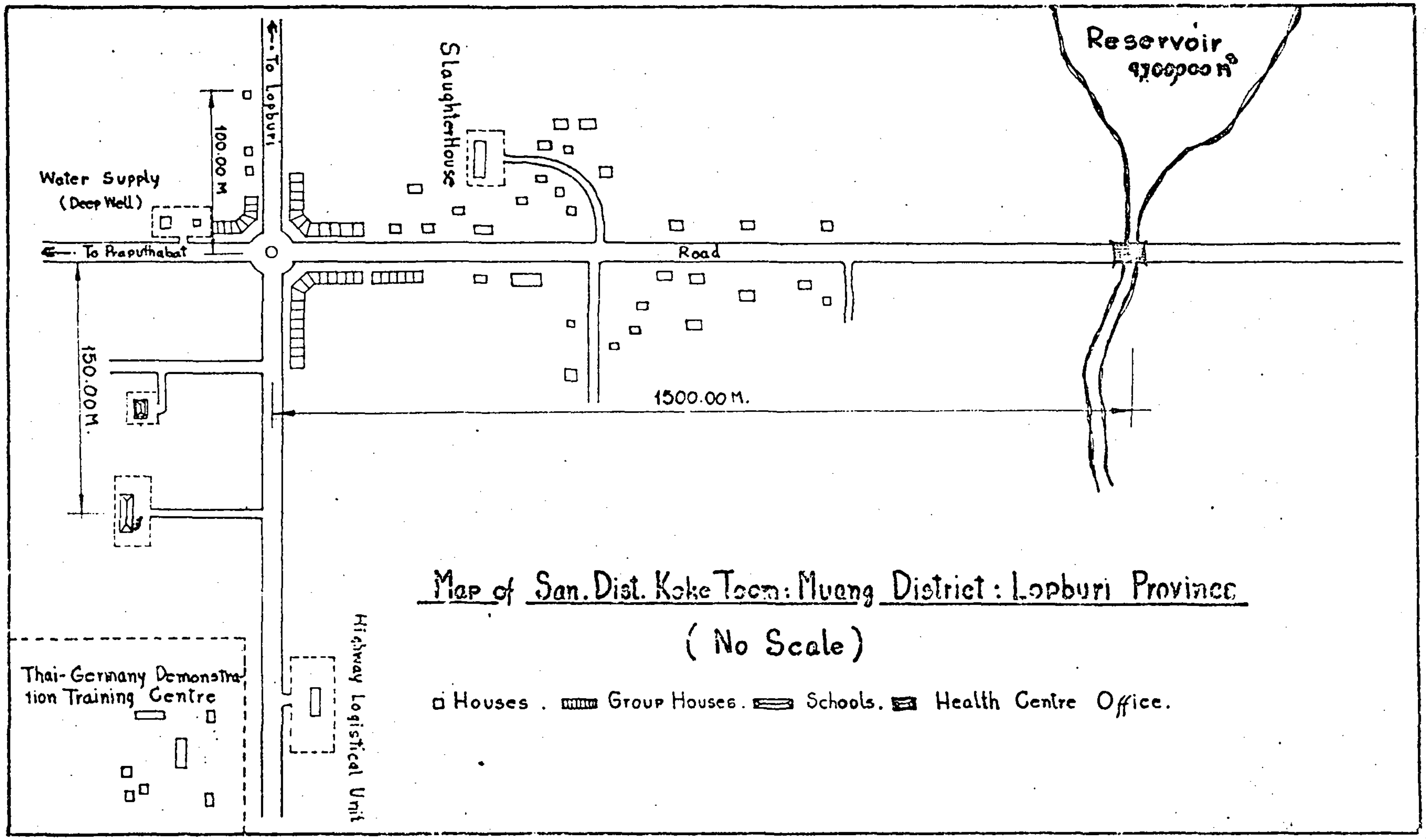
chief Village Head

Committee ....

....

....

....


Map of San. Dist. Koke Toom : Muang District : Lopburi Province
(No Scale)
Houses . Group Houses . Schools . Health Centre Office.
Reservoir
To Lopburi
Slaughterhouse
100.00 M
Water Supply
(Deep Well)
To Praputhabat
Road
150.00 M.
1500.00 M.
Thai-Germany Demonstration Training Centre
Highway Logistical Unit

Preliminary Survey

Village Bang Lao the 1st Amphur Muang Province Singhburi

1. Houses 153 Population 1,200

2. Present Water Usage

Source River For consumption

Source Deep Well For drinking

Source Irrigation Canal For consumption

3. Raw water source to be used for water supply

✓River ✓Canal Reservoir ✓Deep Well

Others ....

3.1 Capacity of the source enough

3.2 Qualities of raw water

Turbidity ✓High Medium Low

Odor Yes No

Colour red

Taste -

algae Yes No✓

Other singnificant impurities -

....

4. Area available for plant construction 200 M^2

5. Villagers interested in obtaining water supply ✓High Low

6. Any contribution from village

6.1 land from Mr. Kasem Kingmali

6.2 financial problem can be negotiated

6.3 -

Social and Economical Studies

1. Highest school level in the village. grade ....1 - 4..........

2. Distance to the nearest 12th grade school ....6..........km.

3. Villagers vocation

Rice Growing	..........90..........%
Farming	..........—..........%
Trading	..........13..........%
Government Officer	..........51..........%
Labor	..........2..........%
Average yearly income	..........12,000..........Baht

4. Building and Facilities

Water Supply	Yes	✓No
Electricity	✓Yes	No
School	✓Yes	No
Mealth Office	✓Yes	No
Mill	Yes	✓No
Temple	✓Yes	No

5. Local administration ....✓..........

chief Village Head	Mr. Kasem Kingmali
Committee	Mr. Chamroon Srisawang
	Mr. Chun Chornpanchu
	Mr. Sai Meedee
	Mr. Chiam Buthclee

Preliminary Survey

Village ....Bang Lao.... the 5th Amphur ....Muang.... Province ....Singburi....

1. Houses ....156.... Population ....907....

2. Present Water Usage

Source ....River.... For ....consumption....

Source ....Deep Well.... For ....consumption....

Source ....Canal.... For ....consumption....

3. Raw water source to be used for water supply

✓River ✓Canal Reservoir Deep Well

Others ....

3.1 Capacity of the source ....enough....

3.2 Qualities of raw water

Turbidity ✓High Medium Low

Odor Yes ✓No

Colour ....red....

Taste ....tasteless....

algae Yes ✓No

Other singnificant impurities ....-....

....

4. Area available for plant construction ....-.... M^2

5. Villagers interested in obtaining water supply ✓High Low

6. Any contribution from village

6.1 ....hard to get financial.... support

6.2 ....because of low income....

6.3 ....

Social and Economical Studies

1. Highest school level in the village. grade ....1 - 7........

2. Distance to the nearest 12th grade school ....6........ km.

3. Villagers vocation

   Rice Growing ....90........ %

   Farming ....-........ %

   Trading ....20........ %

   Government Officer ....10........ %

   Lobor ....3........ %

   Average yearly income ....6,000........ baht

4. Building and Facilities

Water Supply	Yes	✓ No
Electricity	✓ Yes	No
School	✓ Yes	No
Health Office	✓ Yes	No
Mill	Yes	✓ No
Temple	✓ Yes	No

5. Local administration ....decentralized....

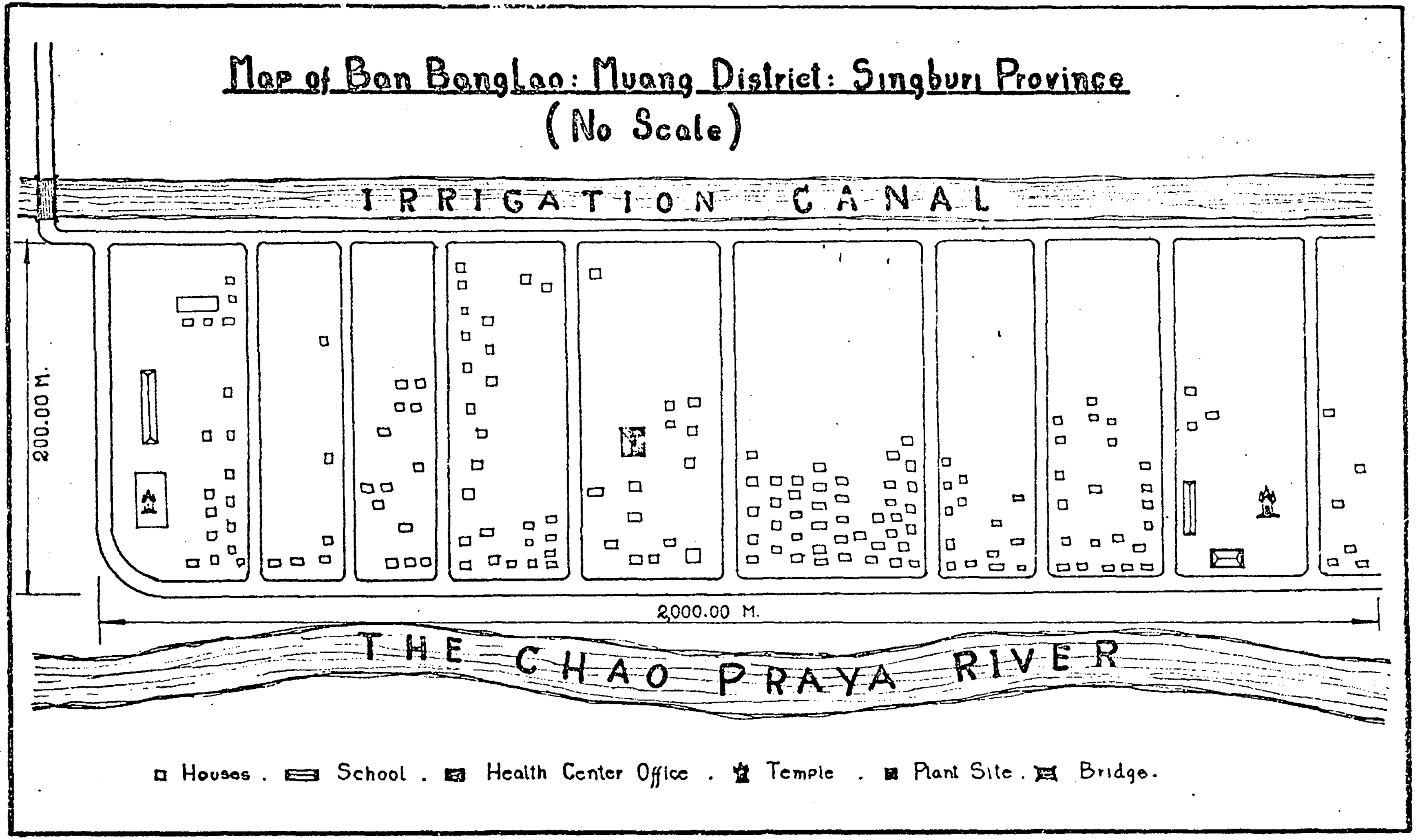
   chief Village Head ....Mr. Chalerm Kongkamee....

   Committee ....Mr. Chalerm Kongkamee....

   ....Mr. Wan Paichoo....

   ....Mr. Nam Boonpuang....

   ....Mr. Thawat Kongkamee....


Map of Ban BangLao: Muang District: Singburi Province
(No Scale)
IRRIGATION CANAL
200.00 M.
2,000.00 M.
THE CHAO PRAYA RIVER
Houses . School . Health Center Office . Temple . Plant Site . Bridge.

Preliminary Survey

Village ......Chung........ Amphur ......Nakorn Luang...... Province ......Ayudhaya......

1. Houses ......243...... Population ......1910......

2. Present Water Usage

Source ......Deepwell...... For ......Drinking......

Source ......Pond...... For ......Consumption......

Source ......Rain...... For ......Drinking......

3. Raw water source to be used for water supply

River ✓Canal Reservoir ✓Deep Well

Others ....

3.1 Capacity of the source ......enough......

3.2 Qualities of raw water

Turbidity High ✓Medium Low

Odor ✓Yes No

Colour ......green......

Taste ......-......

algeae ✓Yes No

Other singnificant impurities ......chemical impurities from fertilizers......

4. Area available for plant construction ......400...... M^2

5. Villagers interested in obtaining water supply High ✓ Low

6. Any contribution from village

6.1 ......financial can be negotiated......

6.2 ....

6.3 ....

Social and Economical Studies

1. Highest school level in the village. grade ....1 - 7........

2. Distance to the nearest 12th grade school ....7..........km.

3. Villagers vocation

Rice Growing ....80.......... %

Farming ....8.......... %

Trading ....2.......... %

Government Officer ....3.......... %

Labor ....7.......... %

Average yearly income ....5,000.......... baht

4. Building and Facilities

Water Supply	✓Yes	No
Electricity	✓Yes	No
School	✓Yes	No
Health Office	✓Yes	No
Mill	✓Yes	No
Temple	✓Yes	No

5. Local administration ....decentralized....

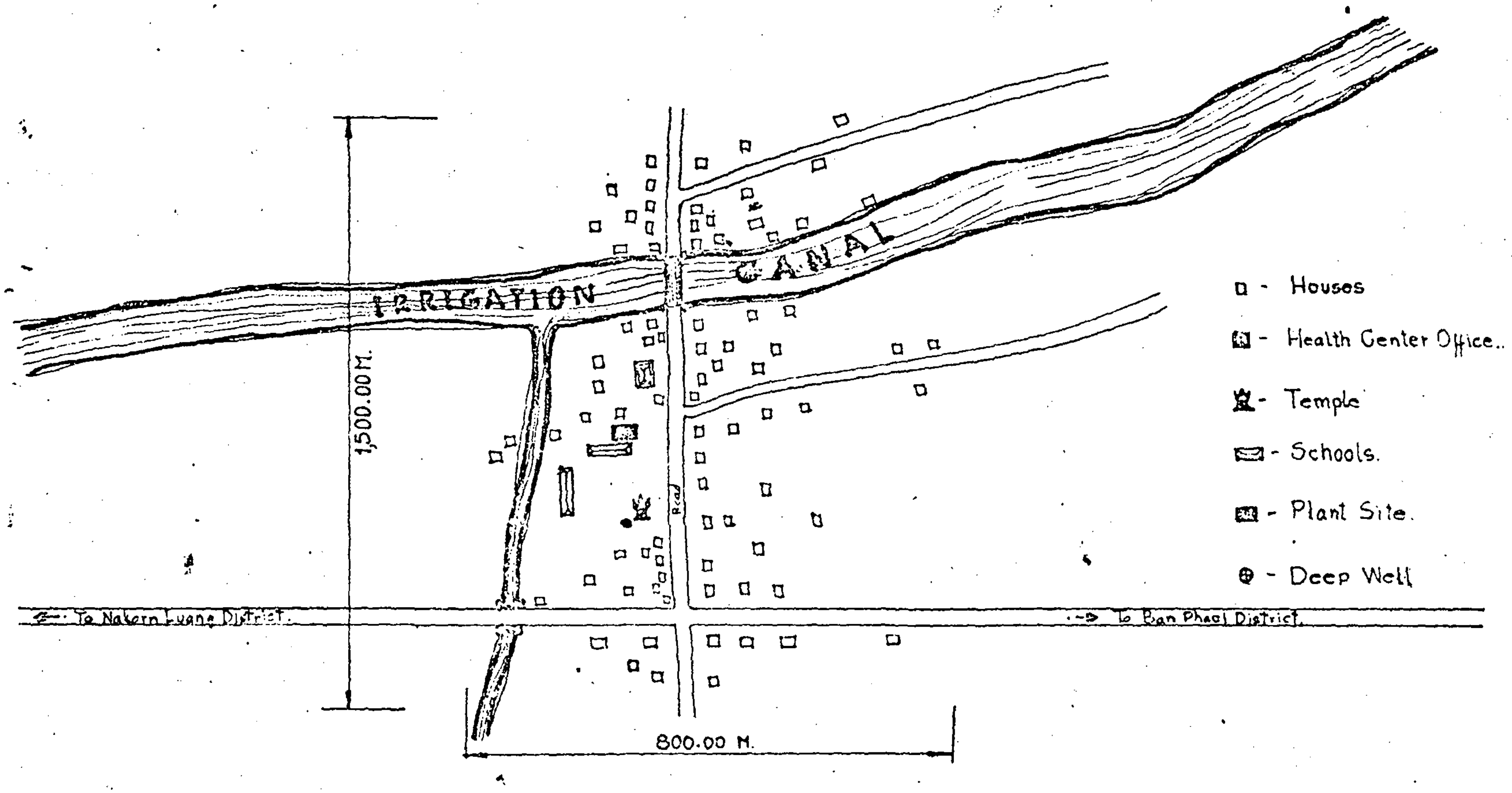
chief Village Head ....Mr. Somnuek Songkraotham....

Committee ....Mr. Somnuek Songkraotham....

....Mr. Thawin Praedam....

....Mr. Manee Homsawan....

....Mr. Yuan Saisuthirak....



Map of Ban Chung : Nakorn Luang District : Ayudhaya Province. (No Scale)

Preliminary Survey

Village ......Ban Paeng...... Amphur ......Promburi...... Province ......Singburi......

1. Houses ......3,174...... Population ......1,387......

2. Present Water Usage

   Source ......River...... For ......Consumption......

   Source ......Irrigation Canal...... For ......Rice growing......

   Source ......Deep Well...... For ......Agriculture......

3. Raw water source to be used for water supply

   ✓River ✓Canal Reservoir Deep Well

   Others ....

   3.1 Capacity of the source ......enough......

   3.2 Qualities of raw water

Turbidity	✓High	Medium	Low
Odor	Yes	No	
Colour	......red......		
Taste	......tasteless......		
algae	Yes	✓No	

   Other singnificant impurities ......-......

   ....

4. Area available for plant construction ......100...... M^2

5. Villagers interested in obtaining water supply ✓High Low

6. Any contribution from village

   6.1 ......financial......

   6.2 ......land......

   6.3 ....

Social and Economical Studies

1. Highest school level in the village. grade ......1 - 7......

2. Distance to the nearest 12th grade school ......13...... km.

3. Villagers vocation

Rice Growing ......80...... %

Farming ......-...... %

Trading ......10...... %

Government Officer ......20...... %

Labor ......10...... %

Average yearly income ......10,000...... baht

4. Building and Facilities

Water Supply	Yes	✓No
Electricity	✓Yes	No
School	✓Yes	No
Health Office	✓Yes	No
Mill	Yes	✓No
Temple	✓Yes	No

5. Local administration ......✓......

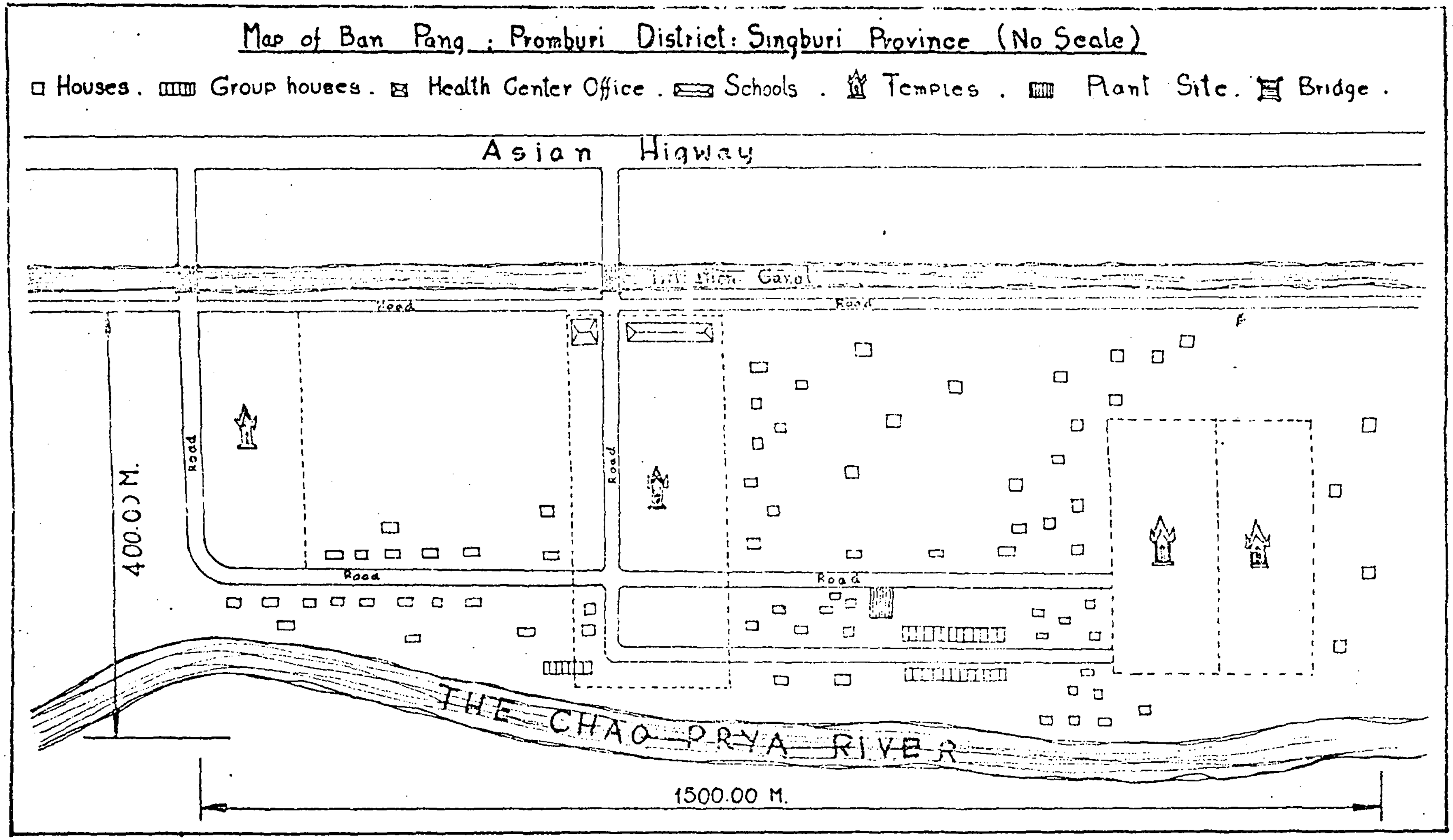
chief Village Head ......Mr. Champee Deepraum......

Committee ......Mr. Prasert Chaisomboon......

......Mr. Manop Boonnithi......

....

....



Map of Ban Pang : Promburi District: Singburi Province (No Scale)
Houses . Group houses . Health Center Office . Schools . Temples . Plant Site . Bridge .
Asian Higway
Road
Road
Road
Road
Road
Road
THE CHAO PRYA RIVER
400.00 M.
1500.00 M.

Preliminary Survey

Village ....Ban Pa.............Amphur....Kaeng Koey........ Province ....Saraburi..........

1. Houses ....150.............. Population ....965..................

2. Present Water Usage

Source ....the Pasak River............ For ......Consumption..................

Source ....Rain....................... For ......Drinking.....................

Source .... For ....

3. Raw water source to be used for water supply

✓River Canal Reservoir Deep Well

Others ....

3.1 Capacity of the source ......enough through year..........

3.2 Qualities of raw water

Turbidity ✓High Medium Low

Odor Yes ✓No

Colour ....green........

Taste ....

algae Yes ✓No

Other singnificant impurities ....chemical from waste..........

discharged from Cement Co. ....

4. Area available for plant construction ....400..............M^2

5. Villagers interested in obtaining water supply ✓High Low

6. Any contribution from village

6.1 ....any contribution...................

6.2 ....can be negotiated..................

6.3 ....

Social and Economical Studies

1. Highest school level in the village. grade ....4 - 6........

2. Distance to the nearest 12th grade school ....22..........km

3. Villagers vocation

Rice Growing	..........30..........	%
Farming	..........60..........	%
Trading	..........3..........	%
Government Officer	..........2..........	%
Lobor	..........5..........	%

Average yearly income ....6,000..........baht

4. Building and Facilities

Water Supply	Yes	✓No
Electricity	Yes	✓No
School	✓Yes	No
Health Office	✓Yes	No
Mill	Yes	✓No
Temple	✓Yes	No

5. Local administration ....✓..........

chief Village Head

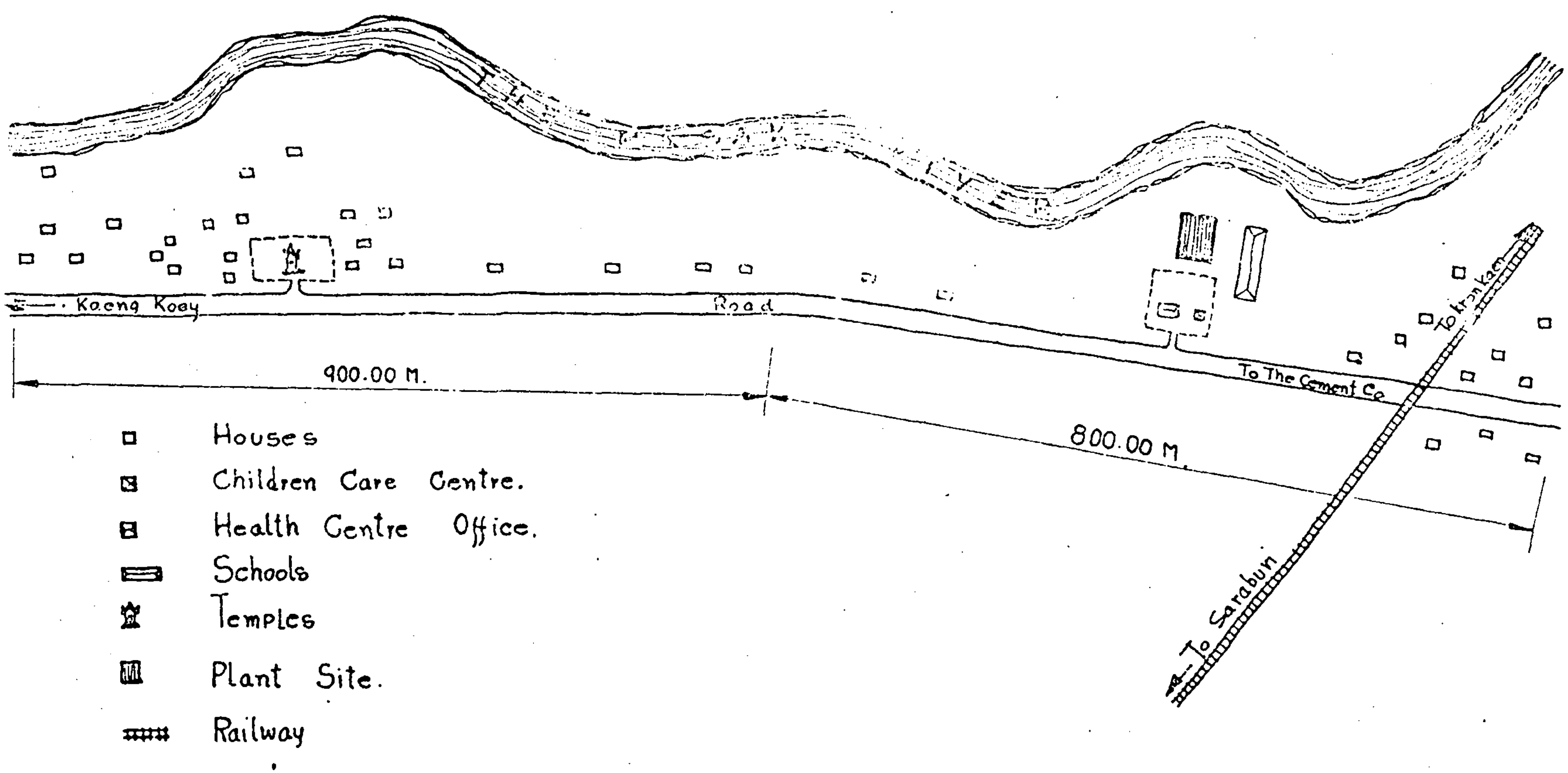
Committee ....Mr. Piya Sirima...........

...........Mr. Singh Tepmanee...........

...........Mr. Kam Wongvitak...........

....

Map of Ban Pa; Kaeg Koey District; Saraburi Province (No Scale)



SLOW SAND FILTERS

Community Water Supply Division
Department of Health
Bangkok, THAILAND

No.	CONST. YEAR	BAN	AMPHOE	CHANGWAD	CAP. m³/hr	SOURCE	POP. SERVED	CONST.COST ฿	CONST.COST PER HEAD,฿	REMARK
1	1966	GONG NANG	TA BOR	NONGKHAI	20	Deep Well	2 482	735 300	296	+ Aeration
2	1967	TA KOR	MUANG	NAKON PANOM	10	River	1 368	397 700	291	
3	1967	PO SRI	BANG PLAMA	SUPANBURI	10	Creek	1 123	312 000	278	
4	1967	S.TEPKRASATRI	TALANG	PUKET	20	Waterfall	2 725	410 000	150	
5	1967	S.BANNANG STA	BANNANG STA	YALA	10	River	1 450	375 000	259	
6	1967	DON MOON	SOONG MEN	PRAE	10	Deep Well	1 500	374 490	250	+ Aeration
7	1968	PAK WAN	NANG RONG	BURIRUM	20	Reservoir	2 067	257 000	124	
8	1968	S.BAN AMNAJ	AMNAJ JAROEN	UBON	10	Creek	1 700	430 000	253	
9	1968	HOOB TAPONG	CHA-UM	PETCHBURI	10	Canal	1 200	464 000	387	
10	1968	S.YARANG	YARANG	PATTANI	20	Deep Well	3 240	417 500	129	+ Aeration
11	1970	NONG BUA	PU RUA	LOEI	10	Spring	1 089	195 000	179	
12	1970	PA NOK KAO	PU KRADUNG	LOEI	10	Spring	1 750	300 000	171	
13	1970	S.DAN SAI	DAN SAI	LOEI	30	Spring	4 151	390 000	94	
14	1970	KOK MOR	TUP TUN	UTAITANI	10	Creek	1 981	370 000	187	
15	1970	HARN KAEW	HANG DONG	CHIENG MAI	10	Deep Well	1 873	428 500	229	+ Aeration
16	1971	S.NONG GO	KRANUAN	KHON KAEN	50	Reservoir	9 563	1 180 000	123	
17	1971	S.PUA	PUA	NAN	30	Creek	3 428	500 000	146	
18	1971	S.JAE HOM	JAE HOM	LAMPANG	20	River	2 407	596 000	248	
19	1971	NAM LOM	NAKON THAI	PISSANULOK	10	Spring	581	131 000	225	
20	1972	S.TUB SAI	PONG NAMRON	CHANTABURI	30	Stream	1 875	600 000	320	
21	1972	PUAN PU	PU KRADUNG	LOEI	10	Spring	1 846	230 000	125	
22	1972	SUKSASONGKROH	MUANG	TAK	10	Creek	585	254 900	436	
23	1972	S.RON PIBOOL	RON PIBOOL	NAKON SRI TAMMARAT	30	Waterfall	2 124	638 000	300	
24	1974	S.KANOM	KANOM	NAKON SRI TAMMARAT	10	Waterfall	3 755	1 150 000	306	
25	1975	MUANG BANG	LOM KAO	PETCHABOON	10	Waterfall	850	185 000	218	
26	1976	S.TAPLA	TAPLA	UTTARADIT	20	Reservoir	2 206	418 000	189	
27	1976	S.GROK PRA	GROK PRA	NAKON SAWAN	30	Deep Well	5 000	960 000	192	+ Aeration
						TOTAL	63 919	12 699 390	199	S. = Sanitary District

Every plant : no pre-treatment, disinfection by chlorination, supply by gravity, operated 8 - 15 hr./day by trained operator.

Community Water Supply Division
Department of Health
Bangkok, Thailand

Average Construction Cost (฿) of Community Water Supply Plants

Ground Water

Filtration \ Capacity (m^3/hr)	10	20	30
SLOW SAND FILTER	401,500	576,400	960,000
RAPID SAND FILTER	382,400	569,800	710,700

Surface Water

Filtration \ Capacity (m^3/hr)	10	20	30
SLOW SAND FILTER	368,800	420,200	532,000
RAPID SAND FILTER	444,000	671,700	761,000

บันทึกข้อความ

ส่วนราชการ ....

ที่........................ วันที่...

เรื่อง ....

For the preparatory activities of the second phase of the Slow Sand Filtration Project, seven Village Demonstration Plants have been selected and theyare the following:

1. Ban Klang, Muang District, Prathumthani Province;
2. Ban Pai Nong, Nakornlaung District, Ayudhaya Province;
3. Ban Kok Toom, Muang District, Lopburi Province;
4. Ban Bang Lao, Muang District, Singburi Province;
5. Ban Chung, Nakornlaung District, Ayudhaya Province;
6. Ban Pang, Promburi District, Singburi Province;
7. Ban Pa, Koreng Koey District, Saraburi Province.

In every village investigations are to be carried out via preliminary surveys and social and economic studies and a town-map of the mentioned village must be drawn.

1. The preliminary survey includes:
    1. Location of village
    2. Number of houses, population
    3. Sources of water for drinking
       Sources of raw water for water supply with capacities and qualities
    4. Area for plant construction
    5. Village's need of water
    6. Contribution

2. Social and economic studies include:
    1. Level of school
    2. Distance
    3. Vocation
    4. Income
    5. Public facilities
    6. Local Structural Organization

3. Map
    1. School
    2. Temple
    3. Health Centre
    4. Grouping of houses
    5. Distance
    6. Level

NO	Location.	Population: Number	Need	Interest	Income	Source of Water: Quantity	Quality	Contribution: Local	Government	Aid	Maps	Area	Org.
1.	Ban Klang Muang District Prathumthani Province	500	H	H	20,000	H	M	Land	✓	✓	H	✓	✓
2.	Ban Pai Nong Nakornlaung District Ayudhaya Province	1253	H	H	5,000	H	M	Land Cash Material	✓	✓	H	✓	✓
3.	Ban Kok Toom Muang District Lopburi Province	2500	H	H	30,000	H	H	30,000 ฿	✓	✓	H	✓	✓ (S.D)
4	Ban Bang Lao Muang District Singburi Province	2107	M	H	4,000	H	M	Land cash	✓	✓	H	✓	✓
5	Ban Chung Nakornlaung District Ayudhya Province	1910	M	M	5000	H	H (L)	Land cash	✓	✓	H	✓	✓
6	Ban Pang Promburi District Singburi Province	1387	H	H	10,000	H	M	Land cash	✓	✓	M	✓	✓
7	Ban Pa Kaeng Koey District Saraburi Province	965	H	H	6,000	H	M	Land	✓	✓	L	✓	✓

who international reference centre for community water supply

postal address: p.o. box 140, leidschendam, the netherlands
office address: nw havenstraat 6, voorburg (the hague)
telephone: 070 - 69 42 51, telegr.: worldwater the hague, telex: 33604

SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT II - 7

Structuring of designs for Village Demonstration Plants

STRUCTURING OF THE DESIGNS FOR VILLAGE DEMONSTRATION PLANTS

With reference to item 5 of annex B of the Outline of the Programme for the second phase of the Slow Sand Filtration Project. (Working Document II - 1)

Suggestions for starting points for preliminary designs:

- quantity of water : 50 - 100 (l/cap./day)
- adequate water supply : 24 (h/day)
- continuous operation : 20 (h/day) (effective production period, for design purposes)
- filtrationrate : 0.1 ($m^3/m^2/h$)
- number of filtration units : $\geq$ 2
- complete plants : pre-treatment installation (PTI), biological slow sand filtration (SSF), storage (STOR) and a distribution provision (DIS)

Calculation example for Slow Sand Filtration-area per capita:

A. Say: 50 (l/cap.day) = 0.05 (m^3/cap.day))
20 (h/day), effective production and) then:
0.1 (m^3/m^2 h), filtration rate)

required filtration area per capita:

$$\frac{0.05\ (m^3/day)}{20\ (h/day) \times 0.1\ (m^3/m^2\ h)} = 0.025\ m^2$$

B. Say: 100 (l/cap.day); then: 0.05 m^2 per capita required

Design Alternatives:

Following above points some indications can be given for the capacity (m^3/day), the production (m^3/h) and the filtration area (m^2) for the four catagories (I - IV) of number of consumers that may be distinguished (see: Table A,) respectively for 50 - 100 (l/cap.day). Emphasis on catagories II and III.

	Table A.	number of consumers (-)	capacity (m^3/day)	production (m^3/h)	filter area (m^2)	design alternatives
	I	< 500	< 25 - 50	< 12.5 - 25	< 12.5 - 25	- simple household unit - cluster filter (±200) - single infiltration gallery (river bed) - energy from man; gravity
*	II	< 2,000	< 100 - 200	< 5 - 10	< 50 - 100	- PTI + SSF + (STOR) + DTS - river bed intake + SSF + etc. - number of filter units ≥ 2 - mechanical pump (diesel); gravity
*	III	< 5,000	< 250 - 200	< 12.5 - 25	< 125 - 250	- PTI + SSF + STOR + DIS - number of filter units > 2 - mechanical pumps (electricity); gravity
	IV	< 10,000	< 500 - 1000	< 25 - 50	< 250 - 500	- complete plant - number of filter units ≥ 4

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT II - 8

GUIDANCE TO TASK GROUPS PHASE II

GUIDANCE TO TASK GROUPS PHASE II

I. Introduction

In order to formulate recommendations for further studies and specific activities in the context of the programme for the second phase, participants are requested to review and discuss some selected items in task group sessions.
It is suggested to form two task groups, A and B.

II. Task group A. (room 505)

1. Composition

Dr. Beshir
Mr. Gecaga
Mr. Ingawale
Mr. Lert
Mr. Monney
Mr. Tjiook

2. Subjects

Task group A is requested to draft recommendations regarding the set-up and implementation of the various educational and motivational activities to be carried out in the 2nd phase. The task group may consider to cover at least the following subjects:

- creation of local interest, participation and involvement, related to the various levels in the community (policitians, consumers, technician);
- establishing or strengthening of the necessary organizational infrastructure in the community;
- set-up and implementation of a basis public health education programme;
- selection and training of an operator;
- development of an instruction manual for operation and maintenance of slow sand filtration plants

With regard to the subjects concerned, the task group is requested to formulate criteria for the selection of villages; this is to be done on the basis of these recommendations.

3. Terms of reference

1. To thoroughly review and to discuss the selected subjects, as indicated in item II.2 and to comment on the available information, such as:

- background document II-1
- paragraphs coneerned of working document II-1 (especially para. 6 and 9 of annex B)

2. To draft clear and comprehensive recommendations on the selected subjects regarding the set-up, preparation, and implementation of the various activities, the procedures to be followed, the means to be applied and the priorities to be allocated.

3. To formulate criteria for the selection of locations for the village demonstration plants', with regard to the subjects as indicated in item II.2, taking into account the drafted recommendations concerned.

III. Task group B. (room 117)

1. Composition

Mr. Abdulla
Dr. Boateng
Mr. Paramasivam
Dr. Thanh
Mr. Waweru
Dr. Ballance

2. Subjects

Task group B is requested to draft recommendations regarding the set-up and implementation of base-line and impact studies regarding the public health and socio-economic aspects of the programme of activities for the 2nd phase of the project. The task group may wish to cover at least the following subjects.

- set-up and implementation of a public health baseline study;
- indications for improvement of the public health and the set-up and implementation of evaluation studies;
- set-up and implementation of a socio-economic baseline study;
- indicators for improvement of socio-economic status and set-up and implementation of evaluation studies.

With regard to the subjects concerned, the task group is requested to formulate criteria for the selection of villages; this is to be done on the basis of these recommendations.

3. Terms of reference

1. To thoroughly review and to discuss the selected subjects as indicated in

item III.3 and to comment on the available information such as

- background documents II-2 and II-3
- paragraphs concerned of Working Document II.1 (especially para 8 of annex E

2. To draft firm recommendations on the selected subjects, regarding the set-up, preparation and implementation of the various activities, the procedures to be followed, the means to be applied and the priorities to be allocated.

3. To formulate criteria for the selection of locations for the village demonstration plants' with regard to the subjects as indicated in item III.2, taking into account the drafted recommendation concerned.

who international reference centre for community water supply

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office address: nw havenstraat 6, voorburg (the hague)
telephone: 070 - 69 42 51, telegr.: worldwater the hague, telex: 33604

SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

WORKING DOCUMENT II - 9

Suggested Criteria for the Selection of locations for Village Demonstration Plants

SUGGESTED CRITERIA FOR THE SELECTION OF LOCATIONS FOR VILLAGE DEMONSTRATION PLANTS

1. NATURE OF RAW WATER SOURCE
   Suitable quantity and quality of surface water at a reasonable distance from the village.

2. TYPE OF WATER TREATMENT NEEDED
   No groundwater of good quality, easily available. Treatment by Slow Sand Filtration feasible.

3. POPULATION DISTRIBUTION
   Suitable size and density of population.

4. VILLAGE NEED
   Adequacy of existing supply insufficient. Prevalence of water borne diseases.

5. VILLAGE INTEREST
   Community interest and involvement. Willingness to participate and to contribute

6. NATIONAL DEVELOPMENT PROGRAMME
   Village should fall in National Development Programme. Possibilities for interlinkage with multi-sectoral projects should be considered as well. (e.g. irrigation scheme).

7. SOCIO-ECONOMIC STATUS AND VILLAGE POTENTIAL
   Economic growth potential. Insufficient water for productive non-domestic use. Time savings from water collection journeys. Existing village institutions. Adequate organizational infrastructure in village.

8. INVESTIGATIONS
   - Accessibility of village by road
   - Reasonable access to laboratory facilities

9. EDUCATION / MOTIVATION
   - School facilities available in or nearby village
   - Availability communication services
   - Facilities for health education programme
   - Availability health unit
   - Facilities for training local operator

10. Possibilities for interlinkage with multi-sectoral projects.
    (e.g. irrigation scheme)

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

BACKGROUND DOCUMENT II - 1

Some Suggestions for the Training Components of the Programme for the second Phase of the Slow Sand Filtration Project

by

Dr. N.F. Carefoot

Pan American Health Organization

Lima

Peru

SOME SUGGESTIONS FOR THE TRAINING COMPONENTS FOR THE PROGRAMME OF THE SECOND PHASE OF THE SLOW SAND FILTRATION PROJECT

by Dr. N.F. Carefoot

Referring to Annex A of the Draft Outline of the Programme for the second phase, the various developmental stages for this phase are:

	Preparatory Activities		Realization VDP		Demonstration & Testing		Follow-up	
XX	9 months	XXX	6 months	XXX	6 months	XXX	3 months	XX

Taking into account the above timetable and the project orientation toward community involvement, I wish to present the following for consideration:

Preparatory Activities Stage:

1) Preliminary selection of the village is made by the Project Management Committee following the selection criteria. It is assumed that official contact with the village up until this time has been minimum.

2) Materials are prepared suitable for a public meeting regarding the village demonstration project; e.g.:

- A brief description of the international character of the project with a large size map to point out participating countries. Emphasize that results of demonstration will be reported nationally and internationally;
- A visual presentation (slides or posters) showing a check list of the village selection criteria;
- Details of the site selection requirements;
- A slide presentation (or poster size drawings) to illustrate details of a SSF such as construction, operation and maintenance;
- An explanation with visual aids of the benefits to the individual and community of a SSF over their present system;
- An explanation with visual aids of the funding arrangements for the project;

- An outline description with visual aids, where possible, of proposed "before" and "after" studies.
- A definition of the obligations and responsibilities associated with the project -- village, national government, participating institutions.

3) Official meeting with village council (village leaders) is arranged for a government representative and a representative of the participating institution.

4) During meeting it is explained that the village has been tentatively selected for a SSF demonstration project. Using materials prepared for the public meeting a scaled-down version is presented to the village council. Questions are answered. Their support is requested as well as their cooperation to authorize and arrange a public meeting. If answer is affirmative, follow-up step is a public meeting. If answer is MAYBE arrange further meetings. If answer is negative --- select another village and start over.

5) Where practical, arrange visit for village council to the participating institution SSF investigation model.

6) Arrange suitable advance publicity so as to ensure good attendance at the public meeting, for example: posters; radio spots; local clubs; door-to-door; telephone calls; newspaper articles.

7) Hold public meeting. Introduction of the government representative and participating institution representative as well as the project by the village leader. Hopefully a statement of his support for the proposed project. Presentation by the two(2) representatives of all the SSF materials prepared for the public meeting. Supportive participation, if possible, of the District Medical Officer to comment on water-borne diseases. Village leader should ask for a vote (secret ballot or show-of-hands depending on local custom) of support for the project. If vote is affirmative, village is selected for demostration project. At this point the formation of a community volunteer action group to work under the guidance of the Project Coordinator from the national level could prove useful to help with promotion and health education. If vote is negative -- start over with another village.

8) Simultaneously with preparations for and the carrying out of the public meeting, development of the Plan Operator's Manual can be underway. A minimum job requirement recommended for the WTP Operator is that he must be able to read and write. This may not always be possible however and it is therefore recommended that the Operator's manual by in picture form as much as possible with a minimum of written text.

9) It is highly desireable that the operator be hired shortly before the start of construction of the SSF. Thus he can receive a short induction course re: construction, operation and maintenance of the plant. Hopefully a brief observation visit to one of the investigation units can be arranged for the new operator in conjunction with this initial training effort.

10) Following an affirmative vote at the public hearing it is suggested that arrangements be made to hold health education instruction in the local school (s). Said instruction to be carried out by the local public health authorities, under direction of a Health Educator where possible, in collaboration with the local school teachers. Emphasis to be placed on waterborne diseases, personal hygiene, safe water, etc. Through the children there exists a reasonably good chance of also reaching the parents. Concurrently with health education in the schools, community groups, unions, etc. should be approached and health education presentations made to them. Highlighting in such presentations the SSF's affect on water quality. Contact with key families in the community is suggested as supplemental to mass and group health education activities. These families can be encourage to pass on information to their neighbors.
It is strongly recommended that teaching aids such as: slides; posters; films, etc., be used as much as possible in all health education presentations.

II. Realization VDP Stage

1) To develop awareness in and around the village, a volunteer committee project could be formed to erect a sign at the construction site. The sign to provide a few details of the character of the project, names of participating agencies, cost sharing, etc.

2) The initiation of construction with a ground-breaking ceremony officiated by the village leaders could serve as another interest generator. Depending on the size of the community and local customs local authorities may wish to consider a picnic in conjunction with this ceremony.

3) It is considered highly desireable that the VDP operator participate in the actual construction of the SSF. Knowledge thus gained of the plants construction should be beneficial in his understanding how it operates.

4) During the construction stage it is suggested that periodic progress reports be made to the village leaders and the general public. Such reports to be visual as much as possible, e.g.: slides; bar graph indicating percentage complete to date; funds expended; etc.
It is further suggested that field trips be arranged with the local school authorities for children to visit the construction site and be briefed on what is happening and the significance of the SSF in connection with their future water supply.

5) Continuation of the basic health education program in the community.

6) A chronological photographic record could be started at the beginning of this stage to be used for future meetings with interested neighboring communities.

III. Demonstration and Testing Stage

1) On-the-job training of the Plant Operator is concluded, the Operator Training Course evaluated and necessary adjustments made in the Manual/Course.

2) Continuation of the basic health education program in the community.

3) Arrange tours for school children and general public to the facilities now in operation. Demonstrate "raw" water vs. treated water.

4) Continue maintaining photographic record.

5) Referenced to the baseline studies some trend indicators should be developed in connection with the effect of the SSF on the incidence of water-borne diseases common to the community. This information could be presented to the community and given publicity.

6) Dissemination of results to interested national, regional, international entities.

7) Establish a "feedback" mechanism for results (good & bad) of the SSF continued operation.

IV. Follow-Up Stage

1) Continue health education

2) Recommendations could be developed on national training activities for other communities in the process of constructing a SSF.

3) Arrange visits to the demonstration facility of interested neighboring community leaders and prospective Plant Operators.

V. Health Education and Operator Training

Suggestions in connection with Health Education and Operator Training are attached as Annexes 1, 2, & 3. These tabulations are by no means presented as exact blueprints for training activities, but rather as "idea generators" for IRC and the participating agencies during future deliberations.
The suggestions concerning Basic Public Health Education are not intended to be all inclusive - either as to "Units" or "Topics". To be in-line with the people's needs and aspirations such a program must be prepared with community participation. Annex 1, hopefully, will provide some perspectives on designing, with the community, a P.H. Education program. Annex 2 suggests some basic steps in developing community participation.
WHO Offset Publication No. 20 entitled, "Guide to the Integration of Health Education in Environmental Health Programs" is recommended as a useful reference for those directly involved, country by country, with the planning and

implementation of the Basic Public Health Education Program.

In preparing Annex 3, "Suggestions re: Operator Training -- SSF Project", the WHO booklet, by L. Huisman and W.E. Wood was used as a reference for topics and the instruction outline. It is the opinion of the writer that this reference booklet lists the topics and subject matter in a logical sequence that could serve as an outline for the SSF Project. The text of the booklet is however considered to be too sophisticated for the educational level of a rural community plant operator. It is therefore suggested that the Plan Operator's Training Course be a simplified presentation which follows the aforementioned outline.

For the Plant Operator's Manual, as stated previously (p.6 item 8) it is recommended that picture language be used as much as possible. It is suggested that highlights of the first three topics be presented in the Manual followed by details of "Filter Design and Construction" along with "Operation and Maintenance".

In connection with training the SSF Operator the Chinese aphorism is recommended as a guiding principles:

If I hear it,I forget;
If I see it, I remember;
If I do it, I know.

SUGGESTED BASIC PUBLIC HEALTH EDUCATION PROGRAM

UNIT No. 1: BASIC SANITATION

TOPIC	EDUCATIONAL OBJECTIVE	INSTRUCTION OUTLINE	METHODS & MEDIA	EVALUATION
Water	To foster support for the SSF project	* Common water-borne diseases * Contamination of water supplies-typical examples * Protection of water supplies * Water purification - typical examples with details of SSF	Talks with families, or small groups, or large audiences with audio-visual aids. Han-out material also suggested.	Attainment of support of the community.
Excreta Disposal	The creation of a social norm in favor of using letrines	* Disease hazard of improper disposal * Privies & latrines * Proper location * Simple construction * Personal Hygiene	Talks with families, or small groups, or large audiences with demonstration and audio-visual aids.	Development of a favorable attitude toward the use of latrines.
Garbage Disposal	Adoption of proper sanitary measures for disposing of garbage.	* Relationship between un-sanitary garbage disposal & disease transmission. * Insects and rodents * Sanitary measures for disposal - Individual - Community	Ditto	Adoption of proper sanitary measures.
Food	To increase the knowledge of the community in connection with food storage, handling and preparation	* Examples of correct and incorrect - storage, handling and preparation. * Importance of correct measures * Simple suggestions on improving - storage, handling and preparation.	Ditto	Adoption of the sanitary measures.

ANNEX 1

ANNEX 2

SUGGESTIONS RE: DEVELOPING COMMUNITY PARTICIPATION

1. Carry out a family census (to be updated annually)
   - 1.1 Population by age groups
   - 1.2 Most commonly found health problems.
   - 1.3 Most frequent environmental problems.
   - 1.4 Most common social problems.

2. Make a sketch of each locality.

3. Identify leaders in each area and request their cooperation.

4. Identify problems in the community by means of:
   - 4.1 Interviews with the leaders.
   - 4.2 Community meetings
   - 4.3 Create committees

5. Orientate the community to identify:
   - 5.1 Health problems
   - 5.2 Potential resources
   - 5.3 Feasible solutions

6. Carry out meeting with teachers in the area in order to:
   - 6.1 Form a teaching outline for health education
   - 6.2 Obtain Teachers' cooperation to "sensitize" children to personal hygiene
   - 6.3 Send the sick children to the health center

7. Discuss problems found in the community with:
   - 7.1 Local authorities
   - 7.2 Community leaders
   - 7.3 Public health officials

SUGGESTIONS RE: OPERATOR TRAINING - SLOW SAND FILTRATION PROJECT

TOPIC OR TASK	EDUCATIONAL OBJECTIVE	INSTRUCTION OUTLINE	METHODS AND MEDIA	EVALUATION
Introduction	To create an awareness & understanding of the importance of safe drinking water.	* Water quality - importance * Contamination of community water sources * Typical water-borne diseases * Simple treatment options	Talk with audio-visual aids	Measure increased knowledge (entry and exit evaluations)
Filtration of Water supplies	To develop an interest in and favorable attitude toward slow sand filtration as well as provide basic background information.	* Brief history * Comparison of filter types * Elements of a SSF * Purification in a SSF * Application of SS filtration * Limitations of SSF's * Advantages of SSF's	Talk, "live" demonstration and audio-visual aids	Measure increased knowledge (entry and exit evaluations)
Theory of biological filtration	To foster a clearer understanding of the treatment process.	* Mechanisms of filtration * Effects of algae on filters * Simple hydraulics of filtration * Effects of filtration on delivered water quality	Talk, demonstration, models and audio-visual aids.	Measure increased knowledge (entry and exit evaluations)
Filter design & construction	To enable operator to recognize the various component and communicate knowledgeably about the plant.	* Supernatant water reservoir * Filter-bed * Under-drainage system * Filter box * Filter controls * Covering of filters	Talk, field trip and model with applicable audio-visual aids plus Plant Operator's Manual	Measure increased knowledge (entry and exit evaluations)
Operation and Maintenance	To develop the required skills necessary for efficient and effective operation and maintenance	* Placing the SSF in service * Filter cleaning * Resanding * Cleaning of filters	Talk, real-life demonstrations, in-service training plus Operator's Manual	Measure skills.

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

BACKGROUND DOCUMENT II - 2

NOTES ON THE PUBLIC HEALTH COMPONENT OF THE SLOW SAND FILTRATION PROJECT

NOTES ON THE PUBLIC HEALTH COMPONENT OF THE SLOW SAND FILTRATION PROJECT

1. INTRODUCTION

It is necessary firstly to recognise that the public health component of the slow sand filtration project is not going to be a major contribution to our understanding of the interaction between water supplies and disease. It will not be possible within the scope of the slow sand filtration project to undertake investigations of sufficient complexity to make any radical new contribution to this subject. However, it should be possible to collect a variety of good data on the microbiological quality of the water supply and to collect data which are at least indicative of the possible interactions between the village water supplies constructed and the health of the communities concerned. The public health component of the studies can be built around three separate aspects of the problem, namely I. microbiological quality, II. patterns of water use and III. morbidity and mortality. These will be discussed in turn.

2. MICROBIOLOGICAL WATER QUALITY

It is appropriate to design a programme of investigations on the microbiological quality of the water at various stages in the supply system. One should study quality changes at various points in the supply system. Thus we need to know the quality of the raw water which is being extracted. The quality of the water as it enters the pre-treatment, as it leaves pre-treatment, as it leaves the slow sand filter, as it leaves the tap and quality as it is eventually used in the house. We will thus obtain a complete profile of the changes in microbiological water quality as the water passes through the system and eventually to the house where it is to be used. The appropriate tests to be conducted are for either E. coli or faecal streptococci or both. A total coliform test is not appropriate to the testing of untreated waters in the tropics and should not be used. Both E. coli and faecal streptococci are most conveniently and accurately enumerated by the membrane filtration procedure but, if the equipment for this is not available, most probable number techniques may be employed instead. The field experimental technique would either be based on returning samples to a central laboratory or upon the use of a mobile laboratory facility in the back of a landrover. The alternative of using the central laboratory is probably preferable. Therefore a suitable hospital near the demonstration sites may be selected. Water samples should be collected in sterile bottles, placed in polystyerine containers in dry ice and returned to the laboratory for testing within a few hours of collection. Provided the samples are transported on dry ice and the water temperature is kept under 5°C the changes in bacteriological quality will not be sufficiently great to upset the findings. If this technique is to be adopted, it is clearly necessary that a suitable hospital laboratory is located within a few hour's drive of the demonstration sites and equally it is necessary that the demonstration sites should be on or near a road. It is of some importance that water quality tests are done on the water in the house immediately prior to use as well as on the water as it comes out of the tap in order that contamination between collection and use may be examined.

3. WATER USE PATTERNS

Fairly simple experiments may be designed to compare the pattern of water use before and after the construction of the demonstration supplies. The key point of comparison here with regard to health is simply the volumes of water used and a simple comparison should be made between the litres per capita per day used before and after the construction of the supply.

A major increase in the volume used is indicative of a potential benefit to health resulting from possible improved hygiene. Data on changes or lack of changes in the volume of water used may, in conjunction with bacteriological data discussed above, be used to help interpret the health data which will be discussed in section 4.

4. MORBIDITY AND MORTALITY

It is worthwhile making some effort to collect data on morbidity and mortality in demonstration villages before and after the supplies constructed and also on a couple of control villages over the same period. Probably the most satisfactory approach at reasonable cost is to try to make use of such health records as may be available. In particular it would be ideal if the demonstration sites were reasonably close to either a large clinic or a small rural hospital which was known to keep reasonably good records of patients' visits. Then, providing that the home village of patients is accurately recorded in all cases, it would be possible to search the records of this clinic or hospital in order to obtain data on reported water-related disease before, during and after the construction of the water supply. It will also be possible to do the same thing with similar neighbouring villages which are not sites for the demonstration project. Because of the probable poor diagnostic quality of rural health records, it is preferable to collect data on groups of diseases rather than on specific diagnoses. Thus, for instance, the faecal-oral category of diseases may be indexed by collecting data on all diarrhoeas, while the water-washed category of diseases may be indexed by collecting data on all infectious skin disease. It is important that the staff of the clinic or hospital concerned are not aware of what is going on during this procedure, otherwise it is highly likely that their record keeping behaviour will change in response to the interest displayed by the investigating team. A second way of getting at the possible health impact is through analysis of samples, particularly stool samples, in the community. But this is clearly a much more expensive and ambitious undertaking. It might be worthwhile to do a complete stool profile of the community in which the demonstration project is to be built before and after the project, and also perhaps in a couple of control communities at the same period. It might also be worthwhile to do an infectious skin disease survey, preferably by a dermatologist, in a similar manner. It is probably not worthwhile contemplating questionnaire surveys on the occurence of diarrhoea or other symptoms over a particular time period since these questionnaires typically yield data of very uncertain reliability.

5. CONCLUSIONS

It must be realised that immediate measurable health benefits from the village demonstration projects are unlikely to be found. Of more importance possibly are the data on microbiological water quality and changing water use patterns. It should be possible to give a clear idea on changes in microbiological quality achieved and also on the changes in volumes of water use achieved. If then no health impact is observed, this is not because there is no potential health benefit from what has been done, but simply that other inputs in the community are needed at the same time before the potential health benefits are to be realised. I would, therefore, think it is not worthwhile expending a great deal of time and energy on the health data side and probably the approach of working through a hospital or clinic records may be the most sensible one. By using existing hospital records, it is possible to paint a good portrait of the water-related disease spectrum in the community concerned, the relationship of water-related diseases to all other infectious diseases and any possible seasonalities or other interesting features which are occuring in the water-related diseases. This can be done relatively quickly and relatively easily and provide a good health background against which ones' demonstration water supply projects may be judged and assessed.

Reference: "Lesotho Report", Ross Institute of Tropical Hygiene

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SLOW SAND FILTRATION PROJECT

FIRST MEETING OF PROJECT PARTICIPATING INSTITUTIONS

VOORBURG, THE HAGUE, THE NETHERLANDS, 22nd - 30th NOVEMBER 1976

BACKGROUND DOCUMENT II - 3

NOTES ON THE "SOCIAL MANAGEMENT" ASPECTS OF THE SLOW SAND FILTRATION PROJECT

NOTES ON THE 'SOCIAL MANAGEMENT' ASPECTS OF THE SLOW SAND FILTRATION PROJECT

It is widely recognised that the success of many preliminary technical development projects depends as much upon 'social factors' as upon the appropriateness of the technology. Yet in general, little has been done to analyse these social factors since this involves expertise not normally represented in technical agencies. A considerable advance could then be achieved by subjecting the project to careful planning and monitoring as an exercise in demonstration and innovation and by including social and economic factors within the evaluation of the improved water supplies.

'Social Management' in this project could usefully concentrate upon:

a) A consciously thought out approach to the design and implementation of each experiment to enable the water authorities in each country to appraise the experiments and, if they are successful, to draw up plans and procedures to use them on a wider scale.

b) Appropriate local level (village and district) management for the different types of technology to ensure that participation becomes actual as well as rhetorical.

c) The social and economic benefits to the users of improved domestic water supplies; both short and possibly long term.

All three components should be carefully planned in advance and continuously monitored as the projects proceed.

The following are some initial thoughts upon three components:

a) The experiments as a precident.
Experimental projects carried out in conjunction with national agencies will inevitably act as a precident both within the implenting authority in the local communities. It is important that they do not establish expectations that the authorities responsible for future developments would be unable to meet.
This implies:
- That the public, the water authorities and local politicians are made aware of the experimental nature of the projects and that the invitation to participate is issued to the participants in the experiment only.
- That at an early stage the water authorities are invited to think out a possible strategy for incorporating slow sand filters within their water programme so that the constraints inherant in a programme of this kind can be incorporated within the design parameters of the experiments, effecting their location, cost, management, etc.

Particular care should be taken that the funding and supervision of experimental projects do not become factors which alone explain the outcome of the experiments. It is for this reason that national participants in the project should be invited to consider the role of foreign donors both in the experiments and in subsequent programmes.

b) Appropriate local level management.
Community participation may be a desirable goal but too much reliance should not be placed upon local communities for sustained management even of simple technology. It will normally be necessary for administration to take the major responsibility for maintenance of water supplies, though some involvement of local persons in the management of the system may be possible. Depending upon the nature of the technology and upon local circumstances experiments in local participation in planning, implementation management and maintenance should be convicted and carefully monitored.

It is thus very important to work out what the role of the water authority is to be in servicing the supply systems directly or in supporting village bodies. Adequate personnel must be available and financial arrangements made.

c) Economic and social benefits.
While domestic water supplies currently feature perminatly in the development programme of several countries it is usually difficult to attribute direct economic benefits of these supplies. Domestic supplies (particularly supplies in which there has been an investment in disinfection of filtration) will usually be separate from water supplies for livestock or agriculture. Economic benefits are likely to be confined to the benefits of improved health. These benefits may be difficult to identify if they exist at all, but if they can be located then the economic benefits consist in reduced expenditure on medical services or increased productivity resulting from more healthy people. Attempts can be made to identify these two factors.

Time savings from shorter water collection journeys are likely to constitue the main economic benefit. They are easily calculated and "before and after" time budgets can be conducted for a sample of households to see whether the time saved is devoted to productive purposes. It may then be possible to attribute an economic value to the time allocated to productive activity which can be taken on a measure of economic benefit.

It is important however that too much should not be expected of economic benefits calculated this way. Clean supplies are an improvement to the standard of living in themselves.

Socially the benefits have to be assessed in part through the people's own perceptions. Perceptions of water quality, of disease and its cures, of hygiene, and of the value of social activities associated with water supplies like gossip at the tap, should all be taken into account in assessing the value that people place upon improved water supplies.

Conduct of the Studies

The study of benefits (c) could for the most part be conducted in conjunction with bacteriological and technical studies "on site" in the villages. These are formal, quantitative studies that can be carried out by research assistants.

Project process and management studies are not site bound and rely upon critical judgement. For these studies it would be necessary to look for specialist sociology or management trained personnel to be responsible in each country for this aspect of the study.