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The Hague, The Netherlands

International Training Seminar On Community Water Supply In Developing Countries

A compilation of papers presented during
the Seminar held in Amsterdam,
The Netherlands 6-10 September, 1976

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Established in 1968 at the Netherlands' Institute for Water Supply in Voorburg (The Hague), the WHO International Reference Centre for Community Water Supply (IRC) is based on an agreement between the World Health Organization and the Netherlands Government. In close contact with WHO, the IRC operates as the nexus of a worldwide network of regional and national collaborating institutions, both in developing and industrialized countries.

The general objective of the IRC is to promote international cooperation in the field of community water supply. Operating as a catalyst, the IRC works closely together with its collaborating institutions as well as international agencies, national entities and individuals.

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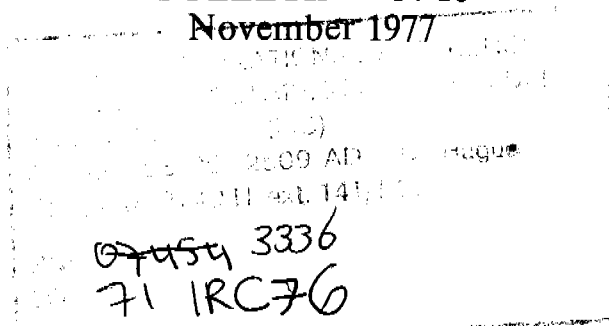
INTERNATIONAL TRAINING SEMINAR ON
COMMUNITY WATER SUPPLY
IN DEVELOPING COUNTRIES

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The views expressed in the papers are those of the authors, and do not necessarily reflect the views and policies of their respective organizations, nor of the WHO International Reference Centre for Community Water Supply.

CONTENTS

	<u>page</u>	
FOREWORD	5	
SUMMARIES OF PAPERS	7	
PAPERS		
<u>GENERAL</u>		
Paper 1	Current Situation of Community Water Supply in Developing Countries S. Unakul	19
Paper 2	A Strategy to Meet Short and Long Term Water Demand in Developing Countries H.R. Shipman	31
Paper 3	The Experience with National Sector Studies: Identification of Constraints and Priorities Dr. E. Becher	43
Paper 4	A Successful Approach to Community Water Supply Programming in Latin America Prof. J.M. de Azevedo Netto	57
<u>PLANNING, FINANCE, ORGANIZATION AND MANAGEMENT</u>		
Paper 5	Planning Water and Sanitation Systems for Small Communities D. Donaldson	71
Paper 6	Financing a Rural Water Supply Programme M.C. Mould	105
Paper 7	Organization and Management of Community Water Supplies M.C. Mould	115
Paper 8	Operation and Maintenance. The Case of Mexico F.L. de la Barra	129
<u>HUMAN FACTOR</u>		
Paper 9	Towards a Fuller Appreciation of Community Involvement G.A. Vierstra	147
Paper 10	Assessment of Manpower Needs and Training Programmes H.W. Barker	159
<u>TECHNOLOGY</u>		
Paper 11	Research and Development Needs in Community Water Supply J.M. Dave & R. Paramasivam	173
Paper 12	In-Country Production of Equipment and Chemicals for Community Water Supply B.B. Rau	191
Paper 13	Drinking Water for Every Village; Choosing Appropriate Technologies M. Beyer	213
Paper 14	Some Basic Ideas on Establishing a Water Treatment Technology J. Arboleda Valencia	229
Paper 15	Low Cost Distribution Systems Prof. J.M. de Azevedo Netto	267



FOREWORD

The International Training Seminar on Community Water Supply in Developing Countries, held in Amsterdam from September 6-10, 1976, and organized by the WHO International Reference Centre for Community Water Supply was attended by managers, chief engineers, and public health officers from twenty-seven developing countries as well as by representatives from international organizations.

The main objective of the seminar was to exchange ideas and experiences and to discuss approaches, methods, and techniques that can contribute to an accelerated provision of water supply and sanitation facilities to larger sectors of the population in developing countries.

Water is essential for personal and domestic hygiene, and fundamental to an improved standard of living. However, over one thousand million people, living in developing countries, do not have reasonable access to a safe and adequate source of water. Water related diseases rank amongst the major causes of morbidity and mortality of people of all ages. An adequate supply of safe drinking water to all the people can make a significant contribution to the prevention of diseases and the preservation of health.

The seminar dealt with various aspects of water supply, such as policy, planning, organization and management, finance, human factors, and technology. The papers presented at the seminar are likely to be of interest to a broader audience and could be used in regional and national seminars.

For this reason the present publication has been prepared providing a compilation of the papers. Short summaries have been made to assist the reader in the identification of papers of particular interest to him. Reprints of individual papers are available.

Requests should be addressed to the WHO International Reference Centre for Community Water Supply, P.O. Box 140, 2260 AC Leidschendam, the Netherlands.

SUMMARIES OF PAPERS

1. Current Situation of Community Water Supply in Developing Countries

S. Unakul

Based on global surveys of WHO in 1970 and 1975, the author reviewed the current situation in community water supply and excreta disposal and the progress made during the first half of the decade. Corrected targets for 1980 are to provide 91% of the urban and 36% of the rural population with water supply at an estimated investment of US \$ 21,000 million during 5 years. It was shown that lower unit costs and appropriate design criteria, technology, and level of service are necessary, so as to serve more people. The survey also indicated typical constraints which hamper progress; insufficient internal financing and lack of trained personnel were given high rating by the countries. Although the surveys may not give a very accurate account of the situation, the magnitude of the problem and resources required could very well be assessed. National programmes are required to develop the sector, with international and bilateral collaboration as available.

2. A Strategy to Meet Short and Long Term Demand in Developing Countries

H.R. Shipman

Project planning and implementation can seldom be realized within 5 years, so that new activities can only change the situation after 1980. For medium term planning (1985) countries should base their plans on the present situation, needs, and resources. To set realistic goals which can reasonably be achieved, data from past and present performance are required. Based on data from the WHO survey, corrected country data and per capita cost figures can be used for setting appropriate targets which are within the country's resources including; manpower for design, construction, and operation. Targets have to be converted into a working plan. For the required engineering and feasibility studies, local consulting capacity needs development. Other factors which require attention are organization and management, a well defined policy, and manpower development. For the long-range strategy (1990 or later) advance programming would be beneficial for a sound development and yearly updating of five-year plans was advocated. A review of service levels and investment needs for the sanitation sector was also given.

3. The Experience with National Sector Studies: Identification of Constraints and Priorities

Dr. E. Becher

Studies of the Community Water Supply and Sanitation Sector have been undertaken to provide basic information on the actual situation, to identify problems, to lay linkages with national plans, and to make recommendations for the development of the sector. A sector study may also stimulate the national planning process. A review was given of five years of experience of sector studies carried out by the WHO/IBRD cooperative programme in 32 countries. An elaboration was made on sector study and follow-up procedures in conjunction with national development plans, the role of WHO and IBRD staff in assisting the governments, and the structure of the sector report. Also dealt with were information requirements, economic and financial aspects, institutional options of the sector, manpower planning, and its relation to country health programming. To develop the sector it was suggested that programmes should be related to national policies and objectives, e.g. in the context of rural or regional development.

4. A Successful Approach to Community Water Supply Programming in Latin America

Prof. J.M. de Azevedo Netto

The author analyzed the main factors which contribute to the advancement of basic sanitary conditions in Latin America including motivation of the community for appreciation of the benefits of the water supply, sanitary education necessary for getting public support, technology based on suitable criteria, and adequate financial resources. Important factors are the local contribution, manpower development, foreign aid, and exchange of information to utilize know-how available elsewhere. Based on a study of the economic situation in a low economic level region the policy proposed was to modify design criteria of the supply system (in order to lower cost) and to motivate and involve the population in construction and operation. With gradual development of the community, the supply can be upgraded and improved criteria introduced.

5. Planning Water and Sanitation Systems for Small Communities

D. Donaldson

The author analyzed the unique characteristics of rural water supply planning, such as the great number of similar units required (which should be handled as a total programme), the extra efforts needed for the community to accept the supply, and the limited funds that can be raised by the community itself. An inventory of water supplies needed and of the required human, technical, and financial resources would

provide data for a master plan to which high-level commitment was recognized to be a condition for success. Basic elements for a successful water supply programme were summarized as: community participation necessary for appreciation of and responsibility to maintain the supply, technical flexibility to meet a large variety of problems with simple solutions, and the use of well trained sub-professional staff to relieve the few engineers of repetitive tasks. It was observed that a separate organization for rural water supply and sanitation was often beneficial to a sound development of the sector.

In an example the various stages in planning a village water supply was illustrated: programme planning and budgeting based on preliminary figures and estimating of materials to be allocated for which a field inspection is required.

6. Financing a Rural Water Supply Programme

M.C. Mould

For financing a rural water supply programme, both government and public attitudes towards water charges are of relevance. In a number of countries a safe water supply is viewed as a social service for which charges should be kept to a minimum. The paper advocates that, as a general principle, user charges should be set at as high a level as possible because the extent of the water supply programme (and to some extent its continuation) will depend on this source of funds as well as on general public revenues. Changing government and public attitudes towards water charges will take time and requires a continuous effort. Whatever pricing policies are adopted, village water supply programmes in many countries are likely to need continuing support from national revenues. In providing a water supply to an individual village, the level of service should be carefully tailored to the circumstances. Adopting the principle that the villagers should meet at least part of the costs, the determination of their ability and willingness to pay remains a serious problem. Many rural water systems break down due to lack of funds for operation and maintenance. Thus, in the author's view, the real problem will be to collect any water charges, which should cover at least all operating and maintenance costs, and preferably should also make a substantial contribution towards the scheme's construction costs.

7. Organization and Management of Community Water Supplies

M.C. Mould

In many systems of organization and management of community water supplies which exist, political factors directly affect the organization. Thus, a supply can be established as a public service or an industry; it can be developed as an individual

sector or part of urban/rural or rural development, planning should aim at adequate political representation to ensure allocation of the available resources. Organization units at various levels with typical allocations of powers and functions were illustrated. Organizational areas could be based on topography, or on administrative delimitations as part of rural or urban/rural areas. Efficient development, cooperation, and maintenance could be performed by a public utility operating in a watershed and drainage area. A utility covering urban and rural areas would permit cross-subsidizing and would be capable of employing adequate technical and financial staff. To benefit from effective operations, integrated urban/rural units and multi-sectoral organizations are options worth considering. The importance of a good manager responsible for organization and management was underlined and training should serve the objective of early selection and development of good managers.

8. Operation and Maintenance. The Case of Mexico

F.L. de la Barra

The rapidly growing number of drinking water supplies which required rehabilitation mainly due to inadequate operation and maintenance had led to legislation which in Mexico delegates administration, operation, and maintenance to the communities served. State and rural councils were set up to assist in these tasks and a Technical Council at federal level to provide technical and administrative support. The author elaborated on the functions and operational methods of these councils. Promotional activities for better users appreciation of the facilities were found necessary to clearly define responsibility for the maintenance and to get better financial returns. In pilot studies close relationships were found between the various elements of the programme, such as village selection, choice of type of project, promotion of programme, and construction and operation within the sector. It was advocated that sector policy should be part of a national plan for rural development.

9. Towards a Fuller Appreciation of Community Involvement

G.A. Vierstra

On the basis of a case study of a self-help water project in Kenya, the main features of 'community involvement' were described. The author presented the case history of the project and evaluated the most important reasons why the enterprise was favoured by successful community participation. Local involvement in water development was shown not to be only restricted to the provision of labour, local materials, or cash, but, in fact by the mobilization of a 'cooperative mentality'

within the community which formed the very basis of the process. Thus, the community finally determined its own priorities, developed gradually a form of collective decision-making, as well as a cooperative action to reach the designated goals. A crucial role in this process was played by the local committee. The case history also showed the variety of factors which should be taken into consideration when evaluating the opportunities of community involvement in water projects. Crucial factors are the stage of development of a village, the social-psychological forces that may arise when communicating an innovation, and the village's social and economic structure. The paper ends with a list of suggestions for a rural water development policy incorporating the essential element of community involvement. It was recommended that a component of 'social action research' be included in rural water projects so that programmes can be adjusted. The author finally stressed the importance of compiling a reference catalogue of social management systems, systematically arranging empirical evidence on the approaches to community involvement which were successful and the related social, economic, and cultural conditions.

10. Assessment of Manpower Needs in Community Water Supply

H.W. Barker

The author reviewed the arguments why training should be undertaken, i.e. in financial terms it represents an investment in people which gives good returns, and organized and systematic training will assist the trainees to reach the status and standards of experience in the shortest possible time. Furthermore, it will enable people to properly utilize and not misuse facilities. Some observations were given regarding gaps and problems on the subject of training. The scattered labour force often lacks basic education, adaption and dissemination of training know-how is needed, information on availability and quality of training is lacking, and there is a shortage of trainers so that tutoring should be an integral part of the duties of managers and supervisors. A six-month fellowship training programme for trainers was proposed and for lasting impact it was advocated to allow a separate training budget. National, regional, and international activities were reviewed which aim at an organized and systematic training programme. Individual waterworks with their direct needs should, however, get their own programmes started and a sample collection of training topics and requirements was offered.

11. Research and Development Needs in Community Water Supply

J.M. Dave & R. Paramasivam

In view of limited resources in developing countries research development has the important role to find simple and economic solutions for a reliable community water supply.

For urban systems research and development aim at reducing treatment costs via increased performance in water treatment and distribution. Some areas of study in India are: the development of coagulant aids to replace alum, high rate settlers, a two-layer filter with local bituminous coal or crushed coconut shell as upper layer, improvement of distribution networks, and related leak detection.

Socio-economic problems and low education level of rural areas pose different requirements. Development of groundwater needs simple and reliable exploration methods, suitable lifting devices, and new techniques for hard rock drilling.

Other interests are disinfection of open dug wells (for which the pot chlorinator was developed), defluoridation, desalting of brackish water, iron removal for village use, and biological filtration. Adaptation of water quality standards to suit the economic status of the community or country was suggested.

The author further discussed the role of NEERI, as a national environmental research laboratory, and how international exchange of information, coordinated research, and exchange of scientists would support country programmes.

12. In-Country Production of Equipment and Chemicals for Community Water Supply

B.B. Rau

The assurance of an adequate availability of materials and equipment is the prerequisite for success of large community water supply programmes. In meeting the current and anticipated demands, local materials available, and indigenous expertise and labour should be exploited to the fullest possible extent. Constant and consistent quality control of the locally manufactured materials and equipment is necessary. In-country production of materials and equipment for community water supply programmes should be stimulated by promotional measures of the government as it forms an integral part of the national development plan.

The author described the various methods employed by the Government of India in stimulating the establishment of adequate manufacturing capacity and maintaining its efficiency. A number of regulatory measures was reviewed.

An explanation was given of the government policy of selective permission for foreign equity participation and technical collaboration in fields of high priority and in areas where the import of foreign technology is necessary. It was stressed that streamlining of licensing and approval procedures should receive continuous

attention.

13. Drinking Water for Every Village; Choosing Appropriate Technologies

M. Beyer

Rural water supply programmes should be closely integrated with other sectors of rural development. In providing villages with water supplies appropriate technologies must be chosen and applied.

The question of selecting and applying a water supply technology in any given area of the world is one of proper integrated planning and implementation. Sources of water differ widely, and so do the demographic and socio-economic conditions. The design of any project should be adapted to meet the real needs of the village population, be realistically conceived, be prepared within the framework of economic and manpower development planning, take careful consideration of social attitudes, as well as the potential for development of the local population, and should permit maintenance at a level not beyond the capabilities of the villagers.

The author stated that for rural water supplies in many developing countries groundwater remains the most important source of water. For water supply projects based on groundwater to be efficient, hydrogeological surveys and geo-physical studies of individual sites should be carried out. Modern exploration techniques may be very useful, at least to shortcut the reconnaissance phase of many projects. Considerations pertinent to the use of surface water, rainwater, and spring water are also given in the paper. The UNICEF assisted government water supply programmes in Bangladesh and in India are briefly commented upon. It is recognized nowadays that it is of great importance for people to understand the benefits of facilities and keep them operating.

14. Some Basic Ideas on Establishing a Water Treatment Technology Adapted to Developing Countries

J. Arboleda Valencia

Referring to failures experienced, the author stated that water treatment technology as applied in highly industrialized countries may be completely inappropriate in developing countries. Water treatment technology, adapted from conventional water treatment methods has been generated and applied in a number of developing countries. The author described several treatment plant elements used in Latin America including: hydraulic rapid mixing of coagulants, hydraulic flocculation, sedimentation with manual sludge handling, rapid filtration units capable of being backwashed without the use of pumps or elevated reservoirs, and declining rate filtration eliminating the use of rate-of-flow controllers.

The simplified designs as described have the advantage of lower initial capital investment, reduced costs of operation and maintenance, and good heated water quality.

The practical application of the adapted technology is illustrated for the treatment plants of Cochabamba (Bolivia) and Prudentopolis (Brazil). The plants are operating successfully and their construction costs compare favourably with conventionally designed plants.

When applying the innovated technology in the upgrading of existing treatment plants, the hydraulic capacity of the plants in many cases proves to be the main constraint.

15. Low Cost Distribution Systems

Prof. J.M. de Azevedo Netto

The distribution network is often the most expensive part of water supply systems, usually taking 50 percent or more of the total construction cost. Experience shows that considerable economy can be obtained in the design of distribution networks, particularly for rural communities.

Substantial cost reduction may result from the application of modest but realistic design parameters and the adoption of simplified lay-outs.

In small rural communities of developing countries, distribution networks can be designed for providing an adequate water supply for domestic purposes only. Residential roof water tanks may be used to limit the distribution network hydraulic requirements so that small diameter pipes can be used.

The author makes a brief comparison of different lay-out patterns for distribution networks from conventional networks (all pipes interlinked) to simpler models permitting the installation of secondary pipes of minimal diameter without interconnecting them. Examples were given showing the various possibilities for simplification and cost reduction of the distribution networks.

PAPERS

Presented at the Seminar

GENERAL

CURRENT SITUATION OF COMMUNITY WATER SUPPLY
IN DEVELOPING COUNTRIES

by

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September, 1976

CURRENT SITUATION OF COMMUNITY WATER SUPPLY
IN DEVELOPING COUNTRIES

1. Introduction

Safe and adequate water supply is vital to the world population as the diseases related to poor sanitation continue to be a major health problem in developing countries. Provision of water supply alone will, however, not be effective in preventing these diseases unless it is accompanied by proper disposal of excreta and other wastes. There is a growing realization that the provision of safe water supply and excreta disposal not only improves health and well-being of the people but also has an important role in the promotion of general economic development. Therefore water supply and waste disposal should be developed as an integral part of national economic and social development programmes. For planning activities in these two fields properly it is necessary to assess the present situation, identify constraints and set up priorities and targets suitable to the available resources.

2. The Global Picture

In 1970, the World Health Assembly adopted as the basis of a preliminary report the following targets for population to be served with safe water supply by the end of the Second UN Development Decade (1971-1980):

<u>Urban:</u>	by house connections	40%
	by public standposts	60%
<u>Rural:</u>	20% to have reasonable access to safe water	

In 1972, consequent to the first global survey through questionnaires, the World Health Assembly reviewed the situation and adopted revised targets as follows:

<u>Urban:</u>	by house connections	60%
	by public standposts	40%
<u>Rural:</u>	25% to have reasonable access to safe water	

In late 1975, the progress achieved by developing countries during the period 1970-1975 was reviewed and assessed by a second global survey. The mid-decade achievements (1975) were analyzed keeping in view the targets which had been recommended. On the basis of the findings of the survey and the varying degrees of progress achieved, suggestions were made for regional targets for the end of

the Decade (1980). The investments required to meet these targets were estimated. The report was then submitted to and adopted by the World Health Assembly in May 1976.

Global survey in developing countries	Percentage of population served		Targets by end 1980	
	1970	1975	Old	New
COMMUNITY WATER SUPPLY				
<u>Urban:</u> by house connections	50	57	60	68
by public standposts	17	20	40	23
<u>Rural:</u> with reasonable access to safe water	14	22	25	36
EXCRETA DISPOSAL				
<u>Urban:</u> with connections to sewerage systems	28	25	-	38
with household systems	44	50	-	56
<u>Rural:</u> with satisfactory excreta disposal facilities	9	14	-	24

In 1970, 160 million people in urban areas of developing countries did not have access to piped and safe water supply and 1.100 million in rural areas did not have access to reasonably safe water supply. In the same year, in the urban communities 130 million people did not have adequate excreta disposal facilities, and 1.160 million people in rural areas did not have sanitary disposal facilities for excreta.

The population remaining to be served by safe water supply as of 1975 was: in the urban sector 140 million people and, in the rural sector 1.100 million people. This gives a total of 1.240 million people in the developing countries that have no adequate water supply. Similarly in the excreta disposal field 140 million people in urban areas and 1.200 million people in rural areas have no adequate sanitary facilities meaning that 1.340 million people in the developing countries had no adequate excreta disposal. It is worth pointing out that the developing countries included 2.835 million people in 1975 as against the total world population of 3.967 million people, that is 71%. In spite of rapid urbanization, particularly in some regions in Africa and in Latin America, it is estimated that even by the year 2000 more than one half of the people in developing countries

would still be living in rural areas.

3. Investment required to meet new targets

These estimates are based on estimates given by the countries in 1970 for the per capita expenditures for water supply and excreta disposal. These per capita costs have been multiplied by a factor based on average increase of consumer price index to obtain a 1975 cost figure; so the estimates are based on so-called 1975 dollars. The approximate annual per capita investment for the next five-year period for the estimated 1980 populations of developing countries is shown in brackets:

Sectors	Additional popula- tion to be served by 1980 (Million)	Investment required to meet targets (Million US\$)
<u>COMMUNITY WATER SUPPLY</u>		
<u>Urban:</u> by house connections (\$3.23)	168	12 000
by public standposts (\$0.70)	56	2 500
Total urban:	224	14 500
<u>Rural:</u> (\$0.82)	255	6 500
Total urban and rural for community water supply (\$1.81)	479	21 000
<u>EXCRETA DISPOSAL</u>		
<u>Urban:</u> by house connections (\$2.72)	139	10 000
by household system (\$0.68)	108	2 500
Total urban:	247	12 500
<u>Rural:</u> (\$0.25)	185	2 000
Total urban and rural for excreta disposal (\$1.25)	432	14 500

Some may feel that the unit costs assumed are too low; consequently the investment required would be more. On the other hand, it is essential to remember that even the modest targets assumed will remain a mirage on the horizon unless drastic efforts are made to lower unit costs by using appropriate design criteria, appropriate technology, appropriate level of service suited to the economic status of people and involving communities in the planning, execution and maintenance of projects. A real reduction in per capita costs is required if more people are to

be served. Most governments have a policy of improving the lot of the poorest sectors of the community. A basic minimum level of service, particularly in water supply and sanitation is being aimed at for all the populations, before improving the situation of those already served.

4. The Regional Picture (See tables attached)

The 1975 survey has shown that progress in the five-year period 1970-1975 has been variable from region to region. For this reason, for the first time, the World Health Assembly in 1976 adopted specific targets that have been mentioned before are derived figures from the adopted regional targets.

Targets may be thought of as means to an end; their main purpose being to stimulate and sustain enthusiasm and effort. They have to be set carefully. If they are expected to have any real meaning the targets should be fixed at country level as those who set them may be presumed to have more control over the policies, resources and strategies needed to achieve them.

Targets can only be achieved by a real assessment of the problem, by concerted action by governments with firm policies and allocation of resources to meet and overcome identified constraints. Haphazard development of ad hoc projects is a wastage of resources that developing countries can ill afford.

It is interesting to note that the survey reveals some typical constraints to the progress as identified by the Member States. They are as follows (not in order of priority as priorities vary from country to country):

- a) insufficient finance
- b) lack of trained personnel
- c) inappropriate administrative framework
- d) inappropriate financial framework and lack of administration
- e) insufficient local production of material leading to a need for importing manufactured goods
- f) lack of external assistance
- g) inadequate legal framework etc. and
- h) lack of community participation

It also brings out the criteria used by the governments in the selection of areas for providing water supply as listed below (not by priority):

- a) population
- b) scarcity (lack of water)

- c) development
- d) health
- e) social
- f) willingness to pay for the development of utilities
- g) cost

5. Conclusions

The WHO surveys may not give a very accurate account of the current situation of community water supply and excreta disposal of developing countries because it is only a compilation of information provided by the Member States through questionnaires. Nevertheless, it is the best available data in this field at present. It does, however, serve the main purpose; that is, of giving an idea of the enormous task and resources required in order to achieve even the modest targets recommended by the World Health Assembly. For this reason the World Health Organization is collaborating with Member States in national programming for this sector as a part of overall health and socio-economic development. This concept is also now increasingly applied by most of the United Nations Agencies. The collaboration of international and bilateral agencies in national planning and programming and implementation of basic sanitary services provides a challenging opportunity in the coming years.

References:

- 1) Director-General's report to the Twenty-Ninth World Health Assembly, Community Water Supply and Waste Water Disposal (Mid-Decade Progress Report), WHO A29/12 Rev. 1, Geneva, 1976.
- 2) Pineo, C.S., Subrahmanyam D.V., Community Water Supply and Excreta Disposal Situation in the Developing Countries - a commentary, WHO Offset Publ.No.15, Geneva, 1975.

Table 1

PROPOSED TARGETS FOR ACHIEVEMENT BY 1980
(PERCENTAGE OF POPULATION TO BE SERVED) AND THE
ESTIMATED INVESTMENTS NEEDED

Region	Proposed targets for 1980						Total investment required to reach the proposed target (millions US \$)		Additional population to be served by 1980 (in millions)	
	Community water supply			Excreta disposal			Water supply (a)	Excreta disposal (d)	Water supply (e)	Excreta disposal (f)
	Urban		Rural	Urban		Rural				
	House connections (a)	Public standposts (b)	(c)	Public Sewers (d)	Household systems (e)	(f)				
Africa	45	35	35	20	75	25	3 070	960	52	33
Americas	80*	15	50*	55*	45**	46*	10 920	6 230	99	106
Eastern Mediterranean	60	30	25	20	75	25	1 650	3 470	49	73
Europe	80	15	80	30	30	30	680	450	22	19
South-East Asia	60	30	35	35	60	15	3 480	1 670	235	157
Western Pacific	85	15	35	35	65	60	890	1 610	22	44
Global	68	23	36	38	56	24	20 690	14 390	479	432

* Targets established in the Ten-Year Health Plan for the Americas.

** Target assumed for calculating weighted global average, corresponding investments not estimated.

COMMUNITY WATER SUPPLY - PROPOSED NEW REGIONAL AND GLOBAL TARGETS FOR ACHIEVEMENT BY 1980, IN THE LIGHT OF PROGRESS
MADE IN 1971 - 1975

Region	Percentage of urban population served									percentage of rural population with easy access to safe water			percentage of total population served	
	by house connections			by public standposts			by either houseconnections or by public standposts							
	Accomplished		Proposed target 1980	Accomplished		Proposed target 1980	Accomplished		Proposed target 1980	Accomplished		Proposed target 1980	Accomplished	
	1970	1975		1970	1975		1970	1975		1970	1975		1970	1975
Africa	33	36	45	34	29	35	67	65	80	13	21	35	21	29
Americas	61	67	80*	15	14	15	76	81	95	24	30	50	54	61
Eastern Mediterranean	56	52	60	23	28	30	79	80	90	19	16	25	37	37
Europe	47	67	80	21	14	15	68	81	95	45	63	80	52	70
South-East Asia	35	47	60	15	21	30	50	68	90	9	19	35	17	29
Western Pacific	65	75	85	11	16	15	76	91	100	23	30	35	40	50
Global	50	57	68	17	20	23	67	76	91	14	22	36	29	38

* Target established in the Ten-Year Health Plan for the Americas

Table 3

EXCRETA DISPOSAL - PROPOSED NEW REGIONAL AND GLOBAL TARGETS FOR ACHIEVEMENTS BY 1980, IN THE LIGHT OF PROGRESS MADE IN 1971-1975

Region	Percentage of urban population served									Percentage of rural population with adequate disposal			Percentage of total population served	
	By connection to public sewerage system			By household systems			By either public sewerage or household systems							
	Accomplished		Proposed target 1980	Accomplished		Proposed target 1980	Accomplished		Proposed target 1980	Accomplished		Proposed target 1980	Accomplished	
	1970	1975		1970	1975		1970	1975		1970	1975		1970	1975
Africa	8	13	20	40	67	75	48	80	95	23	21	25	27	31
Americas	36	30	55*	39	50	45	75	80	100	23	22	46	55	57
Eastern Mediterranean	7	10	20	55	53	75	62	63	95	12	14	25	24	30
Europe	31	20	30	12	18	30	43	38	60	5	18	30	20	26
South-East Asia	28	26	35	49	52	60	77	78	95	4	6	15	17	20
Western Pacific	27	24	35	54	57	65	81	81	100	11	43	60	31	55
Global	28	25	38	-	-	56	72	75	94	9	14	24	25	32

* Minimum target established in the Ten-Year Health Plan for the Americas.

COMMUNITY WATER SUPPLY - INVESTMENTS NEEDED IN THE FIVE-YEAR PERIOD 1976-1980 to
MEET THE PROPOSED NEW REGIONAL TARGETS FOR 1980
(In millions of US dollars at 1975 price levels)

Region	Urban			Rural	Total
	For population to be served by house connections	For population to be served by public standposts	Total urban	For population to be served with reasonable access	
Africa	1 230	410	1 640	1 430	3 070
Americas	7 320	1 440	8 760	2 160	10 920
Eastern Mediterranean	990	150	1 140	510	1 650
Europe	280	100	380	300	680
South-East Asia	1 250	390	1 640	1 840	3 480
Western Pacific	720	50	770	120	890
Global	11 790	2 540	14 330	6 360	20 690

Note: Weighted average unit costs per capita for each region from the 1970 survey have been multiplied by an inflation factor to obtain 1975 unit costs. For want of a better index, estimates of rises in consumer prices were based on data published in International Financial Statistics, 29, No. 1, 1976.

EXCRETA DISPOSAL - INVESTMENTS NEEDED IN THE FIVE-YEAR PERIOD 1976 - 1980 TO
MEET THE PROPOSED NEW REGIONAL TARGETS FOR 1980
(In millions of US dollars at 1975 price levels)

Region	Urban			Rural	Total
	For population to be served by connection public sewers	For population to be served by household systems	Total urban	For population to be served by adequate disposal	
Africa	440	380	820	140	960
Americas	5 620	-	5 620	610	6 230
Eastern Mediterranean	1 620	1 360	2 980	490	3 470
Europe	340	70	410	40	450
South-East Asia	790	550	1 340	330	1 670
Western Pacific	1 040	330	1 370	240	1 610
Global	9 850	2 690	12 540	1 850	14 390

Note: Weighted average unit costs per capita for each region from the 1970 survey have been multiplied by an inflation factor to obtain 1975 unit costs. For want of a better index, estimates of rises in consumer prices were based on data published in International Financial Statistics, 29, No. 1, 1976.

A STRATEGY TO MEET SHORT AND LONG TERM
WATER DEMAND IN DEVELOPING COUNTRIES

by

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The opinions expressed in this paper are those of the author and are not necessarily those of the World Bank

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A STRATEGY TO MEET SHORT AND LONG TERM
WATER DEMAND IN DEVELOPING COUNTRIES

Introduction

It has been said that in planning for water supply, five years into the future is the present. Observations made on a rather large number of countries whose water supply project history is currently available, lead to the conclusion that for projects involving international financing, from the day that planning started until water came out of the tap, has seldom been less than five years, and not infrequently several years more. Generalizations are always dangerous and it is necessary to define the nature of the project, the extent that foreign consultants or experts are needed, the source or sources of finance, and the extent to which foreign supplies, equipment, and construction specialists will be involved, before a reasonable judgement can be made on time requirements. Nevertheless, as one notes the goals or targets proposed for 1980, coming out of the WHO 1975 survey, it would appear that any new work now initiated will be unlikely to produce water at the tap until after 1980. We therefore are forced to live with the results of the efforts made between 1970 and 1975 in the planning and development of water projects and which are now in varying stages of construction. This is not to say that where communities now have adequate source capacity, additional people cannot be served before 1980. They can, and likely will be, through limited locally financed projects which require only transmission and distribution extensions and expansion.

The following discussion outlines a number of actions which countries can take in the medium-term and in the longer range to overcome existing problems in meeting the needs of their people for a safe and accessible water supply. The medium-term is defined as the period between now and 1985 and the longer range from that time onward. The proposals made follow a sequence starting with a definition of the problem in the country; selecting several optional goals or objectives which can be submitted to the national planning and/or finance authorities for decision on the one most feasible for achievement; establishment of a program of work for the next five years which specifies the actions required by year to meet the objectives; and to then initiate actions on engineering studies and on changes in organization, management, policies, and methods necessary to permit the program to succeed. In discussing each of these actions, a background of the present world situation is presented and used as a basis for evaluating worldwide targets for 1985 and 1990. Countries should start with their own data and goals in the preparation of specific plans. The worldwide data will be a useful frame for each country to assess its own

position. The data may also be of interest to those who wish to consider the future requirements for funds and to assess the magnitude of the task which has to be undertaken. To everyone concerned, there must be a recognition that finding the funds to meet targets is only part of the action if the investments made are to contribute to the maximum to the countries' development.

Targets, Goals, and Planning

The WHO 1975 Survey Report of water and sanitation in the developing countries presents data on the current status of urban and rural water supply conditions and proposes global targets of 91% of the urban and 36% of the rural populations to be served by safe water by 1980. The World Habitat Conference resolution calls for all people of the world to have access to a safe supply of water by 1990. Targets and goals are meaningful only if discussed in the context of a specific country and in the light of the present situation. Costs associated with any given set of goals have to be weighed against other needs and what is reasonably attainable. For the global outlook analyses of the 1980 and 1990 goals leads to the conclusion that the short-term 1980 goal, as previously noted, is beyond the point where much can be done about it. It either will or will not be achieved depending on projects now underway or to get underway at the latest within the next two years. For the 1985 and 1990 goals, the following figures may be of interest:

- a) Urban population for countries included in the WHO 1975 survey report is taken as 1975 = 589 million, 1985 = 889 million and 1990 = 1,025 million.
- b) Urban population growth 1975 to 1985 = 300 million; additional to 1990 = 136 million.
- c) Urban population served in 1975 = 445 million; unserved = 144 million.
- d) Additional urban population to be served by 1990 - $144 + 300 + 136 = 580$ million, or roughly 39 million people per year from 1975 onwards. After 1990 population growth alone will require levels in excess of 40 million per year rising to about 50 million in 2000 using an urban growth rate of 4%.
- e) Rural population in countries surveyed is taken as: 1975 = 1,719 million, 1985 = 1,903 million, 1990 = 1,994 million.
- f) Rural population growth 1975 to 1985 = 184 million; additional to 1990 = 91 million.
- g) Rural population served in 1975 = 310 million; unserved = 1,409 million.
- h) Additional rural people to be served in 1990 = $1,409 + 184 + 91 = 1,684$ million.

Goals

The WHO report has estimated that the cost of a global program to serve 91% of the urban (house connections and public hydrants) and 36% of the rural (reasonable

access to safe water) by 1980 would be \$14.5 billion and \$6.5 billion respectively giving a total of \$21 billion for the five year program. This is \$4.2 billion per year and reflects a per capita cost of \$65 for urban and \$25 for rural systems. These costs are in 1975 dollars and will differ from country to country and region to region. The annual figure of \$4.2 billion can be compared with a figure of \$5.4 billion which is reached using the same per capita cost figures but using a target of 100% urban and rural people to be served by 1990. In other words, the 15 year program designed to reach the WHO targets by 1990 would require a total investment of \$49.5 billion, while \$63 billion would be required to reach 100% service level by 1990. The \$4.2 billion and \$5.4 billion figures can also be compared with the amounts shown in the WHO 1970 survey as representing total investment and total external investment in the year 1970. Unfortunately, figures on total investment made in any one year from all sources are not presented in the 1975 survey report. The 1970 data show that roughly \$1 billion was invested in that year of which about \$700 million reflected external funds. Before commenting on these figures, it should be noted that the \$1 billion stated to have been invested in 1970 if expressed in 1975 dollars might represent around \$2 billion and can be compared with the \$4.2 billion and \$5.4 billion annual requirements shown above.

In challenging the 1970 WHO investment figures no criticism is intended because of the extreme difficulties encountered in assembling such data. Communities receive funds from their local government, from Provincial or State Governments, from one or more line items in national budgets, from one or more external sources, from suppliers' finance, and from private organizations. For countries where considerable decentralization exists, or where more than one agency has responsibilities for water supply, and where rural operations are separated from urban, to obtain even a notional estimate is next to impossible.

Turning to external sources of finance, the task of obtaining accurate data is equally difficult and only the international banks have sufficient centralization and classification of lending operations to permit reliable figures. Some of the bilaterals regard the information as internal, some are decentralized and do not show sector breakdown on assistance provided, and others may provide assistance in packages where the exact amounts ending up in water supply are hard to identify. Having pointed to the problem, the 1970 figure of \$1 billion can be questioned on the grounds that if \$700 million came from external sources in that year, the \$300 million difference between that and the \$1 billion total which reflects local investment has to be greatly understated. It is the author's view that in any given period, government funds from all internal sources directed at water supply generally exceed external investment. On World Bank projects for example, it is common to find

that the Bank loan is for no more than 50% of total project costs. It is also known that while Bank loans may involve one large project, many smaller projects are going forward under local financing. It is therefore concluded that if the \$700 million figure for external funds in 1970 is taken, local investment should have been at least that amount and logically much more. If this is true, then the \$1 billion figure may, more accurately have been \$1.5 billion or \$2 billion. The significance of raising this point is that in deciding to what extent the 1980, 1985, and 1990 goals are achievable, some idea of how much is being done now, or in any past year, is needed. One can either conclude now that the goals are hopelessly high and cannot be achieved without a three or four fold increase over past levels, or conclude that with a reasonable effort they can be attained. In the final analysis, the exercise rests with each country and the past, present, and proposed performance. Unfortunately, too few countries have data with sufficient accuracy to permit more than a duplication, on a smaller scale, of the crystal ball exercise presented in this analysis.

As a first step, each country should take the WHO data, correct it for accuracy and update it to the present. It should then establish several alternate targets for 1985 and 1990 and, using per capita cost figures and other information specific to that country, establish the investment requirements for each set of targets. A decision should be made on the target which the country decides is best and this target then subjected to further analysis because in many countries even if funds are made available for construction, limitations on technical manpower for design construction, and operation may preclude the achievement of the goals.

The Work Plan

Targets to be reached at the end of a five year period must be converted into a work plan which establishes for each year the actions to be taken. These will include the listing of all communities to be included in the plan and the determination of which ones to take up first and which in later years; the staff requirements and assignments should be established; transportation and equipment needs should be identified; and liaison arrangements made with all concerned ministers and political bodies. The work plan should cover the program in general, and a separate plan established then for each community. The objective of all this is not to create a voluminous amount of paper but rather to permit awareness in advance of problems that will come up and to avoid them or resolve them before they bring particular actions to a halt.

Project Identification and Community Selection

In the five-year work plan prepared by the water supply organization and agreed upon with the appropriate ministries and officials, there needs to be a selection of communities on which work is to be initiated in year one. It is assumed that each community will be approached and found to want the project and is willing not only to pay the full costs of operation and amortization of the loan, but also to make an initial contribution toward the costs. One of the most effective ways of establishing community interest and, in turn, the priority to be assigned for its selection, is the willingness of the community to make an initial contribution against the costs.

Project Preparation

The elements of a fully prepared project for which internal or external funds are to be obtained, are as follows:

- a) the engineering and feasibility study;
- b) the financing plan and the financial projections;
- c) the construction schedule;
- d) the proposal on how the construction is to be done and supervised;
- e) the proposed arrangements with the community on what it is initially responsible for, what its obligations will be, and the means for determining how much users will be charged for water;
- f) proposed arrangements on the organization, management, financial records, and operation of each system; and
- g) the economic justification of the project.

Only one aspect of the foregoing will be discussed because it is the one on which the others depend, it is the activity associated with the engineering and feasibility studies. Without such studies there can be no project and no basis on which to move to the other actions. This is the action which many countries and their water agencies are not taking and which prevents a more aggressive program to be undertaken.

Who Does the Engineering

There is a common misconception that international financing agencies require the use of foreign consultants. This is not true. The requirement is that the engineering be done in a competent manner; that it leads to the least cost solution; and that it will be within the ability of the people benefited to support. This means that engineers of the water organization, local consultants, or foreign consultants can be called upon. For large, complex projects it is the rule in the highly

industrialized countries to engage consultants for at least part of the work. The extent to which foreign consultants will be needed by developing countries has to be assessed by the water agency, the government, and the financing source. To the maximum extent possible, local consultants should be used. Much could be said on the ways by which this national resource could be stimulated or better used. It will suffice here to say that in any strategy for the medium and long-term development of the water supply facilities of a country, every effort should be made to build up the local consulting capacity.

Organization, Management and Policies

It has been said that good staff can make any organization function reasonably well, but that even with the best of organizations effective management will not occur if the staff is incompetent. The obvious objective should be a good organizational structure tailored to the needs of the country and staffed by experienced and competent staff. It will be necessary for most water organizations to immediately proceed on the actions needed to reach agreed objectives without waiting for major changes to occur in their organizational structure. Units may be added, or minor changes made without the need for major reorganization. If problems exist which will require major changes, studies could be initiated leading to reorganization later when the studies are completed. It is in countries which have decentralized government or decentralized water operations where problems are commonly encountered which may require ad hoc arrangements and which will permit the country to move forward in its water programme through a co-ordinating or other responsible central body. This would assist in bringing all of the parties together and expediting the actions which must follow. Most external investment agencies will likely place importance on the water sector organization and will usually be willing to assist in development of the institutional arrangements.

Management performance is an area where most water organizations need improvement. Education and training, experience in the organization, and willingness to assume responsibility are important attributes in the selection of key staff within the organizations. Delegation of authority and responsibility with follow-up on performance are inherent requirements for good management. Management also needs an accounting system which permits knowledge of the financial performance of the enterprise and which can be the basis for sound financial planning.

Policies governing the operations of water organizations are of fundamental importance if new projects are to move forward on schedule and if existing systems are to be properly operated and maintained. An established policy which requires that all those who benefit from the water supply will pay for its full

costs, needs to be laid down by government and strictly adhered to by the water supply management. It is one of the most important policies surrounding water supply organizations and for most countries will be one of the factors surrounding success in the attainment of objectives. Financial requirements for the greatly expanded programmes proposed for the next 15 years will be high. Many governments will not be able to fund such programmes from the national budgets and from foreign investments alone. Funds generated from operations will have to be available to supplement anticipated shortfalls. Even for the countries where national income is sufficient to permit substantial subsidy of the water supply programmes, the rationals for charging the full costs of water as a policy can be sustained through the benefits gained by conservation of scarce water resources and by a greater public awareness of the value of water and the need to safeguard the facilities which provide it. Financial performance criteria are commonly established by external lending agencies whose objective it is to insure that the projects they finance contribute the maximum toward the country's development. A water project which not only requires scarce budgeted funds to construct but also requires partial operating subsidies on a continuing basis not only robs other sectors of their need for funds but also sets the stage for poor maintenance because funds for maintenance are commonly the first to be cut when budgets are tight.

Government policies which enable the managers of water organizations to recruit, promote, reward, discipline and to follow, in general, sound personnel policies are important for the improvement of management. Where policies are clearly defined, it then becomes the Governments' role to hold management responsible for their implementation, and for performance.

Manpower Development and Training.

As noted earlier, countries may have the willingness to provide the funds needed to meet desired targets but they may not have the technical resources necessary to do the engineering; carry out the other actions required for project preparation; arrange for the letting of contracts, supervise construction; and then arrange for the needed management, operation and maintenance of the facilities. The work plan should therefore estimate the numbers and types of personnel required, arrange for recruitment and training, and propose ways for carrying out the work during the early years until the manpower resource begins to meet the need. Specifically, this will require the preparation of a manpower and training plan at the earliest possible date. This activity can be financed or assisted by various bilateral and multilateral agencies concerned with water supply. The international banks will normally include funds in their loans to

support such activities. Training should be established as an ongoing activity and not discontinued at the end of the interim programme.

The Long Range Strategy

The long range strategy should be based on a recognized goal which anticipates the provision of safe and reasonably accessible water supply to all the people. While 1990 may be a reasonable horizon for longer term planning now and for certain countries, it is likely that the 100% target cannot be met by many until year 2000 or after. The pace and experience gained by each country after the first five years will permit adjustments to later plans and goals.

While use of five year planning increments is common to many countries, it has a serious defect as commonly applied. The plan is frequently fixed for five years whereas it should be updated every year with one more year added. A five-year plan developed for 1977 to 1982 should be reviewed at the end of 1977 and moved to a 1978-1983 plan, etc.

A number of benefits result from advance programming. First, with water supply many water sources available now may not be available 10 to 20 years from now. Action is required many years in advance to insure availability of the sources when needed. Second, national planning and financing agencies when faced with facts on number of people now without water, and number to be added in the years ahead, can take decisions on country objectives and obligations which they cannot do now. Their support is fundamental to the water supply officials who seek funds. Thirdly, manufacturers of pipe and water supply equipment who may be interested in setting up local factories cannot evaluate market requirements until the country has clearly laid out and approved programmes which will extend for at least five years and which present information on the extent of construction to occur in the period. The same holds for development of the local consulting industry. If local engineers are to make the commitments required in setting up a full time consulting firm, they have to be assured that there will be work for them. Finally, unless water organizations look to the future, they will not have a very productive future because year to year planning, budgeting, and operations with no perspective on where they are going, will convince few that they should be given additional resources.

Sanitation

This paper discusses the short-term and long-term strategy to meet water demand in developing countries. Because sewage disposal facilities are usually required long before all potential consumers receive water service, a brief review of existing service levels and future investment needs is necessary to illustrate total funding requirements of the sector.

The WHO 1975 survey report of water and sanitation in the developing countries presents data on the current status of urban and rural sanitation services and proposes 94% of the urban population and 24% of the rural population be provided with excreta disposal services by 1980. As already noted when discussing water supply targets, not much can probably be done today to reach 1980 goals. However, actions can be taken to meet 1985 and 1990 targets and the following figures will help in establishing such targets:

- (a) Urban population for countries included in the WHO 1975 survey report is taken as 1975 = 589 million, 1985 = 889 million and 1990 = 1,025 million.
- (b) Urban population growth 1975 to 1985 = 300 million; additional to 1990 = 136 million.
- (c) Urban population served in 1975 by public sewers = 147 million; by household systems = 218 million; not served = 224 million.
- (d) Additional population to be served by 1990 = 224+300 +136 = 660 million, or 44 million per year from 1975 onwards.
- (e) Rural population in countries surveyed is taken as: 1975 = 1,719 million, 1985 = 1,903 million, 1990 = 1,994 million.
- (f) Rural population growth 1975 to 1985 = 184 million; additional to 1990 = 91 million.
- (g) Rural population served in 1975 = 241 million; not served 1,478 million.
- (h) Additional rural population to be served in 1990 = 1,478+ 181+91 = 1,750 million.

The WHO report estimates that the cost of a programme to serve 94% (38% with public sewers and 56% with household systems) of the urban population and 24% of the rural population would be \$12.5 billion and \$2.0 billion respectively for a total of \$14.5 billion in five years. This amounts to \$2.9 billion per year and is based on per capita costs of \$72 for public sewers, \$23 for household systems and \$11 for rural disposal systems. Based on these per capita costs and assuming only small increases in investments in the succeeding fiveyear periods ending in 1985 and 1990 (\$15. 3 billion and \$16.5 billion respectively), the following targets could be accomplished.

	<u>%</u>	<u>1980</u> <u>millions</u>	<u>%</u>	<u>1985</u> <u>millions</u>	<u>%</u>	<u>1990</u> <u>millions</u>
Urban population served with public sewers	38	286	50	445	60	615
Urban population served with household systems	56	326	40	356	30	400
Rural population	24	426	37	705	50	997

Total investments for the 15 year period would amount to \$46.2 billion. This figure probably underestimates the cost by a wide margin; as the per capita costs encountered for public sewer projects usually range from \$80 - \$300 while the average reported by WHO and used in this calculation is \$72. Using a per capita cost of \$150 for public sewers but maintaining the other cost and the percentages served would increase the total investment programme to \$80 billion.

THE EXPERIENCE WITH NATIONAL SECTOR STUDIES:
IDENTIFICATION OF CONSTRAINTS AND PRIORITIES *

by

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Cooperative Programme In Pre-Investment Planning

* Note: Dr. Becher's presentation for the Training Seminar was based on sector studies made by the WHO/IBRD Cooperative Programme in the period 1972-1976. Analysis and suggested strategies based on this experience were reviewed in a Workshop for National Water and Sewerage Development, held in Delhi, 22 November - 3 December, 1976. The present paper is a summary emanating from this workshop and gives recommendations for better planning and management of water and sanitation works at national level (see also WHO Report P20/133/2, Geneva, 15 December, 1976).

THE EXPERIENCE WITH NATIONAL SECTOR STUDIES:
IDENTIFICATION OF CONSTRAINTS AND PRIORITIES

1. Development of the Community Water Supply and Sanitation Sector

A. Strategies for National Sector Development

- (a) There is a need for the development of an information base for situation analysis and problem identification.
- (b) There is a need for the formulation of sector development plans.
- (c) Sector development should be encouraged by means of inter-sectoral linkages with productive sectors such as irrigation and with others such as rural development or primary health care.
- (d) The most difficult portions of the sector development are the development of the rural segment as well as of the sewerage sub-sector. This means that the mere "financial cost/benefit" orientation has to be moved to a more economic, or even to a human welfare functions, orientation.
- (e) In conjunction with the above, it is important to analyze and formulate policies for sector development (e.g. Minimum Needs Programme).
- (f) There is a need for developing both the decision-making process and the data base required which should go hand in hand.

B. WHO* Collaborative Efforts with Governments

- (a) WHO input should be in planning activities which include sector study, country health programming, sector planning and environmental health planning.
- (b) A sector study should stimulate the national planning process
 - either during the process of the sector study, or
 - through recommendations on the planning machinery.

*World Health Organization

2. Sector Study Process

- (a) A sector study should be strategically placed in the process of national development. It may focus on key policy variables, or undertake more in depth analysis on specific issues or function as a starting point for national sector planning and programming or act as a process leading to the generation and selection of investment projects.
- (b) Generally complete coverage will be requested with emphasis on project identification possibilities.
- (c) A sector study report should consist of four parts:
 - (i) a brief summary of three to five pages phrased in laymen's language;
 - (ii) a short descriptive section giving sectoral information;
 - (iii) analysis, projections, project identification where possible, and recommendations;
 - (iv) annexes giving information and data collected in support of what is discussed in the report; superfluous data should not be submitted even in an appendix.

(ii) and (iii) should not normally exceed 20 pages.
- (d) The request for a sector study will as a matter of principle emanate from the Government of a Country and be relayed to the WHO/IBRD*Cooperative Programme (CP) (through IBRD Washington, WHO Geneva, WHO Regional Office or WHO Representative in the country). The country engineer and the Regional Office will start collecting all possible information.
- (e) The next step will be a reconnaissance mission by a WHO/IBRD staff member designated to have full responsibility for the overall study. This mission should result in the preparation of a draft of item (c)(ii) and draft terms of reference and a study work plan. The required staffing for the full mission will be identified at this stage along with timing and counter-part input.

*International Bank for Reconstruction and Development

- (f) Terms of Reference will be finalized between Government, WHO and IBRD.
- (g) The full mission will commence next.
- (h) More national participation in the process of sector study is required.
- (i) The timing of sector studies should be geared to the national planning cycle where possible.

3. Follow-up Process

It is assumed that the sector studies have been carried out in conjunction with the Development Plan. It is desirable that the report should be presented to the Central Planning Unit or its highest equivalent established body, i.e. Finance Ministry, etc.

- (a) The follow-up should be done by the agencies concerned, with the support of IBRD, its visiting teams and WHO staff, i.e. WHO country engineer, WHO Representative or other WHO personnel.
- (b) One of the main purposes of the follow-up should be to induce Government to formulate policies for more rational investment in the sector to develop projects for investment.
- (c) The watchdog for the follow-up should be the local representatives of the WHO and IBRD who should advise the Governments concerned and keep their head-offices informed.
- (d) The follow-up should be on a continuing basis in keeping with the Government's aspirations.
- (e) It is emphasized that the WHO country engineers should play a more effective role in this respect.
- (f) The follow-up activities should include a periodic review and evaluation of the sector study recommendations.

4. Role and Requirements of WHO Staff

The country engineer is the essential link between the government and the organization in respect to sector development, and his assignment vis-à-vis sectoral development is of crucial importance. The expertise and capacity available at the various levels of the organization should be conceived as a support to him. Among other things, his role should include:

- (a) Assistance to the national agency(ies) to develop a suitable information system for water and sewerage sector development (supplemented by expert assistance as required).
- (b) Preparation and regular updating of country reports relating to water supply, sewerage and sanitation facilities in the country and also making recommendations for improvement and/or remedial measures.
- (c) Assessment of the need and acceptability for a sector study by the National Government and assistance in formulating action towards initiating the study.
- (d) Assistance in strengthening the national agency(ies) in the planning, design, construction, operation, maintenance and management of water supply, sewerage and sanitation facilities.
- (e) Together with the regional staff, providing assistance in all aspects of sector development including review of development plans, projects and facilities in the sector.
(In the activities (b), (d) and (e) no substantial assistance will be needed from Headquarters).
- (f) Acting as a focal point for technology transfer of the experience of some other countries.

Not all WHO field engineers can be considered as being able to cover all sectoral activities as they may be fully occupied in their specific projects. It could also be, by virtue of the fact that he is located with one or other government agency, that he will not be able to discharge activities outside the scope of that particular agency. To make the role of the country engineer more adaptable and effective in the development of the Sector, attendance at

orientation and short study courses in more specialized aspects of planning, economics, finance and management will be advisable.

In view of the intimate knowledge and appreciation of the local conditions, the country engineers should actively participate in the writing of the sector report.

1. SECTOR REPORT STRUCTURE

- (a) The structure should be kept flexible to satisfy the needs of the client(s), i.e. those who will put the findings to use. The study should be ideally a collaborative effort of WHO, IBRD and the Government, to the extent desired by the Government.
- (b) The report should be framed in a manner convincing to the economic planners and financing agencies. It should bring home to the planners the relative importance of the sector vis-à-vis other sectors.
- (c) The report should contain a summary of three to five pages, a short situational analysis, be brief (25 pages), void of technical jargon, focus on major aspects, and treat statistical data as appendices.
- (d) The report should compare planning of the sector to national planning and other sectors; should examine the possibilities of resource mobilization to assist sectoral development, and should include an assessment of the capacity of the beneficiaries to pay for service. It should report the financial accounts of the sector and the debt service record.
- (e) Institutional and organizational recommendations should be justified within the local legal and administrative environment.
- (f) Project identification and follow-up process should form an important part of the report.
- (g) The report should provide comparative data of other countries within the same Gross Domestic Product range where the sector is better developed.
- (h) Policy and programme alternatives should be developed based on solid analysis embracing efficiency and equity considerations.

2. INFORMATION REQUIREMENTS

- (a) The data and statistics collected by the sector study have been found very useful not only for the sector study itself but also in terms of

the development of the data base for sector development.

- (b) However, there is a tendency to collect too much detail and difficulties have been experienced especially in collecting the data in rural areas.
- (c) In some cases, much information was collected but it was not grouped in the manner required for analysis. Otherwise, in some cases, recommendations were not well supported by data (e.g. when recommending higher tariffs).
- (d) Caution must be given to the accuracy and reliability of data.
- (e) The methods used for the data collection were open to criticism but there was no conclusion as to how to improve them. There was, however, an opinion that field visits may be the best way of collecting the data, particularly in rural areas.
- (f) It was agreed that output should determine input, i.e. analytical framework or planning methodologies should determine the data requirements. Thus, development of the data base should go hand in hand with the development of planning itself. Planning should be initiated irrespective of a good data base.
- (g) Most of the data can be collected prior to the sector study so as to enable the study team to devote more time to analysis and planning.
- (h) Country reports of SEARO* have the following purposes: to assist countries in developing the data base required for their sector development, and to enable WHO to fulfil its coordinating role in channeling external financing to countries. It can also serve as an information base for future sector studies.

3. ECONOMIC AND FINANCIAL ASPECTS

- (a) National and sectoral growth objectives determine the investments required. The sector analysis should compare this sector with other sectors and with the total budget.

* South East Asia Regional Office

- (b) Synthesized financial data must be prepared in order to present a composite picture of the flow of funds in the sector. Recent performance evaluation is desirable to judge chances for absorbing higher allocations. Debt service performance of sector agencies should form part of the sectoral analysis.
- (c) Often in economic planning, physical production and infrastructure investments come first and water, health, etc. investments are treated as residual under social services. The new approach of planning in packages for various sectors combined makes it possible to bring together revenue earning and losing activities. Lending in such instances has to be through intermediaries often yet to be established.
- (d) Economic policy alternatives e.g. efficiency versus equity considerations, should be clearly stated when recommending action or appraising the sector. Manpower policy and welfare objectives determined at central government level should guide the sector analyst.
- (e) Recommendations on tariff policy changes and rate structure should be preceded by a careful study of the socio-economic evidence by the national agencies concerned.
- (f) Tariffs may serve multiple purposes, of raising revenue, resource protection, and income redistribution according to countries and agency policies. Water use patterns should be compared with income and wealth distribution patterns when evaluating tariffs and connexions charges.
- (g) Indexing tariffs may be an effective measure for shielding agency operations from inflation.
- (h) Ability to pay can mostly be assumed in urban system development and willingness to pay is often demonstrated in rural areas where people express a strong preference for water over other investment. Cross-subsidization is facilitated in rural development projects that include various schemes (e.g. agricultural production).
- (i) There is no appropriate policy on economic grounds of favouring public standposts versus private connexions but with the same amount of funds, reasonably safe service can be brought to more people by favouring stand-

pipes, although for health reasons private connexions are preferable.

- (k) Project appraisals including economic, technical, financial, commercial, organizational and management aspects are strongly influenced by locally prevailing conditions. Guidelines for appraisal, especially on engineering aspects, help to guard against costly options.

4. INSTITUTIONAL OPTIONS

- (a) There are several policy options open to the institutional aspect of the sector. Some of them are: fiscal, private or autonomous public organization, centralized versus decentralized systems; the separation versus the combination of urban and rural sub-sectors.
- (b) Each country has its own tradition and governmental system. Each country should be looked at in its own right in a sector study without applying any pre-conceived ideas of planners or analysts. However, the presentation of the experiences of some other countries is very useful.
- (c) When analysing alternative organizational set-ups, the important factors to be considered are: economy of scale, the better utilization of available manpower, the possibility of cross-subsidization, the community participation and the reflection of community needs and wants, and inter-sectoral linkages.
- (d) Organizational changes can take place as a result of political decisions. Political factors can be either positive or negative. Bureaucrats are often the ones who resist organizational changes. However, the sector study should be more careful in recommending organizational changes which are difficult to carry out in any countries. Any recommendations on organizational changes must be well justified in the analysis.
- (e) One should not neglect health agencies as sector development authorities.

5. MANPOWER PLANNING

- (a) Most previous sector studies have identified manpower as a basic con-

straint for the sector development, but they have not gone into more detailed analysis. An unresolved question is whether manpower studies should be a part of the sector study or its follow-up.

- (b) In manpower planning, the question is how to match future manpower requirements and future manpower supply both in terms of number and skills.
- (c) There are many factors of uncertainty in planning for manpower: for example, future technological development, service to population coverage, government decentralisation and autonomy policies, role of contractors for meeting service requirements.
- (d) While appreciating the importance as well as the difficulties involved in manpower supply-demand projection, more attention should be given to immediate improvements.
- (e) One of the possibilities is to change the pattern of manpower utilization and this may often demand innovative approaches.
- (f) Another possibility is to convert other professions such as chemical engineers into the sector by re-training, while making efforts to keep the present and future manpower supply in the sector by means of better promotion or remuneration systems, etc. In addition, careful measures must be taken to keep necessary manpower in the rural services. A difficult problem to solve is manpower drift to overseas.
- (g) Manpower planning should also investigate the possibility of establishing mechanisms to satisfy the manpower demand; an example is to institute a programme to train the required operation and maintenance staff after the completion of construction.
- (h) Above all, manpower planning should lead to implementation, and any planning exercise must be geared to the national planning process.

6. COUNTRY HEALTH PROGRAMMING

- (a) CHP places its emphasis on the development of national capacity for health planning and programming and for the formulation and management of projects.

It is a national undertaking, technically assisted by WHO. Its client is the country but it also serves as input to WHO programme planning.

- (b) CHP tries to relate itself to the existing planning cycle of the country. It takes up to two years on the first exercise but could be reduced to six months or so at later stages.
- (c) There are some notable differences between CHP and sector studies, one of which is orientation. In CHP, water supply and sanitation is looked at as one solution toward health objectives; on the other hand, health in a sector study is just one of the objectives of the sector.
- (d) CHP can generate projects in the environmental health services including in water supply and sewerage. However, since CHP is more or less centered around the Ministry of Health, it tends to touch only the rural segment of the sector.
- (e) However, considering that the majority of the population of developing nations still lives in rural areas and that the major portion of sector investments in rural areas must come from internal financial sources, CHP is one of the important mechanisms for sector development.
- (f) Thus, both the sector study and CHP should be effectively utilized for sector development, while efforts should be made to minimize any possible duplication of efforts (such as data collection at country level).

7. INTER-SECTORAL LINKAGE

- (a) The way to develop the sector is to "market it" by relating it to the national policies and major objectives. For example, the sector can be integrated within the broad context of a Regional Development Programme or Rural Development Programme.
- (b) When determining the target population for the sector programmes and projects, the first attention should go to the national development objectives such as the upgrading of the urban poor or the rural population.
- (c) Some of the important inter-sectoral linkages are with: the creation of

employment opportunities by means of labor intensive techniques; the environmental quality control programme; water resource development, etc.

- (d) The sector component should be integrated into large development projects such as new town development projects, new village settlement projects, tourist resort and area development projects, etc.
- (e) The sector development should be well-coordinated with urban, regional and national physical planning. One of the important subjects is the protection of drinking water supply sources by means of land use control in watershed areas.
- (f) The issuing of building permits is an important tool by which sector development can be assured in any future land development. It is also a way of increasing private investments in the sector.
- (g) In achieving coordination with other sectors and programmes, the process of planning is the most important. Planning is a political process, accompanied by learning, communication and conflict resolutions. Planning should be a continuous activity and the key to its success is the participation of key persons from the relevant and important agencies.

A SUCCESSFUL APPROACH
TO
COMMUNITY WATER SUPPLY PROGRAMMING
IN LATIN AMERICA

by

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A SUCCESSFUL APPROACH TO COMMUNITY WATER SUPPLY PROGRAMMING
IN LATIN AMERICA

The Region

The Latin American region stretches from the farthest south of the United States of America to the antarctic territories, covering over twenty countries with a total population of 300 million inhabitants.

Over an area of 22 million square kilometres, all kinds of geographic conditions can be found, from equatorial forests to deserts and from lowlands to the high Andean plateaux.

All human races have mingled with indigenous people to constitute the present population. Communities range in size from a few hundred people to several million inhabitants. The economic level of the population can be assessed by the region's per capita income that falls within the range of US\$100.- to US\$1,500.-

Fifty per cent of the nations are predominantly rural in character, this rises to 70 per cent in some of the Republics.

Sanitary Achievements

Since 1960, the Latin American countries have been making dramatic efforts in the field of basic sanitation (water supply and sewerage networks and/or facilities for disposal of excreta).

Substantial resources have been channelled into these projects, while the number of public works completed is also considerable; as a consequence, the number of inhabitants serviced increased from 70 million in 1975 to about 120 million at present, an increase of 50 million.

In percentage or relative terms, these results do not seem as impressive, owing to the two following major factors:

- excessive population growth in Latin American countries;
- progressive urbanization, a phenomenon whereby urban growth rates can raise two-fold the overall growth rates.

In spite of this, over 70 per cent of the urban population currently enjoys public utility services.

An Example for Developing Countries in Other Regions

One of the difficulties hindering the implementation of global water supply programmes in developing regions - which is seldom perceived by specialists from industrialized nations - arises from the enormous differences between these two worlds, not only in the techno- economic conditions, but also in the political, social and human aspects. The primitive notion that what is fit for an industrialized country is also fit for a developing one must be interpreted with some reserve, when not to be replaced by a different attitude.

It is much simpler and more convenient to transfer technology from a developing to a lesser developed nation than to try to apply solutions originating from industrialized countries. This is why the experience of many Latin American countries can prove highly profitable for other even less developed regions.

Income per capita in Latin America varies between US\$100.- and US\$1,500.- and the existing technical solutions have already been adapted to local conditions.

The cost of water supply systems has been reduced considerably:

- conventional public systems - US\$ 30 - 50 per capita
- simplified public systems - US\$ 10 - 30 per capita

These costs are roughly equivalent to 20 per cent of current costs in the United States.

Chief Restrictive Factors

A detailed analysis of the conditions and developments in the field of basic sanitation in Latin America reveals that several factors play a decisive role in programmes for the supply of potable water. These factors, discussed below are the following:

- motivation;
- leadership and management;
- financial resources;
- technology;
- manpower or qualified labour;
- sanitary education;
- foreign aid;
- exchange of information.

Motivation

The primary condition for aiding a community is its own willingness to be helped: a recognition of its own needs and the critical evaluation and acceptance of the solutions proposed.

Everybody prizes water, but very few people appreciate the importance of water supply systems, and most do not realize that there are maintenance requirements to be met and that the service must be paid for.

Motivation should be encouraged so that it will exist at all levels: in the Government and its planning bodies, among business managers, economists, politicians, leaders, as well as among the population involved.

Several meetings have been held periodically between the health ministers of all Latin American nations. One of these meetings, held in the early part of the last decade in Punta Del Este, resulted in the first Latin American agreement to conduct a large scale development programme for water supply and sewerage facilities.

The accomplishment of pioneer programmes in pilot areas gave the first major stimulus to the population benefiting from these projects and also to their leaders, politicians and water authorities.

Technology

The success of basic sanitation programmes is strictly related to the availability of proper technology. The use of technology suitable for local conditions yields the following advantages:

- economies of scale in the projects;
- simplification of the system, facilitating its operation and maintenance;
- better utilization of local resources such as labour and materials.

Both the criteria used in and parameters of a project greatly influence the cost of the works. The cost of water supply systems can vary between US\$10.- and US\$100.- per capita, or even more, depending on the project's features and the local conditions.

A project for a public water supply system in a Latin American city with 300,000 people was commissioned to an important North-American engineering consultant.

While the proposed project was considered excellent from the engineering aspect, the cost was above 18 million U.S. dollars, making the venture economically prohibitive. A second proposal was made using criteria compatible with local conditions. Costs were thus reduced to US\$8,000,000 and the project was completed successfully. Such instances occur often, but with a difference: many times the higher priced project goes through.

Latin America has developed its own technology, which accounts for the ever increasing success of its programmes. This technology has been continuously updated and improved with the support of innovative research.

Leadership and Management

Leadership is present in any society, but sometimes the leaders are unable to allocate priorities. As far as regional rural programmes are concerned, it is essential to identify the leaders and to convince and instruct them in order to optimize results from activities directed by them. Once persuaded they are able to motivate the community itself and it is easier for them to obtain the necessary financial resources.

Developing countries generally lack qualified men for management positions. Specialized training programmes are fundamental for the improvement of these professional men.

Financial Resources

Obviously all public works require adequate financial resources. Many times these resources are available but not allocated to sanitation works. There is wide consensus on the fact that the use of government funds is made in a competitive setting, subject to numerous pressures.

Financial resources may be obtained from the following sources:

- federal government;
- regional authority;
- provincial government;
- local (municipal) government;
- population benefiting from the service;
- foreign agencies.

The first four of the above sources are those most commonly resorted to.

Experience shows that it may be greatly inadantageous not to use all of these possibilities to channel available resources into the programmes.

Participation of the local population, either by means of financial contributions or in the form of labour, is highly advantageous, with the additional benefit that such a direct participation tends to motivate users of the services, since the population starts to view itself as the "owners" of the public works.

Manpower and Qualified Labour,

Lack of qualified labour is a major obstacle in solving water supply problems in developing nations. Importing skilled labour is a palliative but merely a provisional measure. The only permanent solution is the training of local labour at all levels of activity.

In Latin America, efforts to achieve these goals have been carried out in the following order:

- preparation of engineers in sanitary engineering courses given in developed countries;
- intensification and improvement of courses in hydraulics and basic sanitation;
- organization of regional courses in sanitary engineering;
- provision of short courses at various levels;
- training programmes in the working environment.

To give an idea of the size and scope of an intensive training programme, it is worth mentioning the example of Brazil where 60,000 people are currently being trained for the country's future work in water supply programmes.

Sanitary Education

Sanitary education might be considered as the basic ingredient, or the cornerstone, of any public health programme. Public support for community programmes is obtained through sanitary education, which ensures correct usage of the services provided in this area.

Proper acknowledgement, however, should be given to the fact that sanitary education programmes involve mass phenomena, require huge resources and will only produce results in the long-range.

One way of promoting sanitary education is to use the school system for carrying out special teaching programmes for children. To achieve this, it is first

necessary to train the teachers.

Foreign Aid

No developing country can do without foreign aid offered by developed nations. Foreign aid is extended in the form of technical assistance, supply of materials and financial grants or loans. In many developing countries there is a widespread feeling that such aid should be further expanded.

An important step in this direction was the persuasion of international bankers to grant loans for the construction of public water supply facilities in developing countries. Before that, the application of resources in this field was considered a high-risk operation for banks.

A still unresolved problem is that many international organizations seem unaware that technical aspects must be adapted to local conditions, as referred to earlier. Another problem is the lack of cooperation and coordination between the numerous organizations extending foreign aid.

Exchange of Information

The development of a nation is a dynamic process yielding an enormous amount of experience. Unfortunately, no practical mechanism has yet been initiated for the retrieval and application of the invaluable data existing today; and moreover, no operational system exists for dissemination of the information available.

Particular solutions are duplicated and errors are repeated in ignorance of earlier failures or successes. In countries where resources for scientific investigation are extremely scarce, even research is often reproduced due to the lack of knowledge about what has already been done.

It is indeed strange that this should occur in an age when there are ample resources in the communications and information retrieval fields. Hence the importance of acknowledging the high priority of a global information system in the field of basic sanitation.

A Case-history

Maranhao, one of Brazil's poorest states, is located in the North on the Amazon, Basin. With a little over 3,000,000 inhabitants, the population density is quite low in relation to its area of 325,000 square kilometres. The state has

130 municipalities with an urban population of 770,000 people (25 per cent) and a rural population of 2,230,000 (75 per cent). Annual per capita income is at present around US\$100.-

A water supply programme covering 65 rural communities was conducted in this state. The first step consisted of persuading and motivating state authorities of the importance of such a programme. A governmental enterprise, CAEMA, was then formed to administer the programme for supply of potable water. Management of this company was retained by an engineer specially trained for the required functions.

After studying the prevailing economic conditions among the population, the management of the new enterprise concluded that the proposed water supply programme would be viable only with the implementation of the following measures:

- Substantial reduction of costs of the proposed works;
- Direct participation of the population in the construction and operation of the system;
- Reduction of operating costs;
- Financing of residential water connections.

To meet the first requirement, several projects for simplified water supply systems were conceived. These simplified projects differ from conventional systems in the following basic parameters:

<u>Parameter</u>	<u>Conventional Project</u>	<u>Simplified Project</u>
Water supply per capita	250 litres/day	70 litres/day
Minimum diameter	50 mm	25 mm
Minimum pressure	10 m	6 m
Service reservoir capacity	33 %	20 %
Average cost per capita	US\$20 - \$40	US\$10 - \$20

To instruct and motivate the population still not acquainted with public water supply systems, community work was promoted by the State Company with the cooperation of the State Social Service Department, which operated through its Social Welfare Foundation. Its social workers, specially trained to carry out the "community action" work, were used for the project.

Preparatory work in each selected community was accomplished in accordance with a community development plan comprising the following stages:

- Compilation of data needed for the project and for a socio-economic survey;
- Mobilization of the community and promotion of the project;
- Organization of a local pro-water Board comprising five members chosen by the population;
- Supervision and follow-up of the public works;
- Sanitary education;
- Evaluation of activities.

A 2,000 people community (Guimaraes), was selected to serve as an experimental and operational model. The plan was accomplished here with great success, as witnessed by the following results:

- Ninety per cent of the population agreed to subscribe to the water supply services and to pay the required rates;
- The population participated actively in the project's construction by excavating all ditches and laying down the pipes; all 7,000 metres of ditches for the water mains and pipes were excavated within only 18 days;
- The population agreed to operate the services under the direct supervision of the Board.

Total cost of the project was estimated at US\$32,000.- Capital allocation and participation of investors was broken down as follows:

State Water Supply Company	US\$20,000	(60%)
Municipal Government	US\$ 6,000	(20%)
Participation of the population (manpower)	US\$ 6,000	(20%)

The programme conceived to supply potable water to this small town brought about a series of unexpected additional benefits. For instance, community cooperation experienced for the first time arose public interest to accomplish other works such as the construction of schools, sports clubs and many other ventures.

Stimulated by this successful experience, the State Water Supply Company, CAEMA, designed a master programme to extend potable water supply services to 106 communities. To date, 65 new water supply networks have been completed. The State Company is now undertaking the preparatory work for a second programme for construction of sewerage systems.

A New Approach for Developing Projects

In areas where the economic level is just too low to render conventional projects economically feasible, a new approach can be considered which consists of developing projects in successive stages of technical complexity. This approach consists basically of implementing first a minimal project capable of being upgraded and expanded within a specified time into a simplified project and later, if necessary, into a conventional project. Technically speaking, it is quite possible to conceive a system that allows for this upgrading.

First stage

- Water source, preferably ground water
- Installation of pumps
- Reservoir
- Piping to feed public fountains or standposts

Second stage

Construction of a minimal water supply network servicing the most densely populated area.

Third stage

Expansion in size and scope of the system. Strengthening of piping and mains (large sizes).

Such upgrading is made possible as the user's appreciation and demand for the services provided increase, while at the same time the economic standard of the population is raised.

This gradual development of the system would follow closely the expansion of demand for the services, since the project takes into account that in the initial years of implementation the great majority of existing housing would not have the required conditions for installation of the internal piping needed to benefit from piped water supply services.

List of "DO'S" and DON'TS" derived from the Latin American Experience in the last decades

For the success of water supply and sanitation programmes the following deficiencies should be overcome:

1. Lack of leadership and good management;
2. Lack of motivation in all levels (government, planners, politicians, technicians and the beneficiaries);
3. Lack of general plan (National, Regional);
4. Lack of coordination between several authorities and organizations involved;
5. Lack of a strong entity or organization in condition to deal with the problem;
6. Unrealistic approach (social, economical, technical, financial);
7. Improper technology and deficiencies of design (lack of adaptation);
8. Insufficient financial resources;
9. Continuous delays in the execution of the programmes;
10. Inadequate water rates and excessive subsidies;
11. Lack of qualified manpower and lack of a training programme;
12. Improper attitudes and actions towards operation & maintenance;
13. Lack of information;
14. Lack of sanitary education of the public at all levels and in government circles.

Summarizing:

- a) Try to explore and utilize all sources of funds and support, including the participation of the population
- b) Do not try to solve a global problem by using a case by case approach

PLANNING, FINANCE

ORGANIZATION & MANAGEMENT

PLANNING WATER AND SANITATION SYSTEMS
FOR SMALL COMMUNITIES

by

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PLANNING WATER AND SANITATION SYSTEMS
FOR SMALL COMMUNITIES

Introduction

There once was a King who was famous for the problems he could solve. People came from miles around to watch the Wise Men of the world pose problems to him. But, try as they would, they never could pose a problem he could not solve. He was known far and wide as the King who had all the answers. One day, one of his sons said, "Oh, wise father, tell us your secret, in order that we might reign as wisely as you in our turn." He turned to them and said, "My secret has two parts: The first part is that one need realize that the only difficult problems are those that are poorly stated. Once you have your questioner clearly define his problem, the answer is usually obvious. Thus, to solve a problem, one must first define it. Secondly, one must realize that the crucial phase in solving a problem is the process by which it comes to be defined. So, ask lots of questions until you are sure you understand the question and the resources you will have to solve it, and then your answer will usually be obvious."

Thus it is with planning water and sanitation systems for small communities. We must first clearly define what it is we want to do, the resources we have, and the time frame we have within which to complete the "task." As simple as this may sound, the world is littered with programs that have set out to "solve" a problem that no one could define.

Ask what the purpose of a Community Water Supply and Sanitation Programme should be, and ten country officials will probably give ten different answers. Is it to provide water? How much? What quality? Over what period of time? Is the program to be a self-help scheme? If so, why? How will community participation be included? When? For how long? Why? These are some of the questions. But, unlike the King of the story, I do not have the "answers"--only a few guidelines to help guide your efforts.

What is a Community Water Supply?

Following the advise of the Wise King, let's examine our problem and see if we can't define its limits and the resources available to solve it.

Many professionals who have always dealt with urban water and sanitation systems (In a realistic planning sense, the two elements--provision and disposal--are merely elements of the same process and should be treated as a continuum with differing time frames.) often ask, "What is so special about designing and building systems for these small communities? Aren't they just an urban system on a smaller scale?" As one stops to reflect on the question, he begins to see vast differences. Let's try to identify and examine these differences and then see how they influence the planning process.

What are the differences?

As one examines how the various elements of planning and executing a water and sanitation system for a large (3,000 or above) and a small community (3,000 or less), at least five areas of basic differences can be identified.

These are:

- Programs vs. Projects
- Community Acceptance and Education
- Financing Schemes
- Repetition of Units
- Technical Assistance
- Community Participation

Now, let's examine each area in more detail.

Programmes vs. Projects. - If one were to envision the provision of a water system (This could be at least a public fountain in the central square, or a well.) to every small community grouping in the country of Perú, the resulting program would provide water to about ten of the 13 million people in the country. But to do so would mean providing systems to about 80,000 communities ranging in size from 50 persons to several thousand. Table I shows the population distribution versus number of communities for rural countries in Central America.

As one approaches this problem, it is obvious that, in order to design the systems for the limited number of larger cities, a project approach must be followed in which one uses specialized engineering and management talents-- often foreign consultants--to study, design, finance, construct, and operate each project as a unique entity.

Whereas -- as one tries to extend the coverage to increasing numbers of cities, towns and villages-- the approach must change from a project to one

TABLE 1.
POPULATION DISTRIBUTION VERSUS NUMBER OF
COMMUNITIES IN CENTRAL AMERICA
May 1977

Population by groups	Belize	Costarica	El Salvador	Guatemala	Honduras	Nicaragua	Panama	Localities	%
From 100,000 and more	--	1	2	1	2	1	1	8	0.03
From 20,000-99,999	1	5	5	4	2	5	4	26	0.06
From 2,000-19,999	5	101	91	143	82	49	77	548	1.29
From 500-1,999	29	250	1,085	1,829	997	580	207	4,977	11.76
Less than 500	190	5,912	1,050	15,944	1,519	4,651	7,494	36,760	86.86
TOTAL LOCALITIES	225	6,269	2,233	17,921	2,602	5,286	7,783	42,319	100.00
TOTAL POPULATION	135,280	1,966,000	3,999,000	6,001,000	2,654,000	2,107,000	1,646,000	18,508,000	

Source: Quadrennial Projections

of a program concept where one finds that the problems are not technical as in the large cities; rather, they are of an organizational, administrative, political, managerial, or financial nature. And often they constitute unexpected and difficult barriers. Assisting the countries to resolve such issues is frequently more helpful than in providing technical or financial aid.

The "urban" professional will find difficulty with this approach -- for, in a program approach, technical decisions must often be subordinated to management and logistic decisions. For example, the number and kind of pumps used in the program should be kept to a minimum in order to reduce supply and repair problems, regardless of technical solutions; whereas, in a project approach, a pump is designed to fit a specific technical solution and the logistic system is then adapted to its unique characteristics and service needs.

Community Acceptance and Education. - Another basic difference between the "urban" and "community" design is how the users visualize their relationship to a public water supply and how they accept or reject its cost and benefits.

The urban dweller seldom has an alternative water source (i.e., well, et cetera). Moreover, because the majority of them have had water and sanitation for many years, there has been created an awareness of the benefits that can result from the presence of such services. Thus, little time and/or effort need be expended in convincing the urban populace of the need for more or better water. A piped supply of good-quality water is taken for granted and is considered as a part of the urban scene. (In fact, this supply may vary from a public fountain, which provides 20 to 30 liters/capita/day to a house connection providing 200 to 300 liters/capita/day.) In a small community, there is usually no equivalent to the urban "demand" for water and sanitation services. In the villages, water supplies are often distant; shared with domestic animals; and have little or no physical structures connected with them.

Thus, one can see that an urban-type demand for "service" (i.e., high-quality water, delivered under pressure 24 hours a day near to the point of ultimate use) along with its various physical structures would not exist in the smaller communities without some motivation to change deeply ingrained water-use customs. This educational effort to overcome often deeply rooted traditional use habits and customs will have to be carried out with a subtlety and knowledge of local habits, be exceptionally well directed and accomplished in

phases over a long period of time. Thus, the governments should include the cost of this effort in their cost estimates as they design programs to bring water and sanitation to smaller communities.

Financing Schemes. - Most "urban" dwellers have long accepted the principle that they must pay for the convenience of having quality water delivered near to the point of ultimate use. They accepted long ago having to pay on the basis of the quantity consumed. The establishment of water rates to cover the cost of investments and systems operation has made it possible to finance and maintain the momentum necessary to meet the growing demand.

However, in the smaller communities the principle of paying for water is usually not well accepted. The inhabitants often feel that water, like air, is a gift from God. Coupled with this belief is the fact that those living in the smaller communities have less capacity to pay than their "urban" counterparts. Thus, developing financing schemes is often difficult and time consuming and requires a good understanding of local habits (for example, bills may be timed with local harvests).

Since the smaller communities frequently find it difficult to obtain the capital for construction--even when they unite into a national or regional program-- the initiative for organizing and financing these programs usually comes from the central or regional government.

In order to help share the cost, the benefitted communities usually contribute labor and local materials (normally up to 20 percent of construction costs in Latin America) for construction and then pay a water rate that as a rule covers local operation and minor repair expenses. To back up such local efforts, the national program organizes a series of regional operation and maintenance teams.

Thus, it can be seen that, in financing an urban scheme, all of the required funds come from the community itself in the form of water rates. Whereas, in the smaller communities, about 80 percent of construction costs comes from outside the community (via loans, grants, et cetera), the remaining 20 percent comes from direct community participation (construction materials, labor, et cetera). In the smaller communities, water rates cover local operation and maintenance costs, whereas major repair, program supervision, and direction costs are borne by the national government.

Repetition of Units. - As one examines the thousands of systems required by any small community water program, one is struck by the number of repetitive elements: water tanks, pump houses, et cetera. Substantial costs savings are therefore to be had if standard designs, techniques, and approaches are utilized. In addition, costs can also be reduced by using technicians who are trained in the repetitive systems in order to reduce the need for scarce professionals.

To meet the demand for water and sanitation services, a "systems" approach to their promotion, design, construction, and operation has been developed in Latin America. Under this approach, the program is broken down into its component parts--community promotion, technical design, program financing, et cetera--and each is studied for its effect upon the others. A program model is then developed which coordinates these elements into the lowest cost solution that will best focus the program elements (human, financial, technical, and management) on the desired goal (i.e., a large-scale program that will result in the building of the greatest number of systems in the shortest time, as well as their long-term operation).

It is obvious that, since a community program must repeat many tasks in thousands of villages--in some countries, tens of thousands--the development of "standardized" techniques is basic if one is to multiply ever present limited resources.

Under this approach, projects would be designed as follows: Using existing maps or aerial photographs (taken by using a handheld 35-mm camera from a light airplane), standardized design criteria (for example, 200 liters per house per day, et cetera), pre-designed elements (tanks, pump houses, et cetera), and standardized equipment lists. (See Figure I.) Once the design has been reviewed by a professional, the materials would be assembled in a central yard and sent to the community as a package, along with all the necessary tools and items not readily available locally. In the area of community involvement, professionals would design techniques and strategies for involving the community; formalize them by carefully designing coordinated modules for each phase; and then train and supervise workers assigned to carry them out at the local level. The design and timing of both the technical and community promotion modules are determined by the needs of the particular project considered in the context of the overall program.

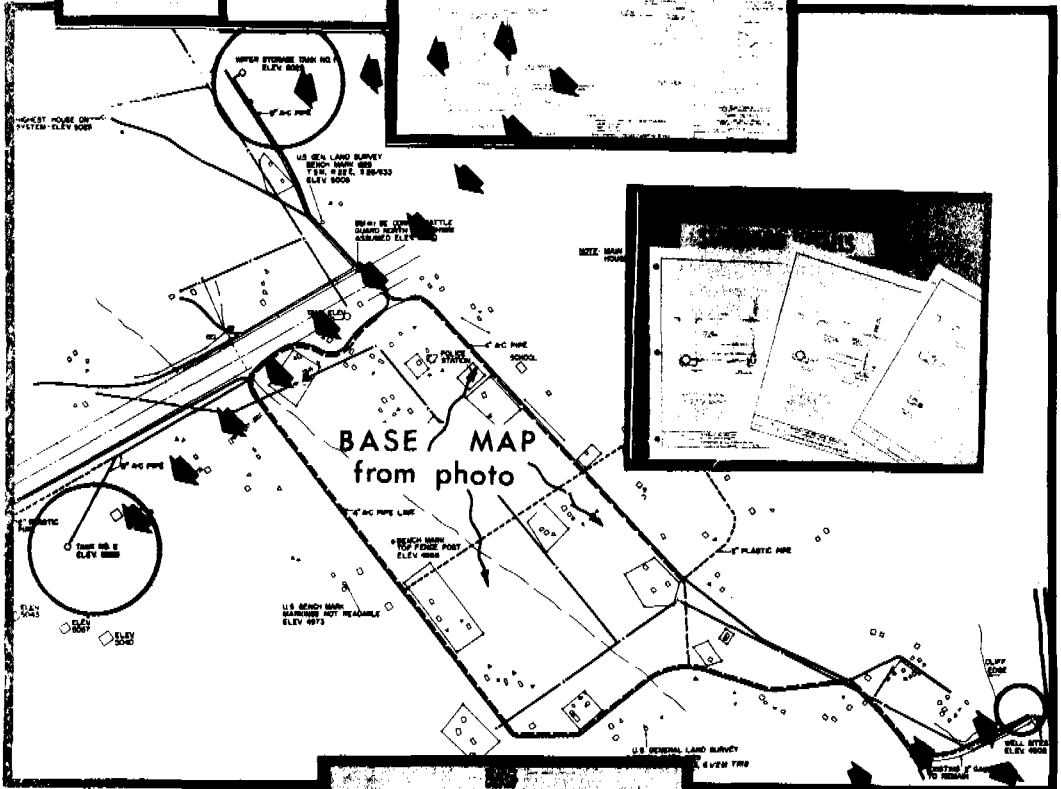
Technical Assistance. - For technical assistance to be effective, it must be timely and relevant. To be so, experience has shown that it must be multidisciplinary and carried out in close collaboration with the ultimate user. All of this depends upon a clear and constant dialogue between the experts, the administrators, and those who are going to use the system.

Unlike that given to urban programs, technical assistance to a community water supply program must work in close cooperation with the educational, financial, and community participation schemes in all the phases, and it must be community-"wise" and "oriented." Experience has shown that such efforts--and often the resulting organizations--should be exclusively related to this sector.

Figure 1.

Select from Standard Design Elements the one closest to Engineering Calculations

Standard Storage Tanks



Total Design
By Selection From Predesigned
STANDARDS

Program Planning

The Planning Process

The Wise King pointed out that, in order to solve a problem, one must first define "it." But what he forgot to say was that once "it" was defined the name of the game was to build "it" and operate "it" over the next X number of years. In other words, the proposed "solution" must fit a realistic evaluation of current and/or potential resources so that "it" can be built and maintained. Otherwise, the planner is merely carrying out an interesting professional exercise--and the needs of the developing world are too great to indulge in that kind of luxury.

The planning process being described in this paper is a mixture of pragmatism and good engineering practice that has resulted in the desired goal of self-help community water schemes for communities of 500-3,000 people that were built and are being operated by the users. The basic philosophy of this effort--which is "Let's start!" --was summarized by Dr. H.G. Baity, formerly Director of the Division of Environmental Health and Professor Emeritus of the University of North Carolina, USA) when he said regarding the age-old argument of quantity versus quality, "...It becomes logical to give (some) water to as many of the people as possible rather than to give a perfect supply to a few ..." In implementing this concept, Dr. D.A. Okun, also of the University of North Carolina, stated that "...A Sanitary Engineer (and Planner) can cloak himself in the respectably conservative (and safe) mantle of 'standard practice' and be a useful servant of society. (But) If one accepts Dr. Baity's argument, the same "professionals," applying the same 'standard practice' within developing countries, would be a wastrel--perhaps even immoral ..." (1)

The philosophy stated above is not a plea for lesser standards of practice. Quite the opposite! Anyone who has worked under these circumstances is aware of the extreme difficulties that can be and are encountered. What is needed is a corps of inquiring, dynamic, resourceful professionals. They must be imaginative and willing to exercise the ingenuity demanded by these dynamic programs. For it is clear that the process of (1) providing, first, basic services (This could mean several handpumps throughout a community.); (2) upgrading (This could be removing the handpumps and providing piped water to multiple water stations throughout a community.); (3) improving (providing patio connections for those who can afford the cost); (4) expanding (providing basic services to those without); and (5) maintaining (on a long-term basis) is neither simple, small-scale, nor well understood.

The process we are speaking of has at least four interlinking phases.

The purpose, the emphasis, and the areas for each are summarized as follows:

1st Phase (Obtain the Commitment.)

- a. Obtain program commitment from highest level of government.
- b. Establish program infrastructure.
- c. Start training of key professional and non-professional personnel.

2nd Phase (Establish Construction Program.)

- a. While emphasis is on construction, establish operation and maintenance concept.
- b. Start training of human resources for operation and maintenance phase.
- c. Establish local/regional administrative capability.

3rd Phase (Improve Local Operational Capacity.)

- a. Continue expanding coverage.
- b. Emphasize development of local/regional operation and maintenance capability.
- c. Improve local/regional administrative capability.
- d. Speed up training of human resources for operation, maintenance and administrative units.

4th Phase (Upgrade and Maintain Service).

- a. Continue construction to expand coverage.
- b. Improve local/regional operation, maintenance, and administrative capability.
- c. Expand systems to cover those not yet served with basic services.
- d. Improve and/or upgrade existing services (i.e., public fountains to patio connections to house connections, et cetera.)

Now, let's look at how one would go about obtaining the commitment, developing a program, and constructing the systems.

Planning the Program

As the Wise Kind pointed out, to solve a problem we must first define it. Therefore, let's look at how one would go about planning and implementing a program to provide water and sanitation services to the numerous small communities scattered throughout the countries.

The basic step for planning the preliminary phase (Obtain the Commitment) are:

1. Define the possible solutions and costs.
2. Estimate development, production, and management costs for each solution.
3. Determine the coverage for each solution.
4. Determine the critical bottlenecks.
5. Determine which solutions are feasible to start with current resources and estimate future needs.
6. Select one solution that optimizes use of resources, minimizes costs, and provides the maximum coverage in the minimum time.
7. Obtain a firm, long-term, high-level commitment for the selected solution.

In carrying out the aforementioned steps, while one must be thorough, he must also be realistic. He must keep in mind that the goal of our effort is to be able to provide water and sanitation systems which can and will be operated on a long-term basis and not just the development of a plan to do so. He must constantly ask, "Will this action produce water in a village?" Our goal must be to start and then upgrade--but start! Even though the "ad-hoc" approach may appear to violate the planning doctrine of comprehensiveness, it is nevertheless an effective tool if one has a "framework" plan that is updated as work progresses.

Increasingly, the countries are realizing the need for a generalized master plan that would provide a framework within which to develop the specific elements. Such a "framework" plan should be constantly updated as progress is attained.

In its broad dimensions, such a "framework plan" might well be developed from the following elements:

- An inventory of the countries' villages and potential solutions.
- An analysis of the technical, financial, and human resources needed (i.e., estimates of cost per project, output per worker, and bills of materials).
- A preliminary checklist of projects and sub-programs.
- An organizational scheme, including allocation of functions between national, regional, and local levels.
- A management plan covering administrative arrangements such as personnel and manpower plans.

In all this, it is important to remember that all this "planning" has to be pursued in accordance with some time schedule--or at least with a preconceived sequence-- in mind. The overall timing must be synchronized, and the individual elements must be staged in relation to one another and to other development plans. All aspects should be controlled by a viable administrative plan since the elements of these projects are highly sequential (first, handpumps; then public fountains; then patio connections; and, finally, house connections), as well as multi-purpose, multi-stage, and multi-facility in nature. It should be stressed that the object of this effort must be to provide water to people. The planning process is merely a tool which should be used to accelerate the process. It is not an end in itself.

Program Inventory

The first step in planning a community water program is to develop an inventory of the various communities and available resources.

In one country, this was done by using university engineering students under the direction of a few sanitary engineers at a total cost of + US\$55,000.- After a short indoctrination, the students were put to work compiling data from all the existing systems that could be identified. They visited the agricultural and rural development agencies, the national and regional planning offices, the public work agencies, the civil action groups of the military, the census bureau, the national mapping offices, as well as the regional housing and vector control programs.

From this data, the professionals found that existing aerial and/or topographical maps could be used to plot the location of systems that had been built. Often they were able to identify what kind of systems had been built and whether or not they were still in operation. Everyone was surprised at the amount and kinds of information that were readily available.

The data was then broken down by regions in order to identify areas of need versus possibilities for solution. The known systems were plotted in relation to the population centers, roads, trails, et cetera. Then, those communities that lacked systems or that had systems that were no longer in operation were identified and grouped by population (5,000 to 3,000; 3,000 to 1,000; 1,000 to 500; 500 to 50). Teams of community promoters, technicians, and vector control officials were sent to visit all the communities that could be reached by a road. During their visits--which were usually made in

the course of their other duties--they completed a simple, two-page data sheet; made a basic sketch of the community layout; and tried to identify current and potential water sources.

For each community, the data was summarized on two sheets -- (1) a data sheet and (2) a community layout sheet. From these, tentative system layouts were made and cost estimates were developed. In many cases, these were little more than educated guesses; but, overall, they provided a tool that allowed the program managers to start the next phase of the planning effort. (See Appendix)

Estimate of Resources Needed

The next step was to analyze what human, financial, and technical resources were available and/or would be needed. This meant that the program officials had to develop "best guess" estimates for the output of the various professionals and technicians who would be required to operate the program. For example, the following requirements were found to be necessary in order to undertake a program for building 100 to 150 piped water systems per year in communities of 1,000/2,500 inhabitants.

Output per engineer

20 projects/year for promotion, data collection, and system design when modular approach and standard designs used.

Number of administrative staff required

40 central office staff (administrators, personnel officers, supply experts, accountants) and
10 semi-officers (community promoters, operation/maintenance experts, and community advisors)

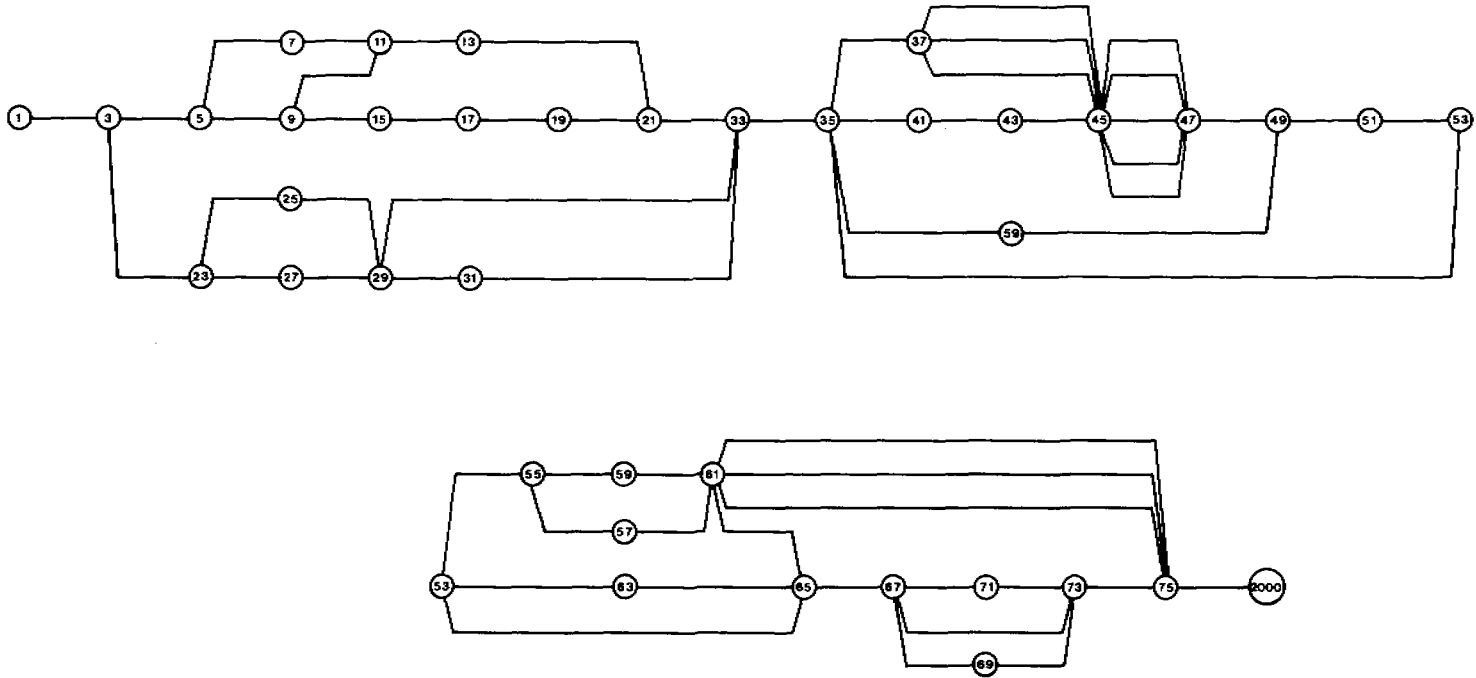
Cost per project

Cost per capita of \pm US\$30/capita (See Village Water Supply paper of World Bank for range of costs.); cost to organize a local water board to promote self-help scheme, \pm US\$300

When the foregoing cost estimates and many others were combined with those of the bills of material, it was possible to develop estimates of when and how much money and human resources would be required to undertake each solution. Figure I1 shows the various steps that should be reviewed in developing these estimates for each project.

FIGURE II

PROGRAM OF WORK FOR A TYPICAL
PROJECT IN THE NATIONAL RURAL
SANITATION PROGRAM



(See next page for list of above activities)

Development of Preliminary Checklist of Projects

As the first step in this element, a set of selection criteria had to be established. Those used by the program mentioned above are shown in Table II.

TABLE II
EXAMPLES OF CRITERIA USED
FOR SELECTION OF TARGET COMMUNITIES

-
- | | |
|-------|---|
| No. 1 | Communities with largest number of inhabitants (not more than 2,000). |
| No. 2 | Those having access by roads for trucks. |
| No. 3 | Those communities that have expressed interest, have requested the system, and offered it assistance (including financial) in its construction and operation. |
| No. 4 | Communities located within one of the zones of influence of the national and/or local development plan |
| No. 5 | Project not requiring an unusual or expensive solution |
-

Note: In practice, the criteria were not applied in a rigid manner but were used as guidelines. It was found that the selections made prior to starting the first two phases of the program were adhered to in 70 percent of the cases. A lack of response to the third and fifth criteria was found to be the main reason for removing a community from the list.

By using these criteria, it is possible to select those community systems that have the greatest chance of success in each region. These should be proposed as your first stage target. For nothing succeeds like success; or, said in another way, if your first projects are well used and have a high degree of community acceptance and use, the "users" will spread the "word" and future work will be much easier than if the first systems are rejected.

Once the list of projects is developed, it should be reviewed by the program staff with an eye to how, where, and when the most opportune time will be to start the various regional and local projects.

Getting the Commitment

With the aforementioned data sheets and resource requirement plans, program officials are in a position to make a strong plea for the resources they will need on a long-term basis versus the piecemeal approach so often used. The "framework" plan allows proposed financial resources to be studied in relation to the overall effort.

Experience has shown that a strong commitment to the proposed program at the national policy level is necessary--even essential--in order that the systems being built can be kept in operation for a period long enough to develop the community's understanding of the benefits provided by the system. Once they understand, the process becomes one of a continuous upgrading of the basic service until it reaches "urban" levels and is financially self-sufficient. But the first step is to obtain the commitment.

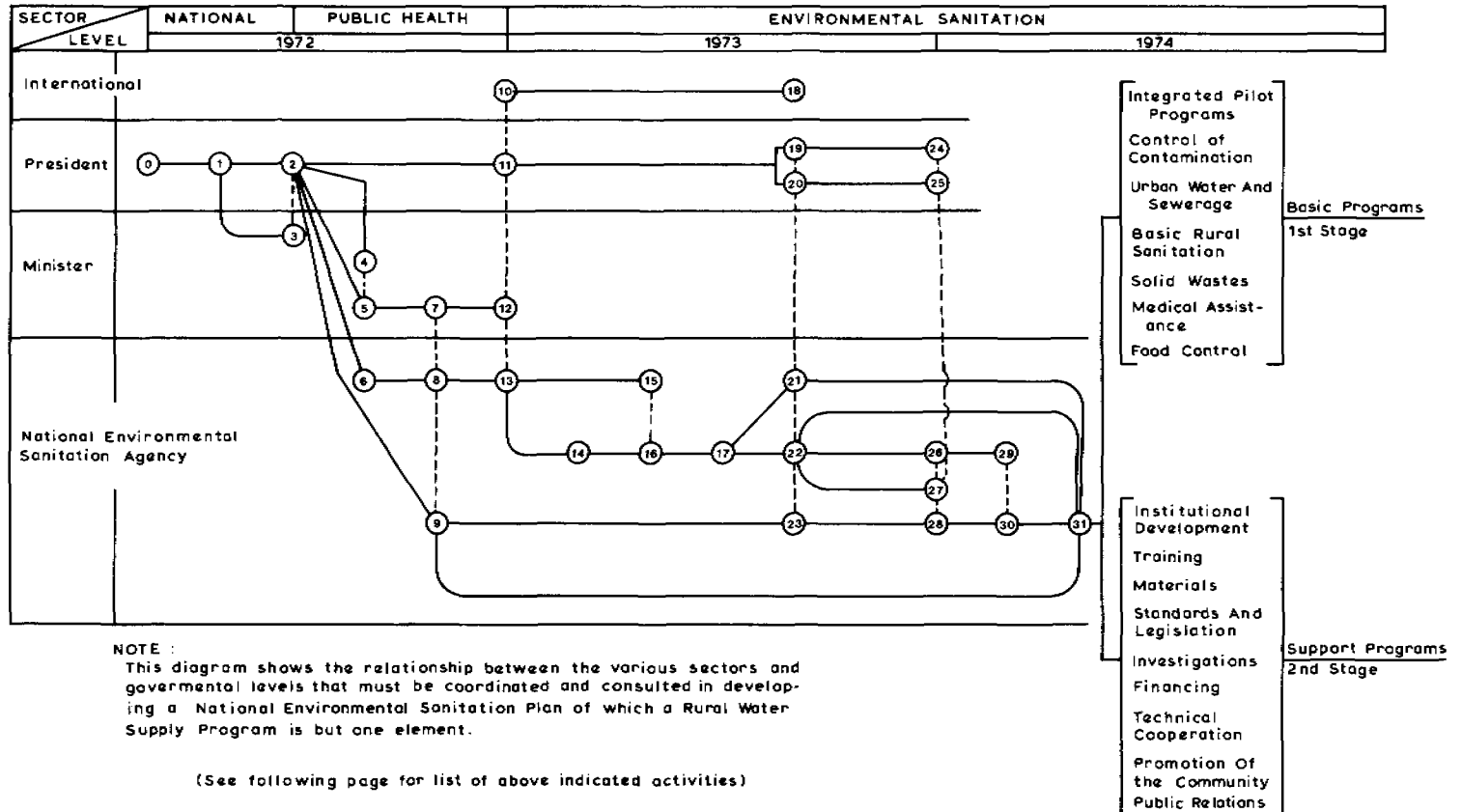
Because these types of programs are often considered "social" in nature; because, in its early years, it will require subsidies; because it will take several years to design and organize the program; and because of the lead time required to train staff in the community participation and technical cooperative area--all branches (planning, financial, and technical) of government must become committed of this program. The best way to achieve this is to obtain a high-level commitment--one that starts with the President and continues on through the government and the years. Nevertheless, even with the maximum of commitment, much will ultimately depend upon the efficiency and speed with which the appropriate technical, financial, and human resources can be built up within the country and, of course, upon the extent of these resources. Figure III diagrams the various governmental levels, sectors, and time frames that had to be observed in one program which followed the above indicated process.

PROGRAM OF WORK FOR A TYPICAL PROJECT IN THE NATIONAL RURAL SANITATION PROGRAM

<u>Event</u>		
<u>From</u>	<u>To</u>	<u>Activity</u>
1	3	Preparation of the work
3	5	Preliminary estimates of the community
5	7	Onsite observation of the community
7	11	Classification of data
11	13	Development of description of community
13	21	Delivery of material
5	9	Desk study of community
9	11	Classification of data
9	15	Distribution of survey forms
15	17	Carry out survey
17	19	Tabulate survey
19	21	Deliver material for analysis
21	33	Summarize data
33	35	Develop preliminary project
3	23	Preliminary topographical studies
23	27	Topographical surveys
27	29	Compile topographical work
29	33	Develop topographical plans
23	25	Studies for water sources
25	29	Compile data re water sources
29	31	Deliver materials
31	33	Summarize data
35	37	Contact with formal leaders in village
37	45	Sanitary education lectures; preparation for assembly; conversations with community
35	41	Contact with informal leaders in village
41	43	Hold group meetings
43	45	Develop preliminary assembly program
45	47	Hold meetings in schools to explain programs; Use formal leaders to explain program; make final arrangements for community meeting; utilize informal leaders; conversations with community.
47	49	Compile promotion data
35	59	Approval of draft project
59	49	Preparation of project
49	51	Complete project
51	53	Project approval
35	53	Preparation of bidding of project
53	63	Opening of bids for construction
63	65	Review of bids for construction
53	55	Planning for community contribution
55	59	Obtain pledges for community contribution
59	61	Development of agreement by Agency and village
55	57	Develop water board
57	61	Legal documentation for water board
53	65	Provincial contribution
65	61	National contribution
61	75	Preparation of agreement with community; Training of community; Education of the community
65	67	Signing of contract and reprogramming
67	71	Installation of the distribution system
71	73	Installation of house connections
67	73	Construction of tank
67	69	Preparation of well
69	73	Installation of pump
73	75	Final tests
75	2000	Deliver system to the community

FIGURE III

DECISIONAL PROCESS FOR DEVELOPING
NATIONAL PLAN FOR ENVIRONMENTAL SANITATION



DECISIONAL PROCESS FOR DEVELOPING NATIONAL PLAN FOR ENVIRONMENTAL SANITATION

<u>Event</u>		<u>Activity</u>
<u>From</u>	<u>To</u>	
0	1	Develop philosophy and national plan of action
1	2	Reorganization of Ministry of Health
1	3	Develop law of obligatory civil service
2	11	General studies of the sectors
11	19	National development plan
11	10	Transfer to parallel action
10	18	Ten Year Health Plan for the Americas
11	20	National Development Plan
19	20	Transfer to parallel action
19	24	National Fund for Pre-investment (FONAPRE)
20	25	National Fund for Investment (FONADE)
2	4	Reorganization of Health Ministry
2	5	National Health Code
2	6	Preliminary health investigations
2	9	National Water and Sewerage Plan for Ten Years
5	7	First Stage National Health Plan
7	12	Second Stage National Health Plan
10	11	Transfer to parallel actions
11	12	Transfer to parallel actions
12	13	Transfer to parallel actions
7	8	Transfer to parallel actions
8	9	Transfer to parallel actions
6	8	General sanitation plan for 10 years
8	13	1975 Plan for Environmental Sanitation
13	15	Financing for 1975
13	14	National and regional personnel
14	16	Provincial personnel
16	17	Previous inquiries into environmental problems
17	21	Investigation work at the provincial level
17	22	Ten Year Sanitation Plan
19	20	Transfer to parallel actions
20	21	Transfer to parallel actions
21	22	Transfer to parallel actions
22	23	Transfer to parallel actions
21	51	Normal sanitation control activities
22	51	Pilot programs - Rural Sanitation
22	26	First post graduate course (Theory)
26	29	First post graduate course (Practice)
22	27	National Fund for Sanitation (FONASA)
9	23	Plan for sanitary works financed by IDB
23	28	Urban water and sewerage plan 1974
28	30	Financing for 1974
30	31	Integration of Environmental Sanitation Agencies
26	27	Transfer to parallel actions
27	28	Transfer to parallel actions
29	30	Transfer to parallel actions
9	31	Normal project work of urban water and sewerage projects (Force-account work)

Program Implementation

The Challenges

The final step in the planning process -- Implementation -- will depend on the countries' ability to meet three challenges.

The first challenge will be that of winning the whole-hearted participation of the system's users in the promotion, construction, and operation of the water (and sanitation) system. Experience has shown that this participation can best be gained by having the users contribute labor and materials for system construction and by their paying the local costs of operation and maintenance of their system through a local water board. (Regional and national program costs will be covered by the central government in the first phases.) For is has been found that systems built without community participation are usually unappreciated by the community, as they feel no stake in it and no obligation to maintain it. Experience has shown also that neither coercion nor paternalism has proven very successful.

The second challenge will be the program's ability to meet a large variety of problems with simple, often novel, solutions. This will demand a great deal of technical skill and flexibility, an open-mindedness, and a knack for developing and implementing simple, foolproof, rugged designs.

The third challenge will be in the use of sub-professional personnel. While professional managers and engineers who are experienced in community systems should manage the program, their task will be so great (and they are so few) that they will have to devote their time to directing, planning, policy forming, reviewing, and supervising the program. The day-to-day contact with the communities, the collection of basic field data, the exploration for and measurement of water resources, the preparation of the repetitive system modules from field data for review by engineers, as well as the inspection visits to the completed systems. They will all be done by a specially trained cadre of sub-professional sanitarians and/or promoters.

One could summarize the basic elements for a successful community water supply program in the following terms: COMMUNITY INVOLVEMENT, TECHNICAL FLEXIBILITY, and USE OF WELL TRAINED SUB-PROFESSIONAL STAFF.

Program Infrastructure

When in full swing, a community water supply program will consist of thousands of schemes scattered all over the country in various stages of construction and operation. This characteristic, which is one of the fundamental differences from an urban system, will dictate the kind and location of staff, as well as the structure of the organization.

In his excellent presentation to the Regional Seminar on Rural Community Water Supply in Khon Kaen, Thailand (March 1970), WHO Consultant Morton W. Lieberman presented the following series of remarks (slightly edited) regarding the functional organization of such a program. His remarks, which follow, apply equally well to a community water supply program.

He indicated that, functionally, such a program should fall into six divisions:

1. "Program planning, policy making, and evaluation. This would include the related functions of finance, contact with the legislative and executive branches of government, and relations with international and bilateral agencies.
2. "Promotion, education, and field surveys.
3. "Engineering design, reviews, specifications, standardization, and cost estimating.
4. "Construction, supervision of construction, contracts, and procurement.
5. "Operation, maintenance, and repairs--including the training and supervision of local operators.
6. "A service division handling routine administration, personnel matters, payroll, transportation, et cetera.

"The deployment of staff, and hence the allocation of duties, will vary with each country, depending largely on the degree of decentralization, but certain areas of operation and lines of authority may be considered as generally applicable.

Dr. Lieberman went on to say:

"Program planning, policy making, and evaluation should be conducted at national level by the organization director (whose background is preferably a sanitary engineer with considerable executive experience), the

chief engineer, and their deputies and aides. Among the principal duties of this group would be the preparation of short- and intermediate-term programs within the framework and time schedule of the national master plan and the procurement of the financing necessary for execution.

"Promotion, education, and field surveys would be the duties of the sanitarians. Their work would be under the overall supervision of the chief engineer and the more direct supervision of regional, state, or district engineers. Consideration may be given to the creation of the posts of regional or head sanitarians. To be effective in this specialized task, these sanitarians must be trained as engineering auxiliaries and permanently stationed throughout the country. The size of the area to which a sanitarian is assigned should be such as to permit him to establish a working relationship with all of the rural communities in his area. To gain the confidence of the community leaders so that his advice on water supply and other environmental sanitation matters will be his primary task. This will not be easy or accomplished in one meeting. It will take time, patience, and skill, and the sanitarian should be given special instruction in the techniques of how to win friends and influence people, with due consideration for the mores, beliefs, and prejudices of the people he is working with. He may have his efforts reinforced from time to time by higher-echelon personnel and visits of the regular health educator, but it is believed that prolonged personal contacts and a common-sense, down-to-earth approach stressing both the health and economic benefits of safe water will be most effective. He will be the one to make the villages aware of the need and create the demand for improved water supplies. He will show them how it can be accomplished by their own efforts supplemented by government contributions of materials, equipment, and technical direction. The specially trained sanitarian thus emerges as the key man in the rural community water supply program. His position should be accorded the dignity and compensation that it deserves ...

"The engineering division would review the individual water supply schemes submitted by the sanitarians, supplement and revise these submissions as necessary, and put them in final form for execution. The amount of work required to be performed by this division will depend on the quality and thoroughness of the field data submitted by the sanitarians. The division should be headed by a chief design engineer under the general supervision of the chief engineer. Design and related work may be decentralized to well staffed provincial offices, if this will promote efficiency

"The construction division may execute all work directly or with the assistance of other governmental agencies such as Public Works or Community Development. In special cases, work may be let to private contractors. Whatever the arrangement, a major duty of the division will be to plan the integration into the whole operation of the labor and materials voluntarily contributed by the community

"The administrative division is strictly a service operation for the other divisions and has no policy-making functions whatsoever. The division should not make any decision with respect to personnel, salaries, privileges, transportation, or other activities that may inhibit or influence the substantive functions of the organization. This matter is stressed because the assumption of such prerogatives by administration in the name of economy or convenience or efficiency is a common occurrence, usually resulting in a detriment to the operation. It is an insidious illness that unfortunately afflicts many otherwise fine organizations and should be avoided"

The foregoing description is an oversimplification of a complex organization. For it to work, there must be a great deal of divisional coordination and interdependence, as well as a minimum of bureaucracy and a maximum of responsiveness to and support for local problems. One must constantly remind himself that the object of the program is to assist the communities to build and operate their water systems, not to develop a smooth-running paper mill. For the long-term value of the program will depend on how well the community schemes are operated and maintained.

Quoting again from Dr. Lieberman's paper on the subject:

"A National Rural Community Water Supply Organization will function best if it is largely self-contained and relatively autonomous. Authority should be exercised in a straight line from the director through division heads to the field. Workers in the field will frequently come under pressure from provincial and district political officers to shape work schedules and commitments in accordance with their plans and wishes.

This is perfectly normal and proper, and such requests should be submitted to the organization headquarters for analysis and decision. But under no circumstances should a member of the water supply organization be required to take direct orders from a provincial or district political or administrative officer. No matter what degree of autonomy is given to the rural water

supply organization, it will not be able to operate in a vacuum. Liaison must be maintained with legislative, financial, accounting, planning, legal, and other branches of government. To avoid overlapping and conflicting activities, coordinating committees will have to be established with other agencies working in fields of allied interest"

Where Should It Be Located?

In his closing remarks, Dr. Lieberman discussed the aspects of location for such programs within governmental structures:

"... The final question is, 'In which government ministries or agencies can a community water supply program work with maximum effectiveness?' The usual location is in the Ministry of Health or the Ministry of Public Works, whereas, in some countries, the Ministry of Agriculture is favored because it already has close liaison with the villages and may control most of the available water resources through its irrigation activities. But the choice will depend on the administrative organization in each country and the relative development and traditional functions of the various ministries.

"A recent comprehensive assessment of the WHO/UNICEF assistance to rural water supply determined that the most successful programs were those executed through health ministries, with well developed sanitarian services. And among these the very best results were obtained where independent sanitary engineering organizations were established within the health ministries for the primary purpose of conducting the rural community water supply programs....

"But, whatever ministry is given the responsibility for community water supplies, it is important that a separate organization or unit be set up for the purpose with its own engineer-director, its own staff, budget, quarters, and equipment. This organization should preferably be responsible directly to the Minister or Agency Head and not report through another department. Its duties should be specifically and solely for the community sector. It should not be combined with urban water supply, irrigation, or other activity. It has been observed that, where such functions are combined, this sector always received the least attention"

APPENDIX
to
Planning Water and Sanitation Systems
for Small Communities

EXAMPLE OF INVENTORY
FOR
COMMUNITY WATER SUPPLY PROGRAM

SOME STAGES IN ESTIMATING
FOR A VILLAGE WATER SUPPLY

In this appendix, some suggestions are given on the methods of estimating for a hypothetical village water supply in an equally hypothetical country. Cost and design figures are given only for the purpose of illustrating methods and bear no relationship to actual values anywhere. The following assumptions have also been made:

- a. The village projects is one of a large number to be constructed under the national program.
- b. Inadequate staff is available to make detailed surveys, designs, and estimates for individual projects of this nature.
- c. The preliminary reconnaissance is to be carried out by a field sanitarian in the course of his routine duties.
- d. UNICEF assistance, in the form of imported materials and equipment is available.
- e. Upon completion, a closer examination of actual costs will be made, which will permit better design and estimation of future projects of a similar type.

First Estimate

In the "program-planning" stage, no details are available other than the following:

Zedorzi is one of the villages recommended by the health authorities of Whai Province for inclusion in the program, since it has a water supply of doubtful quality with periodic failures. The population shown in the national census is just over 2,000 (including some scattered dwellings outside the community), and the village lies on a sandstone plateau, where water is known to exist and to have been extracted elsewhere from bore holes.

A preliminary figure of US\$12 per capita is used for program estimating, and US\$24 is initially allocated for the project. Priority 3 (i.e., commencement in the third year of the program) is allotted in the accepted proposals.

Second Estimate

In the "budgetting" stage of the program, few further details are available about the village, but it is necessary to make certain assumptions about the sources of funds for the rural water supply element of the program. The estimate is increased to US\$25,000 because it is known that a school and health center must be supplied, and the village has been included in the list of

those to benefit from UNICEF assistance. A rough division is made as follows for inclusion in the overall budget for the third year of the program.

Materials to be provided by UNICEF	
(30% of total)	\$ 7,500
Contribution in kind by villagers	
(20% of total)	5,000
Cost to government within program	
(50% of total)	12,500

This may also be expressed in terms of cost per capita of the population--for UNICEF materials, \$ 3.75; for local contribution, \$ 2.5; and for cost to government, \$ 6.25--totaling \$ 12.5 per-person capital cost.

Third Estimate

The third estimate on which materials will be allocated from UNICEF store and government liabilities assessed (including the drilling of the well which is to be carried out by another ministry) must be based on an inspection of the village by a member of the field staff so that actual conditions may be ascertained. To ensure comparability with other projects and for ease of compilation, a standard form is used for, but adapted to, each project.

In the example shown, the form consists of four sheets, the first two of which are completed in the field and the second two in headquarters--the whole forming a record of the estimate, list of materials required, and the information upon which these have been based. It also includes a sketch plan of the village--not to scale, but sufficiently dimensioned for the purpose and identification of the site chosen for the bore hole.

At this stage, it is possible to assess the population to be served more accurately (some of the previously mentioned 2,000 live too far from the village to be served) and to relate the estimate to actual requirements in terms of length of pipe, size of pump, and reservoir rather than the "rule-of-thumb" formula based on theoretical population. The convenient device of translating totals into "costs per head" enables better comparisons to be made between different projects as well as between the different stage estimates and the final costing after installation is completed.

RURAL COMMUNITY WATER SUPPLY RECONNAISSANCE

Name of community: *ZEDORZI* Province: *WHAI*

Priority awarded in programme *3* Type of supply proposed *Pumped, standpipes*

Local authority *Village Council* Approximately *6 connections*

Population to be served: Present *1890* Future *2100*

Special *Health Centre, Market, School under construction*
Training Post (Arachos Ltd).

Present water source: *Wet Season - shallow wells, rock at 30ft (sandstone)*
Dry Season - soaks in dry stream bed, which occasionally
dry up, requiring walk to waterhole 4 km downstream.

Proposed water source: *Borehole. Provincial Geological Department estimates*
80-100 m, probably lining unnecessary, siting immaterial.

Availability of electricity: *No* ; of building materials: *Sand and gravel good.*
Little building stone, No truss timber.

Access to village: *Good. On all-weather road 85 km south of Whaiville (Provincial*
Centre)

Community representatives } *Village Head (Sarkin Zedorzi) and 5 councillors*

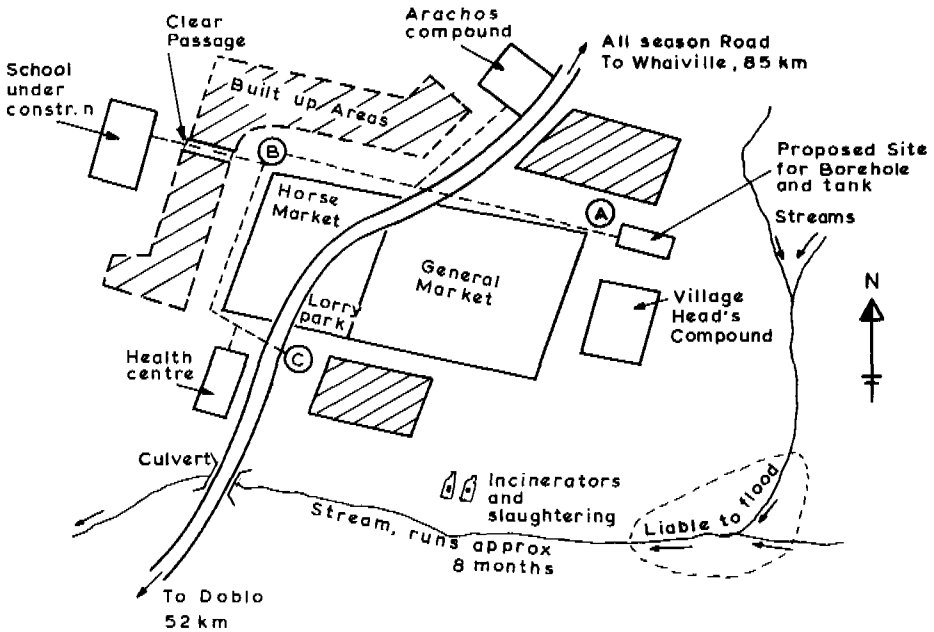
Interviewed, comments } *Community prepared to supply labour, sand, gravel. All*
sites vacant and free. Village will pay for operator
and accept other recurrent costs up to a maximum of
\$E 2 per head per annum. Arachos requires connection
(max cons 1000 liters pd. in trading season 200 l.pd
remainder) and will pay installation cost and share of
recurrent.
Village head requires connection, possibly 2 others
depending on installation cost.

Other remarks: *Villagers eagerly awaiting water supply. Likely to be*
fully cooperative. Best construction period November-
April.

Page 2 of Form
for completion
in the field.

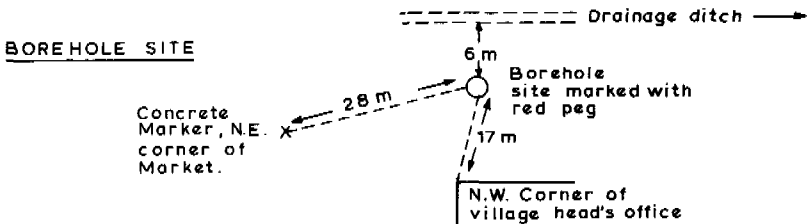
SKETCH PLANS

(additional sheets may be used, but must be stapled into form)



A and B - 4 standpipe sites C - 2 standpipe site

AB = 280 metres, BC = 170 metres, B to school 100 metres, Arachos connection 80 metres from line AB. All standpipes approx. same level as borehole site. School site + 17 m. Health centre + 11 m. Arachos + 1 m. No high ground for reservoir, tank raised approx. 5 metres required.



Date of reconnaissance

Signature and description of reporting
Officer

16 - 6 - 1970

Maras Aivo, Sanitarian, Whaiville

DESIGN INFORMATION

1. Consumption: *Immediate 100.000 lpd, rising to 180.000 lpd*
2. Source : *20 cm Borehole, say 100 m deep, probably unlined below 10 m.*
3. Treatment : *probably unnecessary. Check water analysis after completion of borehole*
4. Pumping : *15 cm reciprocating borehole pump with 10 HP diesel engine (UNICEF no. 2 pumpset) pump 90 m below surface*
5. Storage : *40 cm sectional steel tank 5mm X 2m deep on concrete blockwork support 5 m high, 5 m from borehole*
6. Piping : *rising main, 15 cm dia galvanized, 110 m + 3 bends
distribution 10 cm dia PVC, 455 m + 3 bends
5 cm dia PVC, 200 m + 3 bends
10 no. 5 cm off 10 cm tees: 6 no. 5 cm off 5 cm tees.*
7. Public Standpipes : *Concrete block stepped type 2 x 4 tap, 1 x 2 tap, wastenot valves, concrete aprons drained to soakaways.*
8. Other Connections: *Health centre: 1 tap over sink, 1 over washbasin, 2 external. School 2 external, further pumping may as necessary, Arachos 1 external with provision for extension. others allow 3 external standpipes and 100 m of 5 cm dia PVC pipe.*
9. Other Items: *1000 liter diesel oil store below water storage tank, 10 meters of 1 cm dia fuel piping.*

Date: 8.7.1976

Signature of officer completing page 3.

D. Sina

MATERIAL REQUIREMENTS AND ESTIMATE

	<u>Subtotal</u>	<u>Total</u>
	\$E	\$E
<u>From UNICEF assistance</u>		
No. 1 Size 2 pumpset (10 HP Diesel) 15 cm dia	1750	
455 meter. PVC pipe, 10 cm dia à 0.69	315	
200 m. PVC pipe, 5 cm dia à 0.55	110	
110 m. Galvanized rising main, 15 cm dia à 1.20	132	
Miscellaneous pipe fittings say	25	
No. 1. Sectional steel tank, 40 cum, complete with cover, bolts, indicator and pipe connections	2400	
No. 1. Oil storage tank, with pipe (10 m) and fittings, 1 cum.cap.	120	
Standpipe fittings, 2 x 4 set, 1 x 2 set. Type 3.	65	
Total, UNICEF SUPPLIES	<u>4917</u>	<u>4917</u>
<u>From Government funds</u>		
Borehole in sandstone, 100 m deep, 20 cm. int. dia à \$75	7500	
Lining grouted in position, 10 m à \$50	500	
Cement, 12.000 kg. à \$10 per 100kg	1200	
Road Transport, Cement, UNICEF supplies, equipment, etc, say	1000	
Skilled craftsmen, say 150 man/days à \$ 4	600	
Miscellaneous say	1000	
Total, Govt. expenditure	<u>11800</u>	<u>11800</u>
<u>Local Contribution</u>		
Labour for gathering sand and gravel, for pipelaying and construction. Say 1000 man/days à \$2.5	2500	
Local transport and miscellaneous	200	
Total Local contribution	2700	<u>2700</u>
TOTAL ESTIMATED COST	\$E	<u>19417</u>
	say	<u>19.500</u>

Analysis

Estimate expressed per head of existing population-

UNICEF assistance	Govt. funds	Local contribution	Total cost
\$E 2.6	\$E 6.3	\$E 1.4	\$E 10.3

FINANCING A RURAL WATER SUPPLY PROGRAMME *

by

Maurice C. Mould
Financial Adviser
WORLD BANK
Washington D.C.

* Note: The following text is quoted from chapter 3 on Financial Aspects of the World Bank Paper "Village Water Supply", March 1976, which Mr. Mould has made use of in his presentation and which he has reviewed and expanded upon.

September, 1976

FINANCING A RURAL WATER SUPPLY PROGRAMME

Increasingly, national or urban water supply utilities aim to achieve and maintain financial viability. This policy has four objectives:

- To encourage the development of financially responsible management resulting in better investment decisions at the utility level, better financial planning, and more cost-effective operations.
- To ensure the availability of adequate funds for operation and maintenance.
- To mobilize resources for the development of the sector by generating an internal cash flow which will enable the utility to service borrowings and help finance part of its expansion programme.
- To make consumers aware of the financial consequences of their use of the service.

In a number of countries, however, both governments and consumers have the attitude that good water supply is a social service, for which charges should be kept to a minimum. This attitude must be changed, at least insofar as it applies to higher-income areas, if resources are to be freed for extending service to the poorer and rural areas; consistent social policies require that, as a first step, anyone able to pay should be charged at least the full cost of service.

In villages, relatively high unit costs and relatively low consumer incomes make the inability to pay a further problem in recovering a reasonable proportion of total costs. Moreover, the existence of some alternative source of water - however inconvenient and unsafe - and a general lack of appreciation of the benefits of using a safe water supply makes the imposition of higher user charges undesirable. The problem is, therefore, how to achieve these objectives - which remain applicable even at low levels of financial performance* - in those circumstances.

Changing government and public attitudes toward water charges takes time and education. As a general principle, user charges should be set at as high a level as possible because the size of the programme, and to some extent its continuing operation, depend on this source of funds as well as on general public revenues.

* Where a water undertaking is heavily dependent on government funding to meet debt service and serve recurrent costs, the mobilization of resources clearly cannot be achieved by generating an internal cash flow. However, the underlying concept behind this objective can still be realized if the undertaking makes proper financing plans and obtains clearly defined government contributions toward these plans, rather than proceeding on the basis of an ad hoc annual budget.

But the level of these charges must take account of village income levels, and the method of assessing them - by region, by individual village, or on some other basis - will need careful adjustment to the characteristics of each particular programme. Whatever pricing policies are adopted, village water supply programmes in many countries are likely to require the continuing support from national revenues. Government funds will be necessary to cover not only the initial costs of construction, but also the costs of establishing and running the administrative unit, and of initial and continuing training. It would be prudent to include part of the operating and maintenance expenses, at least in the early stages of a programme. Governments should recognize this implied commitment when they undertake such programmes; failure to look beyond first costs has been the cause of severe problems of the operating stages in many cases.

Sources of Funds

Five potential sources of funds for village water programmes may be perceived: the government budget, foreign loans, institutional lenders within a country, subsidies from urban water systems, and the villages themselves. The amount of funds allocated to village water supply from the first two sources is usually determined by the government on the basis of national priorities and the needs of other sectors of the economy.

The third source of funds - the institutional lenders of a country (insurance companies, banks, etc.) - has been largely untapped so far, either because the lending institutions are relatively undeveloped or because the institutions responsible for rural water are not acceptable as borrowers. One of the objectives of improving rural water institutions should be to enable them to attract funds from these sources.

The fourth potential source of funds - subsidies from urban water systems - is a natural extension of internal cross-subsidization already occurring within the urban systems: typically, industrial and commercial consumers pay a relatively high tariff, while only a nominal charge, if any, is made for water distributed through public hydrants. However, many urban systems, particularly those where migration has greatly increased the numbers of the urban poor, are already having difficulty in maintaining an adequate service. Urban dwellers naturally strongly resist any large increase in their tariffs in order to subsidize supplies to other areas. The extent to which urban systems will be able to make any sizable contribution to the needs of smaller communities is, therefore, questionable.

In these circumstances, the total amount available to meet initial and recurrent costs is dependent to a large degree on the contribution from villages. It seems clear that, if the needs for village water supply are to be met in a reasonable time, the targets for collecting capital and operating costs from the villages must be as high as possible. The more government funds have to be used to cover operating costs, as is now usually the case, the fewer new systems will be built.

Level of Villages' Payment

It is widely held that villages in general are so poor that they are unable to pay anything toward the costs of a water supply system. While this view may be correct in the case of the smallest and poorest villages, the prospects for collecting a reasonable proportion of the costs are probably better than is generally thought if the following conditions are fulfilled: The standard of service should be carefully tailored to the needs of the individual village; villagers should be given basic health education so that they appreciate the benefits of improved water supply; and a policy of maximizing user charges should be vigorously enforced.

Several good reasons exist for asking villages to pay part of the costs, both of construction and of operation and maintenance, of their water supplies:

- It is desirable that beneficiaries contribute toward the cost of the services they receive.
- As discussed above, this will enable the programme to be larger.
- It will help to ensure that funds are available to meet operating expenses and the costs of minor repairs.
- It will increase the villagers' sense of responsibility for the system, and so encourage good maintenance and careful use of facilities.
- Since villagers should participate in the decision on the level of service to be provided, the requirement that they make a capital contribution (whether in money, materials, or labour) will ensure that this decision is carefully considered.
- It will establish the principle of payment for services received; this will become more important if, at a later stage of development, a higher level of service is desired.

Complicating Factors

Application of the minimum levels to each individual village enables a village to understand clearly the financial implications of installing a water system. But some complicating factors may make it more desirable to establish levels for groups of villagers or by some other category:

1. Other things being equal, systems for smaller (usually poorer) villages are more expensive per capita than those for larger (usually more prosperous) villages. If the systems to be provided have already been reduced to the cheapest possible level, the requirement that each individual village makes payments at a predetermined level may have the result that only the larger villages qualify for new systems. This may be advisable from the standpoint of economic growth but is less desirable on social grounds.
2. Since systems using groundwater are generally much cheaper than those using surface water, more villages will qualify in areas where groundwater is available, even though the need in these areas may be less.
3. The relationship between per capita costs of installing and operating a system and per capita income will vary from village to village and from country to country. The most expensive systems may be required in the villages least able to afford them.

Some circumstances may also make it unreasonable to expect villages to provide a substantial capital contribution, such as:

- Resettlement schemes, in which people are to be attracted to new villages by the services available.
- Rural development projects, in which the cash incomes of villagers will not increase markedly until crops mature, perhaps after a number of years, and where it may be prudent to allow, at the design stage, for a high proportion of house connections, even though villages may not desire them initially and may not be able to afford them.

In these cases, the initial capital contribution may be kept low and may be largely replaced by higher water charges, covering not only operation and maintenance but also depreciation. (This, however, increases the strain on government finances during the early years of the programme). Alternatively, fairly large contributions, financed from a short-term revolving fund, may be required later in the programme as villagers request house connections.

The WHO survey shows that of the 84 countries giving details of charges for rural water supplies, 24 countries (29 percent) required villages to make some payment toward capital costs, and 61 (73 percent) insisted on some payment toward operating expenses. Many countries showed various degrees of cost recovery; only 23 (27 percent) indicated that they made no charge at all for rural water. The Bank's experience is that many countries do not consistently enforce charging policies, and arrears may be extremely high.

Even with a decision in principle that villages should meet part of the costs, determining their ability and willingness to pay remains a serious problem, because of a lack of reliable data on rural incomes, and because many villages have essentially a barter economy and little cash changes hands. IDB,* whose projects provide a fairly high level of service and correspondingly have a relatively high per capita cost, has found that communities may be expected to pay between 3 percent and 20 percent of the capital costs of their systems, averaging about 10 percent. Water charges, set at about 3 percent to 5 percent of the income of the head of the family, cover at least operating and maintenance costs and possibly also some depreciation. Very rarely can families pay more than 5 percent of their income for water charges*.

Similar levels of payment could probably be required as a minimum elsewhere, provided that the level of service is carefully tailored to village needs and resources. For example, in the poorest areas each family might be required to contribute one man-day of labour in helping to dig a simple well to be fitted with a handpump, and this labour contribution might be equivalent to 10 percent to 20 percent of the cost of this simple system. Operating and maintenance costs for handpump systems are a few cents per person per year, and should be affordable even in poor villages with a noncash economy.

Both capital and operating costs are naturally higher for more elaborate systems, but attempts to establish guidelines on the proportion of these costs to be paid by the beneficiaries have not been successful. The Bank does not have sufficient data to take a position. In many countries of Asia, per capita rural incomes are \$ 50,- per annum or lower, but only a small proportion of this is in cash. In these cases, if a village is unable to make a cash contribution to the capital

* I.D.B. - Inter-American Development Bank

* Guidelines being developed for the PIDER rural development programme in Mexico suggest that the monthly water tariff should not exceed the equivalent of one day's pay at the prevailing minimum wage.

costs of a scheme, labour or materials should be accepted instead. Using village labour can be desirable because it generates additional employment. However, the availability of labour may fluctuate with the agricultural cycle, and project work may be curtailed during planting and harvesting seasons. On a number of projects an unreliable work force has led to a wasteful use of material and to delays and difficulties in project execution.

Nevertheless, with system costs in the range of \$ 20 to \$ 40 per capita, it should not be difficult to identify a suitable local contribution in kind (e.g. digging pipe trenches, collecting sand for filters of concrete) equivalent to at least 10 percent of project costs^{*}. A greater problem may be deciding how villagers can best contribute to operating and maintenance costs. Since they may have some difficulty in making cash payments for chemicals or energy, villagers should be given the opportunity to contribute labour (e.g. for cleaning filters or sedimentation basins, or for regular operation of the scheme).

As a first approximation, levels of payments on many projects might be set to cover at least 10 percent of construction costs and all operating and maintenance costs. These levels would be applied to the "basic system" costs, with a supply through public hydrants. Where individual householders require private connections, they should normally meet the full additional costs, probably with the assistance of some form of revolving loan fund. While contributions to capital costs and to operating and maintenance expenses are both important, more stress would be laid on the village covering operating expenses than on its contribution to construction costs. It is relatively easy to ensure that the construction costs are provided for in a well-defined programme, but experience shows that many rural systems break down shortly after completion due to lack of funds for operation and minor repairs.

To increase the funds available to the programme, the minimum levels of payment suggested above should be reviewed in every project, during project preparation as well as periodically thereafter, and raised when possible. This may be done by establishing payment levels according to village size or potential income, provided that the villagers accept the rates as equitable. It may even be done on a village-by-village basis, as is done in some Latin American countries, where villages vie with one another to make the maximum contribution and so receive higher priority in the programme.

* For example, villages in the Republic of Korea are now contributing, through the Saemaeul (village renewal) movement, over half the construction costs of simple piped water supplies.

The decision on the levels of payment and the way in which they are to be applied has to be taken by the government, since the government will be responsible for funding the programme. It is extremely difficult to draw up general pricing rules when the ability to pay and the system costs may vary widely from village to village, and when "social" objectives such as improved health or income redistribution are an integral part of the concept of the programme; each decision will have to fit the specific case. Whatever decision is taken, it should be reviewed periodically and the targets altered if necessary, to reflect changes in village economic conditions and consumption patterns. Frequently, the basic data on which to base such a decision - for example, sector needs, estimates of capital and operating expenses, villagers' ability to pay - are not available.

Collection

The financial performance of village water supply programmes will almost invariably be well below that normally required in urban projects. The reasons for accepting lower standards are pragmatic, based on experience. The typically low incomes of villagers, and the existence of some alternative source of water - however inconvenient and unsafe - simply make it impossible in most cases to charge the full cost of the service. The real problem will be to collect any charges*.

Metering of individual supplies, the usual and most equitable basis for charging in urban systems, will not generally be justified in villages where consumption is small and where only a few houses may have individual connections. As a rule, revenue meters should only be used in villages for commercial or industrial consumers (if any) and possibly for a few large house connections; other house connections would be charged at a flat rate, with a flow-limiter in the supply line to reduce wastage.

Inhabitants dependent on public hydrants for their supplies will normally pay a flat rate, for example, through individual or family fees, head taxes, a water tax, or an assessment on property. Part of the state revenues received by the village may be used to meet the charges for hydrant supplies. In some countries (e.g. Kenya), water from public standpipes is sold by a subcontractor, who

* Experience on IDB projects shows that charges for water are more readily collected where house connections are provided. This may be a factor in deciding whether to incur the higher costs of installing a system with a high proportion of such connections.

purchases it from the water undertaking. However, the cost of the standpipe attendant may double the cost of water to the consumer.

The situation is further complicated by the use of the smallest coin for each container: Even if only one cent is charged for a 20 liter container (the typical size in many countries), the effective rate is \$ 0.50 per cubic meter, which is much higher than the normal domestic tariff. On the other hand, because quantities used are small, the total monthly bill per family is not excessive - about \$ 2.30 for a family of six using 25 liters per capita per day - and the consumers receive a reliable service because the subcontractor has an interest in maintaining the hydrant in good order (since the selling price of water cannot be reduced, this raises the possibility of the water undertaking increasing its price to the subcontractor in cases where he would make excessive profits, and returning the profit thus made to general village revenues). In some countries, this system may greatly reduce consumption: In Ethiopia, when charges for standpipe water were waived during a cholera outbreak in order to encourage greater use, consumption increased several times. The strict control over the dispensing of water from sales points means that users are unlikely to wash out the containers adequately, or to wash themselves, so contamination of the containers from soiled hands becomes a health problem.

The choice between various charging methods is largely dictated by local conditions, and should normally be made on the basis of administrative simplicity, acceptability and the likelihood of effectiveness. The Bank research project on possible improvements in public hydrant design and other methods for reducing wastes is concerned with, inter alia, methods of charging for public hydrant supplies.

Where one system serves a group of villages, the individual village consumption may be assessed from bulk meters on supply pipelines, records of the number of operating hours of pumps etc., which will usually be necessary for operational control of the system. On this basis, system operating and maintenance costs can be fairly allocated.

In conclusion, the village payment should be as high as circumstances allow in each case, normally with water charges covering at least all operating and maintenance costs, and including a substantial contribution toward the scheme's construction cost. For this to be possible, the system's capital and operating costs must be reduced to a level compatible with villages' willingness and ability

to pay. Moreover, the levels of service to be provided in many of the poorer countries will have to be minimal if water supply is to be extended to a reasonable proportion of the rural population without placing an intolerable strain on the national economy.

ORGANIZATION AND MANAGEMENT OF
COMMUNITY WATER SUPPLIES

by

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The opinions expressed in this paper are those of the author and are not necessarily those of the World Bank

September, 1976

ORGANIZATION AND MANAGEMENT OF COMMUNITY WATER SUPPLIES

INTRODUCTION

1.01 It is not possible in this brief paper to either review the many systems of organization and management of community water supplies (CWS) in the world or to predict the ideal pattern or model for development of such systems in the next 15-20 years. Instead, an overview of the "state of the art" is presented, with some suggestions for short-term changes which may be appropriate in certain communities. The views expressed are those of the author, and do not represent those of the World Bank, to whom the author is indebted for much of the research and experience, which form the basis of this paper.

1.02 To supply adequate, safe water supplies to communities, which may range in population from less than 100 people to many millions, and in countries having populations of under 3 million to over 600 millions, calls for a universal range of organization and management systems. Obviously there can be no ideally conceived systems to fit each state or community and many variations in organizations and systems exist and will ensue. There is no end to human ingenuity and many intriguing systems have, and will result. The systems and ideas propounded in this paper do not refer to any specific country or community, but are intended to provoke discussion and hopefully lead to small improvements in the organization and management of CWS.

POLITICAL POLICIES AND CWS DEVELOPMENT

2.01 Organization of community services is directly affected by national political policies and socio-economic development. Therefore, anyone seeking to organize or re-organize CWS at any level must first have regard to the importance and priorities awarded to the sector by the various political levels in a society. Effective legislation is essential for good organization and management. To obtain new or amending legislation, political soundings on acceptability should be made in the initial stages. These soundings should be made to determine a government's views on the form, size, control and priorities of CWS in a society. It may not be sufficient to obtain the views of senior government officers, many of whom may have a vested interest in preserving the status quo. Experience has shown that the political level may be receptive to change, particularly for improved organization and management, but has been unable to break through its governmental or

public service systems to achieve reforms.

2.02 Political determination of whether CWS is to be a public (or social) service, or an industry should be a primary decision. In most developing countries CWS has been established as a public service. There are two principal reasons for this - (i) colonial developers approach to CWS was to attach the responsibility to PWDs or municipalities; and (ii) the belief that political control of water supplies is better achieved when it is a public service. However, in considering re-organization of CWS the opportunity to develop the sector as an industry should not be dismissed. Development as private industry or as semi-public (private with public participation) may prove to be a more effective means of promoting efficiency, of achieving improved financial performance, and of releasing public funds for less developed sectors. The World Bank, particularly in urban areas, has encouraged water undertakings to become self-financing. Although many such utilities remain under public control, their operations are, or are being developed on commercial/industrial lines.

2.03 A third background factor to be considered is whether CWS should be regarded as an individual sector, or whether it should be included as part of multi-sectoral activities, such as urban and/or rural development. The effective interaction of investments and operations of sectors in a community is best achieved by multi-sectoral planning. In order to achieve rapid expansion of CWS and other social sectors in the post 1945 period, many countries opted for individual sector development. In a number of countries, this has resulted in erratic patterns of inter-sector investment and of CWS development. Many claim that CWS has suffered by this individual sector approach, and that CWS has been unable to obtain its fair share of limited resources. However, the reverse has also occurred, where the CWS sector has pre-empted investments which could have been better utilized by diversion to other sectors. If the single sector approach is to be adopted, sufficient safeguards in the resources planning organization should exist to ensure CWS receives a correct resources allocation - natural and fiscal.

2.04 Allocation of scarce resources is usually finally decided at the political level. It is therefore essential that a CWS organization should be capable of making adequate representation to the political level. This will require a structural organization which can (i) receive early warning of impending political decisions and, if desirable, urge

necessary changes; and (ii) plan new technical and fiscal developments for political approval without undue delays, but which should be subject to inter-sectoral planning constraints. Often CWS has been organized from a low level in a Ministry, having responsibility for several sectors, with CWS given relatively low priority. Typical examples are as a branch of PWD, or a department of a Ministry of Local Government. The primary aim of a CWS organization planner should therefore be to ensure that CWS has an adequate political representation, which in turn, should ensure inter-Ministry or departmental status. These points of representation and status are essential when sectors have to compete for scarce resources.

2.05 After determining political policies for CWS development, regard must be had to the key actual and potential resources for CWS - water sources and finance. If the allocation of either to CWS is likely to be politically restricted for the short to mid-term (5-15 years) the organization and management should be shaped accordingly. An organization should be maintained at a level sufficient to meet the short to mid-term demand only, and should increased resources suddenly become available, early expansion should be met by short-term hirings of services, until the future pattern of development is assured.

SIZE AND COMPOSITION OF SECTOR

3.01 A critical decision has to be made in the extent of centralization and decentralization of control. To fulfil the responsibilities in paragraph 2.04 above, there has to be a national representation for CWS, but this may, or may not, take the form of central control. Some countries, particularly with up to 50 million population and small land areas tend to adopt central control, whereas larger nations often pass direct control to States or Provinces, leaving only planning and resource allocation at the centre. Often the reasons for this choice lie in history, rather than in logic. An organization planner should determine as precisely as possible the costs and benefits of a tiered or decentralized organization. This applies particularly to ensuring that effective communication regarding planning, development, research, training, with resource needs and utilization can travel expeditiously from top to lowest levels and in reverse.

3.02 CWS is about people, for people and inevitably executed by the people in the absence of provided systems. It is therefore essential that the impact of their representation and participation can be present.

This can best be achieved by local level representation, which probably means some form of local authority or agency. Experimentation in this structural reform is widespread and no universal solution appears likely, but two factors should carry more weight than others - the size and distribution of population in a given area. It is unlikely that an organization for CWS can support at local level more than 10 million people (the size of most major metropolises today). As the density of the population decreases the problems of communication and water transmission increases, so the problems of organization grow more difficult and expensive. Other factors, such as water sources, communications, and ability of local managements, will affect the decision, but an optimum local organization is most likely to be directly related to size of area and the population density.

SYSTEMS OF ORGANIZATION

4.01 In deciding on the optimum pattern of national organization, consideration must be given to (i) the roles or responsibilities of each level; (ii) minimizing of overlapping responsibilities; (iii) communications; and (iv) extent of peoples' representation at each level.

4.02 As stated above, no universal solution can apply, but as a demonstration the following organization of CWS in a country could be considered:

LEVEL 1. National

- (a) National Assembly
 - Minister of Natural Resources
 - Minister of State for CWS
- (b) Ministry of Natural Resources
 - Departments of (say)
 - Water Resources
 - CWS
 - Irrigation
 - Mineral Resources

LEVEL 2. Provincial/State

- (a) Assembly
 - Minister for CWS
- (b) Department of CWS, or
 - CWS Development Corporation

LEVEL 3. Local

- (a) Local Authorities, or Water (CWS) Authorities, or Public Utilities, or Local Development Institutions, e.g. Rural Development Board.
- Representation by Mayors, elected representatives, headmen.
 - Management by specialized staffs.

4.03 In small national organizations, Level 2 above may be omitted and its powers and functions divided between Levels 1 and 3.

4.04 Typical allocation of powers and functions between the three levels above could be as follows:

LEVEL 1: In collaboration with other ministries, particularly planning, finance and foreign affairs, to (i) determine allocation of international and national resources (water and fiscal) to CWS for long term planning; (ii) review and/or determine tariff systems, and determine short-term fiscal support level (if any) for CWS, with allocations through Level 2; (iii) obtain international goods, services and training required by Levels 2 and 3; and (iv) provision of national level technical, administrative and financial training for CWS staffs, including natural CWS research and/or development centre(s).

LEVEL 2: (i) Provincial/State allocation to Level 3 or Level 1 (i) and (ii) allotments, together with available Provincial/State resources follow tariff reviews; (ii) promotion of CWS developments, with provision of development funds and where necessary construction of facilities; (iii) monitoring and supervision of technical and fiscal operation of CWS; and (iv) acts as CWS facilities provider of last resort.

LEVEL 3: Provision of potable water supplies; (ii) sound technical and fiscal operation and maintenance of CWS; (iii) development of new facilities; (iv) training and local level research; (v) giving levels 2 and 1 early warning of impending local problems for CWS.

AREAS OF ORGANIZATION

5.01 Ideally CWS organizational areas should be identifiable with topographical features, e.g. watersheds, drainage areas. There are technical and financial advantages in optimum use of one or more water sources in a watershed area, by establishing common treatment and transmission systems to serve the entire area, regardless of existing urban/rural or other. Unfortunately this idealism is rarely achieved, because administrative (usually political) boundaries were drawn long before the need to use CWS topographical boundaries was recognized. Public utilities type organizations have sometimes succeeded in defining more suitable areas by disregarding existing administrative areas, but an organization planner is likely to continue to meet resistance to his rational recommendations for a water shed/drainage area for a CWS authority, principally from the in-built resistance of local administrators and also because a proposed CWS area may not conform to existing electorate divisions.

5.02 In preparing any re-organization proposals, for the short-term there are often advantages in selecting existing administrative areas. The ongoing machinery of government, of taxation and of representation can be used inexpensively with minimum of change, but any organization proposal should evaluate the short - and long-term benefits and costs of alternative CWS area organizations. Compromise can be introduced, and with skilled planning and design, for example, it may be possible to recommend a system of bulk treated water supply for a complete watershed area and to retail this supply through the existing local CWS authorities. This may not represent the least cost solution for the majority of CWS authorities in the watershed area.

5.03 A comparatively new approach to CWS area organization lies in the development of multi-sectoral authorities in rural or urban/rural areas. Urban areas have long been organized by multi-sectoral authorities which included CWS as a function but even in developed countries the involvement of rural CWS in rural multi-sectoral authorities remains limited. A number of developing countries, some assisted by the World Bank are initiating large scale rural development programmes which include CWS. However, the desirability of adopting the topographical definition of an area appears to remain a secondary consideration in a number of such developments. Area selection is based on such considerations as poverty levels, industrial development needs, agricultural expansion, or relocation of population. Such primary objectives, although vital, can still be rendered ineffectual

by the absence of adequate CWS. It is therefore suggested that planners of multi-sectoral development, particularly rural, or urban/rural, should give early consideration to the optimum form of CWS organization in any scheme.

UNITS OF ORGANIZATION

6.01 The common factor in CWS activity (or any other form of public sector activity) is the government department. Para. 4.02 recognizes a necessary continued role for this unit. Many organization and methods men have tried, and will continue to try (with varying degrees of success) to organize or re-organize government departments, so it is not proposed in this paper to discuss in depth the ideal organization of a government department. It is probably more appropriate to review the role played by the middle/lower level units of CWS i.e., public utilities, development corporations, local authorities and specialized agencies.

6.02 The ideal form of agency for efficient development, operation and maintenance of CWS is probably a semi-public water supply and sewerage corporation (i.e. a public utility) operating in a watershed and drainage area. This is because it can have (i) maximum control of extraction, use and disposal of water, (ii) access to public financial participation; and (iii) private and political representation. A utility should be able to engage and replace the necessary skilled staff at market prices (not constrained by government salary and pay scales) and to thereby operate and maintain the services at maximum efficiency at minimum cost. It should be required to demonstrate its technical and fiscal efficiency to government and should be allowed either by internal cross-subsidy through rates, or by government subsidies, to give access to sufficient water to provide good health and well-being for those who are unable to meet the full cost of water.

6.03 Various organization structures have proved successful for water utilities. Typical of these are (i) a Board of Management, e.g. a Chairman and eight members, including two or three local elected representatives with, or without a public official; (ii) a General Manager, who sits on the Board; and (iii) a Management Executive consisting of the General Manager, the Chief Engineer, the Financial Manager (who may also be a Board member), the Secretary, and the Personnel Officer. Most boards and/or Management Executives have yet to introduce the utility's trades union representation, but there is an increasing awareness of the contribution which can be made by such representation.

6.04 Many urban areas will continue to have CWS provided by local authorities usually municipal corporations, councils or boards. These authorities probably have three key deficiencies preventing satisfactory CWS operation in the mid-1970's. Firstly, their areas of service usually are selfish, extending only to their boundaries and ignoring neighbouring rural or urban/rural communities, including those through whose areas their treated water transmission lines often pass. Secondly many are insolvent, relying increasingly on government support for payment of salaries and wages. Water supply cost, in many cases, have not been recovered through specific taxes and charges. Instead a local general tax is levied from which all services are expected to be financed. Higher local taxation never has been popular, and the increases in local taxation which would have been necessary to meet the 1973-75 international inflationary trends have not been introduced. Many local taxation yields now fall far short of fiscal requirements of services. The third problem for local authorities is the capability and capacity of their staffs. Many countries run their local government service at a lower level (in quality and rewards) than the government (or public) service. This is due in part to the diminishing real incomes of local authorities, but also to the desire of the public service to remain as the premier service.

6.05 For local authorities to improve their CWS organizations, two important steps appear necessary - (i) to separate the accounting and fiscal function from other local authority services, and to raise the income yield from their consumers to match expenditure levels; and (ii) the public service and local government service should be merged. The former step can best be achieved by early introduction of beneficiary taxes and charges for CWS, with gradual but consistent reduction of local and/or central government subsidies, except to support the weakest sections of a community. Merger of the staff services will probably be a longer process, but should be introduced by requiring the senior technical, administrative and financial posts to be filled by government service officers, who could receive incentives for such service in the form of earlier promotion (where merited) or in cash.

6.06 Organization units in rural areas range from water boards to multipurpose rural local authorities. The latter suffer even more than the urban local authorities from the problems described in paragraph. 6.04. Their tax base is usually lower and the staffing often of the lowest calibre. A better solution as already proposed in paragraph 6.02, would be a utility covering urban and rural areas, with an ability to cross-subsidize and capable of supporting adequate technical and financial staffs. Where this solution

is not available, an area water authority, having local authority characteristics is probably the best alternative. The governing body should consist of a Chairman, local elected representatives, government, CWS officials(s), and local key businessmen, e.g. farmers, goods or service providers; with a General Manager. The latter should have a small management team - engineer, secretary, accounts officer. The provincial/state government should have a CWS financial/engineering team which would assess regularly (say every three years) the operational requirements and fiscal capacity of the authority and lay down guidelines within which operations and maintenance and revenue collection must be performed. Government subsidies, where required, would be advanced on the basis of these guidelines, but subject to approval of local annual budgets.

6.07 The foregoing review of organizational units deals with the local level, which is the most important. However, at Level 2, where this exists, or otherwise at Level 1, there is an increasing need for some form of development and monitoring authority. Each additional increment of water supply is likely to be more costly than the last - and should be the least-cost solution. This is calling for greater technological skills than have often been applied in the past. The days when the PWD or irrigation. Departments could be called upon to introduce or supplement supplies are almost gone. Instead CWS is requiring its own geologist, hydrologists, water treatment experts, economists and financial analysts. Level 3 authorities, unless very large cannot afford these skills, but these should be available to them. These services can best be provided by a form of Provincial, or State or regional development authority which may be a government agency or corporation. Because this body exists primarily to implement established government policies, its political representation can be at a minimum and its management can be by professionals. The principal powers and functions are to act as a CWS planning. Planning in this context is multipurpose - not only water supply facilities, but development of resources, regional/national demand and supply forecasting, tariff structures and long-term manpower planning and training. Design, construction and development finance agency with a secondary but equally important role as CWS monitoring and quality control agency, constantly reviewing the performance of Level 3 authorities. In the event of failure of a Level 3 authority this agency could act on behalf of government to ensure continued operation of CWS.

6.08 The agency should have a Management Board consisting of a

Chairman (who could be a Provincial or State Minister), a Managing Director and a small team of senior government and CWS officers. Key officials, such as the Chief Engineer and Finance Director should also be represented. The managing Director should head a management executive of up to five senior officers and if the agency's area of jurisdiction is large it may need to have semi-autonomous regional divisions represented on this executive. It should be noted that where a Level 3 authority is capable of executing any of the powers or functions of this agency, it should be encouraged to do so. The nearer the exercise of power is to the people who are paying for the service, the greater the likelihood of efficient performance.

6.09 This type of development agency has probably to be supported by a government budget as part of the costs of CWS but should be required to sell its services to Level 3 authorities, e.g. engineering design and construction supervision, or management consulting services.

ADMINISTRATORS OR MANAGERS

7.01 In many countries, development of CWS management has been unnecessarily the subject of dispute between bureaucrats and technocrats. Who should manage - the engineer - or the administrator? Such discussions have only succeeded in observing the real issue, which is the need for effective managers. Many engineers and administrators are capable of being managers, but many are also unfortunately not managers. CWS has to develop effective managers, who may be drawn from any profession or speciality field associated with CWS or even externally if their management ability is adaptable to CWS.

7.02 CWS authorities have an urgent problem to establish organizations, personnel and training systems which will help identify and encourage the development of managers. The long established and inherently dubious system of management through seniority ranking should be terminated, and replaced by modern training and selection systems. The best manager is not an administrator, or engineer, or accountant - he is the best trainer in his organization. The more successful he is in training his staff to efficiently carry out their functions, the more successful as a manager he will become.

WHO SHOULD BE RESPONSIBLE FOR ORGANIZATION AND MANAGEMENT;

8.01 The manager should be responsible for organization and management. This responsibility in CWS may devolve from the most senior CWS secretary of government to the manager of a small waterworks. At every stage managers should be constantly reviewing their organizations. In many large organizations, e.g. development corporations, government departments, managers have

tried to pass the responsibility to specialized groups called organization and methods departments, or to external consultants. This has been due, in part, to the failure of managers to fulfill their responsibilities, but in other cases, employment of specialists can be fully justified, particularly when a major re-organization is required.

8.02 The designation of a person or group to be responsible for organization and management requires consideration. Advice of specialized professionals should be obtained. Any CWS management, when considering re-organization should not assume that a CWS department or branch is more qualified for this role than others. The ability to advise on organization and management has become a specialized activity, and the wrong choice of adviser(s) can result in loss at least of credibility of management, and at worst of damage to the CWS organization. Each head of branch of engineering, accounting, law or administration should ensure that any proposed organization provides for efficient execution of their particular responsibilities and each branch will require differing approaches to organization procedures, to staffing, and to methods of implementation.

AVAILABILITY OF TRAINED AND EXPERIENCED STAFF

9.01 Manpower needs and training are the subject of a separate paper but, a discussion on organization and management cannot be complete without reference to this vital component.

9.02 Training is being provided for virtually all aspects of CWS activities. Training is available in universities, colleges, schools and on-the-job. It is this last form of training which is the most successful in producing managers. Organization and management courses have proliferated in recent years; many are well designed and are successful. However, only if the participants can return to their jobs and practice that which has been taught in the classroom, can the training be successful and complete. Managers have to allow their staff to become organizers and managers in their daily operations. CWS remains a service of traditional methods and thinking, and there is too little encouragement for innovation particularly in organization, management and delegation. Many of the organizations have been developed on colonial public service lines, which were rigid, unchangeable and where seniority was the key factor for promotion. Too often the best technician became the managers as a reward for meritorious service.

9.03 Training for organization and management today and for the immediate future should have as a primary objective the early selection of good managers and their deliberate development for this role, regardless of

basic training and qualifications. This will mean giving early, and sometimes heavy responsibilities to young people. If adequately trained, these people will be capable of accepting the challenge. This has been satisfactory even in many other services and industries, and CWS should not be an exception.

OTHER PROBLEMS

10.01 For historical reasons of urban development, CWS organizations have often been structured to segregate urban systems from rural systems. Today there appears to be little logic remaining in this form of organization, particularly if organization planners adopt the regional or topographical approach to definition of areas of control. Nevertheless, frequently we see formation of "XYZ Urban Water Board" as a new institution. One reason for this continued isolationism is because organizers, managers - and engineers still do not know how to organize rural water supplies systems - or because the rural people may prove to be a fiscal burden on the urban society - therefore they are excluded, to be dealt with at some time in the future. The 1980 - and future targets of WHO and HABITAT - are unlikely to be fulfilled unless rational organization of CWS is permitted, and the continued separation of urban and rural organizations should be a matter of continuing concern to good managers.

10.02 Organization and management of rural water supply remains as the most backward area of CWS. Part of the reasons are expressed in the preceding paragraph but others also exist. The 19th and early 20th century developments in CWS were in urban systems to prevent spread of disease in rapidly growing urban industrial areas. Consequently the talents of CWS were concentrated in these towns and cities, while the rural areas were left to continue to develop and maintain their new systems by local community - or family - efforts. Little experience was gained by public service in organization of rural water supplies, except as part of irrigation schemes. Consequently when the post-1960 population expansions highlighted the deficiencies of the rural areas, CWS had few people skilled in rural organization, and fewer who were willing to leave the comfort of the towns.

10.03 By the mid-1970's, there are signs of improvement, but it should be recognized that the present concepts of rural water supplies organization will be incapable of meeting the rural water supply demand of 2001 - that is assuming WHO and the world's nations will continue to press for 100% coverage at some time beyond the 1980 targets.

10.04 It is doubtful if CWS organization should be based on rural areas only, but as already suggested as integral urban/rural units. Experiments are continuing with this form of organization and international organizations concerned with CWS should closely monitor performances.

10.05 Shortage funds can and does act as a constraint to good organization and management. The principal effect is a resultant inability to employ good managers and staff. However, fiscal constraints should not prevent innovation - rather they should encourage new ideas and better planning of scarce resources. A good organization should be the most economical system available, and should not absorb resources which could be better utilized on development, or operations and maintenance.

POSSIBLE FUTURE DEVELOPMENTS

11.01 Experimentation should continue with urban/rural units, particularly to determine their (i) efficacy; and (ii) optimum size. There does not appear to be any detailed research into an optimum size of organization, and advice on this aspect of organization is urgently required. There is a current tendency to aim for large units on grounds of economies of scale, but communications are likely to be a limiting factor for some time. However, absolute definition of size may not be possible, if only for the reason that one good manager may be able to organize and administer a substantially larger unit than inferior managers. Nevertheless it is unwise to develop an organization around personalities, and therefore development of future guidelines on optimal size of units would be valuable.

11.02 A second development is likely to be the increasing use of multi-sectoral organizations, particularly in rural areas. Rural development authorities are becoming increasingly effective and it is possible that their success may draw small towns and cities into a regional organization which would include CWS. The major problem for such authorities is also likely to be organization and management, and unless this can be achieved, it is unlikely that their present popularity will continue.

OPERATION AND MAINTENANCE

THE CASE OF MEXICO

by

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Mexico

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OPERATION AND MAINTENANCE; THE CASE OF MEXICO

1. Background

With Mexico's participation in the meeting of American countries held in Punta del Este, and the signing of the International Agreement, a commitment was made to attack and solve within a maximum period of twenty years, the problem of introducing potable water into rural areas. The first necessary measure was the creation of an organism under the Ministry of Health and Public Welfare, organized within a legal frame that would enable this organism to fulfil efficiently its assigned functions. This gave birth in 1961 to the Construction and Sanitary Engineering Commission as a decentralized public entity.

In the programme's initial stages a guideline was established stipulating that water supply would be made available only to communities with less than 1500 inhabitants. Later on, it was considered that rural communities were those with a maximum of 2500 inhabitants and a minimum of 500, taking also into consideration safety in the operation of the system as well as socio-economic characteristics.

Finally, it was considered that the service should be extended to all communities that showed eminently rural characteristics, regardless of the number of inhabitants. However, a rank of 300 to 3000 inhabitants was established, taking into consideration that at any level under 300, the cost of the service per inhabitant would be too high and that at any level over 3000 it would acquire implications that would definitely differ from those of social health.

Rural populations in Mexico vary in character as do the environments in which they are located across the national territory, which is modified by geographic, climatological, social, historical and cultural factors. Thus, it is possible to find a high degree of development in populations located at the large irrigation districts, tourist zones, industrial areas or along the northern border, and conditions of extreme poverty at the plateau, at the Mixteca region in the State of Oaxaca and at the mountain ranges of the State of Chiapas. It can be said that most of the rural communities have as a general characteristic and common denominator: poverty, dispersion, unhealthy conditions and lack of organization for collective work.

The origin of the communities has been, in part, the settlement of groups of population on the ~~banks~~ banks of rivers, lakes, brooks or water storage sources.

Most groups, however, settled at absolutely unpromising sites, forced by voracious land owners who during the Colonial age and before the Revolution had full domain of productive areas, or motivated by the lack of foresight in agrarian distribution which did not take into consideration the need to concentrate the nucleus of population in areas with the most elementary resources to meet future development. Initially, and for the type of community described, projects were constructed according to very elementary standards and procedures which, with time, have been improved upon. At present, the community is selected and the project, programme and actual construction follow standards and procedures which have been clearly defined and shown to be effective. In every instance, a ten year demand is foreseen and the supply is projected on the basis of hydrants and individual house connections. In this first stage, the project includes the source, distribution tank, pipe lines, pumping equipment and 33 per cent of the distribution network for primary supply. The communities have to expand their networks using funds collected from the users of the service.

The Construction Commission delegated the responsibility for executing the programme to the Office of Tap Water and Sewerage (Dirección de Agua Potable y Drenaje). To date, this Office has constructed 95 per cent of the projects undertaken in all rural areas of our country, as part of annual programmes which have had an increment from 200 to 1,200 projects. The present panorama, with almost - 10,000 communities serviced, place us at mid point from total satisfaction of the needs of populations justifying the project. Due to the simultaneous development of the programmes and their fundamentals and standards, certain deficiencies were found in the execution of the first projects, which have since been corrected.

The basic aim of the programme was the improvement of health conditions. Other elements have been included later, such as economic development, prevention of migration of rural population to urban areas, etc. The legal basis for the programme emanates from the Political Constitution of the United States of Mexico, which, since 1917, in its Article 27, provides that "Ownership of the land and water within the National Territory corresponds originally to the Nation, which has had and has the right to transfer domain thereof to the individuals".

Nuclei of population lacking land and water as well as those that do not have them in sufficient quantities to meet the requirements of the community, shall have the right to become owner. This article of the law is the origin of the Federal Law on Water Resources, which declares the public utility of tap water projects and services and regulates the improvement and utilization of such projects which were only recently implemented.

All the above resulted in deficiencies in the operation of the projects, resulting to a lesser degree, from failures in promotion and planning and from changes in the construction criteria, and, to a greater degree, from irresponsibility in operation and maintenance on the part of the benefiting communities, due to insufficient motivation and training with respect to these activities.

As the problem of projects already constructed which required immediate rehabilitation reached alarming proportions, it was imperative to initiate a plan containing a general solution. The first step was the promulgation of the "Law for the Supply of Tap Water and Sewerage to Rural Areas" on July 20th, 1967, which stipulates the necessary structures to administer, operate and maintain the systems, directly by the communities with the support, advice and coordination of state and federal government authorities. This law established the need to institute the following bodies, the first two at a local level and the third one for each federal entity:

- a. Board for Water Introduction
- b. Rural Board for Administration, Operation and Maintenance
- c. State Council

The functions of these bodies are to promote and follow up the construction of projects, to act as recipients of completed projects in order to take charge of their operation, to maintain and preserve them, and subsequently to carry out expansions as required. Confirming the results of the above analysis, we have observed that the action to be taken falls within two main areas: first, the creation of a supporting body which we have called the Technical Council and, second, the structuring of Tap Water State Councils in rural areas. The second area corresponds to State Governments, but the tasks of promotion and counselling during implementation fall on the Technical Council.

Summing up, the problem as identified and analyzed can be solved with the creation and operation of the Technical Council and with the implementation of State Councils.

2. The Technical Council

For several years after the law for the supply of water in rural areas was promulgated, the actions taken had neither the consistency nor the intensity required by the urgency of the case. In the last two years, and due to the extent of the problem, it has been necessary for the Office of Tap Water to participate directly, when measures aimed at solving the roots of the problem were needed, i.e., to

achieve self-sufficiency for each one of the systems and, consequently that of the bodies which at a state level (State Councils for Tap Water in Rural Areas) are in charge of administration, operation and maintenance of the systems, involving moreover the incorporation of economic resources derived from the operation of the projects which may be added to the federal investment.

Within the above framework, the responsibility falls directly on the State Governments, which are autonomous. In view of the above, the action that the Federal Government through its Tap Water Office can take in this respect, should be limited to technical administration, operation and maintenance of the systems.

2.1 General Analysis

In accordance with the background outlined, an analysis was made of the causes, the actions to be taken, the resources available and the additional resources to be proposed. This was based on the following thesis: Tap water in rural areas will continue to be an acute problem until the structure of the approach followed to attack the problem is modified. It is necessary to follow new paths beginning from the planning of the project through its construction and maintenance. But above all, it is necessary to accept that only by planning an economic amelioration of tap water services in rural areas that could be added to federal investment, will it be possible to hope for its integral solution.

2.2 Analysis of Causes

Experience has amply shown that the principal causes preventing preservation of the useful life projected for the supply of water in rural areas are:

- 2.2.1 Deficiencies with respect to the quantity and the quality of information previous to the integration of the programmes permitting rational planning and consequently a better administration, operation and maintenance.
- 2.2.2 Lack of appreciation of the importance of the service by the users of those responsible for its maintenance in benefited communities.
- 2.2.3 Lack of the necessary economic resources and of the adequate organic structure for the administration, operation and maintenance of the system within the State Dependencies responsible for the performance of these functions, as well as the adequate technical training of personnel according to the requirements of each one of the existing installations.

2.3 Actions to be taken

- 2.3.1 Determination of standards and priorities for the selection, support and construction of projects in different locations, postponing for a short time those that have little possibility of attaining economic self-sufficiency on the basis of a reasonable charge for water services.
- 2.3.2 Review and intensification of promotional activities, before and during construction of the project, through a qualified promotor and through all personnel having direct or indirect contact with the community (resident engineers, contractors, officers, etc.) without detracting from the objectives vis-à-vis improvement of living standards.
- 2.3.3 Counseling and strengthening of rural and state councils, from an economic, technical and administrative point of view, aimed at an adequate organization that will permit them to secure economic resources to become self-sufficient; and striving for the establishment of these councils in communities or areas where they do not exist at present.
- 2.3.4 Preparation of educational material, accessible to personnel operating the system locally, with practical guidelines for administration, operation, maintenance and expansion of the system.
- 2.3.5 Training of the Council personnel, before introduction in the location, simultaneously with the construction of the project.

2.4 Resources available

- 2.4.1 Instructions for the selection of locations, as well as guidelines for preparation and construction of the project.
- 2.4.2 Guidelines for the operation of water supply systems in rural areas.

2.5 Proposal of additional resources

- 2.5.1 Preparation of a supply programme at a national level for 4000 locations which are not being serviced at present, with a population ranging between 300 and 3000 inhabitants.
- 2.5.2 Location and construction of supply sources before the definite preparation of a programme aimed at ensuring the supply in communities serviced, considering 200 wells and 100 surface water sources.
- 2.5.3 Study and application of general promotional techniques with the purpose of training personnel who are in contact with the community.
- 2.5.4 Creation of a Technical Council to liaise between the government dependencies responsible for the administration, operation and maintenance of tap water supply systems and the organism responsible for the construction of the project.

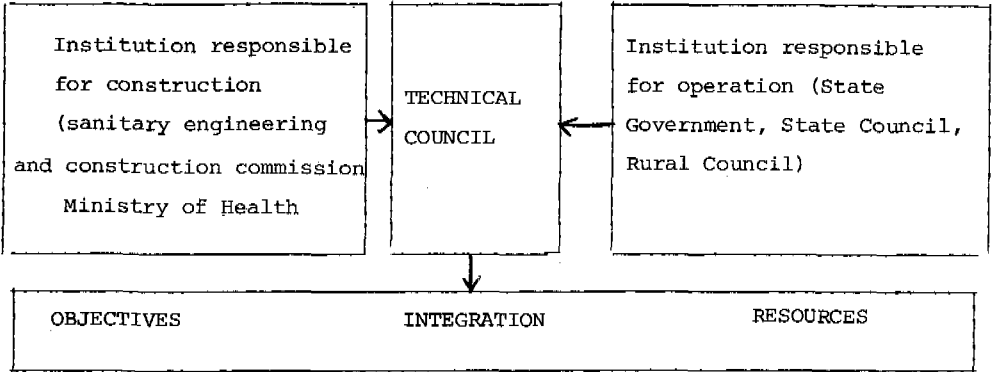
3. Organization of the Technical Council

Experience of water systems so far has shown there is a tendency for increasing rather than decreasing or eliminating of deficiency. The responsibility for the high percentage of deficient systems can be traced to the body or government dependency in charge of their construction, to the body in charge of administration, operation, maintenance and possible expansion, and to the community receiving the benefit. This knowledge coupled with the growing need to implement massive construction programmes led to the view that the practical way of helping preserve the useful life of already operating systems was to strengthen the groups (both at state and community level) responsible for the technical, administrative and financial aspects of the systems. To this effect, the setting up of a Technical Council was proposed which, jointly with State Councils, would study and evaluate the administrative, operational and maintenance aspects of the systems and would propose solutions that would foster an efficient operation, in support of policies in effect in the field of water supply in rural areas. The Technical Council was set up with the following objectives:

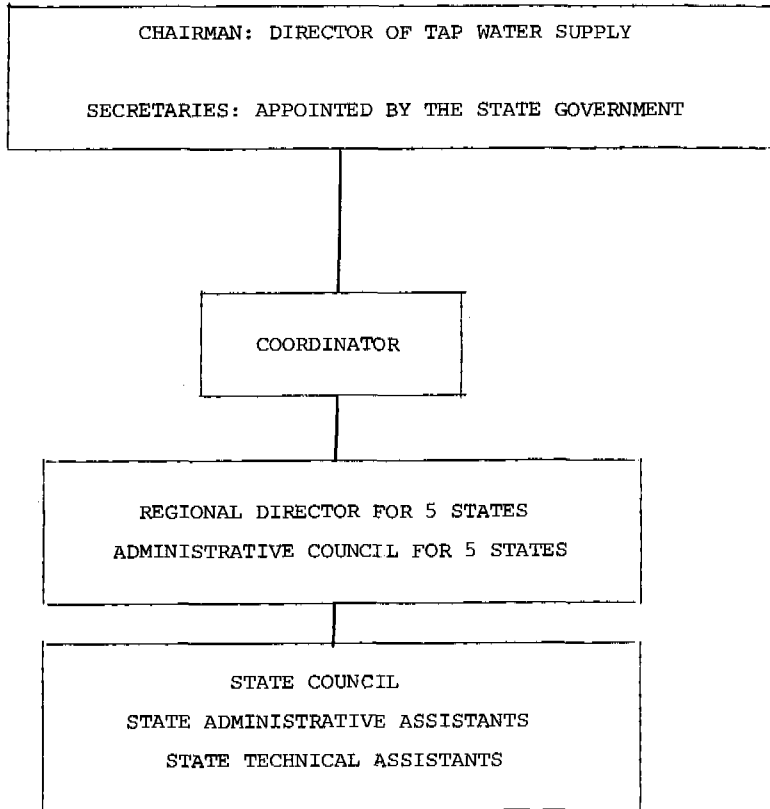
- 3.0.1 To evaluate and up-date problematics of water supply for domestic consumption and use in rural areas within the corresponding areas.
- 3.0.2 Administrative organization of State Councils, implementing the necessary organic structure.
- 3.0.3 To give technical assistance to all bodies established, offering them simultaneously the initial economic support for establishing an adequate operation aimed at ultimate self-sufficiency.
- 3.0.4 To supervise the activities periodically, to assess the operation's efficiency and thus enable adjustments to be made towards a better utilization of available resources.
- 3.0.5 Through the activities of the Councils, to ascertain that systems operate efficiently and that distribution networks are expanded as necessary to connect individual intakes, with the purpose of making the service available to the largest possible number of users; securing the economic resources required for the support of the administration, operation and maintenance of the system on the basis of self-sufficiency.
- 3.0.6 To establish the necessary action within the Councils for the training of specialized personnel and of community personnel in charge of the operation of the system.

3.1 Organic Integration and Implementation of the Technical Council

Due to existing needs and restrictions, the Technical Council was constructed as a liaison organism, as illustrated below:



Operationwise, the Council was built up as follows:



The first step taken by the Technical Council after its constitution and organization, was to carry out a national survey through a meeting attended by 23 of the 31 states, with the purpose of obtaining information on the manner in which each one of them was operating. Experiences and suggestions were recorded and the National Association of State Councils for the Supply of Tap Water in Rural Areas was set up.

On the basis of this information, the following plan of action was prepared:

- 3.1.1 Suggestions to the institution in charge of construction, with respect to the amendment of policies applied in the selection, programming, construction and delivery of the projects, on the basis of data furnished by the States.
- 3.1.2 Development of a pilot plan for three states, according to a methodology cognizant of current restrictions in all states.
- 3.1.3 Development of a national plan, on the basis of the pilot plan and always in accordance with a previously determined methodology.

3.2 Strategy of the Plan of Action

Being conscious of the fact that this is not the first national or international effort aimed at optimizing the operation of existing tap water supply systems, work was undertaken in accordance with a methodology based on legal, social and idiosyncratic restrictions and policies of each state, with the purpose of correcting the procedures currently in effect and, on the basis of the experience obtained, aimed at an ideal solution of the problem. In other words, in some cases it will be possible to integrate the communities immediately to the State Council, and in other cases the integration will be gradual: funds resulting from service charges will be handled by the state or by the community, etc. The most important consideration is that the entire action will be evaluated, that is, we will be experimenting at the same time that we solve problems directly by modifying policies of action in accordance with the results obtained in the different states. Initially, an organization was prepared aimed at arriving at ideal conditions in accordance with the information available at that time. In accordance with the situation prevailing in each one of the states selected for the pilot plan, we established the organization closest to the ideal organization for each particular case.

Summing up, the actions taken covered: The analysis of the state problematics and as a result the need for administrative, technical and financial assistance. Within the area of administrative assistance, we prepared the operation and organization manual of the State Council, classifying the principal activities under the following sub-groups:

- Promotion
- Accounting administration and personnel administration
- Analysis of rates and collections
- Establishment and control of warehouses
- Establishment and control of revolving funds
- Introduction and training programmes
- Evaluation and control procedures

In the technical area, training of personnel for the operation and maintenance of the system at a local and state level. Determination of spare parts required for maintenance, and of piping and parts required for necessary expansion of the system or for regional warehouses. Determination of costs of operation, maintenance and expansion. Determination of preventive and corrective maintenance programmes. Analysis of factors involved for the purpose of calculating service rates. Financial support was obtained from the Federation and from the State Governments. It is applied to two main items: first, administration of the Council and second, expansion of networks, parts for pumping equipment, etc. A high percentage or all of this investment is recuperable, as it represents a subsidy, it will remain as a patrimony to construct a revolving fund making it possible to continue investing in other systems, thus increasing recovery through service charges and permitting self-sufficiency.

As an important administrative aspect in states lacking the corresponding legislation, we promoted the installation of the State Council and the introduction of the respective law. Throughout, the final purpose of this programme must not be lost from sight; that is, to carry the benefits of a constant supply of tap water to the homes of rural inhabitants, which requires expansion of systems and their correct operation and maintenance.

3.3 Goals

The goals established for the general plan are as follows:

3.3.1 Development of the pilot plan in the states of Tlaxcala, Aguascalientes and Puebla, with the purpose of achieving in 1977 the self-sufficiency of the

corresponding State Councils, the integration of all projects to the State Council, the expansion of systems so that at least 80 per cent of the inhabitants of supplied communities receive home service, and so that the entire supply will be operating constantly, controlling waste and the quality of water supplied.

3.3.2 National plan. Achieve the same objectives as the pilot plan in at least 15 states more by 1979 and in the rest of the republic by 1982.

Short term investments in the pilot plan are the following:

Tlaxcala	\$ 2,000,000.00
Aguascalientes	\$ 1,600,000.00
Puebla	\$ 2,800,000.00

and the national plan foresees an investment of \$ 80,000,000.00 through 1982.

4. Analysis of Specific Cases

As an example of the activities of the Technical Council and of the development of the plan in general, we are making an analysis of the findings in Tlaxcala under the pilot plan and in Southern Lower California, under the national plan. (See following 2 pages)

DESCRIPTION	STATE UNDER THE PILOT PLAN	STATE UNDER THE NATIONAL PLAN
	TLAXCALA	SOUTHERN LOWER CALIFORNIA
<u>4.1 Background</u>		
a) Existence of water supply State Council	Constituted in 1969 covering only the rural areas	Not formally in existence. Each community operates its own system
b) Scope	97 systems, received but not operated by the Council	76 systems received by the communities
c) Type of source		
Spring	30.7 %	8.6 %
Infiltration gallery	4.3 %	28.2 %
Deep well	64.0 %	63.2 %
Surface water	1.0 %	
d) Operated by		
Community Committee	72.0 %	93.55 %
Ministry of Hydraulic Resources	24.5 %	6.45 %
State Council	3.4 %	
e) Expansions		
Moderate	54.4 %	32.6 %
Non-existent	45.6 %	67.4 %
f) Condition		
Operating (1974)	96.5 %	92.62 %
Individual house connections:		
g) Need	5 inhabitants/ connection	7 inhabitants/ connection
Situation	12 inhabitants/ connection	14 inhabitants/ connection
h) Population benefited with house connections	41.6 %	50.0 %
i) Population receiving actual benefit through home intakes	40.14 %	41.31 %
j) Special character- istics	Good supply, high percentage of popula- tion receiving water from public standpipes with the consequent problem of low return from service charges	Good supply, communities dispersed or with few inha- bitants, important problems with quality of water which on occasions is supplied for domestic use but not for human consumption
k) Handling of funds	Directly, by the community	Directly by the community
l) Corrective maintenance	Repairs provided by Federal and State Governments, high degree of rehabili- tation	Repairs provided by Federal and State Governments, high degree of rehabilitation
m) Preventive maintenance	Non-existent	Non-existent

DESCRIPTION	STATE UNDER THE	STATE UNDER THE
	PILOT PLAN	NATIONAL PLAN
	TLAXCALA	SOUTHERN LOWER CALIFORNIA
<u>4.2 Restructuring</u>		
a) Legal aspect	The law is regulated and measures are taken for its application. The council is restructured. An organization manual is prepared	The law creating the council is prepared and sent to Congress. The council is implemented. An organization manual is prepared
b) Investment programme:		
Administration	\$ 32,000.00	\$ 65,000.00
Tools and equipment	\$ 60,000.00	\$ 100,000.00
PVC piping	\$ 804,000.00	\$ 154,000.00
Special parts	\$ 112,000.00	\$ 21,000.00
House connections	\$ 690,000.00	\$ 475,000.00
Replacement parts for equipment	\$ 130,000.00	\$ 98,000.00
Pumping equipment	\$ 200,000.00	\$ 152,000.00
	-----	-----
	\$ 2,000,000.00	\$ 1,000,000.00
c) Handling of funds	Collection of service charges handled by the community for investment in the community's system and to cover operating cost. A fixed fee for preventive maintenance is paid to the State Council	Collection of service charges handled by the Council for the state. Funds can be transferred from one community to another
<u>4.3 Results</u>		
a) Rate level	Low as compared to average Income	High as compared to average income
b) Degree of self-sufficiency	Monthly income of the Council from fixed fees for preventive maintenance \$ 75,000.00 Monthly expense \$ 30,000.00 Monthly surplus \$ 45,000.00	Monthly income \$ 127,600.00 Monthly expense including operating expense \$ 87,000.00 Monthly surplus \$ 40,600.00
c) Revolving fund	Investment \$ 900,000.00 Recuperation: Cash \$ 250,000.00 Installments \$ 155,000.00	Investment \$ 848,000.00 Recuperation: Cash \$ 375,000.00 Installments \$ 113,000.00
d) Scope	100% of the systems	100% of the systems
e) Need	299,842 LM= 100%	70,120 LM= 100%
Prior existence	191,182 LM= 63%	52,390 LM= 75%
Expansions made	61,732 LM= 20%	7,500 LM= 11%
f) Water intakes		
Need		
Prior existence	15,487 units= 100%	4,579 units= 100%
Expansions made	8,756 units= 55%	3,061 units= 67%
Installations	2,000 units= 14%	650 units= 14%
g) Preventive Maintenance		
Crews	(mechanic, plumber, promotor)	(mechanic, plumber, promotor)
Vehicles	2	2
Monthly visits	21	21
Warehouses	1	1
h) Instruction		
Regional Seminars	2	2

5. Training Courses

5.1 Objectives

The principal objective of intensive regional and national courses is the training of personnel for the construction, operation and administration of tap water systems. These intensive courses cover three phases:

- Field practice
- Theoretical courses
- Human relations

For the purpose of these courses, participants are divided into three or four work teams to obtain a higher degree of participation through the integration and identification of all attendants.

5.2 Theoretical Course

Theoretical training consists of work sessions where all groups are gathered. Here the practical training is improved by emphasizing the need to instill in the participants the urge to perform their duties efficiently. With the purpose of establishing a common criterion in the development of these activities, courses are conducted by a group of instructors, some of whom are professionals of ample experience in the different areas of interest, as well as officers of the Tap Water Supply Department. The topics covered in these training courses include the following: Tap Water In Rural Areas, Description Of A Tap Water Supply Project, Selection Of Pumping Equipment, Internal Combustion Engines, Electric Motors, Piping Installation, Handling Of The Water Supply, Operation And Maintenance, and Administration.

5.3 Field Practice

Field practice courses are conducted during the morning, taking advantage of the resources available in each zone, such as projects in the course of construction, where it is possible to observe deep well drilling as well as different types of source improvement, appraisals, and the rest of the construction of the project. Visits are made to pumping equipment factories as well as to motor and piping factories. The topics covered in these field practices are: Pumping Equipment, Installation Of Pumping Equipments, Eléctrical Apparatuses And Installations, Safety Systems, Operation And Maintenance, and The Principal Parts Of The Engine.

5.4 Human Relations

This is an evaluation, following the case study method through open dialogue, to detect personal failures in the relationship between members of the State or Rural Council in charge of the operation and the inhabitants of the community.

5.5 Evaluation

At the end of each activity, an evaluation is made in order to assess the points of view of all attendants and to identify areas of failure, or to determine where training has been incomplete (attendance, usefulness etc.).

6. Conclusions

The results obtained to date are very satisfactory, as shown by an evaluation of the results of the courses in the case of Tlaxcala and Southern Lower California. In the rest of the states also comprising the pilot plan and the national plan, advancement to date is encouraging. The most important conclusion is that there is a close inter-relationship among all factors involved in all stages of the programme, including the selection of the community to become part of a programme, the type of project, the promotional activities, the institutions in charge of construction and operation, and the policies followed by such institutions, as well as actions or investments in other projects undertaken by the community which have direct influence on the operation of the system, such as roads, electrification, schools, productive activities, etc.

Therefore, we consider that national policies should be established for all investments in rural areas, and that these policies should be congruent. These policies should be established by institutions having clearly defined objectives, and an effort should be made to enable the population to understand and appreciate the benefit of the project to the health and economic development of the community.

It is important to point out that we have not taken into consideration the recuperation of capital invested, which is envisaged for future stages. For the time being, the cost of expansion to the network and individual home intakes is being recovered.

The correct selection of the community is especially important. In Mexico, all projects with only 35 per cent of the network being constructed and no individual house connections installed, have contributed to operation failures.

Service through public standposts, in our opinion, has been poor in rural communities with a good level of development, due to waste, to the lack of conscience with respect to payment, and to the failure on the part of the population to become integrated into the socio-economic system prevailing in our country, as well as to the difficulty in achieving acceptable sanitary and development conditions. It is difficult to evaluate to what extent each one of the corrective actions applied at different levels has contributed to reaching the correct operation of the system. Assuming that the selection, project and construction aspects have been solved, we can conclude that strengthening of institutions, promotion and the establishment of reasonable service charges, are decisive factors in obtaining an adequate operation.

The tendency of our country is towards municipal service. In the case of Tlaxcala this would require integration of Rural Councils in the Municipal Council. In Southern Lower California, it would require decentralization of the State Council to the Municipal Council. The state of Queretaro is a special case where responsibility lies with the municipality.

The methodology applied, as mentioned before, will serve as a guideline to correct actions, as well as to determine the precise moment at which corrective measures should be taken.

All of the above is an effort aimed at solving the problems, not only with respect to the supply of tap water, but also of the integral development of rural communities. This is only a beginning, but solution of these problems will open new horizons which will facilitate the action to be taken in other fields.

H U M A N F A C T O R

TOWARDS A FULLER APPRECIATION OF COMMUNITY INVOLVEMENT

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TOWARDS A FULLER APPRECIATION OF COMMUNITY INVOLVEMENT

Experience continues teaching us how important "community involvement" is to the successful realization of rural water projects.

In practice, however, local involvement in water development is often too narrowly defined in terms of the provision of labour, local materials and/or cash and the presence of a number of local officials (e.g. a water committee) who organize the labour and financial contributions of participants. Such definition overlooks an essential dimension of community involvement, i.e. mobilization of a "cooperative mentality" within the populace to solve its own (water) problems. Community involvement essentially is a process, beginning with gathering awareness that people have the capacity to change their own lives collectively, which finally involves

- 1) identification of community priorities;
- 2) collective decision-making;
- 3) cooperative action to attain designated goals.

Local participation in rural water schemes therefore not only means that people in the community recognize the improvement of their water supply as something to which they attach a high priority but also that planners accept that the socio-economic and cultural setting of the community plays a leading role in the gradual process of mobilization. Voices from outside the community - engineers, health educators, water promoters - must finally listen to voices within the community if true involvement, and successful implementation of a project are to develop.

The Kiairia "A" Self-Help Water Project, which I visited during April 1975, illustrates in its history several crucial aspects of community involvement. Kiairia Section "A", one of the three sections of Kiaria Sub-location (Kiambu District, Kenya) had an estimated population of 2,000 (Sept. 1974). Of the 250 section households, 80% were supplied with water from the self-help water project at the time of my visit. Kiairia with two rainy seasons a year, is in an area with a high potential for economic growth. In addition to maize, beans, cow peas and bananas (subsistence crops), coffee (cash crop) is cultivated. Some maize is also grown for marketing. Livestock is plentiful: cattle, sheep, goats, pigs and poultry. Pedigree cows produce enough milk for both home consumption and for sale.

Because Kiairia is only 40 km. from Nairobi, many residents hold jobs in the city. Consequently, there is a steady flow of cash into the area. Before inception of the self-help water project, people depended for their water supply on 2 streams (1 permanent, 1 seasonal), several wells (1 km. away), and rain.

History of Kiairia "A" Self-Help water project

In 1969 some residents realized that the hydro which had been donated to the Kiairia Harambee Secondary School by the Kiambu County Council might be put to more advantageous use supplying water to the entire community. A Water Committee with 10 members representing all groups within the local population was formed. In addition to the 2 men who conceived the venture, a high-ranking Nairobi bank executive and a school teacher, there were 6 men and 2 women on the committee. Assisted by the District Water Officer, the Water Committee began to plan. They drafted organizational and financial guidelines. The essential importance of maintenance was recognized right from the start. Approval was even given to employing someone on a fulltime basis to see to maintenance; and it was decided that members of the project would be asked to pay separate monthly maintenance contributions above and beyond their initial fees.

The Committee set about mobilizing fellow villagers by explaining potential benefits of the proposed scheme at weekly baraza's (public meetings) and reporting on the present state of planning. Nevertheless, despite their efforts some scepticism originally prevailed about whether piped water would ever reach the village; only 20 per cent of local households at first joined the new project. However, within 3½ months of the conception of the self-help water project, in April 1969 the necessary surveying - again with the District Water Officer's help - was accomplished.

Soon afterwards in a series of general meetings the financial and organizational proposals of the Water Committee were discussed. Lively debate culminated in the following decision: every married man in the village could, as representative of his household, register as a member, provided that he meet certain obligations:

- a) an initial contribution in the form of voluntary manual labour (estimated cost Ksh *300/-) and Ksh 660/- in cash (now being raised to Ksh 760/-, the additional Ksh 100/- to pay for a new electric pump);

* 1Ksh (Kenya shilling) equals about U.S.\$ 0.14

- b) an initial membership fee of Ksh 5/- after voluntary labour has been rendered (now Ksh 20/-);
- c) a monthly maintenance payment of Ksh 3/- (now Ksh 6/-).

With a majority, the membership meeting voted against communal standpipes, and for home standpipes. The use of water for irrigation was disapproved. Members rejected unanimously the idea of water storage in private tanks. Use of water meters was also voted down.

The first crisis arose for the self-help water project when an influential resident, who happened also to be a close friend of several Water Committee members, wanted to sell a piece of property to the project as the site for the proposed storage tank. Technical arguments - the land in question was too low to allow water distribution by gravity from any storage tank there - eased mounting tensions. A short time later ground for project sites was awarded by the Kiambu County Council. Construction began in August 1969. Community membership had increased by then to 40 per cent. The project had remained active in the public eye. The Water Committee developed a favourable image with its frequent open meetings.

In actual construction, members were involved to the fullest extent possible. Professional, wage labourers were used to perform only certain specific tasks, such as building the storage-tanks and laying pipelines. Every member was obliged to provide free manual labour for 2 days/week or to pay Ksh 3/- compensation for each absence.

Difficulties arose when a number of members failed repeatedly to appear to take part in digging chores. Personal relations interfered with automatic levying of approved sanctions. A significant portion of the membership that was conscientiously fulfilling its responsibilities threatened to stop work should exceptions to the rules be tolerated. Finally a general meeting resolved the clash: those who were unwilling to contribute labour were stricken from the membership rolls.

Digging of trenches took all in all 6 months. Construction was completed in July 1970. The costs which the project itself met were Ksh 15.000/- for the storage tank, Ksh 13.000/- for pipes linking pump and storage tank, and pipes for water distribution. The Ministry of Cooperatives and Social Services merely donated 8.000 feet of water pipes. The project supplied conduit to the edge of each member's compound; the owners of standpipes had to pay for pipes into their

150

homes. When the project began to deliver water in August 1970, not more than a year after breaking ground for the first pipe trenches, membership grew gradually. New members were (and continue to be) accepted on conditions similar to those laid down for charter members. Those who joined after construction was completed were asked to pay Ksh 300/- to compensate for failure to contribute free labour.

Project water was not treated chemically. No filter was used. There was simply a rubbish trap, intended to induce sedimentation. Pollution from villages upstream was certainly a problem. During rainy seasons in particular, water emerging from taps appeared muddy and foul. During 1972 project membership began speaking about the need to improve the quality of water provided. However, at a general meeting, support for quality improvement turned out less widespread than the wish first to build a cattle dip. A separate committee was established to pursue this priority goal. A number of Water Committee members served on the Cattle Dip Committee, too. In June 1973 project members voted at a general meeting that everyone should contribute an extra Ksh 100/- for the purchase and installment of an additional electric pump. The original hydro, subject to valve problems, was unable to cope with daily consumption loads. At the time there were 110 members. In April 1974 the new electric pump was in service (cost Ksh 15.000/-).

When last tallied, in September 1974, 80 per cent of section households had joined the Kiairia "A" Self-Help Water Project. Only a few had failed to pay maintenance fees and had therefore been "disconnected". Satisfaction seemed widespread with project achievements, although only half the member households were using piped water for all domestic purposes. Many continued to prefer rain-water or well water for drinking. The appearance of the project water continues to provoke doubts about its potability. Average daily consumption for domestic use approached 60 gallons/member-household, or 35 litres per capita. Roughly 8.800 gallons were in demand each day for watering domestic animals.

The water project has had several visible results for the community (attempts to measure the precise socio-economic effects of the project have, however, not been made). There is today appreciably more cattle raising than before the project began. Practically every household now manages to keep at least a cow. Cooperation within the village has indisputably increased in recent years, a development likely to derive from project experiences. A cattle dip has now been completed (cost Ksh 7.000/-). Plans for electrification are under way. The positive influence of the water project has also been felt beyond Kiairia "A". Adjacent sections have begun to demonstrate a desire to launch similar water projects.

Reading the case history of the Kiairia "A" Self-Help Water Project can reveal a number of reasons why the enterprise managed successful community involvement:

1) initiative for acquiring a water system sprang up within the community itself;

2) a deep commitment to wide representation existed;

it was by plan that a number of small farmers and 2 female representatives held positions in the Water Committee. Participation of women is especially notable, for it is common practice in Kenya (as in other developing countries) that men manage village affairs. However, in developing countries, women have a strong vested interest in water supply: not only do they bear the burden of hauling water but they are the people whose acceptance or rejection of an improved water supply system will determine quite simply whether this system ever will be used. Full participation by women therefore often increases the effectiveness of community control of water systems.

3) users of the water supply took part in project decision-making;

the case history demonstrates that constant decision-making is part of the process of acquiring a water system. In Kiairia "A" members themselves made key decisions during all phases of the project (design, construction and maintenance). What is more, the Water Committee was willing to allow plenty of time for the delicate decision-making process (majority rule) to take place without members feeling hurried or pressed into making up their minds with insufficient understanding of the issues at hand and the possible consequences of their decisions (e.g. for establishing definite financial and organizational guidelines and for determining how to deal with members who shirked labour duties, countless meetings were held). We can indeed speak of a continuous community dialogue in which discussion was based upon clearly formulated proposals drafted by the Water Committee with assistance from external technical experts (e.g. District Water Officer). In this way new technology was "absorbed" by the community rather than imposed on it. Such imposition is an all too common turn of events during which local beliefs, values and knowledge are trampled over blindly by zealous outsiders or even by impatient village proponents of improved water supply. The above-described ways of reaching decisions explain the high degree which people in Kiairia felt themselves committed to final choices.

4) benefits were distributed evenly;

in Kiairia "A" prohibitions against private water storage or use of project water for irrigation purposes were measures clearly designed to promote equal distribution of project benefits. The adopted system of paying initial contributions installments which did not exceed the financial means of members - with tolerance for those falling mildly behind in their payments - also

promoted equability. Even the 2 figures in Kiairia who took the first steps towards realizing a water project, among the most prosperous residents of the village, and all other Water Committee members as well, had typically the same rights and responsibilities as other project members.

5) mobilization of the community was understood to be a gradual process and was pursued with sustained efforts;

at the time of initial project surveying, 3½ months after the first discussion of plans, 20 per cent of local households had become project members. This rose to 40 per cent some 3½ months later, when construction began. Once water began to be pumped into village homes, membership rose sharply indeed. New members were attracted by the many, open meetings which the Water Committee held and also by the consideration that they could join the project under the same conditions as its "first hour" supporters. Crucial, however, was that the project was in a position to point out concrete progress towards fulfillment of its goal. At regular intervals reports about surveying, about the hiring of a maintenance employee, about acceptance of project rules, about acquisition of pipes made it possible to sustain the enthusiasm of villagers who had already taken out memberships and also to imbue the project with an "active image" in the public eye. Local initiative is far from a guarantee of project success. Time and again enterprising planners proceed too quickly to actual implementation without first making sure that the main body of villagers supports them at least to some slight extent. Premature action often leads to a project becoming stranded during construction (storage tanks abandoned short of completion, partial realization of the designed distribution net). If the project actually manages to begin functioning, unless sufficient active community support exists, it is likely to collapse during operational and maintenance phases (members fail to pay their water fees, or people choose to make no use of the improved water supply system at all). The Kiairia "A" Water Committee recognized these pitfalls: they began mobilization of the community even before the start of any construction; they did not undertake any building without first making sure that there were enough fee-paying members to assure the solvency of the project; such financial caution was exercised with regard to maintenance, as well.

The case history of Kiairia "A" is also useful as a reminder of the variety of factors which should be taken into consideration when evaluating the possible course of community involvement, not only in water projects but in most innovative ventures, as well. Not to overlook the obvious, let me state at once how important it is to realize villages may be at very different phases of development. Even

within the same region of one country villages can be at sharply contrasting points of development. Kiairia is a rather advanced community. The people have erected a harambee school successfully. When the water project was launched, members were able to formulate their own interests and were conscious of what they believed should be achieved first to further village prospects: e.g. a cattle dip was seen as more urgent than improving the quality of the water supply. Even in a setting such as Kiairia we have seen how intricate the process of implementing a water scheme can be - how much debate went on, how much energy was invested, how many alternatives were considered, rejected, revised. What then can realistically be expected in terms of efficient mobilization where a village or community has not yet any sense of its own priorities?

Where such a sense is lacking, the chance a rural water scheme will fail is high because villagers do not become truly involved. Their lack of response is all too readily attributed to "apathy", to a laggard mentality, to resistance against innovation, to misunderstanding and ignorance concerning the benefits which a good water supply can offer. The stock response from planners, managers and technicians active in rural water development is that in such villages "motivation" and "health education" are needed to engage the population's active cooperation. However, when such campaigns are undertaken, their results are usually quite limited in villages where previously "the cooperative mind" has not shown traces of development. These campaigns confine themselves as a rule too exclusively to trying to "sell" plans which have already been drafted. True community involvement must rather begin with creating an awareness that together villagers are able to change and to improve their common situation. Indeed, even to be able to speak of a "wish for an improved water supply" presupposes some degree of achieved cooperative awareness.

Social-psychological forces:

Additional social-psychological forces arouse the resistance of some villages to schemes introduced from the outside world. Arriving with their "messages", experts, advisors and government representatives (e.g. health educators, extension workers, water promoters) criticize implicitly the ways in which local residents manage their lives - and often this criticism is delivered with little tact. Water promoters should not forget that wherever they go with their "gospel" people have been providing themselves in one way or another, no matter how primitive, with water to meet their needs. How they get their water has consequences for beliefs, values and behaviour in relation to water and what they do with it. By respecting villagers' values and knowledge, by taking into consideration what water means to

them, promoters will find themselves better placed to design an improved water supply system with people, a system they will use, rather than a system for them, which they may misuse or ignore.

A further consideration is how in many parts of the world central governments have already exhausted a large part of their good will credit in rural areas by initiating projects and making promises which are never fulfilled; villagers, far from blind to their own interests, then see that they have not benefitted them at all. How do people become apathetic and suspicious towards change? - as a consequence of cumulative disappointments, and of accurate assessment of the slight prospects of substantially increased profits or of an improved standard of living. Unrealistic pledges concerning improved water supply which local politicians are prone to make to protect their own elective positions are, in this context, particularly harmful (the best defense against disillusionment from such pledges would seem to be definition of a national water-development policy including clear criteria for site-selection). Similar reasoning dictates that a national policy based upon "worst-first" priorities, will need to reserve adequate funds and manpower to convert words into water.

Village social and economic structure:

The internal make-up of villages can vary greatly, and these differences can all be significant for the chances that mobilization of community involvement in acquiring a water system will succeed. Power struggles in a village, competing factions, vested interests in long-established water sources - such considerations should not be overlooked by planners. Self-interest is deeply seated in rural settings. Existing local social and economic differences within a village therefore play a considerable role even in an event so apparently uncontroversial and positive as acquisition of an improved water supply (cf. difficulties concerning selecting the site for the project storage tank in Kiairia "A"). These differences all too often lead to unfair, or even exclusive, distribution of water to a minority of upper income households, thereby further intensifying intra-community differences. In general rich people in a village are among the most outspoken supports of an improved water supply !

It must be made clear that all groups in the community stand to profit from an improved water supply and that this supply can promote the welfare of the village as a whole. In Kiairia this concept was instrumental in decisions taken to prevent private water storage or use of water for irrigation and in the project's preparedness to accommodate poor members. If properly introduced, cooperation to

achieve a water scheme can become the beginning of community involvement in an on-going process of development (cf. construction of a cattle dip and plans for electrification in Kiairia). Not all rural villages, however, will contain agents of change of the caliber of the teacher and banker in Kiairia. Where such figures are lacking, trained mobilizers will be required to instigate the process of community involvement, and to guide it.

Suggestions for a rural water development policy which incorporates the essential element of community involvement:

1. Use personnel trained in mobilizing communities; community involvement is an intricate process which demands not only familiarity with the community, an understanding of its internal make-up, its decision-making processes and the traditional importance of established water sources to local social and cultural life, but also the ability to communicate directly with villagers and to encourage them to discover and to put to work their "cooperative mind" Such work is too important to be added as an additional responsibility to the tasks of designers, managers or engineers !
2. Begin community mobilization at the earliest possible stage of project development; do not, at any rate, wait until plans are finished and construction is under way.
3. Promote participation by women in local initiatives designed to promote a rural water supply project; it is true that such advice can only be acted upon in certain cultural settings (e.g. the Islamic tradition precludes any active role in public affairs for women), but even where women can make a contribution, this contribution has until now seldom been used to full advantage.
4. Involve the community in every phase of the project; to be effective, community participation must involve a high degree of community control over all project acts and decisions, during planning, design, construction, operation and maintenance phases. Users must be responsible for the project development. This may necessitate adopting certain technology that is far from spectacular. Technology must remain "appropriate", suited to village level. Rather than elaborate construction, in certain villages, minor improvised improvements to already utilized water sources may assure more village participation and therefore greater communal gain than proceeding with plans of a high technical and design standard drawn up by a water engineer.
5. Train members of the community in management administration, in maintenance and in repair, enabling operation and management of the water scheme to be done

by local manpower.

6. Arrive at a clear definition of what responsibilities must be assumed by the government and what responsibilities remain for the local community to meet. The government should extend itself to support local initiative, lending organizational and financial assistance and supplying advice and materials. Timely help should be seen as essential, preventing any loss of local enthusiasm. On the other hand officials should not hesitate to deny assistance where they feel initiative is premature, without sufficient popular backing. A bit of caution at present will avert the collapse of some projects in the future, a collapse which will affect the motivation of villagers to participate in cooperative enterprises negatively.
7. Make a social analysis preparatory to the execution of rural water programmes on any major scale (e.g. regional programmes); definition of priorities in the selection of villages has up to now been largely based on technical, health and demographic factors, neglecting the social factors. Social organization should also be taken into account. A social analysis as referred to above should result in a differentiation of villages based on the degree of probable receptivity to an improved water supply. It may prove to be more cost-efficient to start a programme in communities where success is more likely, so that model "pilot projects" will remain foci of interest to others to whom they serve as examples ("nothing succeeds but success").
8. Include "action research", focused on the process of community involvement in rural water programmes; such research makes it possible to adjust programmes,
9. Compile a reference catalogue of management systems; (cf. Anne Whyte, "Towards a user-choice philosophy in rural water supply programmes", Assignment Children, no. 34, April/June 1976, UNICEF, Geneva, p.41). To date those interested in water supply systems do not have any adequate collection of case materials describing how communities where water schemes have attained a reasonable measure of success in fact managed to convert the wish for water into reality. With a management case-book, in any event, armed with systematically arranged empirical evidence concerning what approaches to community involvement have succeeded under what social, economic and culture conditions elsewhere, planners will be better able than they are at present - equipped with only technical catalogues - to proceed at their tasks with some confidence that users will continue to pay contributions and will keep their system in working order.

ASSESSMENT OF MANPOWER NEEDS AND
TRAINING PROGRAMMES

by

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ASSESSMENT OF MANPOWER NEEDS AND TRAINING PROGRAMMES

INTRODUCTION

1.1. The essence of this Seminar is that it is participatory and its objectives are to inform, discuss and exchange views on a number of highly relevant topics and problem areas concerned with the provision of community water supply in developing countries. Indeed I understand that, in training terms, a Seminar has been defined as: "A short course or conference which makes extensive use of participative methods, including group tutorials, and is devoted to the study of a particular subject".

The participation seems appropriate to the occasion and suggests to me that my participation should be to promote, if not provoke, discussion and a lively exchange of views and experiences on doing better justice to the training of waterworks personnel in developing countries. At the same time it perhaps needs to be said that there is ample scope for doing better justice to waterworks training in developed countries.

1.2 I choose, therefore, not to offer a formal paper on training that sets out to argue a case through to a neat and tidy solution; in this particular area there is no neat and tidy solution. My preference is to draw upon my experience as a full-time professional trainer with some, but never enough, first hand insight to the developing country's problems and to offer a selection of observations, questions and respectful suggestions on the state of the art of training as a basis for discussion in which I hope to benefit as much as anyone else.

Why Train ?

2.1. It is fair for the training specialist to be asked this question which has certainly been put to me many times. In dealing with this at a previous international meeting on this subject it may have seemed that I was taking the question for granted because I said: - "An advantage, perhaps the only one, in setting out to examine and make constructive recommendations on the training of waterworks personnel in developing countries is that there is no necessity to justify the case. It is not required to argue why it should be done but, rather, how quickly it can be done."

2.2. It may be worthwhile to re-consider some of the broad reasons that I went on to give four years ago as a backcloth to the need for manpower planning and training. Have these circumstances changed today?; how much progress have we made?

The circumstances were:

- a) The formidable situation presented to the 9th IWSA Congress by Ir. T. Verheul in his paper on the water supply situation in developing countries where, to meet UN targets for the 1971 - 80 decade, an additional 500 million people are to be provided with a water supply. By the crudest possible extrapolation this could require a minimum additional 250,000 trained waterworks personnel over the period.
- b) First hand accounts of the under-utilisation of newly commissioned water systems due to lack of trained personnel and the subsequent rapid deterioration of plant for the same reason.
- c) The unequivocal response to a WHO questionnaire which requested developing countries to state in order of priority the seven major constraints which are delaying progress in developing water supplies. Lack of trained personnel was rated as the second most serious constraint.
- d) The requirement of the World Bank that one pre-requisite for an investment loan for a water supply project is real evidence that training plans exist to ensure that upon completion the project will be effectively operated and maintained.

2.3. Other and more precise comments are that:

- a) Training can represent in financial terms an investment in human resources greater than is normally made in physical resources e.g. water systems. The water manager is properly concerned and vigilant about his return on investment in physical assets and should equally recognise and accept that a training investment in people will increase the yield from this more valuable resource.
- b) Skill and knowledge about a job or work are best acquired through an appropriate blend of organised training and supervised experience. If the acquisition of skill and knowledge is left solely to unsupervised or inadequately supervised experience on-the-job (exposure training), employee performance will develop slowly and may never reach an acceptable level.

Organised and systematic training will assist waterworks staff, at all levels, to reach the standard of an experienced person in the shortest possible time. This will reduce unit costs.

One of the problems of the developing country, in addition to setting up the training scheme, is to have established standards of performance at which to aim.

- c) Waterworks employees in developing countries are following an inevitable pattern and are becoming, perhaps more quickly than anticipated, organised into unions and associations. The functions of collective bargaining and negotiation are

likely to increase, as will the demand for joint consultation.

The primary reason for providing good training is not, nor should it ever be, to equip the manager with a bargaining tool. Sooner or later however, the manpower and employment considerations that arise in almost any industrial forum for negotiation and consultation will begin to exert pressure upon the need and demand for training of one sort or another. It becomes a matter of enlightened self-interest for the waterworks manager to develop training awareness and to demonstrate this in practical terms. In so doing this will help him to retain the initiative when negotiating or bargaining with employee or staff representatives. A policy statement on training may seem to offer a simple answer except that writing such a statement and making it meaningful, is easier said than done, as many developed countries have discovered.

- d) Closely allied to this trend is the growing recognition among the lower echelons of the waterworks labour force that job aspirations and career expectations should be no less available to them than they are to other levels of employment. The message appears to be that preoccupation with training the professionals and technologists, important though this is, has gone on long enough. In this sense the reason for training is one of maintaining the right balance of skill, knowledge, performance and motivation at all levels of the organisation pyramid.
- e) The rate of the migration to municipal communities in developing countries and the consequential overload on water supply and sanitation services, already under strain, will inevitably create additional hazards to the health and hygiene of the people. A reason for training here is to make the people aware of how best to use and not misuse or abuse the precious public and domestic water installations which exist. Suffice to call this Public Relations and the waterworks man who neglects this does so at his peril.

2.4. So, why train? Whether or not it is necessary to justify the case it is no bad thing to clear the mind on some of the issues and define or re-define a few important objectives. However, the essence of the business is that effective training based upon objective manpower assessment and relevance to the work to be done, makes economic sense.

What are the Gaps and Problems?

3.1. The delegates attending this Seminar understandably should know better than anyone the extent, nature and variety of their manpower and training problems and where, in this spectrum, exist the priority gaps to be filled. Let these therefore emerge in the discussion stage of this programme so that those of us who have

advice or, hopefully, direct assistance to offer can take careful note for future action.

3.2. As a basis for discussion and to lay down a few guidelines which can be sharpened up as the discussion unfolds I propose the following observations:

a) Dispersion of the Workforce

The nature of waterworks operations is such that the labour force is scattered thinly across the area of supply. There is a problem of time and space; operational control is impeded particularly for the supervisor. In such an industrial situation there is a strong argument for the workforce to be versatile and multi-skilled. But, with such dispersion, how can this be achieved by training on-the-job? How can there be enough trainers to go round and what training use can be made of supervisors and technicians in this situation? The problem is to identify the appropriate mix of centralised and de-centralised training, particularly at the operator and craft levels of employment.

b) Availability of Training Material

There is no great overall shortage of training material presently available for waterworks training at a given level or function. The problems are the usual ones of dissemination, adaptation, language, transfer from one level of ability to assimilate to another, and perhaps the cost of setting up a system to overcome these problems. But the waterworks training know-how does exist.

c) Municipal and Rural Priorities

How far and how fast can the developing country afford to get to grips with the problems, which must include manpower and training, of expanding and improving water services in municipal authorities while at the same time not neglecting the circumstances in which rural communities exist. This may be the most difficult problem of all.

d) The shortage of Trainers

It is possible that with ten years of experience of a national waterworks training organisation behind us, we in Great Britain may have more full-time professional waterworks training staff available per head of population supplied than most other countries. And we still do not have enough. The solution may well be to persuade and encourage managers and supervisors that they have, as an integral part of their duties by definition, a clear responsibility to train, tutor and develop subordinate staff. The problem is to get them to do it. The day to day operational waterworks problems in developing countries do not readily convince those in authority that they have time to train others. The paradox is that it is the operational managers and supervisors who have the

the greatest accumulation of knowledge and experience to impart.

There is, however, no real way around this problem which merits serious consideration at this Seminar. This problem is compounded by the continuing preference which appears to be given to the training and career development of professional persons and technologists, particularly in relation to the limited amount of overseas training which is available.

With present priorities as they are the greatest pay-off in seconding staff to other countries for training programmes is likely to be achieved through sending carefully selected potential training staff to a country which is operating a comprehensive training scheme of the kind now being recommended for developing countries. A copy of a proposed six-month fellowship training programme for trainers is attached as Appendix 1 to this paper. Such a programme is available now.

e) Literacy and Numeracy

This is not a training problem or, rather, it should not be. But without commensurate and appropriate standards of basic education how can the basic training be assimilated; Education for life should precede training for a job. But how, for example, can a waste inspector read charts, interpret data and make simple sketch-maps if he cannot read and write? There may be no alternative in the short term other than for the water authorities to break down this "chicken and egg" situation by integrating education and training at least at the basic levels and provide the education themselves.

f) Motivation and Commitment of Managers

I hold the view, contrary to many others, that there is no lack of motivation and commitment to training at senior management level in developing countries. It is a greater problem in developed countries.

The problem seems to me to be one of providing the developing country manager with the right catalyst and resources to enable him to translate his motivation into practical training.

g) Manning Levels

There is a tendency to over-man the developing country public service enterprise. This probably arises from unemployment and political pressures. The corollary to this is usually under-utilisation of waterworks personnel, employment inflexibility and a reluctance to learn new and improved job methods. Manpower planning is as important, if more difficult, when obliged to carry a surplus of manpower as it is when manning levels are based upon work measurement or when the labour market is tight.

The problem remains, how to quantify the amount and quality of training required and this could be regarded as a high priority for management training.

h) Finance and the Training Budget

Good training is not cheap. To make a lasting, if not permanent impact a training programme requires a training budget. In paragraph 2.1(c) of this paper I refer to the WHO questionnaire on priorities for waterworks progress in developing countries. The second priority was for training; the first was for improved internal funding arrangements. The absence of an equitable rating system or charging scheme for water services provided, will retard training as it will any other improvement activity or project. In developed countries it is my experience that in times of inflation and economic restraint, the training budget is among the first to become vulnerable. All the more important therefore for training to demonstrate that, done well, it provides a pay-off, although training evaluation is yet another problem.

i) Public Response

It is too easy to label this problem "Public Relations". As far as I can judge the response of the public consumer is a special problem for the developing country. I am not sure that within the various forms of assistance being provided, adequate provision is being made for this. What is the final value of the most excellent technical assistance programme if, as soon as the project is completed, if not sooner, the water installation, either in total or in part, is being made ineffective through abuse or misuse whether consciously or otherwise; How to get the message "Water and the Community" across to the people is a real training problem and should be reflected in the training budget.

Water Byelaws and their enforcement are part of the answer and a training gap could well exist in this connection.

I am certain and will expect to be told that many more and perhaps more pressing problems exist than these that I have outlined. But this fits the aims and objects of this Seminar in which I hope to learn as well as offer advice. My aim is to help to provide a basis for such a two-way exchange.

Measures to be Adopted

4.1. There are two kinds of measures and methods that may need to be devised or are in fact presently being adopted to reduce the gap between an absence of organised training and a comprehensive scheme of education and training for waterworks personnel. There are on the one hand those provided or in process of

being set up on a regional, national or international basis, and at the other end of the scale there are those provided on a local, waterworks, self-help basis.

The great encouragement and services to training provided by WHO, the International Reference Centre and other national and international organisations including IWSA, are well recognised and need little amplification here. The work of CEPIS, the Pan-American Centre for Sanitary Engineering and Environmental Sciences in providing from its base in Lima, Peru, high quality training advisory and consultancy services to the developing countries in the American Region, is widely acclaimed. The extension of this concept to other strategic locations in the developing areas of the world must surely be welcomed and has immense potential value. The National Sanitation Programme of Brazil which I have been privileged to observe at first hand is a most impressive training venture and conforms to the style of approach recommended at the special IRC sponsored meeting in Bilthoven, the Netherlands in April 1973. The Bilthoven Training Proposal will surely provide a centrepiece for discussion at this Seminar.

4.2. It is of course hoped that these comparatively few major training operations augmented by the others that are to follow will go a long way to closing the developing country training gap that exists today. This cannot however be achieved overnight and, in the meantime, some training can and should be attempted, even if it is ad-hoc and cuts a few corners. Let us therefore aim that at the conclusion of this Seminar the delegates may take away with them at least one idea, reference or technique that will enable them to initiate an action training plan in an area where a gap exists at present. A sample collection for consideration with this aim in mind, any item of which I shall be pleased to amplify at any time during the Seminar, is as follows:

a) Job/Training Analysis

Job analysis in depth and the accurate identification of training objectives are specialised techniques and a permanent training organisation must always have this capability. However, a great number of waterworks operations have already been analysed and broken down for training purposes. Before duplicating this work refer to the analyses which have already been done; it is possible that this material may be used as a basis for your training programme as it stands or with minor adaptation.

b) At What Level to Start?

There can be no standard answer to this question. It depends upon the problems and priorities. A widely held view is that any scheme of training must start

with the managers. If the initial training effort is to be ad-hoc there is considerable merit in starting at the level of the Supervisor and working outwards from this level. An appropriate programme to launch could be "The Supervisor and his Training Responsibilities". Such programmes currently exist.

c) Water Distribution Work

It is more difficult, because of dispersion, to train water distribution personnel on-the-job than any other category of waterworks staff. Fortunately it is not difficult to simulate water distribution operations and short concentrated periods of centralised off-the-job training is recommended followed up by a set programme of supervised practical experience. Examples of simulated distribution training aids are readily available, can be constructed quickly, are not too expensive and do not necessarily need to be located at a central training establishment.

d) Water Treatment Work

Training water treatment staff, particularly the operators, does not lend itself to classroom or centralised training. The plant is difficult and expensive to simulate and is widely dissimilar. Experience has shown that the best results are obtained by training the plant managers and supervisors off-the-job to train, in turn, the remainder on-the-job. Programmes covering simple training analysis and methods of on-the-job instruction are currently in operation and the transfer problem (for developing country use) should not be insuperable. Also available are validated audio-visual slide/tape training programme which can be used as they are or adapted.

e) The Water Technician

Schemes of education and training exist for several categories of water technician. If a developing country is not ready to use a complete scheme, the documentation will contain much useful training analysis data and self-contained training modules for ad-hoc use.

f) Water Byelaws and Regulations

A well illustrated training manual now exists covering the interpretation and application of a set of model water byelaws. This manual is geared to the off-the-job training method.

g) Reference to a Common Task Schedule

A Task Schedule covering a range of waterworks tasks from operator level to management level, has been developed by the International Standing Committee on Education and Training of the IWSA. The hope, if not the intention, is that the Schedule will form a common basis for an ad-hoc task orientated or modular approach to training for a particular task or function. This concept will be

presented to the IWSA Amsterdam Congress by the Working Party of the Standing Committee.

h) A Waterworks Certificate Course for Operators

A great amount of work has been done in recent years to develop a basic scheme of waterworks education for operators and, in particular, for junior entrants or school leavers. Where a developing country has a requirement for such a scheme, those that exist should surely be considered, at least for reference purposes.

i) Training the Trainers

Where a developing country water authority is fortunate to have acquired or has regular access to waterworks training specialists, either full-time or part-time, there would be less dependence if indeed there were any need at all to resort to ad-hoc methods of training. For this reason i.e. that normally it requires a training specialist to train the trainer, emphasis is placed yet again upon the value of concentrating one's investment in overseas training on buying the expertise and experience of a country which has an established waterworks training organisation. The Fellowship Training Programme outlined at Appendix 1 can be used and is available for this purpose.

I would not wish it to be thought that by offering this sample collection of training topics and training needs, these are the most significant for consideration and study during the Seminar. They may only represent the tip of the iceberg; our task should now be to uncover the remainder and by jointly identifying, quantifying and defining these, be better able to do justice to the problem of getting waterworks training started in areas where little or no training is available at present.

5.1. Conclusion

This valuable and well-conceived Seminar sets as one objective, the initiation, planning and implementation of a series of training schemes and courses at regional and national levels. The Training Division of the National Water Council of Great Britain will be very pleased to place at the disposal of this Seminar its training know-how and experience in a joint and co-operative endeavour to meet this objective.

Note: A Glossary of Training Terms used, can be requested through the International Reference Centre for Community Water Supply, P.O. Box 140, 2260 AC Leidschendam, the Netherlands.

INTERNATIONAL WATER SUPPLY ASSOCIATION
Standing Committee on Education and Training

TRAINING THE WATERWORKS TRAINER - A PROPOSED SIX MONTH
FELLOWSHIP PROGRAMME

AIM: To develop the skills, knowledge and experience required to effectively set up and manage a training function in a water undertaking i.e.

All that has to be done in meeting the training responsibilities of a water undertaking. The four main steps are:

- a) Identification of training needs;
- b) The formation of training policy;
- c) Implementing the training plan;
- d) Assessment of training effectiveness.

SELECTION: A professional or graduate level person with at least two years operational waterworks experience and a clearly identifiable motivation towards training.

OUTLINE PROGRAMME

<u>SERIAL</u>	<u>TRAINING</u>	<u>DURATION</u>
1.	Study of the day to day operational problems of a single purpose or multi-purpose water authority or division and their application to training systems currently available in host country	2 weeks
2.	Attendance at a formal off-the-job Training Officer Course	4 weeks
3.	A water industry practical training assessment project - integral with the Training Officer Course - in an operational division approximate to the size and scope of the parent Authority	3 weeks

<u>SERIAL</u>	<u>TRAINING</u>	<u>DURATION</u>
4.	The supervised study of a waterworks training function in action from a national, regional or divisional standpoint	3 weeks
5.	Observation of the overall operation of a waterworks off-the-job training centre	2 weeks
6.	Attendance at a Government Training Centre dealing substantially with instructor training and standard methods of instruction including the development and use of audio-visual aids	2 weeks
7.	Field study of training advisory services provided to a variety of waterworks disciplines and functions	2 weeks
8.	An exercise in the compilation and monitoring of a training budget	1 week
9.	Study of the effective provision and control of on-the-job training in a production situation using experienced supervisory staff	1 week
10.	Validation and evaluation of training effectiveness both on- and off-the-job	1 week
11.	Observation of the inter-relationship and integration of education, further education and industrial training	1 week
12.	Final study and report on the day to day operational problems of a single purpose or multi-purpose water authority or division and the effectiveness of training systems available in host country in meeting the problems	2 weeks
		<u>24 weeks</u>

NOTE:

- (1) Throughout the six month programme the trainee and his programme will remain under the supervision of a nominated member of the professional training staff of the host country.
- (2) If time is available this programme could be integrated with or could follow a Diploma Course in Industrial Training and Education.

T E C H N O L O G Y

4

8

RESEARCH AND DEVELOPMENT NEEDS

IN

COMMUNITY WATER SUPPLY

by

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September, 1976

RESEARCH AND DEVELOPMENT NEEDS IN COMMUNITY WATER SUPPLY

Introduction

Provision of an adequate supply of safe drinking water is a basic necessity for the well-being and socio-economic development of a country. All nations, big or small, developing or developed, have amply realized this fact. The 1973 U.N. Conference on the Human Environment held in Stockholm has also emphasized the need for greater inputs in this area.

Developing countries (excluding China) constitute almost half of the total population of the world. Over two-thirds of this population live in the rural sector. A global survey of the water supply situation in developing countries by WHO * shows that only 14 per cent of this vast population has a reasonable access to safe water. Further, it is estimated that to achieve the second U.N. Development Decade Target of providing the entire urban and 25 per cent of the rural communities of developing countries with safe water, an investment of U.S.\$1400 million will be required.

Community Water Supply Problem of India

The nature and magnitude of the problems encountered by developing countries in the provision of protected water supply are, in many respects, similar if not identical. A detailed case study of the community water supply with special reference to India, which may be applicable to many developing countries, is relevant to this seminar.

India is the second most populous and seventh largest country in the world. According to the 1971 census, the population of the country is 547.37 million, consisting of 108.79 million urban and 438.58 million rural inhabitants. The rural population is distributed in 575,855 villages and 2,931 urban towns. Compared to the industrial and technological progress achieved by the country through the Five Year Plans, provision of water supply has lagged behind the other programmes. This will be evident from the following statistics (expected by the end of Fourth Five Year Plan) Table Nos. 1 and 2.

* Community Water Supply and Excreta Disposal Situation in the Developing Countries - A commentary by C.S. Pineo & D.V. Subrahmanyam, WHO, Geneva, 1975

Table No. 1 - Percentage of urban and rural population covered with protected water supply

	Number total	Population covered (million)	Percentage	
			Number wise	Covered population-wise
Urban towns provided with water supply	1947	90.5	56.4	82.3
Villages provided with protected water supply (piped or otherwise)	36000	21.6	6.3	5.0

Table No. 2 - Allocation on water supply and sanitation

		1951-69 (Rupees	1969-74 in million)	1974-79 Vth Plan
i)	Rural	1320	2000	5740
	Urban	2085	2800	4310
ii)	Allocation on rural water supply as per cent of total outlay on water supply and sanitation sector	<u>First Plan</u> 1951-56		<u>Fifth Plan</u> 1974-79
		12		60
iii)	Allocation of water supply and sanitation as per cent of the total plan outlay			
	a) Rural	0.8		1.5
	b) Urban	0.35		1.15
	Per capita expenditure per year on:			
	a) Rural population	..		2.40
	b) Urban	..		5.00
	Outlay needed in excess of current proposals to cover by 1970 - 25 per cent of rural population with safe water			6400 (million)

As per Fifth Plan Strategy Groups * assessment, if these targets are to be achieved, it will need 5000 public health engineers, in addition to the existing strength of about 3000. Also pipe and other material production capacity will have to be considerably increased.

* Unpublished Report of Working Group on Vth Plan Strategy for Environmental Engineering Planning Commission, 1973.

The consequences of this situation are obvious. In India, it is estimated * that water-borne diseases account for more than half of the communicable disease incidence in the country. In terms of money, the loss due to medical expenses, man-power and reduced productivity is estimated Rs.200 to 1000 million (US\$ 24 to 120 million) per year. The worst sufferers are the really poor as the sickness occurs when the farmer's need for man-power is at a maximum. As a result of this, the national economy suffers significantly. The above statements clearly bring out the urgency to tackle this problem.

Research and Development Needs

In a developing country with competing demands on its available limited resources, water supply (especially to the masses living in the villages) has seldom received a high priority. It has been identified that illiteracy, poverty, lack of skilled man-power, meagre funding by respective governments, inappropriate technology, outmoded administrative and organizational set-ups, etc., have been responsible for the poor progress of developing countries in the provision of this amenity. The need, therefore, for research and development to devise means and ways of promoting the national and international endeavour in the provision of water is evident.

In solving a problem on such a huge financial and physical magnitude, research and development plays a vital role. Not only will they reduce the cost but also help to achieve results expeditiously. The importance of economics can be judged by the fact that, in India, if new techniques can save even 5 per cent on costs, a saving of Rs.320 million (US\$ 25 million) is achieved which can be used to serve additional population. Also newer techniques can speed up the programme considerably.

Many agencies are active in this programme such as the State Engineering Research Institute, universities, schools and institutes of public health, etc. The National Environmental Engineering Research Institute (NEERI) has also made a substantial contribution in this area. Following is a brief review of research and development efforts made so far or in progress.

For the purpose of this paper on research and development in the field of water supply, rural and urban populations have to be considered as separate entities due to inherent physical, social, cultural and economic factors, in a country like India.

* The need for new perspective in community water supply, Journal of Indian Water Works Association, Vol. No. V, No. 2 p. 117.

Urban Needs

Urban systems have to deal with large quantities of water for domestic and industrial purposes in comparison to rural water supply systems and hence the nature of the problem is of a greater magnitude. The collection and treatment which are usually centralized for urban systems have economic advantages. Material, labour and skilled personnel to operate and maintain the systems are more easily available. Channels of communication are many and readily available. The philosophy of 'Water A Saleable Commodity' can be more readily instilled into the urban public.

Among the many problems which need to be tackled in the task of providing a safe piped-water supply, the development of available water resources and the treatment of water to render it safe assume great importance.

Many urban communities depend upon surface sources for their requirements. As a major recipient of liquid wastes, surface waters are often polluted - physically, chemically and bacteriologically. Therefore, modern technology has to provide a choice of treatment methods, which can produce any desired quality of water from any given source, the governing factor being economic and not technical. The job of water engineers is to produce and supply safe water at a minimum cost. This calls for a continuous research and development activity to innovate new economical methods and to improve upon the existing techniques of water purification and supply.

The following are some of the areas of research and development that have greater relevance to urban water treatment and distribution in India, to reduce treatment cost via increased performance.

Coagulant Aids

Alum is the most commonly used coagulant for removal of suspended impurities from water. Sulphur needed for alum manufacture is met entirely by imports. Development of natural and synthetic coagulant aids, can help reduce alum consumption and also increase the filtration rates in existing water treatment plants. NEERI, in India, has developed natural coagulant aids and synthetic ones like CA-15 which are found to be effective and economical for waters with high turbidity (above 300 units). There is a great need for development and indigenous production of more such aids including the raw materials, as well as to evaluate their toxicity potential when used in potable water.

High Rate Settling

Horizontal flow circular tanks and sludge blanket type clarifiers are widely used for flocculation and floc separation. Recent research has led to the successful application of the principle of shallow depth sedimentation using tube settlers or plate settlers. Installation of these devices in existing clarifiers can increase the throughput and efficiency manyfold. There is a need for their development and large scale application especially in existing overloaded plants and for new ones, so as to reduce their size and cost. Also old installations such as over and underflow sedimentation tanks can be modified (as done for Nagpur City) to hopper bottom tanks cheaply with increased efficiency and capacity.

Filtration

The conventional rapid sand filtration is not logical as water is filtered in the direction of increasing grain size and porosity. Further research has resulted in the development of two-layer (coal sand), multi-media filter, up-flow filters, radial filters, etc. A significant contribution by NEERI in this field is the finding that locally available bituminous coal can be used in a two-layer filter in place of imported anthracite, with equally good results.

Also successful results have been obtained by use of coconut shell media (crushed to 1 to 2 mm. size) as the cheap indigenous upper layer. Similar material can also be tested in many other developing countries.

Another improvement in the operation of rapid sand filters is the declining rate method of filter rate control which appears to possess economic and operational advantages. Studies in NEERI have shown that throughput from a regular rapid sand filter can be increased up to 50 per cent or more by this method.

Rectification and Up-rating of Existing Treatment Works

The performance and output of many existing plants can be improved by carrying out in-plant studies.

For example, simple changes in the inlet and outlet arrangements of a settling tank can help reduce short circuiting and improve the hydraulic performance of the unit. The use and application of coagulant aids and filter conditioners can greatly improve the overall performance of the treatment plant.

The simplest method to improve rapid sand filters as experienced is to change the sand media and modify hydraulics by changing the appurtenances. Modification of Kanhan Water Works, Nagpur City, has increased the capacity of filters from 45 million liters (9 mgd) to 70 million liters (14 mgd) per day. The modification was done at a quarter of the cost (Rs. 300,000) of installation of new filters for additional capacity. This simple solution can be applied in many developing countries.

Similarly, conversion of existing overloaded sand filters into two-layer filters can yield greater throughput at minimum cost. Many indigenous materials can be used for such modifications at reasonable costs.

In developing countries an organized survey of existing urban treatment plants can go a long way in identifying the problem spots in a treatment plant and taking suitable remedial measures. This can give substantial increase in treatment facilities with nominal capital investment.

Water Distribution

With a view to economizing, there is a need greater now than ever before of using modern tools of design such as systems analysis and optimization techniques for design of distribution networks. The old networks in many Indian cities have grown haphazardly with the town without any pre-planning. These systems can be improved upon to obtain increased capacity by proper computerized network analysis at a very nominal cost to obviate the need for heavy capital investments in new lines.

Another area of great economic importance to developing nations is leak detection and wastage prevention from old water distribution systems. Experience in India has shown that even as high as 40 per cent of supplied water is lost through leaks in the total system. The development of suitable methodology and equipment for investigation, testing and improvement of water distribution systems from the hydraulic and quality point of view and training of personnel for this purpose can defer, for some time, the need for augmentation of existing supplies. Prevention of leaks in the distribution system also helps in preventing the contamination of treated water in the system especially where the supply is intermittent. Simple techniques like foam swabbing can increase carrying capacity. It can dislodge slime sand, etc. very easily. This will also reduce odour, taste imparted by slimes and reduce chlorine demand with greater safety of supplied water.

Equally important is the use of scrapers to clean pipes of calcium deposits, clay deposits, etc. There are few cities in India with regular Preventive Maintenance Programmes, which should be a routine activity for urban water supply systems.

Rural Needs

In many developing countries it is not uncommon to find a blend of the latest technology and age old traditions, for example, the bullock cart on one side and the supersonic jet on the other. While advanced technology may be relevant in an urban set up, rural areas may need appropriate technology possibly quite different from that required in urban areas. Any system of water supply intended to serve the rural communities should satisfy the essential requirements of simplicity, economy, reliability, durability and acceptability and may have to be totally different from the urban one.

Basic education let alone health education, is of a very low level, or absent, in the rural folk of many a developing country.

A typical problem in India is the lack of finance of local bodies due to poverty, unemployment and low productivity. These, combined with limitation of skilled man-power, pose a challenge to public health engineers to supply water in rural areas.

Simplicity, coupled with economy is perhaps the key element in the choice of the method of water purification and distribution. Since the rural economy is essentially agriculturally based, many communities cannot afford a system which is beyond their meagre resources. The notion that water is a God-given gift and hence should be provided free is still very much deeply ingrained in the minds of rural people.

Similarly a system, however good it may be, is not likely to be successful unless it is in tune with their social customs and cultural habits. The following are some of the areas where research and development efforts need to be strengthened.

Development of Groundwater

For centuries groundwater has been the main source of water supply for the villages, especially where a dependable surface source is not available in the near vicinity. It is probable that for a long time to come, groundwater will continue to be an important source of drinking water in the form of open dug wells, tube wells or infiltration wells and galleries.

The exploitation of groundwater for drinking purposes in the villages will have several other problems. As yet there is no simple and reliable method by which the availability of groundwater in a given place can be readily detected.

In the case of open wells which are generally found to become polluted, it will be necessary to devise effective means for making them sanitary.

Similarly, improvement in the water withdrawal system, manually or by pumping, is the most needed immediate step. In the case of hand pumps for community water supply, it has been identified that the main problem is that of maintenance and upkeep of the pumps. A suitable design and technology to evolve a sturdy, low cost pump that is within easy reach of every individual household is an urgent need. In India WHO/UNICEF undertook a project for the development of a deep well hand pump and have come up with a new design called the 'Bangalore Pump'. The utility and performance of this pump under field conditions is being tested so as to standardize and develop the pump on a large scale for use in village water supply programmes.

Tube wells as a source of drinking water are successful where groundwater is readily available in the alluvial soils. There are instances where the strainers get clogged within 2-3 years due to the mineral contents in the groundwater. Studies undertaken in India, with the help of the Indian Council of Medical Research, have shown that unplasticized PVC strainers wound with nylon ropes are very efficient and give long service.

In scarcity areas where rocky terrain exists and groundwater is not available at reasonable depth, newer techniques of hard rock drilling have proved a boon to India. Under WHO/UNICEF projects on hard rock drilling, rigs have been imported into India and now are also being manufactured locally. The results have shown spectacular success, particularly in the Deccan Peninsula. Areas of basalt and sandstone, where villages never had a water supply, have obtained water at the cost of Rs. 6000 to 8000 only, which would otherwise have required bringing water from a long distance at ten to fifteen times the cost. This technique of deep drilling in hard rock may be an answer for many of the developing countries.

Groundwater Treatment

Disinfection

Open dug wells which serve as a major source of drinking water for rural and small

communities, invariably show the presence of fecal pollution due to use of contaminated ropes, buckets, etc., for drawing water. Disinfection of such waters using gaseous chlorine is not feasible under many conditions. Simple methods using chloride of lime (bleaching powder) developed by NEERI have been found successful in India and elsewhere.

Earthen pots of 7-8 liter capacity with holes (at the bottom for a single pot system, and near the top in the inner pot and 2-3 cm above bottom in the outer pot for double pot systems) for diffusion of chlorine solution) and filled with a suitable gravel layer overlaid with a mixture of bleaching powder and coarse sand are lowered into the well 0.9 - 1.2 m below water level. The bleaching powder solution gradually diffuses and disinfects the well water for a period of about two weeks. This system is less effective in wells with water hardness over 150 mg/liter, due to scaling.

The effective chlorination of rural wells for a longer period would be of immense value, as a public health measure in a country like India where only less than six per cent of the population is supplied with safe water.

Defluoridation

Excessive fluoride in drinking water as well as the prevalence of fluorosis have been reported from several parts in India served with groundwater. Several methods of removal of excess fluoride have been studied in India and elsewhere. The successful efforts of NEERI are:

- Development of sulphonated carbon for defluoridation. Ordinary coke is reacted with sulphuric acid under controlled conditions to produce defluoridation media which can be regenerated by alum solution. This process needs reasonable skill for operation.
- New process using lime, alum and bleaching powder is more simple and equally efficient. The chemicals are applied in pre-determined doses in proper sequence and then water is allowed to settle conventionally. Most of the time this treatment is sufficient to render water potable for rural supply. Occasionally filtration may be necessary if turbidity is abnormal.

Treatment of Brackish Water

There are large tracts of brackish groundwater in many parts of developed and developing countries. In some villages in India, people regularly drink water with salinity as high as 2000 mg/lit. No simple and economic methods are available for

the treatment of such waters for rural and small communities. In countries blessed with plenty of sunshine use of solar energy for distillation may provide an answer. The domestic solar still has already been in use in some parts of Gujarat State in India. It consists of an inclined glass panel with a black painted bottom tray. The water condenses on the glass and runs down a collecting channel. On a sunny day it can produce about 50 to 100 liters of pure water for about ten hours sunshine. If blended, the available water may be almost twice the quantity.

The other developments are reverse osmosis and electro dialysis. Membranes have been developed using local material and technology and research is in progress to develop it on plant scale. Considerable research and development for harnessing such natural resources by developing countries is still needed.

Iron Removal

Many under ground supplies in eastern region of India, have a high concentration of iron. Waters with concentration of about 7 to 10 mg/lit. are being used by many villages. It was therefore urgently felt that proper techniques suitable to rural India are developed. NEERI developed a compact iron removal unit for domestic use. It uses charcoal and sand with aeration. The unit can treat and deliver up to 100 liters of water per day. The unit does need semi-skilled maintenance of washing sand occasionally. For community supply some research is yet necessary to make it reasonable in cost.

Surface Water Treatment

One of the essential requirements of any technology intended for application in rural areas is simplicity coupled with reliability and economy. Slow sand filtration for example, can be a very effective and economic method of preparing drinking water from polluted surface sources. This is not only economical but is sturdy and reliable for both turbidity and bacterial removal. NEERI has designed for canal water, small slow sand filters which are used successfully in Rajasthan and Haryana States for rural water supply. The unit consists of a slow sand filter (6 sq. metres) with a clean water reservoir fitted with two hand pumps. The units supply about 20,000 litres of water to a population of about 500 persons. Also many slow sand filters of different design operating from 0.1 to 0.2 metre per hour rate are in use for rural water supply.

Similarly, the feasibility of using windmills in places where electricity is not available, deserves to be studied.

Water Quality Standards

Another area which needs attention by developing countries is the development of drinking water quality standards. All standards of water quality are relative. It depends upon the economic prosperity of a nation, the awareness of its society for environmental cleanliness and the immunity of the people. What is ideal for one nation may not be practical for another. For example, there are communities in India which consume water with a TDS of 3000 mg/l or even more. This has become inevitable since there is no other better source available even at a distance from the community. Thus the quality standards for drinking water can not be very rigid but have to be rather flexible to suit the economic status of the community, or for that matter of the country as a whole.

Concept of Integrated Rural Development

Mere improvement in availability of safe drinking water in rural areas may not solve all the problems of hygiene and disease prevention. Villagers are apt to contract diseases through contact with polluted water used for laundering and personal cleaning as well as through activities like fishing and agriculture. They must therefore be educated to protect themselves from pathogens when engaged in such pursuits. Rural water supply programmes would have to be integrated with schemes for education on basic health. Construction of latrines, public laundering and bathing facilities have also to be incorporated in these schemes. Such integrated rural development programmes with water supply as one component project infrastructure, can go a long way to improving the standards of hygienic living, and help the villagers derive full benefit from the water supply schemes. The construction and maintenance of a network of rural water supply systems would further open up vast employment opportunities for the villagers and help check their migration to the already overcrowded urban centres, besides generally strengthening the economy of the countryside.

Management and Operation of Community Water Supply

This is an area which needs a considerable change in outlook and attitude. Many treatment plants are operated in a manner that results in very unsatisfactory performance and poor return on investment. Merely constructing a plant is not enough, it is necessary to ensure that it is well operated and maintained so as to serve the needs of the community. Many issues are involved in this aspect.

The principal ones are:

- inadequate finance;
- outmoded or unsuited administrative and organizational patterns;
- lack of trained people.

This results not only in poor water supply service to the community, but substantial financial loss due to improper utilization of funds invested. In developing countries, the organization of community water supply has been handicapped mostly due to old rules or traditions established hundreds of years ago without the flexibility needed for quick action.

There has been a lot of thinking in recent years as to how to go about the institutional approach that would ideally suit community water supply management. A complete departmental approach was found to be lacking in either proper resource mobilization or operation and maintenance of the systems, though many PHE Departments have developed the capacities for designing and installation of the systems effectively. Strengthening and entrusting the local bodies with full authority and responsibility has not yielded the desired results for operation and maintenance and the situation has further deteriorated.

The rural sector in India produces 70 per cent of the gross national product but it has only nominal resources to generate self sufficiency in water supply. Therefore, it is logical that a common set-up for rural and urban areas be considered. This will not only have an equitable base of finance but will also provide a viable organization which can tackle uneconomical rural areas also.

A suggested approach* to meet the institutional requirements for community water supply in India recommends a three-tier system.

- A functional water supply and sewerage management board for each district responsible for operation and maintenance of all systems in the district with powers to assess and collect water and sewerage rates. This board will also be responsible for training of operational and maintenance staff at the district level.
- A water supply and sewerage corporation at the state level which in close cooperation with the district boards will mobilize resources; develop sound investigation, design and construction organization; finance viable schemes in the state; and monitor functioning of the district management boards.

* T.S. Swamy, Adviser, CPHEEO, Ministry of Works and Housing, Government of India. Keynote speech. All India Seminar on Rural Water Supply in Backward and Difficult Areas, Nainital, 8-12 October, 1975

- A bureau of environmental pollution control at national level with its main function to evolve national policies, assists the central Government and Planning Commission in resource allocation and to coordinate at national and international levels, etc.

The above management framework will not entail any major addition of personnel and can be expected to result in better performance.

Financial Management

The financial management of any community water supply involves two major aspects:

- raising adequate funds at low rates of interest for capital investment and
- fixing appropriate water rates to realize a sufficient return on investment.

There is a strong tendency, especially in the rural communities of developing countries, to look upon water as a free gift of nature and the concept of accepting water as a saleable commodity is repugnant to their way of thinking. It is rational to expect that where the basic economy is sound and village productivity can absorb it, the people should pay for water. Further, moulding of public opinion is a basic need in many developing countries. But there are exceptions such as tribal areas in India where it may take decades before a viable village economy is established to pay for water. In a country which has a large population of people living below the subsistence level, a system of charging subsidized lower rates to poorer communities will be necessary if people are to be protected from cholera, dysentery, etc.

Community water supply in rural areas may not be financially viable but it may be economical to provide a subsidized water supply as part of a national development programme.

Training, Information and Extension

For any research organization, training, extension and exchange of information should form an important activity, if the research results are to reach the users and masses. The training could deal with various aspects such as acquainting with the new developments, the scientific management of water treatment plants or simple training of fresh persons to operate community water supply systems. NEERI, in collaboration with CPHEEO (Central Public Health and Environmental Engineering Organization) and other organizations like universities, equipment manufacturers, etc., offers various types of courses covering all these aspects of community water supply.

The courses consist of short-term refresher lectures to communicate new developments, or long-term to train staff on laboratory and plant operation techniques.

The most important aspect of success of any community water supply programme is good public relations. Every water works official should develop the concept of service to the community and understand the importance of satisfactory service to the consumers, creating at the same time a sense of ownership and pride in the minds of the local population.

Information dissemination and extension activity are being undertaken by NEERI through the publication of various technical booklets and manuals and the organization of seminars and symposia. NEERI also conducts international programmes on community water supply in collaboration with WHO-IRC and other UN agencies, or on a bilateral basis.

National and International Efforts

It can be seen that the community water supply problem, particularly in developing countries requires research and development efforts not only at national level but a concerted, combined effort at international levels also.

National Efforts

At the national level, agencies actively engaged in the research and development programme on community water supply are NEERI, CPHEEO (Central Public Health and Environmental Engineering Organization, Ministry of Works and Housing), State PHE Departments, universities, ISI and various equipment manufacturers in the private sector.

National Environmental Engineering Research Institute

NEERI is the only environmental research laboratory, established in the year 1959 under the Council of Scientific and Industrial Research in the Ministry of Science and Technology, Government of India. This laboratory is vested with the responsibility for developing research programmes to improve the environment in which community water supply is an important field. The role of NEERI, as described earlier, is to study the trends of community water supply and identify the problem of priority in India and to undertake research programmes. Considerable success has been achieved in the last fifteen years in several aspects of community water supply (as discussed in detail earlier), covering treatment, distribution, preventive maintenance and sedimentation and disinfection, etc. NEERI has undertaken organized services such as

training, publication and documentation for dissemination of information on the research programme and also other programmes undertaken in the nation.

Office of the Environmental Protection and Coordination

The OEPC under the Ministry of Science and Technology also encourages research programmes in university colleges by providing financial support. This is generally a part of the activity since their main role is to coordinate the policy of environmental protection in the nation.

Indian Standards Institution

The ISI affiliated with the Ministry of Industries, principally lays down the norms for the manufacture of various items of equipment, pipe material, valves, process and treatment units. NEERI is actively associated with ISI in this important task.

Central Public Health and Environmental Engineering Organization, Ministry of Works and Housing

The CPHEEO, under the Ministry of Works and Housing, Government of India, is the central agency for formulation and implementation of community water supply programmes in the nation. They coordinate with the states, the centre and other ministries such as that of Irrigation and Power in the financial and policy matters. Their conscious efforts all along are to achieve maximum national benefits at minimum cost. Utilization of the research results is often channelled through them.

Equipment Manufacturers

There is a large number of equipment manufacturers in community water supply producing water treatment units, filters, drilling rigs and hand pumps. They themselves also contribute to research programmes on increasing the efficiency and suitability of the equipment manufactured by them.

International Efforts

The problem of community water supply in the world is of such great magnitude that it has to be tackled not only at the national, but also at the international level in a comprehensive manner. The developing as well as developed countries have a number of programmes of research and development undertaken or completed for community water supply. Many of these solutions and developments have considerable

scope for successful application in other countries too. Also know-how on simple solutions are available at different places. The areas in which the international community can function successfully are:

- Exchange of Information.

International agencies like WHO-IRC are already active in this field and are publishing various monographs, documents, journals, newsletters, etc. Most of these are published in English and often do not reach the lower level of workers. Therefore, there is a need to strengthen joint cooperation between national organizations and these agencies in spreading the information at the actual worker level. The WHO-IRC can strengthen its activity in collaboration with the developing and developed countries by financing where resources are not available the publication of technical information in regional languages.

- Coordinated Sponsored Research.

There are many problems which are possibly common to different countries and many are trying to solve them by their own efforts. WHO-IRC, IDRC etc., can jointly sponsor such research projects, taking into consideration various priorities. This will expedite not only the research, but also the availability of research results to many countries, simultaneously.

- Exchange of Scientists/engineers.

Exchange of scientists and engineers is another area of international cooperation in which WHO-IRC can play a very vital role. Already there exist fellowships and training programmes under WHO and UNDP. These are probably insufficient to meet the requirements of all the countries. Efforts should be made to strengthen WHO programmes, both through their own finances and channelling bilateral programmes where they deal with common interests so that duplication can be avoided. WHO can also strengthen international efforts through technological assistance and exchange of experts/consultants from one country to another.

Conclusions

The magnitude of the problem of community water supply in developing countries, and India in particular, is enormous and will require not only a large amount of capital investment but also trained manpower, and material resources. The estimated cost of providing ten per cent urban water supply and 25 per cent rural water supply for India will exceed Rs. 8,000 million. The figure for the rest of the world would be astronomical and rather difficult to guess. It is quite obvious that a problem of such great magnitude needs to be given highest priority both at the national and international level.

In view of limited availability of financial resources, particularly in developing countries, research and development should be intensified to find a simple and economical solution for reliable community water supply. Better may have to be substituted by good. This may include the provision of minimum basic need of safe water, utilizing local materials, manpower, etc. For example, in a country like India, a saving of only five per cent will amount to Rs. 320 million (US\$ 25 million) in their target of 25 per cent rural population coverage.

WHO-IRC, IDRC and many such international agencies are playing an active role in solving the problem of community water supply in a broader programme to protect the health of the masses. Their existing programme of publication of technical literature, monographs, training programmes, exchange of scientists and expert services needs to be strengthened. Efforts should be made to publish literature also in regional languages, wherever possible so that the latest research results are available to the field engineers, in collaboration with national or state authorities.

The present system of exchange of technical personnel, experts and training for coordinated research and development activities should be further strengthened. This will increase the dissemination of technical information and know-how to all countries.

IN-COUNTRY PRODUCTION OF EQUIPMENT AND
CHEMICALS FOR COMMUNITY WATER SUPPLY

by

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IN-COUNTRY PRODUCTION OF EQUIPMENT AND
CHEMICALS FOR COMMUNITY WATER SUPPLY

I GENERAL

To achieve the ultimate objective of providing a community with an adequate, safe and potable water supply at a reasonable cost which enables the community to maintain it in the long run, much advance planning is needed in terms of material resources in the various implementation stages of a community water supply programme: investigation, source development, treatment, transmission, distribution and maintenance. The prerequisite for the success of a large community water supply programme is the assurance of an adequate indigenous availability of materials and equipment. Such availability not only reduces the capital and maintenance costs but also helps in drastically reducing the manhours otherwise lost in waiting for even a small component or spare during the execution and operation and maintenance stages.

Test boring including soil and water sampling and testing in the investigation stages; heavy drilling equipment with the needed appurtenances including logging equipment, casing pipes and strainers in the case of ground water development; heavy construction machinery for dam and/or tunnel construction in the case of surface water development; various chemicals and equipment needed for treatment including disinfection; different types and classes of pipe materials; equipment for their trenching, laying and jointing; measures for prevention and control of corrosion; bulk supply of common but suitable building materials like sand, cement, puddle clay; jointing materials like lead, leadwool or rings, testing equipment, steel plates, steel rods, pressed steel tanks, pumping plants, cast iron specials and valves, mild steel and galvanized iron or gun metal water fittings and water meters of different types and ranges are only some of the items needed. It is necessary to ensure an adequate licensing capacity to suit the growing needs, production and installation to meet the current and anticipated demands.

It is only natural that all the materials and equipment needed for such a programme may not be locally available in most of the smaller developing countries - at least, at the initial stages. A national plan should be evolved taking the resource constraints into consideration and the requirements of such a community water supply programme, pitching the standards and material specifications to most the desired objectives but not necessarily the practices prevailing elsewhere. The local materials available and the indigenous expertise and labour should be fully exploited and skills developed and trained for optimal utilization in a

pre-determined period of time. The treatment and other practices should be evolved for easy and consistent adaptability by the communities served of the different available alternatives, the one which could be developed most easily as a lowest cost solution and which can be exported to the neighbouring communities and countries being selected. Where temporary unavailability of certain ideal materials or metals dictate, temporary or emergency provisions and standards should be formulated to specify the requirements to be met during the stipulated interim (or extended) period. They might not meet the long-term standards but would help in developing the indigenous expertise, apart from providing temporary short-term solutions.

There must be constant and consistent quality control of the locally manufactured items so that only tested and approved items go into the open market and compete with the imported ones and justify their presence on their own merit. There are several instances in which improperly tested substitute materials have been put on the market. Despite their inherent and intrinsic superior qualities and their potentiality for being real replacements they have proved a flop. There is a definite need for fundamental research in bringing several innovations already identified and developed in various developing and developed countries into practical use by suitable adaptations and forgings, to meet the country- or area- requirements. For this, there should be complete liaison and rapport between the executive agency (who will specify what improvements are needed), the research agency (who will specify why or how those improvements can be obtained) and the industry (which will incorporate the improvements or produce new materials on a commercial basis with an eye to minimizing costs).

Research and development should be an integral part of material resource development to develop the ideal as well as appropriate technologies and materials needed for the programme. Based on the raw materials availability, regions or zones should be earmarked for development of specified industries, making each zone as far as possible self-contained, reducing the transportation and handling costs to the minimum.

The research studies and solutions obtained on laboratory or bench scale should be translated into the model scale and pilot plant scale with minimum time lag, and the modified results should be tested in the field immediately thereafter. Once reasonable solutions are obtained, they should be immediately licensed for commercial exploitation, even while further studies for additional refinements are in progress. Establishment of a national research and development council for

developing and safeguarding the patents as well as commercially exploiting them is a must for medium and large countries, not only for streamlining the work but also for slashing costs.

The site location and the selection of manufacturing processes should be based on maximum exploitation of local natural resources, causing the least environmental pollution. Special incentives like cheap water and power, tax remissions and rebate in developmental charges should be given to attract the most suitable industries for a particular area. Adequate protection might also be given to withstand competition from established or foreign manufacturers in terms of import substitution incentives, immunity for specific periods and export incentives. Also, rate contracts should be entered into for specified periods (preferably annually or bi-annually) by centralized supply agencies with the manufacturers of the same or similar items conforming to a particular standard specification. This would not only save the time and worry of each executive agency calling for tenders and finalizing the contract themselves but would also enable them to obtain the requirements almost on the spot. Further, it enables the suppliers to optimize their production because of the assured minimum offtake, and for both sides to benefit from centralized inspection and certification with set procedures of payment, lowering the likelihood of arbitration or legal wrangles.

Where foreign collaboration is involved, one must ensure that the local firm gets the full technical know-how including drawings and specifications in a definite time span, and that it is in a position to manufacture the said items independently thereafter. One incentive would be for the local unit to be the local representative in that region for the foreign manufacturer, thus expanding its market worldwide. By gradual localization of the personnel and management, the stigma of 'outsider' is diluted substantially without relaxing the qualitative standards or requirements. An additional incentive for the foreign entrepreneur is that he has first hand experience of the performance of a product or system in a completely different situation with the needed adaptations, including local substitutes, so that he can utilize this experience in transplanting it in other similar regions and expand his domain.

Thus, the in-country production of equipment and chemicals needed for a community water supply programme can be geared to the required level only if an adequate infrastructure in the various strategic supporting areas described above is available.

II CASE STUDY: INDIA

While the experience of India may not be a prescription for solving all problems of all the developing countries, some of the steps adopted there which have given beneficial results, may be recounted here for possible adoption with suitable adaptation.

A CPHEEO

The Central Public Health and Environmental Engineering Organization administers the community water supply and sanitation programme at the national level through the various state public health engineering departments, or autonomous state water supply and sewerage boards at the state level. A community water supply programme is an integral part of the national development plan implemented as 5-year plan programmes. The CPHEEO assesses the future needs of various types of materials and equipment for each 5-year plan based on the likely allocations, in consultation with the Planning Commission, and checks up on their availability in terms of licensed and installation/production capacities of existing manufacturing units and, depending on the necessity, presses for approval of additional licensing capacity through the concerned Ministries of Industrial Development, Directorate General of Technical Development, Directorate General of Supplies and Disposals, Ministry of Steel, Ministry of Petroleum and Chemicals, etc. Shortage of raw materials or moulds or power-cuts or other factors leading to low production; inadequacy or non-availability of railway wagons for transport of raw materials or even finished products; or shortage of containers like chlorine cylinders are identified and effective steps taken to have a continuous supply available of the materials. In periods of excessive demand against limited supplies, CPHEEO accords necessary priorities - topmost priority, high priority and priority - depending upon the urgency of the programme, non-availability of material for diversion from other projects of lesser priority and duration of pendency of the indents. If essential chemicals like bleaching powder and alum are not readily available and supplies become erratic and irregular due to consumption in other spheres rendering water supplies unsafe, they could be declared as essential commodities, and supplies regulated under the Essential Commodities Act. CPHEEO also arranges periodical meetings, seminars and workshops of the Chief Engineer and senior public health engineers when the practical problems encountered in the field, the research findings by the National Environmental Engineering Research Institute, Indian Council of Medical Research and the various post-graduate institutions in public health engineering and the views of the representatives of the equipment manufacturers are exchanged and optimal solutions found. Where it is necessary to import specialized equipment like pneumatic rigs and accessories, the CPHEEO helps the direct import to the state

governments through the Chief Imports and Exports Controller, or obtains them with the assistance of the International agencies like the UNICEF, UNDP, IDA, as a part of a specific project or programme.

B Incentives and Measures for Expansion of Indigenous Industry

1. Financial Incentives:

As a part of the measures taken to ensure balanced regional development, the Government of India have announced certain financial incentives for industries established in selected backward districts or areas which are additional to the facilities and incentives offered by the individual State Governments. Under the central outright grant or subsidy scheme indicated in 1971, the subsidy will be 10 per cent of the fixed capital investment or Rs 0.5 million, whichever is lower, for claims relating to the period ending 28-2-1973. For claims relating to the subsequent period, the subsidy will be 15 per cent of the fixed capital investment or Rs 1.5 million, irrespective of the capital cost of the project, whichever is lower. Capital subsidy disbursed under this scheme will not be taxable as income or revenue receipt in the hands of the recipients. The import policy has also been very much liberalized for the import of raw materials, components and spares in respect of small scale units to be set up in the 102 backward areas specified as of 21-7-1975. Under the Concessional Finance Scheme, for units set up in the 246 backward districts specified as of 3-1-1976, the Industrial Development Bank of India, Industrial Finance Corporation of India and Industrial Credit, and Investment Corporation of India extend concessional finance in the form of a low interest rate and a longer initial grace period and reduction of commitment charges. Under the transport subsidy scheme 1971, 50 per cent of the transport cost of raw materials and finished products is given as subsidy in 10 selected states. The National Small Industries Corporation have reduced the rate of interest from 13½ per cent to 11 per cent for supplying machinery on hire purchase to industrial units set up in backward areas. In case of indigenous machinery the deposit required, has also been reduced from 20 per cent to 10 per cent, and to 5 per cent in the case of imported machinery.

2. Maximum Utilization of Plant and Machinery

To aid meeting of the increased level of demand, the Government announced in October 1966 that industrial undertakings could increase the production of articles for which they were licensed or registered by up to 25 per cent of the capacity so licensed or registered, without obtaining a substantial expansion licence. This was subject to certain conditions, viz. (a) no additional plant and machinery should be installed except for minor balancing equipment procured indigenously;

(b) no additional expenditure of foreign exchange should be involved; and (c) the extra production should not occasion any additional demand for scarce raw materials. However in the case of 65 industries specified in 1972 the industrial undertakings which has not obtained such an endorsement are not entitled to this margin of 25 per cent. In 1972, the Government introduced a scheme of fuller utilization of installed capacity, which, among other things, provided for endorsement of licences issued on a single or double shift basis so as to allow for maximum utilization for a number of specified industries. In case of a number of undertakings, during the course of expansion and diversification, capacities earlier expressed on single or double shift basis, may apply for the endorsement of their licences allowing for maximum utilization of plant and machinery giving, inter alia, details of the undertaking, the particulars of the item and the capacity as shown in the licence, the capacity on maximum utilization basis, the details of imported and indigenous raw material requirements and the actual production of the unit during the last three years. While examining such requests; the Government will take into consideration the relative priority of the industry, the availability of imported and scarce raw materials and the eligibility of the parties to participate in such industries in accordance with the industrial licencing policy of February 1973. In allowing endorsement of the capacities on the maximum utilization basis, the Government may stipulate such conditions as to export or distribution as may be considered appropriate in the respective cases. The facility was extended on 7-8-1975 to units registered with the technical authorities and also with the Directorate of Small Scale Industries.

3. Permission to produce without licence or in excess of licensed capacity

Pursuant to the 20-point economic programme announced by the Prime Minister and as a result of the review of the question of relaxing and simplifying the industrial licensing policies and procedures with a view to stimulating investment in the priority sectors and to ensure fuller utilization of the installed capacities, the Government announced on 1-11-1975 that proposals for the establishment of new undertakings, substantial expansion and manufacture of new articles by medium scale entrepreneurs will be exempted from the licensing provisions in respect of 21 industries. These articles include water pumps beyond 10 cm x 10 cm, industrial and scientific instruments, basic insecticides subject to the conditions that the industrial undertakings should not require imported raw materials, imported capital goods or foreign collaboration. This facility will, however, not be available to items reserved for the small scale sector or to industrial undertakings falling under the purview of the Monopolies and Restrictive

Trade Practices Act (MRTP), or to a foreign company falling under the purview of the Foreign Exchange Regulation Act, (FERA) which will continue to be subject to the discipline of the industrial licensing. Industrial undertakings which are exempted from the need to obtain industrial licences will be required to register themselves with the concerned technical authorities like the DGTD.

Further, with a view to achieve the twin objectives of containing inflation and fuller utilization of installed capacities, the Government allowed with effect from 1-11-1975 medium entrepreneurs to utilize their installed capacities without limit even though this may be in excess of their licensed capacity in 29 industries including diesel engines (above 15 HP) and pumps (other than small pumps reserved for S.S.I.), earthmoving, mining and metallurgical equipment, hydraulic equipment, insecticides, fungicides, weedicides and the like and refractories subject to the following conditions:

- the articles of manufacture are not reserved for the Small Scale Sector;
- the industrial undertaking will not install additional machinery either indigenous or imported; and
- the industrial undertaking does not fall within the purview of the MRTP or FERA.

For undertakings falling under the purview of MRTP or FERA, a simplified procedure for considering their applications for recognition of the utilization of their installed capacity was announced on 4-11-1975.

4. Recognition of Additional Capacities as a Result of Replacement and Modernization of Equipment

The need for replacement and modernization of obsolete equipment has long been recognized. While replacing equipment, an industrial undertaking is expected to take into account the technological developments that have taken place in the intervening period including sophistication in process know-how and technology, higher speed of modern equipment, qualities of materials and the size and capacity of equipment now available in replacement of worn-out equipment. More often than not, this would result in replacement by equipment of a different size or a different design, yielding a higher production capacity.

The Government, therefore, notified on 21-8-1975 that in cases where increased output is the direct consequence of replacement of old equipment, the necessary amendment in the industrial licence will be granted liberally and on the basis of a simplified special procedure provided that such replacement or modernization of equipment does not lead to any distortion of the plan priorities or market shares or

result in any encroachment of products reserved for the small scale sector and there is no net increase in the outlay of foreign exchange. It was also specified that any increase in capacity for the reasons mentioned above will be over and above the normal permissible limit of 25 per cent in production over the authorized/licensed capacity.

5. Automatic Growth of Capacity allowed to selected Engineering Industries

The Government have lately taken a number of measures in order to revive investment and growth in the industrial sector, particularly with regard to fuller utilization of the existing capacities in the different sectors with marginal investments and better operational efficiency. Industrial undertakings particularly in the export field cannot afford to have stagnant production capacities and therefore, the need to keep pace with the trends and technology, to generate internal sources for modernization and rehabilitation and also to partially absorb the escalation in the cost of raw materials, wages etc. is imperative. A committee was appointed by the Government to consider these problems of the engineering industry with a view to increasing our exports and also the competitiveness abroad. Based on its recommendations, the Government declared on 21-8-1975 that industrial undertakings engaged in 15 engineering industries specifically identified by the Committee as being of particular importance to India's effort (including diesel engines, pumps, earthmoving, mining and metallurgical equipment; hydraulic equipment; industrial machinery including chemical plant and machinery), can increase their capacity at the rate of 5 per cent per annum and up to a limit of 25 per cent in the plan period without having to obtain a 'substantial expansion' licence, on the following conditions:

- the product mix should not conflict with the items reserved for the Small Scale Sector;
- the investment requirements should be taken care of by the concerned undertaking itself and the financing institutions should not be approached for any long term capital loans etc.;
- no import of capital equipment should ordinarily be involved but where import of capital goods is envisaged the Government would examine whether suitable export obligation should be imposed;
- the facility of automatic growth would not be extended to undertakings having subsisting foreign collaboration agreements in the restrictive clauses inhibiting exports, unless such clauses are removed;
- the industrial undertaking is not dominant in the line of manufacture and also that the capacity utilization in the concerned undertaking is satisfactory;

- the concerned industrial undertaking should also ensure that in the process of utilizing this facility, the foreign exchange earnings by way of exports are substantially higher than any outlay by way of royalty, dividends etc., if any.

Any increase in capacity under this facility will be over and above the normal permissible limit of 25 per cent in production over the authorized/licensed capacity.

C. Utilization of Results of In-house Research and Development

1. For Commercial Exploitation

The importance of Research and Development (R & D) by both public and private industrial undertakings with a view to achieving self-reliance in technology has been well recognized; as also has the necessity for an industrial undertaking to have some assurance that it will be permitted to set up or expand capacity based on its R & D effort to make it invest in any meaningful R & D.

According to the notification dated 21-8-1975, industrial undertakings other than those coming within the purview of MRTP and FERA are allowed to set up capacity based on the results obtained by their R & D effort. While these undertakings would be required to obtain industrial licences in terms of existing statutory provisions, for the capacity being set up by them as a result of their own R & D efforts, such applications would ordinarily be allowed as a matter of fact.

Where an undertaking is covered by MRTP Act or is a foreign company, it can undertake R & D in areas covered by the Licensing Policy Statement of 1973 and such proposals for setting up industrial capacity may be allowed by the Government on merit. For other areas, it will have to seek the prior approval of the Department of Science and Technology before doing so. If the approval of the Government is obtained for the proposed R & D, the undertaking can proceed with research in that direction with the assurance that its application to set up capacity based on the results thereof will ordinarily be allowed, subject to the priorities and policies of the Government.

2 De-Licensing of Industries set up on the Basis of Technology developed by National Laboratories

The Government have examined measures to be taken to encourage commercial exploitation of technology developed by the National Laboratories in the country

so that technical self-reliance can be successfully pursued. One such step in this direction is that from 7-3-1976 industrial undertakings, other than those falling within the purview of the Monopolies and Restrictive Trade Practices Act and Foreign Exchange Regulations Act, which take up the manufacture of any item based on the technology developed by any of the laboratories established by the Council of Scientific and Industrial Research and laboratories approved by the Department of Science and Technology are exempted from the licensing procedure of the Industries (Development and Regulation) Act. This facility will also be available in respect of sponsored research undertaken by such laboratories on behalf of industrial undertakings. This facility will however, be subject to the condition that the item of manufacture is not one reserved for development in the public sector or small scale sector governed by special regulation. The question of extending this facility to undertakings falling within the purview of Monopolies and Restrictive Trade Practices Act and Foreign Exchange Regulation Act subject to certain conditions is also under consideration.

D. Licensing, Policy, and Procedures

Under the provision of the Act itself, exemptions from the licensing provisions of the Act have been granted to certain categories of industrial undertakings on the basis of investments involved in them, the nature of the industry and the foreign exchange requirements, etc. These limits are also gradually relaxed to promote the growth of industry. The exemption limit which was fixed at Rs 1 million of investment in land, building and machinery in February 1960 was increased to Rs 2.5 million in January 1964 and up to Rs 10 million in February 1970.

1. Small Scale and Ancillary Units

In this sector falls the manufacture of certain articles like water meters, pressure gauges (up to 3.5 kg/cm^2), diesel engines up to 15 HP (slow speed), drawing and mathematical instruments and survey instruments excluding theodolites, boosters, centrifugal pumps up to size 10 cm x 10 cm, asbestos pipes and fittings (for household purposes only and according to ISI specifications). Plastic processed products have been reserved from 16-2-1973 onwards for units in the small-scale sector, i.e. those with investment in machinery and equipment up to Rs 1 million, and in the case of ancillary industries up to Rs 1.5 million. Reinforced cement concrete pipes up to 100 cm diameter have been reserved for the Small Scale Sector from 26-2-1974. This policy of reservation will be continued and the area of such reservation will be extended, consistent with the potentialities and performance of the small scale sector.

Small scale units and ancillary units are exempt from licensing if the following conditions are satisfied:

- The undertaking should not belong to one or another of the following categories:
 - o undertakings whose own assets, or along with the assets of interconnected undertakings, are not less than Rs 200 million;
 - o Dominant undertakings covered by section 20(b) of the MRTP Act 1969;
 - o Undertakings belonging to 'foreign concerns' i.e., foreign companies, their branches or subsidiaries or companies in which more than 50 per cent of the paid-up equity is held directly or indirectly by foreign companies, their branches or subsidiaries or by foreign nationals or non-resident Indians.
- The item of manufacture involved should not relate to one or the other of the specified categories.

2 Small scale and Ancillary Units

The Government's policy is to encourage competent small and medium entrepreneurs in all industries. Such entrepreneurs will be preferred vis-a-vis larger industrial houses and foreign majority companies in setting up of new capacity. Corporations and small and medium entrepreneurs will be encouraged to participate in the production of mass consumption goods, with the public sector also taking an increasing role. The 'delicensed' sector of investments up to Rs 10 million detailed below is meant primarily for small and medium entrepreneurs.

Undertakings other than small scale units and ancillary units with investments in fixed assets in land, buildings, plant and machinery (at the original cost of their acquisition or capitalized value if taken on rent or otherwise held on non-ownership terms; value of all productive equipment including tools and dies, laboratory and testing equipment for the generation and distribution of electricity; equipment for the provision of plant utilities, air-conditioning and steam generation equipment included but excluding other equipment such as trucks and office equipment; and the value of land and buildings in respect of housing colony for workers) not exceeding Rs 10 million are eligible for exemption from licencing subject to the following conditions:

- the additional investment along with the original investment in an undertaking should not exceed Rs 50 million;
- the undertaking should not belong to one or another of the categories listed under condition 1 for small scale units;
- the item of manufacture involved should not relate to one or another of the specified categories;

- the proposed investment should not require foreign exchange in excess of any of the following limits:
 - o five per cent of the ex-factory value of annual production or Rs 0.5 million whichever is less for the import of raw materials (other than steel and aluminium) used in the manufacturing activity in any year;
 - o ten per cent of the ex-factory value of annual production or Rs 0.5 million whichever is less in any year after three years of the commencement of production for the import of components used in the manufacturing activity.

3. Larger Industrial Houses

Larger industrial houses, i.e., all undertakings which by themselves or in connection with other undertakings have assets not less than Rs 200 million will be eligible to participate in and contribute to the establishment of industries like special steels, internal combustion engines, electrical motors, earth moving machinery; industrial instruments; indicating, recording and regulating devices for pressure, temperature, rate of flow, weights, levels and the like; scientific instruments, insecticides, fungicides, weedicides and synthetic detergents along with applicants, provided that the item of manufacture is not one that is reserved for production in the public sector or in the small scale sector. They will ordinarily be excluded from the excluded industries list except where production is predominantly for export. In the latter case they will have to undertake a minimum export obligation of 60 per cent or more of the new or additional production which should be achieved within a maximum period of three years. In regard to articles which have been reserved for the small scale sector, the minimum export obligation will be 75 per cent of the new or additional production to be achieved within a maximum period of three years. The Government will, however, ensure that the remaining quantity available for the domestic market is not so large as to swamp the market.

4. Foreign Concerns

Foreign concerns (i.e. foreign companies, their branches or subsidiaries or companies in which more than 50 per cent of the paid-up equity is held directly or indirectly by foreign companies, their branches or subsidiaries or by foreign nationals or non-resident Indians) will be eligible to participate in and contribute to the establishment of industries in the same manner as larger industrial houses. Their investments will also be subject to the guidelines on the the dilution of foreign equity issued and will be examined with special reference to technological aspects, export possibilities and the overall effect on the

balance of payments. According to these guidelines issued on 19-2-1972, companies with foreign holdings (direct non-resident holdings) exceeding 75 per cent will raise 40 per cent of the estimated cost of expansion (cost of land, building and plant and machinery required for the expansion) by issue of additional equity capital (inclusive of premium, if any) to Indians only; the corresponding proportions for companies with foreign holdings exceeding 60 per cent but not exceeding 75 per cent and those with foreign holdings exceeding 51 per cent but not exceeding 60 per cent will be 33 1/3 per cent and 25 per cent respectively. The companies concerned will be given a reasonable time limit for fulfilling the condition. Further exemptions recently announced by the Government have been dealt under the Liberalization Policy.

5. Approval Procedures

Approval Procedures have also been streamlined to have the various clearances issued within definite time targets. Letters of intent, foreign collaboration approvals and capital goods clearances are to be issued within 90 days of receipt of applications in each case. In MRTP cases, the aim is to give clearance within 150 days, having regard to the provisions of the MRTP Act. It is also the desire of the Government that, wherever possible, entrepreneurs are encouraged to come forward with simultaneous applications for industrial licence and as may be required for foreign collaboration approval and capital goods clearance as well. In such composite or simultaneous cases, the time target will be 120 days for a simultaneous disposal which will cover the licence, foreign collaboration and capital goods application, where, in addition, an MRTP clearance is also involved, the time target will be 150 days.

If an application is approved and further clearances (such as foreign collaboration and capital goods imports) are not involved and no other prior conditions have to be fulfilled, an industrial licence is issued to the applicant. In other cases, a letter of intent is issued. If it is proposed to reject the application, the tentative decision of the Government is communicated to the applicant giving him an opportunity to state his case within a specified period of time before a final decision is taken on the application.

The initial validity period for a letter of intent is twelve months. In cases where only one further clearance, viz. foreign collaboration or capital goods clearance, is needed, one further extension of six months may be considered. Two extensions of six months each may be considered if both are involved. Applications for extensions beyond a total period of 18 to 24 months as above will not be

entertained. If an entrepreneur is not able to file applications for all the clearances he needs within the total periods indicated above, his letter of intent will lapse and he will have to apply for a fresh letter of intent, so desired.

Once the conditions incorporated in the letter of intent are fulfilled, it is converted into an industrial licence. The initial validity of industrial licences will be two years within which period commercial production from the licensed capacity will have to be established. This period can be extended if there is good and sufficient reason for two further periods of one year each. While extensions in suitable cases may be considered favourably where the investor has made serious efforts to commission capacity, a strict view will be taken of cases where adequate progress has not been made so that preemption of capacity and delays in bringing capacity to fruition can be effectively discouraged.

E. Foreign Collaboration

Foreign collaboration is permitted only in fields of high priority and in areas where the import of foreign technology is considered necessary. In other areas, import of technology will be considered on merit if substantial exports are guaranteed over a period of five to ten years and there are reasonable prospects for such exports.

1. Areas of Foreign Collaboration

The Government have issued illustrative lists of industries where:

- Foreign investment may be permitted (including seamless tubes with no royalty and specialized items of chemical and pharmaceutical machinery and blast hole drills with a royalty up to 5 per cent);
- Only foreign technical collaboration may be permitted but not foreign investment (including AC motors above 30 HP and starters, therefore, fractional horsepower and variable speed motors, high pressure pipe and fittings of specialized type other than malleable iron fittings, superior quality sanitary fittings and chemical porcelain with a royalty up to 3 per cent and alumina with no royalty);
- No foreign collaboration, financial or technical, is considered necessary (including asbestos cement pipes, cement, RCC pipes, prestressed and pretension cement products, sanitary ware, water treatment plant, welded GI steel pipes and tubes, conduit pipes, pipe fittings other than specialized types and valves and cocks, other than specialized).

Foreign collaboration for industries not included in any of the above three lists will be considered on individual merit.

2. Considerations for Foreign Collaboration

Some of the important considerations in the approval of proposals for foreign collaboration (financial and/or technical) are indicated below:

Equity Participation: The Government's policy towards permitting foreign equity participation is selective. Such participation has to be justified having regard to factors such as the priority of the industry, the nature of the technology involved, whether it will enable or promote exports which may not otherwise take place, and the alternative terms available for securing the same or similar technological transfer. The ceiling for foreign equity participation is 40 per cent, although exceptions can be considered on merit. The foreign share capital should be by way of cash without being linked to tied imports of machinery and equipment or to payments for know-how, trade marks, brand names, etc.

Technical Collaboration: Technical collaboration is considered on the basis of annual royalty payments which are linked with the value of actual production. The percentage of royalty will depend on the nature of technology but should not ordinarily exceed five per cent. Royalty is calculated on the basis of the ex-factory selling price of the product net of excise duties minus the landed cost of imported components. Royalty payments are subject to Indian taxes. Wherever appropriate, payment of a fixed amount of royalty per unit of production will be preferred. Royalty payments are limited to a period of five years.

Lump sum payments may also be considered in appropriate cases for the import of drawings, documentation and other forms of know-how. In deciding on the reasonableness of such payments, account will be taken of the value of production so that the lump sum and the recurring royalty, if any, is an acceptable proportion of the value of production. Such payments will be subject to applicable Indian Taxes. The lump sum payments are equally phased so that one third is paid first on taking the agreement on record, one third later on the transfer of documentation etc. and finally one third on the commencement of production.

Collaboration agreements are approved normally for a period of five years from the date of agreement, or five years from the date of commencement of production, provided production is not delayed beyond a period of three years from the signing of the agreement (i.e., a maximum period of eight years from the date of signing of the agreement).

3. General Guidelines to be followed

Entrepreneurs are advised to take note of the following guidelines in negotiating foreign collaboration agreements so as to ensure that their proposals conform to the policies of the Government:

- They should, to the fullest extent possible, explore alternative sources of technology, evaluate them from a techno-economic point of view and furnish reasons for preferring the particular technology and source of import;
- The Indian party should be free to sub-licence the technical know-how/product design/engineering design under the agreement to another Indian party on terms to be mutually agreed to by all parties concerned, including the foreign collaborator and subject to the approval of the Government;
- There should be no requirement for the payment of a minimum guaranteed royalty regardless of the quantum and value of production;
- Arrangements or clauses which in any manner bind the Indian party with regard to the procurement of capital goods, components, spares, raw materials, pricing policy, selling arrangements etc. should be avoided;
- To the fullest extent possible, there should be no restriction on free export to all countries;
- The use of foreign brand names will not be permitted for internal sales;
- Suitable provisions should be made for the training of Indians in the fields of production and management. There should also be adequate arrangements for research and development, engineering design, training of technological personnel and other measures for the absorption adaptation and development of the imported technology. Such measures can be undertaken through in-house facilities of the entrepreneur or in collaboration with recognized engineering design, consultancy R & D organizations in the public or private sectors and recognized scientific and educational institutions, where the necessary facilities exist;
- Consultancy services required to execute the project should be obtained from Indian consultancy firms. If foreign consultancy is also considered necessary, an Indian consultancy firm should be the prime consultant;
- If the proposed item of manufacture is covered by a patent in India, it should be ensured that the payment of the royalty for the duration of the agreement would also constitute compensation for the use of the patent rights till the expiry of the life of the patent and that the Indian party would have the freedom to produce the item even after the expiry of the collaboration without any additional payments;
- Collaboration agreement will be subject to Indian laws;

- The Government does not favour requests for extension of the duration of collaboration proposals. All efforts should, therefore, be made by the Indian party to assimilate the technology within the initial duration of the agreement;

4. Specified Procedure for the Import of Designs and Drawings for Machinery Manufacture

With a view to reducing the import of capital equipment and facilitating fuller utilization of fabrication capacity in the machinery manufacturing industry, the Government introduced a special procedure on 7-12-1973 for the import of designs and drawings to facilitate indigenous fabrication of machinery and equipment. According to this, such imports will be allowed only once in a year to one undertaking if the value of such drawings and designs does not exceed Rs 0.5 million and the undertaking is licensed or registered for any of the items covered under 'Industrial Machinery' and 'Machine Tools' in the schedule to the Act, or for rubber machinery or printing machinery which are currently non-scheduled items.

Appendix I gives the Indian Specifications of the different pipes used in community water supply schemes manufactured in India while Appendix II gives the annual licensing and production capacities of some of the materials needed for community water supply programmes and manufactured in India.

SPECIFICATIONS OF PIPES MANUFACTURED IN INDIA

SL. no.	Type of Pipe	Indian Standards Specification no.	Usual dia in mm	Class	Test Pressure at works		Max. working pressure at field	
					in kg/cm ²	Period in sec.	in kg/cm ²	Period in sec.
1.	2.	3.	4.	5.	6.	7.	8.	9.
1.	Centrifugally cast spun iron pipes	1536-1967	80, 100, 125, 150-50-500, 600, 700, 750	LA	35	15	12	
				A	35	15	18	
				B	35	15	24	
2.	Vertically cast iron pipes	1537-1960	80, 100, 125, 150-50-500, 600, 700, 750, 800-100-1200, 1500	A	20		Not less than two-third of the works test - Pressure maintained for at least 4 hours; when the field test pressures are less, the period of test should be at least 24 hours, the test pressure being gradually raised at the rate of 1 kg/cm ² /min.	
				Up to 600 mm dia.				
				600-1000				
				B	25			
				Up to 600 mm dia				
600-1000	20							
1000-1500	15							
3.	Asbestos cement pressure pipes	1592-1970	50,65,80, 100,125 150-50- 500,600, 900	5	5	30	Maximum working pressure will be half the test pressure in each case.	
				10	10	30		
				15	15	30		
				20	20	30		
				25	25	30		
4.	Reinforced concrete pipes	458-1971	80,100, 150,250-50-500- 100-1200	P ₁	2		For use in gravity mains only - working pressure not to exceed two-third of test pressure	
				P ₂	4			
								80,100,150 250-50- 500-600
				P ₃	6			
								80,100, 150, 250,300 350,400
5.	Pre-stressed concrete pipes	784-1959	800,100, 125,150- 50-500-100 1200-200 1800	Twice the design pressure			Half the works pressure for pumping mains and 2/3rd for gravity mains	
				1	5			
					2	10		
					3	15		
					4	20		
6.	Steel cylinder RC pipes	1916-1963	200-50- 500,600 700,900, 1100,1200- 200-1800	1	5			
				2	10			
				3	15			
				4	20			
				5	25			
7.	Mild steel tubes	1239 (Pt 1-1974 & 1387-1967	6-100 6-150 6-150	Light	50			
				Medium	50			
				Heavy	50			
				Special				
8.	Electrically welded steel pipes	3589-1966	200-2000	1	15			
				2	20			
				3	25			
				Special				
9.	Low density polyethylene pipes	3076-1968	40-140 32-140 20-110 12-63	2.5	3.75	One Hour		
				4	6			
				6	9			
				10	15			
10.	High density polyethylene pipes	4984-1972	63-400 40-400 32-400 20-90	2.5	3.75	One hour		
				4	6			
				6	9			
				10	15			
11.	PVC pipes	4985-1969	90-315 50-315 40-315 16-125	2.5	3.75	One hour		
				4	6			
				6	9			
				10	15			

No.	Material	Licensed or registered capacity	Capacity covered by letters of intention	Total capacity covered by licenses, DGTID registration as well as by letters of intent.	Effective capacity likely to materialize by 31-3-1979	Production in tons			
						1972	1973	1974	1975
1	2	3	4	5	6	7	8	9	10
1	Black and galvanized welded steel pipes & tubes	1,216,660 tons	148,000 tons	1,364,660 tons (Besides 64 units with a total applied capacity of 1,569,000 tons registered)	1,900,000 tons	322,219	325,000	335,000	
2	Cast iron spun pipes	520,600 tons	75,000 tons	595,600 tons	595,600 tons	209,000	250,000	287,000	280,000
3	Seamless steel tubes	39,600 tons	-	39,600 tons	39,600 ton (Addl. capacity of about 80,000 if the public sector project under consideration matures)	36,639	30,000	33,000	
4	Asbestos cement pressure pipes	102,000 tons	30,000 tons	132,000 tons	132,000 tons	69,200	84,000	61,000	75,000
5	Water well drilling rigs	406 nos.	150 nos.	556 nos.	556 nos.		Rs. 447 million	Rs. 683 million	Rs. 100 million
6	Hammer drills down the hole	400 nos.	160 nos.	560 nos.	560 nos.				190 nos.
7	Alumino-ferric, aluminium sulphate & alums	245,000 tons	358,000 tons	603,000 tons	345,000 tons		119,698 tons	109,582 tons	138,554 tons
8	Soda ash.	833,000 tons	713,000 tons	1,546,000 tons	880,000 tons	486,000	480,198	518,000	541,000
9	Caustic soda, liquid chlorine	670,038 tons	1,078,927 tons	1,743,965 tons	785,000 tons	395,918 tons	418,791 tons	431,550 tons	442,664
10	Rock roller bits	300 nos.	9,000 nos.	12,000 nos.	12,000 nos.		starts production	9,000	

INDIGENOUS ANNUAL PRODUCTION OF SOME MATERIALS NEEDED FOR COMMUNITY WATER SUPPLY - INDIA

INDIGENOUS ANNUAL PRODUCTION OF SOME MATERIALS NEEDED FOR COMMUNITY WATER SUPPLY - INDIA												FUTURE SCOPE				Appendix II	
IMPORTS			EXPORTS			UNITS IN PRODUCTION						Estimated demand in 1978-'79	Current Industrial Licensing Policy	Current Foreign Collaboration Policy	Raw Materials Indigenous	Required Imported	Other Salient Features
71-72	72-73	73-74	71-72	72-73	73-74	Licensed		Registered		Total							
						No. Installed capacity		No. Installed capacity		No. Installed capacity							
11	12	13	14	15	16	17	18	19	20	21	22	23.	24.	25.	26.	27.	28.
Nil	Nil	Nil	Rs. 638 million	Rs. 859 million	Rs. 1.868 million	15	1,183,960 tons	4	65,000 tons	19	1,248,960 tons	425,000 tons	No further capacity being licensed in view of sufficient capacity having been already sponsored	Foreign collaboration not allowed	(1) Hot rolled steel strips/skelp (11) Zinc for galvanizing	Part of these requirements met from indigenous sources and import is allowed to meet the shortfall as per import policy from time to time.	This is a non-IDA priority industry. No scope for additional licensing in view of already available/licenced/registered capacities.
160	811 tons	620 tons	831 tons	17,677 tons	16,629 tons	3	233,000 tons	6	245,600 tons	9	478,600 tons	550,000 tons	Restricted only for substantial expansion (Minimum economic size of unit recommended is 3,000,000 ton/annum)	Restricted	Pig iron and coke	Pipe moulds	All the existing units are producing grey iron spun pipes. The trend of demand in other countries is for ductile iron spun pipes, for which there is a considerable export market. Being capital intensive the manufacture of ductile iron pipes is being encouraged by the existing manufacturers of spun pipes within their overall licenced capacity, with some additional balancing equipment with simultaneous indigenous development of low phosphorous pig iron.
Rs. 147 million	Rs. 159 million	Rs. 3,132 million				1	39,600 tons	-	-	1	39,600 tons	66,000 tons	Additional demand is to be met by setting up capacity in the public sector	Allowed	Steel blooms (Allied steel & Alloy)	Part of these requirements met from indigenous sources and import is allowed to meet the shortfall as per import policy from time to time	This is a non-IDA priority industry.
-	-	-	Rs. 0.59 million	Rs. 0.29 million	Rs. 1.477 million	3	102,000 tons	-	-	3	102,000 tons	175,000 tons	Having regard to the constraint on account of imported materials, of 140,000 there is no scope of & installed further licensing in capacity of this industry during 175,000 76-77 except on the basis of substantial export obligation to meet requirements in a particular zone	No foreign collaboration allowed	Cement	Raw asbestos fibre	Capital equipment needed is being manufactured indigenously, standardized for a plant of 30,000 T/annum capacity. Since the fabrication is undertaken under specific orders, it is possible to design plants to meet individual requirements.
-	-	-	-	-	-	8 ^x	-	-	-	-	-		Apart from several registered small scale units				
-	-	-	-	15,615 tons	15,219 tons	15	245,000 tons	-	358,000 tons	-	603,000 tons		Upto 150 mm indigenously manufactured higher sizes being developed				
-	-	-	-	Rs. 453 million	Rs. 468 million	-	-	-	-	-	-	375,000 tons	Depending upon the availability of the raw materials/utilities. Addl. licensing may be considered for select areas		Sulphuric acid. Good quality bauxite, large quantity of water. Copious availability of steam		Export during 74-75 was 14,314 ton at a value of Rs. 726 million. Due to extension of water supply programme, the requirement is estimated to be 450,000 t/annum by 1983-84
Rs. 504 million	Rs. 1,299 million	Rs. 1,701 million	Rs. 223 million	Rs. 0.58 million	Rs. 1.28 million	4	633,000 tons	-	913,000 tons	-	1,546,000 tons	488,000 tons	Export oriented proposals in addition to additional capacity to meet the 6th plan needs (in view of the long gestation period) are considered	Generally not preferred	Salt Limestone Hard coke Ammonia	Sulphur	Capital intensive industry. For units adopting standard-Solvay process, 400 t per day part is considered to be economically viable and estimated to cost at about Rs. 220 to 240 million. In the case of modified Solvay (Dual) process, the economic unit could be for a capacity of at least 200 ton/day of each of soda ash and ammonium chloride. A modified Dual Solvay process plant of economic size without having its own ammonia making facility is likely to cost Rs. 170 to 180 million.
46,777	9,574 tons	5,842 tons	27,095 tons	8,176 tons	4,655 tons	31	604,000 tons	-	1,049,000 tons	-	1,653,000 tons	785,000 tons	In view of the long gestation period, proposals for setting up additional capacities are invited.	Not prepared	Salt. Purification chemicals (Barium salt), Graphite, Anodes (partial) and electrical power	Mercury, Graphite, Anodes, Asbestos, Paper/fibre.	Capital intensive industry.
-	-	-	-	-	-	1	3,000 nos.	3	-	1	3,000 nos.	12,000 tons	In view of the growing demand, well prepared schemes for the manufacture of rock-roller bits involving minimum import of components right from the beginning will be considered on merits	Foreign collaboration may be considered	Forgings, bearings	Cutters	Only one unit with a licensed capacity of 3000 nos. per annum has gone into production. Minimum economic size of the unit recommended is 3000 nos. This is an IDA-priority industry.



DRINKING WATER FOR EVERY VILLAGE;
CHOOSING APPROPRIATE TECHNOLOGIES

by

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Note: In presenting his subject Mr. Martin Beyer made use of his article of the same title which was published in Assignment Children No. 34, April-June 1976, UNICEF Geneva.

DRINKING WATER FOR EVERY VILLAGE;
CHOOSING APPROPRIATE TECHNOLOGIES

The entire philosophy of the programmes assisted jointly by UNICEF and WHO for the improvement of environmental sanitation is based upon the premise that the provision of ample supplies of safe water and the sanitary disposal of excreta have a direct and far-reaching effect upon the health and well-being of rural populations. Indeed, it is believed that no other single measure can make a comparable contribution to the improvement of their health and standard of living. The choice of an appropriate technology depends on local conditions.

In addition to the important direct effects of clean water in reducing enteric diseases, a supply of drinking water can provide multiple benefits of broad developmental value. Access to safe water improves the quality of life within entire communities and frees mothers from the burdensome task of carrying water over long distances. Its provision within convenient reach is one of the measures recognized and recommended by governments and agencies alike, as being important for the integration of women in development. Moreover, the provision of village water supplies can be a catalytic element for a widening circle of health-oriented and other cooperative, self-help, community efforts, such as sanitation activities, family food production, reforestation for domestic fuel supply, and local support of health and education services. Such efforts can contribute greatly to the delivery of simple preventive health care by giving the community the capacity to maintain a healthy environment for all its members.

Water Supply and Integrated Rural Development

Rural water supply in developing countries has only in the last decades received more systematic attention from governments, international, bilateral and non-government organizations. It has become increasingly recognized that the problem of rural water supply is closely linked to that of environmental sanitation, and that if any project is to be reasonably successful, the only possible approach is a multidisciplinary one. This means that not only must appropriate technologies

Some of the material in this article is based on the Manual for UNICEF assistance to potable water supply and environmental sanitation programmes, preliminary draft, 21 April 1975.

be applied, but that they must also be linked to the other sectors of rural development, including the education of villagers on the significance and proper use of water supply and sanitation installations, however simple they may be.

In general, a single national organization is formed, to be responsible for all rural water supply. Wherever possible, the villagers are encouraged to contribute in cash to the installation, operation and maintenance of the water supply system. In areas depending on subsistence farming, where the necessary monetary means may be lacking, an input can be provided through the villagers' participation in the labour, such as the digging of wells, and the construction of pump platforms or installations around protected springs and public standposts. The planning and implementation of the project should be coordinated with the government authorities in the different sectors involved, such as planning, local government, public works, health, agriculture and education.

The Choice of an Appropriate Technology

The question of selecting and applying a water supply technology in any given area of the world is thus one of proper integrated planning and implementation. It is difficult to establish a standard scheme, as the choice of the right technology, organization and methods of implementation depends on the prevailing physical, socio-economic and demographic factors.

The sources of water differ widely. They may consist of sparse reserves in tiny cracks and fissures, such as those occurring in the Pre-Cambrian basement of northeastern Brazil and many countries on the African continent, or they may be abundant springs such as on the mountainsides of the Himalayas.

The demographic and socio-economic conditions similarly show great variations. The relatively small and scattered agglomerations in Central Africa are often strung out along the roads. They present a different setting from that of the clustered houses of Indian villages.

Thus each area in the world has its own set of parameters and problems requiring a solution of their own.

The design of any project should therefore:

- be adapted to meet the real needs of the population
- be realistically conceived in order for the government and other participating organizations to be able to implement it with the means and manpower really at hand

- be prepared within the framework of economic and manpower development planning
- take careful consideration of the economic and technological levels, social attitudes, and potential for development of the local population. The latter imply as one important element the education of the villagers, especially the children. Through them, knowledge of the benefits of water to their health, nutrition and living conditions can be spread to their families.
- be adapted in degree of complexity to the level of the villages in order to ensure adequate operation and maintenance.

Accessibility and Water Consumption

The accessibility of the safe water supply in relation to the households where it is to be used, is one of the crucial factors in enhancing its health and socio-economic value. Ideally, a piped water supply with one or several taps in each household is the obvious solution. In reality, in many, if not most of the programmes, other solutions have to be sought. The simplest of installations, a dug or drilled well (with one or several in each village), needs to be located not only from the point of view of accessibility, but also according to hydrogeological and sanitary conditions. In an intermediate stage, a simple piped water supply system with public standpipes is able to provide water in acceptable quantities at distances that are at least tolerable from a carrying point of view.

There are no standard figures for the spacing of such public stand pipes, but as an example a recent survey from Libreville, Gabon, shows a mean consumption of 35 litres per person per day up to a distance of 200 metres. This mean then drops gradually to 10 litres at a distance of 800 metres.

The access route, especially if differences in elevation are involved, also plays a determining role in the distances considered acceptable. Another factor is the nature of the water point: whether it consists of an open well, a single hand pump, or public standposts with one or several taps. The ease in the operation of hand pumps or different types of taps is also to be considered.

An Adequate Supply for Individual Needs

The criteria for the quantities needed in order for the supply of safe water to be adequate also vary greatly according to the population to be served, the level of technology that can be utilized for producing the water, the availability of safe water, or - under extreme hydrological conditions - any water.

To the average body intake should be added the water needed for daily hygiene and household use, the washing of dishes, clothes, etc. In some cases, where conditions so warrant, the water quantities aimed at may even be larger in order to make micro-irrigation possible for vegetable and fruit gardening or small-scale farming.

In a Tuareg household in the Sahara, there may not be more than five to six litres available per person per day, barely sufficient for drinking and cooking purposes. At the other end of the scale, the industrialized countries show a daily per capita consumption of 200 to 300 litres or more. A tolerable minimum in a warm climate might be estimated at around 50 litres per day, including water for body hygiene.

Standards for Drinking Water

In view of the fact that the principal aim is to provide safe water for the population, the criteria for water quality should be set as high as possible. The WHO as well as a number of national governments have set well-defined standards for drinking water. These include the limits of physically, chemically and bacteriologically acceptable values. Sometimes the ideal values cannot be fully reached, but attempts should be made to come as close as possible to them.

The anticipated quality must be based on a realistic appraisal of local conditions and the possibilities for yielding safe water, given the technology available. In certain emergency situations, or in areas where the present level of technology has not yet made it possible to provide fully satisfactory sanitary installations, facilities should be designed in such a way that they can later be completed.

Environmental Sanitation and Health Education

The protection of water installations from pollution is of utmost importance, and one of the reasons for combining a water supply programme with environmental sanitation, including the disposal of waste water, waste and excreta.

It is highly desirable that water supply and excreta disposal be undertaken simultaneously in each community. This ideal is, however, often found to be unattainable in practice. The need for a good water supply is obvious, and in almost every case villagers without such a supply are anxious to obtain it and very willing to cooperate in its installation. The equally important need for sanitary disposal of excreta may not be so immediately apparent to them.

Experience has shown that the general rise in environmental standards brought about by a safe water supply, coupled with the example and education provided by health workers, often leads to a later, but more enthusiastic, acceptance of an excreta disposal programme.

The installation of a water supply is also frequently accompanied by the problem of disposing of waste water, which is most acute in compact, densely populated village villages built on impervious soil.

In any case, where there are schools, health centres or buildings of communal use (including markets), the full range of sanitary improvements should be installed from the start. Apart from the obvious health implications for large gatherings, their presence will assist in obtaining the villagers' acceptance of sanitary facilities.

The World's Water Resources

Of a total estimated eight million cubic kilometres of fresh water in lakes, streams and the ground, only some 30 000 cubic kilometres per year might be regarded as available for use over the entire surface of the earth. In reality, the available quantity is much lower, since there are large areas with water occurrences which are uninhabited, while other areas with a dense population do not possess the corresponding necessary resources.

Only a small part of the total fresh water resources consist of surface waters. The majority of these must be regarded as a priori polluted and unfit for human consumption, unless treated. In developing countries, this is economically feasible only in cities, towns and larger communities. Thus ground water remains the most important source of water for human consumption.

The possibilities for the success and efficient operation of any water supply project based on ground water are greatly enhanced if there exist prior regional hydrogeological surveys and data on the location of water points (wells), based on geological and geo-physical studies of the individual sites. There are many highly sophisticated methods available to aid such studies, but in many countries the organization, means and skills to carry them out are lacking.

Still, some of the most modern exploration techniques bear the promise of at least providing a short cut in the reconnaissance phase of many projects. Among such especially interesting new techniques is the computer-based interpretation of

satellite images. This allows rapid coverage of large areas for the location of water-bearing geological structures at a cost which is only a fraction of that of aerial photo material.

The extent of existing reserves and the rate these are being replenished must also be measured. Certain desert areas of the world are underlain by large aquifers (water-bearing formations), into which water once seeped under climatic conditions more humid than present-day ones. Ages of 25 000 - 35 000 years indicate that such waters run the risk of being "mined out", unless precautions are taken to regulate water production.

Exploration and studies also bring to light the physical, chemical and bacteriological properties of ground water. In some regions harmful substances (e.g. fluorides) may occur which generally would make the water unfit for drinking, even if treatment in some cases can improve the water quality. During installation, upon the completion of the facilities and regularly during their use, analyses of the water should be made.

Surface Water

The normal pollution and frequent turbidity of surface waters require the installation and subsequent operation and maintenance of treatment plants. These processes mostly require a costly capital investment, a high operation and maintenance budget, and trained manpower.

However, some water treatment processes are relatively simple and can be utilized - provided that proper maintenance is kept up - for relatively small communities. This is the case of slow sand filters which are basically basins with a layer of sand through which the water is filtered from above and drained through a gravel layer at the bottom. Also available are simple small-sized "package" plants with a combination of units, including flocculation, filtration and disinfection, such as those installed in villages of 1000 - 2000 inhabitants in Thailand.

For domestic use there are certain simple measures and devices that can be used, such as home-made charcoal/sand filters (the "canari" filters of West Africa). Boiling is the best way of rendering water safe. Disinfection by chlorine or iodine are also good measures, although with certain limitations as to the former (not effective against all organisms).

Rainwater

For areas which suffer great difficulties in obtaining water from underground or surface resources, the solution is the catchment and storage of rainwater, even if the rainfall is relatively scarce and intermittent.

Either roofs or specially prepared and protected areas on the ground can function as catchment areas. Water loss through infiltration can be countered by covering such areas with plastic sheets, bitumen or linings of cement/soil mixtures. An important aspect is storage. A covered storage is indispensable in order to protect the water from evaporation and pollution from outside sources.

In certain parts of the world, such as the Mediterranean countries, rainwater catchments were being constructed already thousands of years ago, sometimes on the ground, sometimes utilizing the roofs of buildings. In other parts of the world attempts are presently being made to adapt indigenous architecture to provide rainwater catchment and storage installations, as in the case of the famous villages of the Dogon in the dry Bandiagara plateau in central Mali. The inner walls of their tall granaries can be easily lined with cement or plastic sheets and filled with rainwater collected on the flat roofs.

Other simple constructions for the storage of rainwater have been developed recently in Botswana, Senegal and the Sudan, which seem promising and may provide water where there are no other possibilities at a low per capita cost. An increasingly utilized means of storing rainwater from large natural catchment areas is the construction of sand-and-gravel-filled dams from which water is extracted through a shallow well in the deepest part of the dam. Such a construction has the advantage of also providing good filtration; however, it may be rather costly and require equipment such as for public works.

Spring water

Springwater can in many cases be used without prior treatment, if the springs are properly protected by suitable concrete or masonry constructions with drainage pipes or screens in the ground.

Springs occur particularly in mountainous or hilly terrain. There are many areas in humid parts of the tropical zone, where springs flow consistently throughout the year and can be used for village water supply.

Although the construction of spring protections does not present great difficulties problems may arise in the upkeep of protected springs, such as the habit among many populations to plant or leave trees growing close to the spring for shade as well as sometimes for religious reasons. Once they have gained a certain size, their roots frequently crack the masonry around the spring.

In order to lift water from springs with an abundant yield (or from surface sources) to higher ground, a design more than a hundred years old is now experiencing somewhat of a revival, the hydraulic ram.

Ground Water

The techniques, ancient and modern, for reaching the water resources in the ground range from the simple digging of wells with hand tools to the excavation of the famous ghanats of Iran and Afghanistan, underground galleries which can extend many miles.

The predominant method, however, is the drilling of wells. The first known use of this method was by the Chinese more than 2000 years ago: they developed a simple percussion drill operated with human power. The methods currently most utilized are listed in the annex, which sets out the characteristics and applicability of each method.

The figures given in the table for the construction of water wells correspond to those incurred in implementation in the field, but not including administrative overhead. They only serve to give an idea of the cost proportions, as in reality the costs vary greatly in relation to an intricate pattern of interdependent factors.

Among major government programmes for village water supply around the world, there are two which from a technological point of view are especially interesting. Both are being implemented on a large scale with UNICEF assistance. At the same time they represent two widely contrasted types of technology, each adapted to the special conditions of the respective country.

An adaptation of local village technology: the Bangladesh programme

One is the programme in Bangladesh, where the plans foresee a total of 310 000 shallow wells to be sunk during the period of 1972 to 1980. These wells are "sludged" down into the soft clays and sands of the Ganges delta formations by

local contractors. With the help of a bamboo scaffolding and lever, a galvanized iron pipe is 'pumped' down into the ground. In a one-day shift the four-to five-man group of drillers manages to drill to a depth of 30 metres, withdraw the iron pipe, and replace it with a PVC screen and pipes for the final installation of a hand pump and platform on top of the well. This is an adaptation of local village technology, with the utmost simplicity but at the same time with high efficiency.

Special technologies: the India programme

The other programme, which is technologically very different, is being carried out in the hard rock areas of India. More than 70% of India's surface is underlain by crystalline and semi-hard lava and ash rocks. The groundwater is found in the bottom portions of pockets of loose, weathered rock and in the joints and fissures of the bedrock. The periodic replenishment of groundwater reserves by the monsoon rains causes great fluctuations in the water table. Large parts of the country are areas with frequently recurring droughts and ensuing famines. Lacking the necessary equipment and techniques, the village populations are at great pains to extract any water for domestic use, other than from large open wells. These can be excavated only to limited depths, often not reaching the water table level of the dry season.

The drought in the Indian states of Bihar and Orissa in 1966-67 prompted the first utilization and later development of special technologies for the large-scale drilling of narrow diameter or 'slim hole' wells (four to six inches in diameter) to average depths of 30 to 50 metres for the installation of hand pumps or submersible electrical pumps. Compressed air drill rigs are used with a slowly rotating percussion drill bit, driven by a pneumatic piston (now mostly encased in a motor unit immediately above the bit, called a 'down-the-hole hammer').

The experiences in India encouraged a number of manufacturers to adapt their equipment to the much greater depths needed. They also developed simpler and more rugged machines in order to make them less dependent on often distant repair facilities and to reduce operation and maintenance costs. This has given rise to an increasingly important national manufacture of drill rigs and related equipment.

Although the average depth of water wells in most hard rock areas in the world would not exceed 50 metres, in some places deeper wells must be dug. There are now drill rigs which can reach depths of 200 metres with the advantages of rapid drilling (30 to 50 metres in one shift) and relatively light-weight equipment which permits mobility and easier access to remote well sites.

An interesting application of compressed air techniques is the revitalization of large open wells into which the flow of water has been blocked when the fissures which are normally water-bearing successively become clogged with finer mineral matter. The flow can be restored or improved by drilling new holes with simple pusher leg or hand-held rock drills and integral drill steels.

New Techniques for Water Lift and Distribution

The technology for water well drilling and construction is adequately developed. The question of water lift, however, still presents problems, as the majority of village water well projects throughout the world still have to rely on human or animal power to lift the water to the surface.

A major item in any village water project is therefore the hand pump. Until recently, with the exception of some very expensive constructions, most of the hand pumps available on the market were generally cast-iron pumps, originally designed for single households. Of these, the shallow well (suction) pumps are used for depths of less than seven metres. Deep well pumps for greater depths lift the water by means of a piston in a pump cylinder beneath the water table. It is only very recently that radically new designs have appeared, such as the full-hydraulic pedal pump, developed at the Interafrican Committee for Hydraulic Research in Ouagadougou.

Other innovative technological approaches include research in utilizing wind energy. The use of traditional windmills with horizontal axles for pumping works very well in regions where there is a fair amount of wind throughout the year, and where there is appropriate maintenance. Experiments are now under way on wind motors with vertical axles.

Solar energy is another source much looked to for the future. There are solar pumps working on a trial basis, mostly built for heat transfer by butane gas to steam engines, or submersible pumps run on electricity generated from solar cells. In both cases the sophistication of the equipment and the prices are still prohibitive for other than experimental use. Very recent research and the development of simple solar panels at a fraction of the cost of solar cells (presently about \$ 30 per watt) may prove of interest for the future.

Another potential use of solar energy is for the production of fresh water from sea water in simple solar stills. However, such installations are costly in relation to their output and also require much care and maintenance. Except for some

experimental installations, there are as yet only a few larger ones of 'greenhouse' type in full-scale operation to supply larger communities, notably in Greece, Spain and Algeria.

In many countries where transport is a problem, more and more pipes of PVC or other lightweight plastic materials are being installed. Research has recently gone into the question of 'no-waste' faucets, which prevent waste in public systems through excess overflow of valuable and scarce water.

Equipment and materials for water supply and sanitation are being increasingly manufactured in developing countries. A local technology has often developed, which can be much more appropriate to the actual needs of the country than products that are designed and manufactured in industrialized countries. The development of a domestic water supply on a large scale can thus be accompanied by the promotion of a national technology and industry which opens employment opportunities to local manpower and ultimately becomes an addition to the economy, both on the national and family level (Pakistan, Bangladesh, India, Tanzania, Ethiopia).

Operation and Surveillance

It is essential to build up a suitable organization which will ensure the competent construction and efficient, foolproof operation and maintenance of completed facilities and the effective surveillance of drinking water quality.

Operation is the lesser of the two problems. With the exception of mechanically driven pumps and simple treatment works, the operation is carried out by the users themselves. Provided that the villagers have been taught to correctly use and adequately protect the equipment and that some surveillance can be maintained by a sanitarian or village head, there is no reason to anticipate any trouble in this direction.

The operation of a mechanically driven pump, chlorine doser or slow sand filter is usually entrusted to a villager, who will have received his instruction and simple training from the supervisor during the construction period. When the number of installations employing such attendants is sufficient to warrant it, some provision should be made for more formal initial and refresher training either in an attendants' school, or by the occasional visit of an instructor who will provide in-service training.

Organizing an effective maintenance system

The size of a village installation will normally be insufficient to justify the employment of skilled and experienced men as plant attendants. Maintenance also necessitates stocks of spare parts and the necessary tools and equipment to fit them, which would be most uneconomical for every small installation to hold.

As soon, therefore, as a number of water supply installations have been constructed within an accessible distance, a central maintenance organization in the charge of a skilled mechanic (or mechanical engineer if large enough to warrant this) should be set up. This would comprise workshops and stores, stock spares, be responsible for regular inspection of all equipment within its area of operation, and operate a simple system of accounting to enable the cost of maintenance to be allocated to the appropriate village installation. It could also be made responsible for supervising their operation, if so desired, including the supply of fuel and chemicals to individual projects from bulk storage. Minor plumbing maintenance (e.g. replacement of tap washers) and repairs to broken concrete (e.g. well aprons or latrine slabs) could also be undertaken. Payment of the cost of running the maintenance centre would depend upon the financial system operating in the particular country, but would have to be worked out in advance of setting up the organization.

Recurrent Costs

Leaving out the question of capital repayment, which is rarely possible in a rural project (in any case the villager will usually have already contributed to the initial cost), the following are the types of cost which should be individually assessed:

1. Renewals: particularly for machinery and equipment with an estimated life of 15 years or less. The payment of an annual amount into a sinking fund will ensure that money is available for replacement when required.
2. Operation: labour; fuel and oil or electricity; chemicals; transport.
3. Maintenance: proportion of cost of running central maintenance workshops; spares; tools and equipment; cleaning materials. Regular painting and maintenance of buildings and structures must also be allowed for.

More than a Problem of Technology

At the end of the production line for safe water, whether it is the spout of a hand pump or a public standpost, there stand children, women and men. The chances

for improving their health and social conditions as a result of the installation of facilities bringing them safe water much depends on how they use these facilities. It is symptomatic of the only recent recognition of the importance of a more consumer-related orientation that the vast literature on water supply includes only a few publications on how the consumers see and approach this vital problem.

International, bilateral and non-governmental organizations together with governments now regard the technology of safe water supply as only part of the problem. They increasingly recognize the importance of helping the people served to understand the benefits of the water supply, and the need to win their cooperation to keep the installations operating to improve their own living conditions and those of their children.

GROUND WATER EXTRACTION FOR VILLAGE WATER SUPPLY: METHODS AND CHARACTERISTICS

Characteristics Method (1)		GEOLOGICAL FORMATION			CONSTRUCTION			TECHNOLOGY					COST IN US\$	OPERATION & MAIN- TENANCE	PROJECT EXAMPLES				
		Formation stability (2)	Hard- ness or abrasivity (3)	Particle size (4)	Type (5)	Maximum depth (metres) (6)	Diameter (mm) (7)	No. shifts per 50 m (8)	Speed Relative (9)	Flush medium (10)	Equipment weight (11)	Sophis- tication (12)	Per capita for 50-m well (13)	Complexity (14)	(15)				
I	Excavation Manual: vertical	Unconsol- idated	(low)	Fine to gravel	Dug wells	80	> 1000	200	very low	None	Low	Low	5	Low	Vietnam: shallow wells				
B	Manual: horizontal		(Low)	Fine to gravel	Ghanats	Kilometres	> 800	100	very low	None	Low	Low	(10)	Low	Iran: gravel outwash from mountain slopes				
C	Mechanical: vertical	Unconsol- idated to consol.	All	All	Dug wells	80	> 1500	50	low	None	Medium	Medium	15	Medium	Sahel: deep wells				
D	Mechanical: horizontal		All	All	Galleries (adits)	> 1000	> 1800	10-50	Low to medium	(water, mud, air)	Medium to high	Medium to high	50	Medium to high	Cap Verde: volcanic slopes				
II	Drilling Wellpoint (driven)	Unconsol- idated	Low	Fine	Tubewells	20	50-200	10	Medium	None	Low	Low to medium	7	Low to medium	Liberia: pockets of loose material				
F	Sludging					40	35-50	1 (30m)	Medium to high	Water	Low	Low	1	Low	Bangladesh: Ganges delta				
G	Jetting					50	50-100	2	Low to medium	Water	Low to medium	Low	1	Low to medium	Indonesia: river banks				
H	Percussion	Cable tool	Medium to high	All	"open" and screen wells	200	150-600	25	Low to medium	Water	High	Medium	10	Medium to high	Afghanistan: valley fills				
I						Air hammer	High (all)	All	200	100-200	1	High	Air, foam	Medium	Medium	5	Medium	India: "hard rock" areas	
J	Rotation	Coring	All	All	Exploitation only	> 300	40-150	5	Medium to high	Water, mud, foam	Medium	High	20	(Medium)	Ethiopia: hydrogeological fill sampling				
K						Rotary (fullbit)	Low to medium	All except hard gravel	"open" and screen wells	> 300	> 150	1	Medium to high	mud, air	High	Medium to high	5	Medium to high	Surinam: coastal villages
L						Auger	Low	Fine to medium	100	100-150	1/2	High	None	Medium	Medium	2	Medium	Sudan: Sudd swamp area	
M	Bucket	Unconsol- idated	Low	Fine to medium	Large dia- metre wells	30	1000	2	High	None	High	High	20	Low to medium	Upper Volta: weathered soil pockets				
N	Combination (H to L)	Consol. to unconsol.	All	All	"Open" and screen wells	> 300	> 150	10	Medium to high	Water, mud air, foam	Medium to high	Medium to high	10	Medium to high	Bolivia: boulders above bedrock				

REMARKS TO TABLE "GROUNDWATER EXTRACTION FOR VILLAGE WATER SUPPLY"

All figures are only examples, as the ranges in cost can vary greatly.

- (3) An arbitrary estimate of several factors affecting drilling rates and equipment wear.
- (8) Number of eight-hour shifts needed to sink a 50-metre well.
- (11) Relates to the accessibility of the equipment to the well sites:
 - High : over 6 tons
 - Medium: under 6 tons
 - Low : can be transported by porters.
- (12) Training background needed:
 - High : specialized training and long experience
 - Medium: indigenous experience and on-the-job training
 - Low : indigenous experience
- (13) Hypothetical example, based on 50-meter deep wells for potable water in villages with 1000 inhabitants.
- (14) High : trained specialists needed
 - Medium: villagers with occasional outside assistance
 - Low : can be managed by villagers
- (15) The majority are examples from UNICEF-assisted government projects.

SOME BASIC IDEAS ON ESTABLISHING
A WATER TREATMENT TECHNOLOGY
ADAPTED TO DEVELOPING COUNTRIES

by

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September, 1976

SOME BASIC IDEAS ON ESTABLISHING A WATER TREATMENT TECHNOLOGY

ADAPTED TO DEVELOPING COUNTRIES

Introduction

The problem of water supply for urban and rural areas, in developing countries, presents special characteristics which must be carefully studied before proposing general solutions based on the wide experience obtained through their application in the highly industrialized countries of the world. The fact is that such solutions may turn out to be completely inadequate and fail in their proposed objectives, when applied under different circumstances than those for which they were devised.

It should be kept in mind that each region, in accordance with its particular degree of social and economic advancement, must plan its own industrial development and that water supply is undoubtedly a basic factor in that programme. This is so not only because of the public health aspects, but also because of its being a dynamic element in the quantitative and qualitative increase of the local economic productiveness.

It should also be taken into account that the industry dealing with water treatment processes and equipment is in closer relationship than others with the social and economic aspects of the community; and this makes it even more necessary that the proposed solutions for water problems should be in full accord with the regional environmental conditions, so that these proposals may have a fair chance of success.

This is the main reason why it has happened so often, that in less developed countries the adoption of conventional treatment plants, whether patented or not, has been unsuccessful, since frequently they are poorly operated, partially destroyed or abandoned.

This fact may be easily explained by taking into account the social and economic differences existing between the fully developed countries and those in the course of development. In the former, the prevailing economy of consumption forces the water treatment industry to produce plants and equipment which fulfill the following general conditions:

- maximum safety from the sanitary viewpoint;
- high degree of automation in order to reduce skilled labour costs, which are usually quite high;

- massive utilization of equipment to provide a fair share of work to the metallurgic, mechanical industry
- preference for mechanical solutions rather than the merely hydraulic ones.

These design criteria, in spite of their sophistication, have given good results for over half a century in the industrialized countries and have been exported, together with the equipment, to the countries under development. This has created all kinds of problems, except in the large urban centres which have technical resources similar to those that are found in the developed countries. But, in those areas with a more rudimentary economic progress, a whole series of failures have been experienced, since the social and economic conditions are quite different and unfavourable and, thus, the design should comply with different criteria. In general, for these latter cases the following design criteria ought to be established:

- maximum safety from the sanitary viewpoint, since it can not be accepted that water in countries under development should be of lower quality than that supplied in the fully developed countries. Man's life and health have the same value and should be equally protected in every area of the world;
- minimum utilization of equipment, considering that the countries under development are not, in general, producers but simply importers of equipment;
- maximum use of local materials to utilize the largest possible labour force within the region;
- slight or non- automation, since treatment plants should generate manpower employment.

As it may be inferred from the above considerations, the problems that the designer has to face are completely different from those encountered in the industrialized areas of the world, and therefore it requires the creation of a special type of technology that can be adapted to the circumstances of the countries under development.

Proposed Solutions

Fortunately to aid in performing the above mentioned task, there is available an impressive amount of technical literature which has been published during the last decade and that for the first time, since the plants of Louisville and Little Falls (U.S.A.) were built, has offered to sanitary engineers, a coherent array of adaptations or new ideas which, if fully utilized, facilitate the adoption of significant changes in the conventional methods of water treatment.

The sound application of the results and conclusions of that research work, to practical cases, has induced the development of very advantageous technical methods, which are particularly beneficial to non-industrialized countries and may be applied in the following cases:

- to new designs of water treatment plants; and
- to upgrade existing treatment plants.

As an example of the former it may be pointed out that it has been possible to build treatment plants which do not conform with traditional standards and that, nevertheless, produce water of excellent quality with a minimum of equipment. Most of this equipment may be locally manufactured and, thus, a double purpose may be achieved by reducing the initial investment and lowering operation and maintenance costs.

Regarding the latter, it has been feasible to increase by up to 120 per cent the original capacity of treatment plants, keeping all the existing structures without major modifications and introducing only some changes in the treatment processes, with the resulting economy on capital investment.

Both applications of modern technology are based on the theoretical principles that will be discussed in the following sections.

Rapid Mixing

Recent research work has fully proven the need for producing an instantaneous mix between the coagulants and the water, since the reacting speed of those compounds may be less than one-ten-thousandth of a second, and the reaction is completed in less than one second (1) depending on the water alkalinity (2).

Under these conditions, the effectiveness of the mechanical agitator which has been traditionally employed in most treatment plants, has been questioned by several authors, among them by Vrale and Jordan (3) who conclude that this type of reactor is quite inefficient and suggest the use of piston-flow mixers in which the coagulants are dispersed hydraulically by injection in the raw-water pipe at the plant entrance. Later studies by Stenquist and Kaufman (2) seem to confirm this idea and suggest the utilization of perforated diffusers.

Therefore, hydraulic mixing is at least as efficient as mechanical mixing, and probably more effective in most cases. That is the reason for adopting Parshall flumes, hydraulic jumps, weirs or other similar systems, sometimes with the

addition of diffusers, made with a network of perforated tubing, which contribute to the rapid dispersion of the coagulants, since all those systems besides producing a very good mix, also do away with the usual problems of operation and maintenance of mechanical equipment and, at the same time, reduce construction costs.

Flocculation

The only advantage of mechanical vs. hydraulic flocculation, is its greater versatility since it easily allows an increase or decrease of the water's velocity gradient and, thus, the mixing intensity. On the other hand, it has the disadvantage that a large proportion of the incoming liquid mass bypasses the agitators in a shorter time than the theoretical detention period due to short circuits and, to control this, it is necessary to provide a complicated system of successive compartments. The hydraulic flocculator, instead, is practically free from short circuits producing almost a pure piston flow.

However, it is admitted that both flocculation systems distribute the velocity gradient in a non-uniform manner. Consequently, it may be concluded that both systems are comparable, each possessing its own advantages and disadvantages.

In developing countries there is no reason for not giving preference, on account of its low cost of operation and maintenance, to the hydraulic flocculator which compensate for its lack of elasticity by its very good distribution of the average residence time.

The hydraulic flocculators can be designed with removable baffles to give them more flexibility of operation and for any flow, and not only for small flows as has been customary. Treatment plants of the size of Las Vizcachas and Las Vizcachitas which form part of the water supply system of Santiago, Chile, with a capacity of more than 10 m³/sec., have only hydraulic flocculation; and the proposed expansion up to 15 m³/sec. is also being designed with the same system.

Sedimentation

In designing sedimentation tanks three main types can be considered:

- horizontal settling tanks;
- high-rate settling tanks; and
- vertical, or sludge blanket, settling tanks.

With the horizontal settling tank, mechanical handling of the sludge provides only a partial solution for these problems, because in spite of the fact that it maintains a constant removal of the settled material, it commonly involves operational difficulties which require putting the units out of service in order to repair the mechanical equipment.

Consequently when the sludge is primarily of the inorganic type, comparison should be made on the basis of labour costs. In industrialized countries, where those costs are quite high, mechanical sludge handling may be more economical. But in developing countries, manual removal is probably more desirable for the following reasons:

- it does not require importing equipment nor spare parts; and
- labour costs are comparatively low.

The high-rate settling tanks can be made with asbestos cement plates, since these reduce the settling area to one-fourth or one-sixth of that required by the conventional system and lower the construction costs at least by 50 to 60 per cent.

To collect the sludge, hydraulically drained hoppers can be used thus avoiding the need to empty the tanks at relatively short intervals. The design, however, should be done with great care to preclude increasing excessively the depth of the structures, thus counteracting the advantage obtained by reducing the area.

Finally the sludge-blanket type clarification basins, although offering a compact design, are restricted to use with water of a degree of turbidity varying between 50 and 500 F.T.U. and, as far as possible, never exceeding 1000 F.T.U. It is required also that long periods of very low turbidities (less than 20 F.T.U.) should be avoided, due to the impossibility of maintaining under those conditions an effective sludge-blanket. On the other hand, since the upward velocities with which these units may operate are limited by the weight of the floc particles produced, they seldom can stand loads higher than $80 \text{ m}^3/\text{m}^2/\text{d}$. (1.33 cm/min.), with a tendency to keep a surface load of only $60 \text{ m}^3/\text{m}^2/\text{d}$. (1cm/min.). A further disadvantage is that they require much more careful operation than horizontal or high-rate settling tanks, which may function with velocities two or three times higher (120 to $180 \text{ m}^3/\text{m}^2/\text{d}$).

Filtration

The filtration process is, in general, the most costly and involves the most difficult implementation and construction in treatment plants, since it requires

a larger proportion of equipment. Fortunately, it is in this process where the most drastic simplifications may be made. The following three basic ideas have contributed to make this fact possible:

- the use of a dual-media filter bed of sand and anthracite coal;
- the backwashing of a filter unit with the effluent from other units; and
- the elimination of rate-of-flow controllers which maintain a constant filtration velocity during the filter run.

Sand and anthracite filter media

Traditionally, only sand has been used for the filter bed, with a depth of 0,60 to 1.00 m. and a grain size of 0.4 to 1.2 mm. When backwashing the filter bed with upward flow, if expansion of the sand bed is produced, the finest grains (0.4 mm) rise to the top and the coarser (1.2 mm) remain below. Therefore, the permeability of the bed increases with depth and under these conditions the floc-particles that penetrate into it are less likely to be retained, the deeper they go inside the filter bed. In order to avoid such conditions the ideal scheme would be to invert the size grading of the media in such a way that the coarser material would be left near the top of the bed and the finer close to the bottom.

This cannot, however, be accomplished as long as sand alone is used and the filter is backwashed with upward flow and relatively high velocity. The studies of Baylis (8) first, and later those of Conley (9), showed the feasibility of placing a coarse media of low density such as anthracite ($S_g = 1.35$ to 1.70) over a fine but heavier media, like sand ($S_g = 2.65$ to 2.70). On backwashing these two layers with upflow, the coarse and lighter grains are left over the fine and heavier and, thus, the penetration and removal of impurities takes place in almost the full depth of the bed and, consequently, longer filter runs are secured.

This modification embodies distinct advantages, such as allowing higher filtration rates which are two or three times greater than the conventional ($120 \text{ m}^3/\text{m}^2/\text{d.}$) and, in consequence, a reduction in the filter area which has become only a half to one-third of the area formerly required.

Backwashing with the effluent from other units

Filter backwashing with this system has been practiced in Australia for a long time and, later, was successfully used with the Greenleaf filters, of which there are more than one hundred installations operating in different places in the United States and Canada. It has also been applied in South America on several

plants located in Colombia, Brazil, Peru, Bolivia and Dominican Republic. It is based on the fact that if the filter-effluent outlet is located at a higher level than that of the wash water trough and the filter units are interconnected, on closing the inlet and opening the drainage outlet, the water level in the filter box of the unit that is going to be backwashed, is lowered and this creates a positive head h_2 (see Fig. 1) which reverses the direction of flow through the filter bed and the backwashing is started with the effluent from the adjoining units that provide the upwash flow.

The required value of h_2 to produce a given expansion of the filter bed is a function of:

- the head loss in the underdrains; and
- the head loss required to keep the filter media in suspension.

If the underdrain system is properly designed, it is possible to limit the corresponding friction losses to only 20-30 cms. The use of patented underdrain systems generally causes much higher losses, since they are designed to compensate the high entrance velocity through the influent pipe, with the high head loss through the orificies which uniformly distribute the flow over the filtering area. By interconnecting the underdrain system, this is not necessary, because it is possible to decrease almost completely the entrance velocity of the backwash flow to operate with low head losses in the distributing orificies at the bottom. The loss of head required to keep the media in suspension is only about 35-50 cms. when sand and anthracite are employed. Therefore, the total head loss on backwashing a filter by this system ranges from 55 to 80 cms., and in this way the structures required are only slightly deeper than those of conventional plants, in which the high friction losses in the backwash piping are the cause of the super elevation of wash-water tanks.

Declining rate of filtration

The idea of declining velocity of filtration is not new, either. It was tested by Baylis (4) and Hudson (5) in 1959. Since then, treatment plants in the United States have been designed to operate under this system. Later on, Cleasby (6), in 1969, showed the feasibility of converting conventional filters to variable decline velocity systems and suggested modifications to the traditional design. Basically, the system consists in allowing each unit to filter at a declining rate in accordance with the progressive loss of permeability experienced during the filter run. For that purpose the use of any type of rate-of-flow controllers is eliminated, both at the inlet and outlet where sufficient head loss is produced

to prevent the filter from becoming empty at the start of a run when the bed is clean. That head loss may be introduced by means of an orifice, or a weir, or both. Many plants operate in this fashion in Latin America, such as those in Medellín (Colombia), Lima (Peru), Cuenca (Ecuador), Curitiba (Brazil) and New Loredo (Mexico).

Elimination of Filter Equipment

Combining the three basic ideas, already discussed, it is feasible to get away with most of the equipment which traditionally has been employed in filter installations.

This simplification has several advantages:

- the initial capital investment may be lowered to 60 per cent;
- costs of operation and maintenance are also considerably reduced;
- better water quality may be obtained with less effort.

Hydraulic control of the filters (which should be considered, as opposed to the traditional mechanical control), may be attained through a control weir. This weir may be placed in each filter unit, or a general one may be used for the whole battery. The operation of this type of filter unit is as follows:

When the filtering process is just starting, the liquid level is established slightly above the surface of the water flowing over the weir A (see fig. 2), in accordance with the initial head loss. As this gradually increases, the water level in the filter box begins to rise and the filtering velocity keeps declining until the maximum allowable water level is reached, as limited by the structural conditions of the system. At that moment it is necessary to backwash the filter.

In the first design (fig. 2), with interconnecting conduit and individual weir, in order to backwash each filter it is necessary to open, besides both individual gates (influent and drain), those that interconnect with the other units, in case they are kept closed to measure the flow produced by each one.

In the second design (fig. 3), with a common weir and wooden sluice gates, the only requirement is to operate two gates to start the backwashing. These two gates could be integrated into a single one with two positions: one, when sliding downwards, which would close the drain and open the inlet; and the second causing the opposite effect when sliding upwards. In this fashion, only a single gate would be required to operate the filter.

For an adequate design of this type of filter, it should be taken into account that:

- In order to make backwashing feasible, it is necessary that the flow produced by the whole plant be at least equal to that required for backwashing one filter unit, and preferably greater.
- For this reason, a minimum of four units should be designed so that they may operate with a surface load of $240 \text{ m}^3/\text{m}^2/\text{d.}$, in order to produce an upward velocity of no less than 0.60 m/min. (or a flow of 600 l /min/m^2). To accomplish this, sand and anthracite filter beds are commonly used.
- On closing the inlet valve of a filter, the others have to increase their filtration rate since an undiminished flow continues entering the plant. Therefore a sufficient number of filter units should be installed, so far as economic limitations allow, for a better distribution of the additional load that they receive when one or more of them are being backwashed.
- The influent channel should be able to carry the flow to any filter unit, at any time required, with a minimum loss of head.
- In any design, it must be possible to isolate each unit when repairs are needed, without restraining the free circulation of backwash flow among the other filters which are operating.

The advantages of the proposed system are as follows:

- There is a minimum of mechanical equipment. Only two valves or guaging sluice gates are needed for filter control. No device is required for guaging head-loss,* and rate-of-flow controllers, nor are operating tables, wash-water pumping equipment, a wash-water tank, a wash-water regulating valve, or a pipe-gallery are needed. Everything may be designed with concrete channels or box conduits.
- Backwashing is automatically controlled by the difference in level between the edge of the wash-water trough (F) and the top of the common weir at the effluent outlet. If this weir top is made movable, it is possible to increase or decrease the backwashing rate.
- Once the hydraulic head (h_2) is established, the backwashing operation starts slowly with the descending water level in the filter. There is no risk of an abrupt start in the expansion of the filter bed which may disturb the media.
- There is no possibility of producing a negative head loss.

* The total head-loss is the same for all filters and may be observed directly by measuring the height of water over weir A at the filter outlet.

- If the filters are not backwashed at the proper time, the plant flow decreases and there is a "backwater" effect in the system, which forces the operator to act immediately.

To describe the practical application of these systems a description is given of the treatment plants of Cochabamba (Bolivia) and Prudentopolis (Brazil) which are operating very successfully and were designed and constructed in accordance with the ideas and criteria previously explained.

Cochabamba Water Treatment Plant

The city of Cochabamba (Bolivia) is located in the heart of the Andes at an altitude of 2550 metres above sea level. It has an average temperature of 18 °C with a minimum of 3°C and maximum of 33°C. The present population numbers 160.000 and is expected to increase to about a quarter of a million by 1990.

The water demand now is 0.35 m³/sec. although the yield of the impounding reservoir is only 0.16 m³/sec. as an average, with a maximum yield of 0.25 m³/sec. The difference is partially supplied by ground water, but even so there is a production deficit at present. A plan for increasing the yield of the impounding reservoir up to 0.25 m³/sec. (average) is underway, but this expansion will not be operational before 1978.

Description of the plant

The Cala-Cala (Cochabamba) water treatment plant was designed to operate with a rate flow of 0.23 to 0.25 m³/sec. The physical and chemical characteristics of the water being treated are given in Table 1.

Table 1.

Physical and Chemical Characteristics of the Cochabamba Water Supply

Characteristics	Season	
	Dry	Rainy
Temperature, °C	12-20	8-12
Colour, CU	15-30	5-15
Turbidity, F.T.U.	2-40	2-600
pH Value	6.7-9.2	6.8-7.5
Total Alkalinity, mg/liter	10-25	6-40
Total hardness, mg/liter	40-85	10-134

The raw water is dosed with alum and lime. There are two gravity solution feeders of the constant-level type for aluminum-sulphate, housed in the small chemical building located near the raw water inlet, and a cone-shaped lime saturator. The coagulants are applied through a perforated pipe at the throat of a Parshall flume, and the mixing is produced by the hydraulic jump created downstream.

The plant has one 10.8 m x 2.2 m hydraulic flocculator provided with 71 removable wooden baffles of the horizontal-flow type. The total detention time for the flow of 0.16 m³/sec. is 25.4 min., and for 0.235 m³/sec. is 18.9 min.

The flocculation chamber is divided into three zones that have different spacing for the wooden baffles, and different velocities.

There are three 19.7 m x 5.10 m high-rate settling tanks in the plant, as may be seen in fig. 4. The total surface area is 100 m². In the final 11.2m. of the tanks' length 179 asbestos-cement plates are inserted at an angle of 60°, and at 5.5 cm., centre to centre distance. The width of the plates is 1.20 m. with a length of 2.40 m. and a thickness of 1 cm. They are supported by longitudinal concrete beams located at the centre and the walls of the tanks.

The plant has six high-rate filters with a length of 4.40 m. a width of 2.55 m. and a depth of 5.9 m. The filtering area per unit is 11.22 m². and the total filter area 67.3 m². The filter load for 0.235 m³/sec. is 300 m³/m²/d., and for 0.160 m³/sec. is 205 m³/m²/d. (see fig. 4).

The filter bed is made of sand-anthracite with the following specifications:

<u>Anthracite</u>		<u>Sand</u>	
Depth (m)	0.55	Depth (m)	0.20
Effective size (mm.)	1.0	Effective size (mm)	0.50
Uniformity coefficient	1.1	Uniformity coefficient	1.65

The filter bottom is made up with precast V-shaped concrete beams perforated at both faces of each beam with 1.48 cm. diameter holes. The space between the beams is filled with three layers hollow-plastic balls 5 cm. in diameter and filled with mortar. On this bottom 0.45 metres of graded gravel were laid. The whole filter bottom was made locally.

The filters operate as explained earlier. Only two sluice gates are required to backwash them. Closing the inlet and opening the drainage outlet the water level

in the filter box of the unit that has to be cleaned is lowered and the filtered water from the other units provides the upwash flow. The measured bed expansion obtained is 33 per cent, and no pumping or wash-water control or operating table is needed. To check on the filtered water quality, a pilot light has been left inside the clear water channel, which can be observed from above.

After filtration the water is disinfected with chlorine gas of the standard type, followed by a new application of lime to increase the pH value to saturation level. The chlorinator is located in the small administration building, near the filters that also house a fairly complete laboratory.

Cost and performance of the plant

The total construction cost of the plant amounted to US\$261,380.50 broken down as follows:

	%	US\$
Non-skilled labour	33.5	87,562.48
Skilled labour	2.0	5,227.50
Local supplies	54.08	141,354.30
Imported equipment	9.97	26,059.58
Project cost	0.45	1,176.21

The settled water turbidity has been varying between 1 F.T.U. with an average of 1.5 F.T.U. and the filtered water has been normally below 0.5 F.T.U. with an average of 0.35 F.T.U., but occasionally it gets higher (up to 2 F.T.U.) due to the sudden increase of the flow from 160 l/sec. to 250 l/sec. when it rains on the reservoir area. These occasional peak loads are accepted due to the scarcity of water supply for the city. Strangely enough, the plant has been responding very well to such peak loads and only a small deterioration of the filtered water quality has been observed during those periods when the alum dosage is not adjusted properly. Filter runs are from 70 to 80 hours. Filters are backwashed with water alone for eight to ten min. with 0.60 m/min vertical rise until the final turbidity is quite low.

Prudentópolis Water Treatment

Prudentópolis is a village located in the state of Paraná (South of Brazil), near the famous Iguazú Falls. At present it has 7485 inhabitants and it is expected that the population will be about 14,000 in 1992.

The present water demand is around $1,000 \text{ m}^3/\text{d}$. (11.5 liter/sec.). The raw water is pumped from a nearby river to the treatment plant.

The turbidity of this river water varies frequently throughout the year from 30 F.T.U. to 200 F.T.U. The most common values are between 40 to 70 F.T.U.

Description and capacity of the plant

The design of the plant is based on a modular pattern, each module having a capacity of $1,000 \text{ m}^3/\text{d}$, and is only 4 m. by 4 m. in size. At present only one module has been installed but two more may be added. (see fig. 6).

The plant consists of a hopper-bottom square tank with four 1 x 1 m. filters located at the corners, four 1 x 2 m. high-rate settling basins placed near the outside walls and at the centre a flocculation chamber with several compartments. The complete description of this type of plants is included in reference (10).

The raw water enters at the corner of the tank into a small chamber, 0.8 m. in length, 0.60 m. in width and 1.0 m. in depth, provided with a 0.35 m. circular weir. Aluminium sulphate is applied through three small diameter pipes at the outlet of this weir, taking advantage of the agitation of the falling water for mixing.

The coagulants are applied by means of simplified constant level solution feeders, similar to those used in Cochabamba housed in the second floor of the adjacent chemical building, so that the system operates by gravity. In the same place there is a lime saturation tank that is used for water alcalinization.

The flocculation process takes place in a 2 x 2 m. square tank with four compartments (see fig. 7). A 1/2 H.P. mechanical agitator is installed at the centre, with removable wooden paddles of different section so that the velocity gradient in the chamber decreases with depth.

The water enters at the top of the tank and has to circulate downward through the four compartments provided to avoid short circuiting, and leaves the flocculation chamber by six 150 mm. cast-iron pipes. The theoretical detention times is 25 minutes.

The four high-rate settling tanks are provided with 1 x 1 m. asbestos-cement plates placed at a 60° angle and 5 cm. centre to centre.

The four 1 x 1 m. filter units have a depth of 4.75 m. The filter load is $250 \text{ m}^3/\text{m}^2/\text{d}$. The filter media consists of sand and anthracite layers and the filter bottoms are similar to those of Cochabamba.

The settled water enters the filters through cast-iron pipes attached to a metal box located on the outside faces of the filter walls. To this metal box is connected also the drainage pipe. Two butterfly valves, installed in such a way that one closes when the other opens, are operated with the same handle; thus simplifying considerably the filter operation.

Backwashing is carried out by simply pulling the valves' control handle, so that the inlet valve closes and simultaneously the drainage valve opens. As all four filters are interconnected through a 300 mm. cast-iron pipe, the flow produced by the three units which are in operation returns through the drain pipe and circulates upward washing the filter.

To regulate the backwashing flow a periscopic pipe is left in the clear-water basin located in the chemical and control house, which can be raised or lowered to decrease or increase the upwash. The measured expansion of the filter bed is 70 per cent for a 0.65 m/min. backwashing velocity obtained after 30 seconds of starting the operation. A light type of anthracite is used. To disinfect the water, two vacuum-type chlorinators have been installed with a capacity of 12 kg of chlorine gas per day.

Construction costs

The total construction cost of the plant, including the chemical building was US\$35,000 and therefore, the unit cost per litre per second produced (considering capital investment only) is US\$3,043. This cost compares very favourably with that of a traditionally designed water treatment plant of the same size, which cost ranges between US\$4,500 and US\$6,000.

The normal maintenance cost of the plant cannot be accurately estimated at present, due to the testing programme that is being carried out, the additional expenses of which increase the operational cost.

However, the equipment to be maintained consists only of the flocculator motor, the chlorinators and the two small injection pumps.

The normal activities of plant operation involve the control of the coagulation process including daily jar tests, filter backwashing that is done simply by lifting the control handle, and drainage of the hopper bottom tank that is accomplished by opening a valve for 30 sec. All these activities may be performed by an unskilled operator, except for the jar tests, but this is an unavoidable difficulty in any design or operation of a treatment plant.

Performance records

The Prudentópolis Water Treatment Plant has been operating for nearly a year without any major problem. Careful tests have been carried out daily, and sometimes hourly, to evaluate its performance.

In figures 8 and 9 are included 48-hour data of the operational records that may be considered as typical.

As shown in figure 8, the raw water turbidity changes during the stated period between 70 and 30 F.T.U. and settled water turbidity (except during two hours of operational difficulties with the coagulation process) between 3 and 4 F.T.U., which may be considered as excellent performance.

The filtered water turbidity was below 0.5 F.T.U. all the time not excepting the poor coagulation period. The average value was 0.2 F.T.U.

Treatment plant upgrading

The use of modern technology allows the engineer to increase the production capacity of an existing water treatment plant, from 50 to 120 per cent with a minimum of capital investment. This is achieved by making a careful study of the operational conditions of the plant from two different points of view:

- process characteristics; and
- hydraulic characteristics

The first one involves an extensive laboratory investigation of the physical and chemical parameters of the water and the way in which such parameters are affecting the different processes in the plant. In many cases pilot plant studies (especially pilot filters) have to be conducted during a period of six months to a year, to determine the interrelationship between the different variables and the possibility of upgrading the output of the units without deterioration of the water quality which is the main purpose for investigating the processes.

However, the maximum safe production that a unit can give maintaining the same level of performance, can be constrained by the hydraulic capacity of the system. In many cases this is the main limitation due the difficulties arising from changing pipes and fittings, especially in crowded filter galleries.

Therefore, the investigation of the hydraulic characteristics of the plant becomes one of the basic tasks that have to be undertaken to upgrade such a plant.

Normally, hydraulic profiles of all the units for different flows are prepared to pin-point the main bottle-necks in the system and then an economic comparison is made between the costs of new units and of using the existing ones and increasing the transfer capacity of the corresponding conduits. Only then can a complete plan of modifications of the treatment facilities, stage by stage, be outlined.

Many of the largest treatment plants in Latin America have been expanded in this way, such as: Tibitoc (Bogotá, Colombia) from 3 to 14 m³/sec. Guandú (Rio de Janeiro, Brazil) from 8 to 15 m³/sec.; La Atajea (Lima, Perú) from 7 to 10 m³/sec. Curitiba (Curitiba, Brazil) from 1 to 2 m³/sec. ABC (Sao Paulo, Brazil) from 2.5 to 9.0 m³/sec.; Las Vizcachitas (Santiago de Chile) from 4 to 10 m³/sec.; and la Toma (Guayaquil, Ecuador) from 2 to 5.5 m³/sec. (these last two in design stage). In all but the first mentioned plants no new units were installed. Systems like dual-media filter beds, declining-rate filtration, or tube settlers, were employed.

There are, of course, many other plants throughout the world that have had similar modifications to upgrade their capacity.

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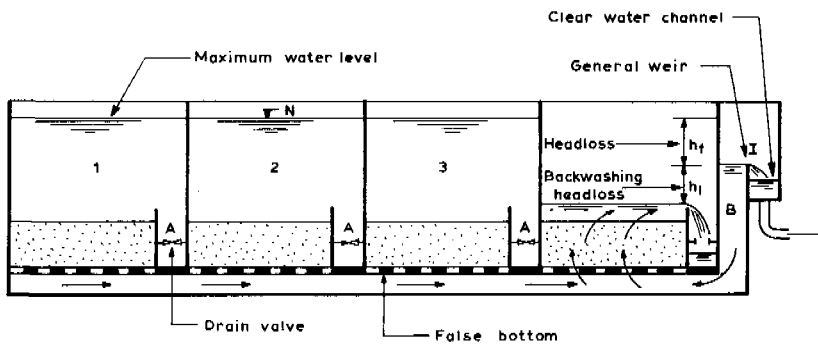


Fig. 1 - BACKWASHING OF ONE FILTER WITH THE FLOW OF THE OTHERS

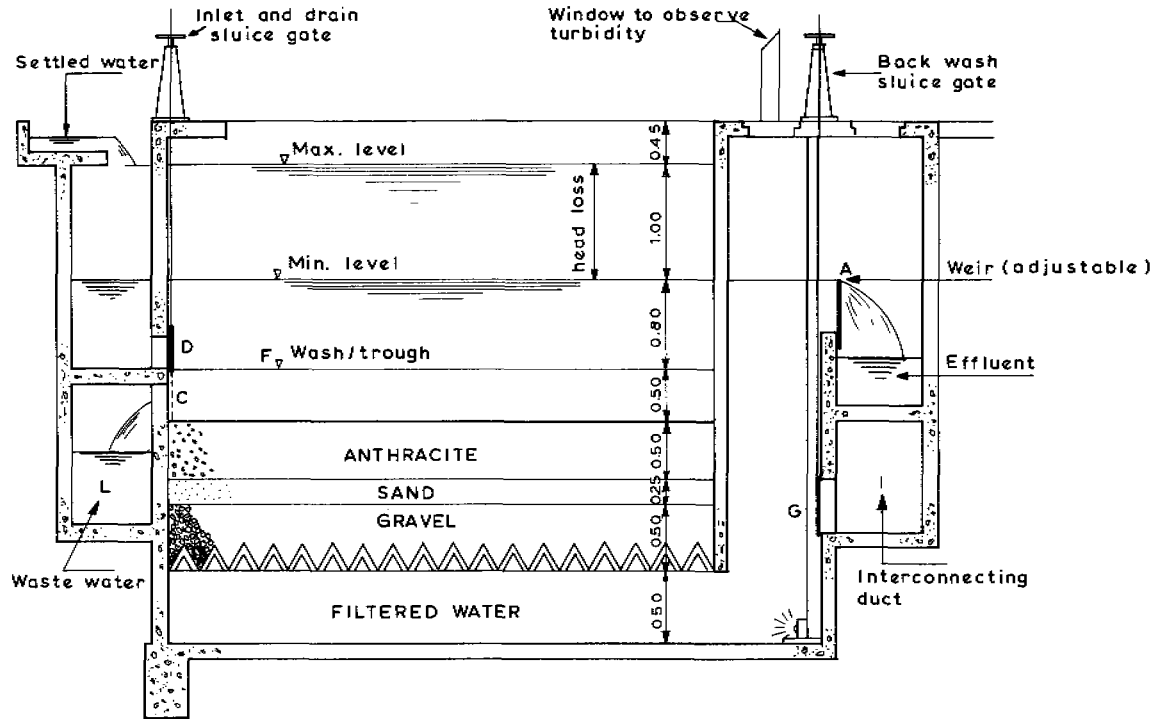


Fig. 2 - FILTER WITH INDIVIDUAL OVERFLOW WEIR IN EACH UNIT

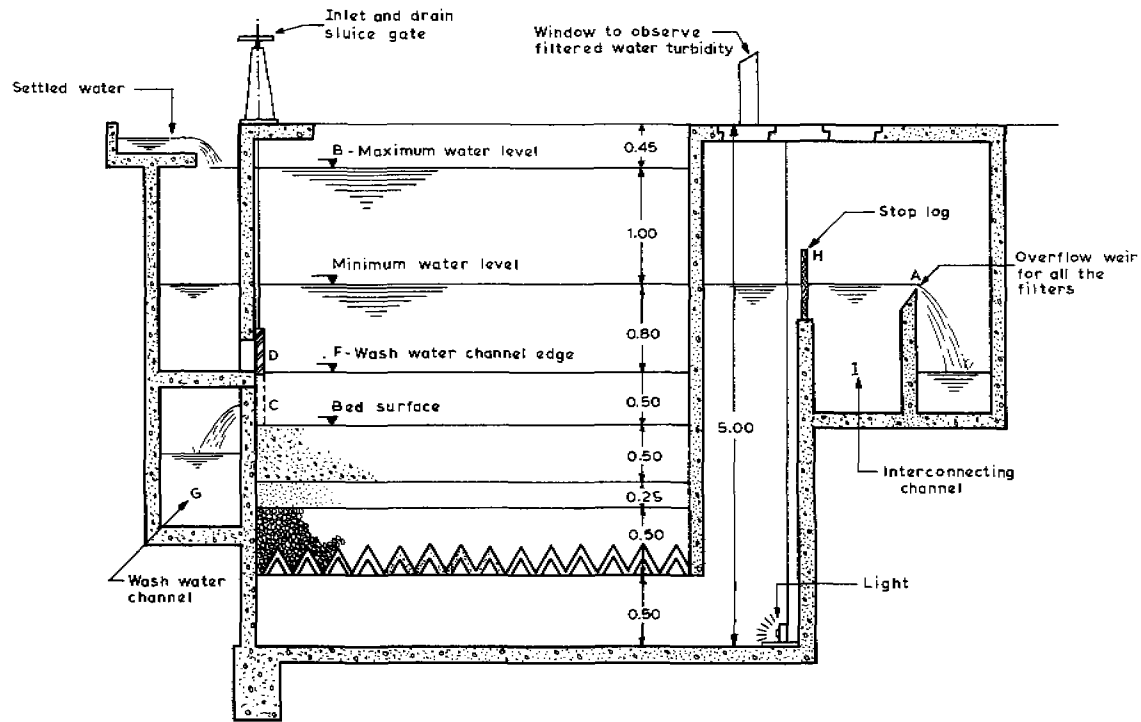


Fig.3 - FILTER WITH A GENERAL OVERFLOW WEIR.

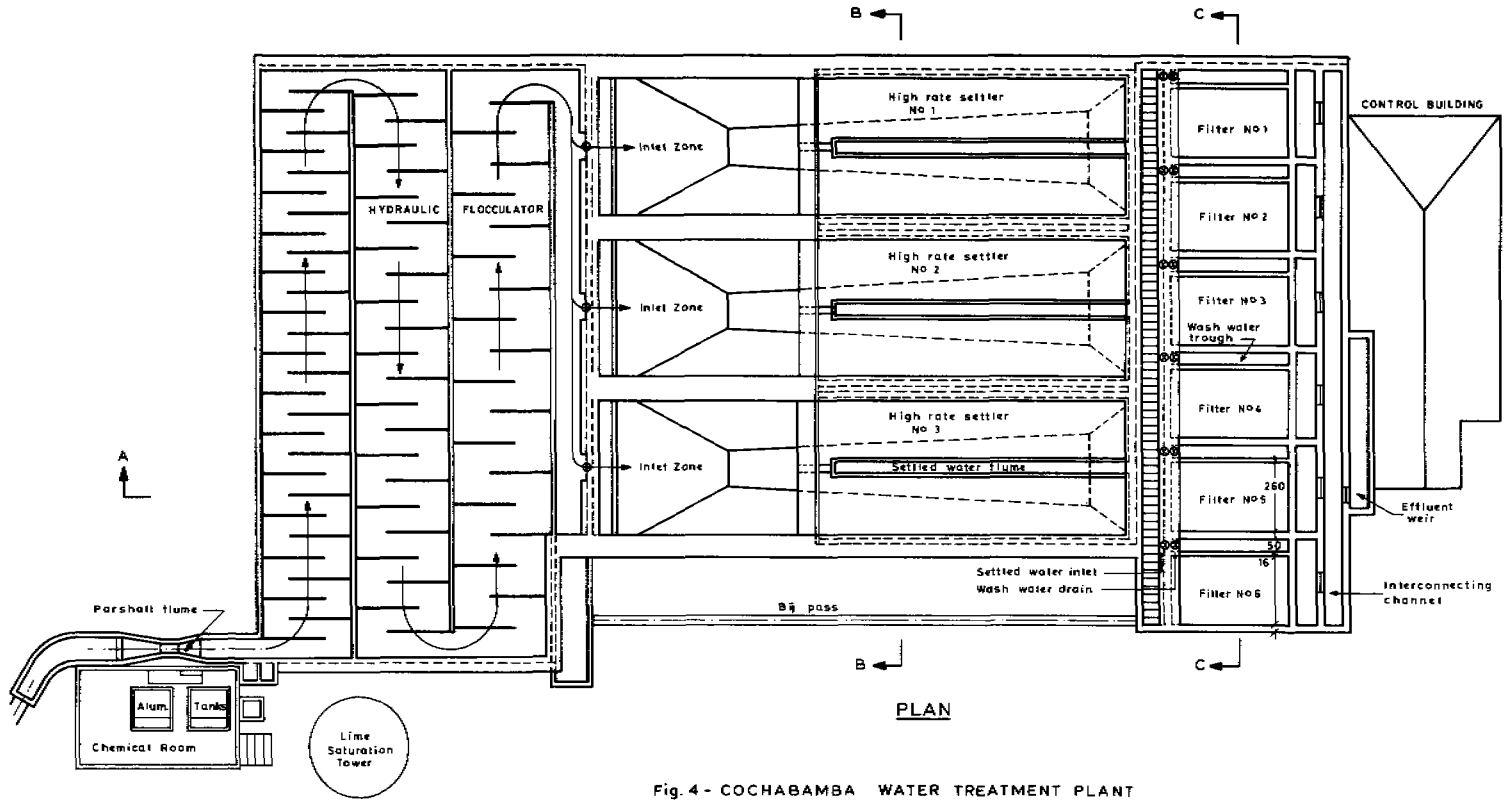


Fig. 4 - COCHABAMBA WATER TREATMENT PLANT (BOLIVIA)

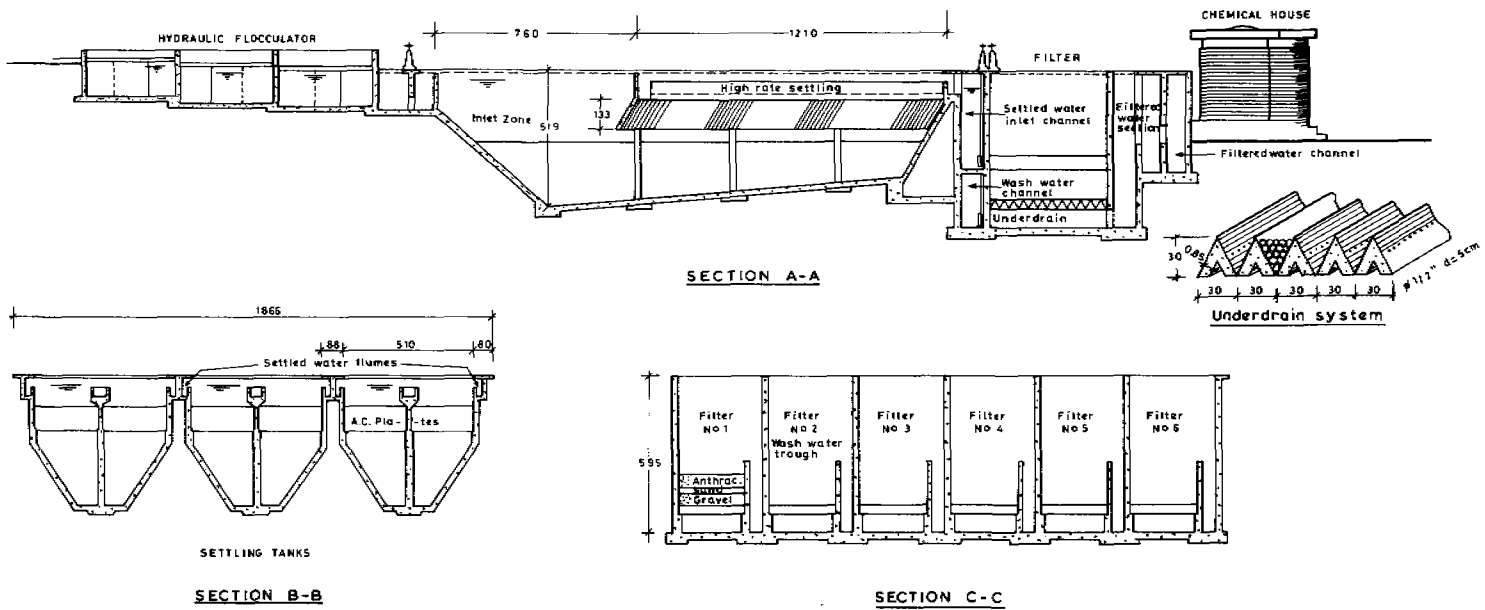
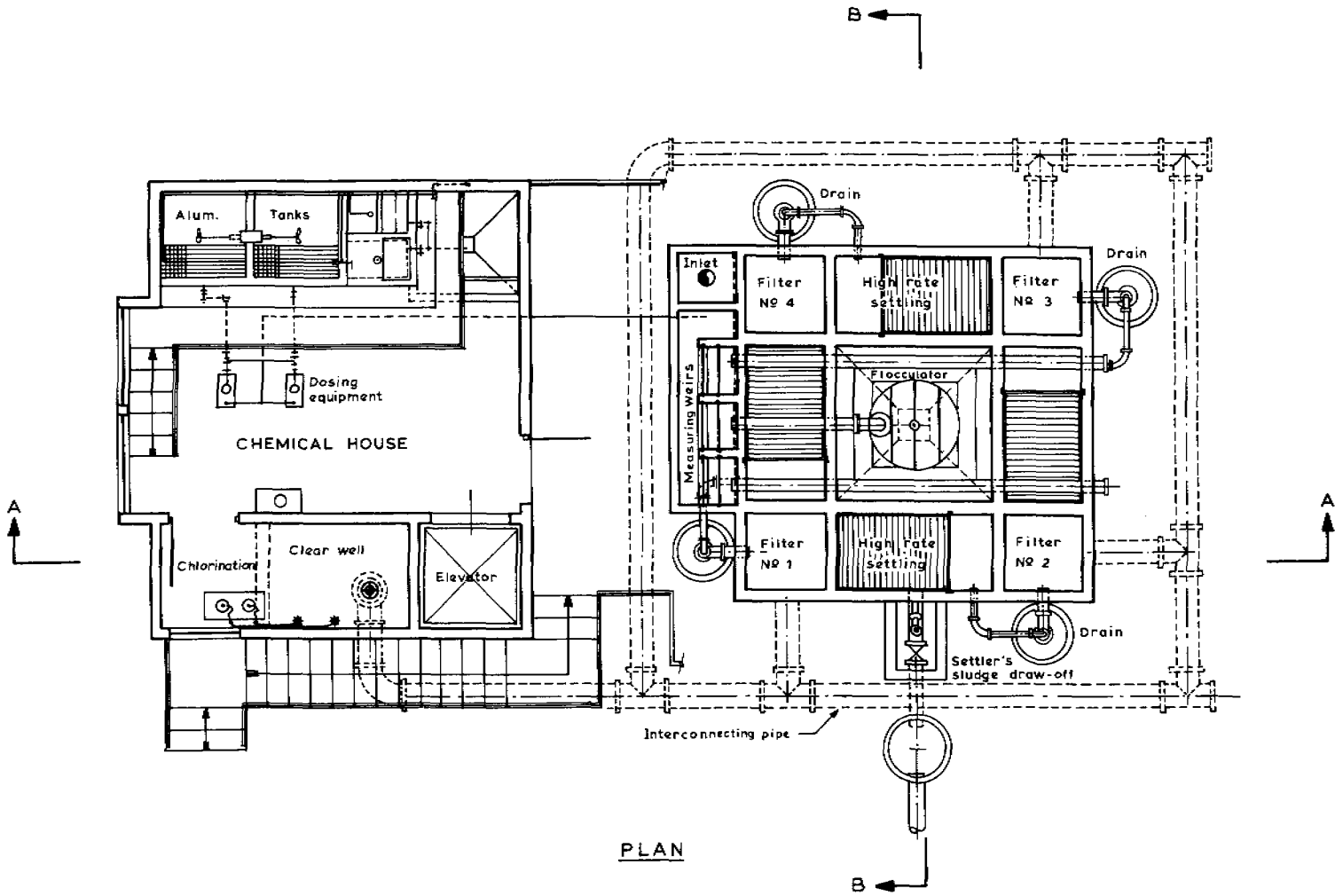


Fig. 5- COCHABAMBA WATER TREATMENT PLANT (BOLIVIA)



PLAN

Fig. 6 - PRUDENTOPOLIS WATER TREATMENT PLANT (BRAZIL)

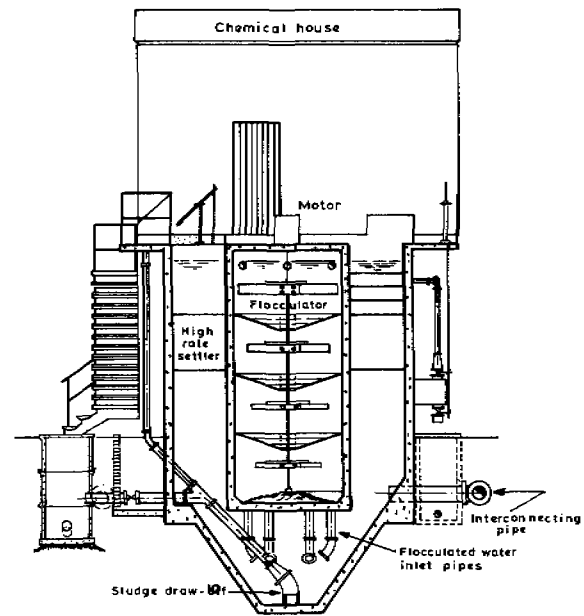
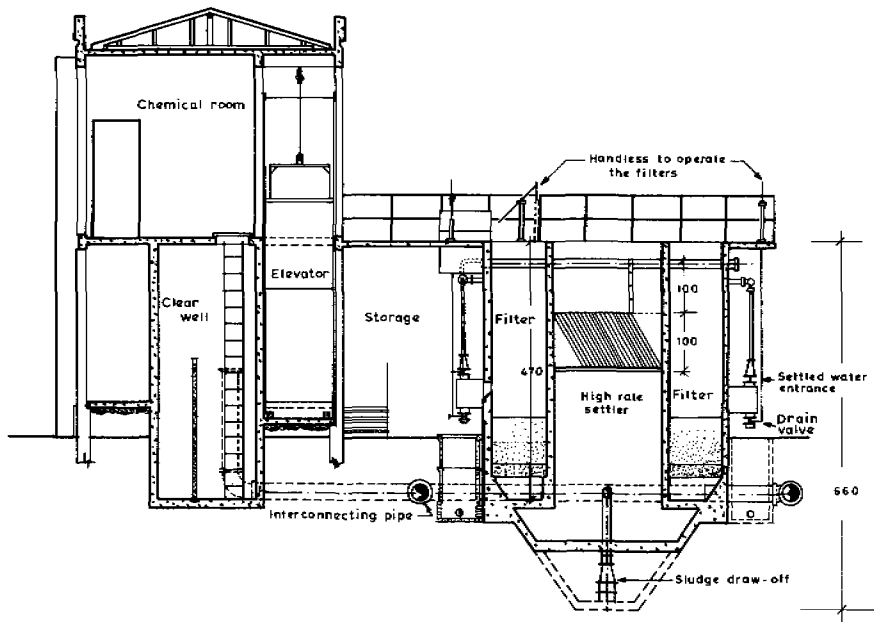


Fig.7- PRUDENTOPOLIS WATER TREATMENT PLANT (BRAZIL)

PRUDENTOPOLIS WATER TREATMENT PLANT
(BRAZIL)

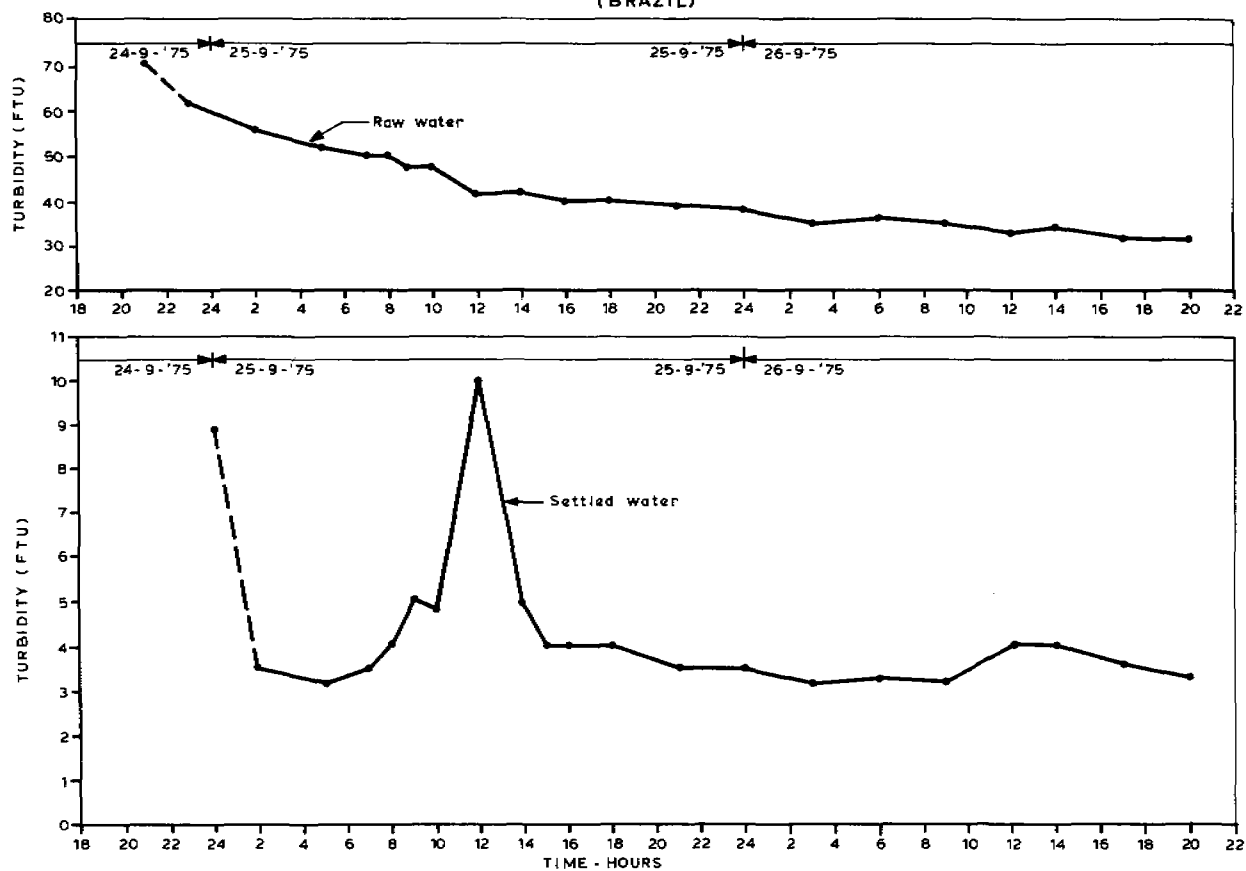


Fig. 8 - HIGH RATE SETTLERS PERFORMANCE

PRUDENTOPOLIS WATER TREATMENT PLANT
(BRAZIL)

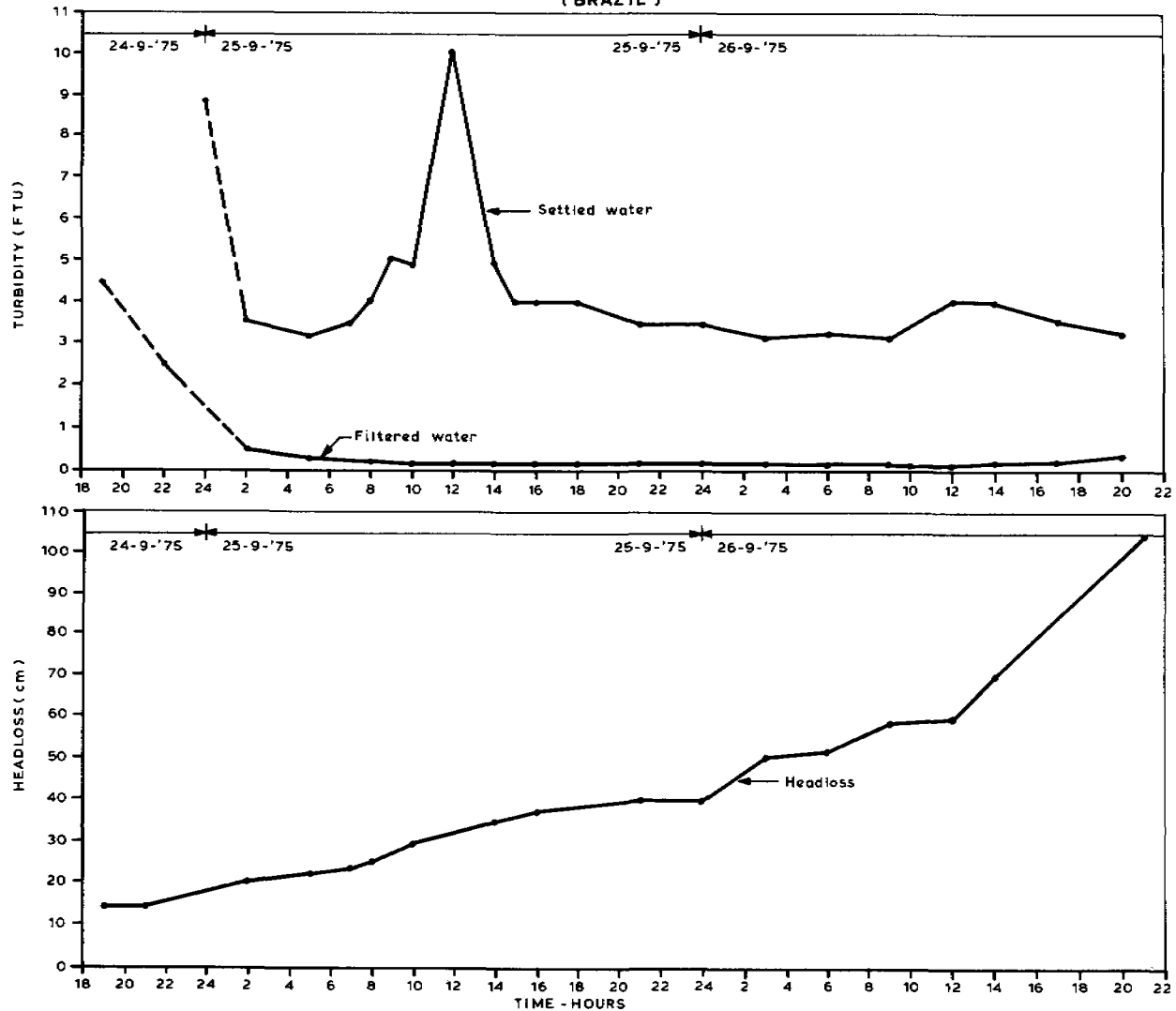


Fig. 9 - DUAL MEDIA HIGH RATE FILTER PERFORMANCE

LOW COST DISTRIBUTION SYSTEMS

by

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Brazil

September, 1976

LOW COST DISTRIBUTION SYSTEMS

1. Introduction

The distribution network is the most expensive part of conventional water supply systems, with costs usually exceeding 50 per cent of the total investment, and running at times as high as 65 or even 70 per cent.

For this very reason, the distribution network merits greater attention from all experts engaged in the overall efforts to reduce costs in order to expand and "popularize" potable water supply systems.

Experience shows that considerable economy can be obtained in the design of distribution networks, particularly in designs conceived for rural communities and small towns.

It is now evident that throughout this century continuous progress has been made in the area of engineering design for waterworks, not only in respect to technical requirements but also regarding greater sophistication.

In industrialized countries and particularly in the modern metropolitan areas, the era and conditions under which potable water supply systems were developed, seem to have been long forgotten, and the technology being adopted in those places may be considered incompatible with the real needs of developing regions.

It is worth remembering, however, that in some developing countries the development process lags 50 or more years behind the industrialized nations and for these countries interesting solutions can be found in history records.

2. Project Criteria and Parameters

Costs of water distribution systems are highly influenced by project criteria and parameters. In industrialized areas, for instance, project criteria always take into account several additional factors other than those expressing residential water demand, of which typical examples are fire fighting facilities, industrial water supply and water for air conditioning facilities.

In small rural communities where no public water supply systems are available at all, these factors are not relevant. The sole requirement in such areas is the

supply of good quality water to the local population.

In less complex waterworks, the hydraulic system is specifically designed to meet consumption requirements of a domestic nature.

A comparison between design parameters is illustrated in Table I.

TABLE I - DESIGN PARAMETERS

PARAMETERS	DEVELOPED COUNTRIES	DEVELOPING COUNTRIES	
		URBAN CENTERS	RURAL COMMUNITIES
Per Capita Consumption Litres/day	200-600	150-300	60-120
Minimum Pressure m H ₂ O	20-50	15	8
Minimum Diameter mm	150	50	30

3. Water Consumption and Flow Patterns

The volume of water consumed in a given community is determined by a great number of factors which will not be dealt with in detail here due to the limited space available. Nevertheless, two of these factors deserve closer attention on account of their importance to this analysis.

The first of these factors refers to the pressure in the distribution mains. With lower pressures, so long as they are appropriate for ordinary use and sufficient to ensure good water quality, consumption is considerably reduced. In rural communities where no high-rise buildings exist, residential plumbing facilities do not require high pressures.

A second important factor is the form of supply, that is to say, the type of residential plumbing facility used. Three typical instances can be considered initially.

Case A - Existence of a single plumbing fixture in each dwelling: one tap directly connected to the network;

Case B - Existence of minimal plumbing comprising several fixtures all connected to a roof water tank;

Case C - Plumbing facilities comprising several fixtures directly linked to the public water supply system without the use of roof tanks.

In first instance (A), consumption per capita is lower and peak flow in the main is determined by the probability of simultaneous use.

In the two other cases (B, C), consumption remains at practically the same levels, but simultaneous demand varies greatly. In case B there is a moment when all tanks are being supplied at the same time. In case C, maximum instant consumption depends upon the probability of a number of plumbing fixtures being in use simultaneously.

4. Fluctuations in Consumption

Water distribution networks are conceived for maximum expected flow ratings. Such flow ratings may be determined by statistical data, probabilistic methods or simultaneous use criteria.

Flow rates for the three examples above may be estimated according to the following assumptions: (Fig. 1).

Number of connections per 80 metres of piping	16
Number of persons per connection	5
Number of persons per 80 metres of piping	80
Number of persons per metre of piping	1
Average water consumption per user, litres/day	85
Coefficient of variation of consumption	4
Theoretical consumption per metre of main.	

$$\frac{85 \times 4}{86400} = 0.004 \text{ litres/s/m}$$

TABLE II Flow Ratings in the System

	1 Connection Q, litres/s	L = 100 m				L = 200 m				L = 400 m				L = 800 m			
		No. Con.	$\sum p$	l/s	q (1)	No. Con.	Ep	Q _l /s	q	No. Con.	Ep	Q _l /s	q	No. Con.	$\sum p$	Q _l /s	q
CASE A	0,3 (1)	16	16	1,2	0,012	32	32	1,7	0,008	64	64	2,4	0,006	128	128	3,4	0,004
CASE B	0,025 (2)	16	-	0,4	0,004	32	-	0,8	0,004	64	-	1,6	0,004	128	-	3,2	0,004
CASE C	0,6 (3)	16	24	2,4	0,024	32	128	3,4	0,016	64	256	4,8	0,012	128	512	6,8	0,008

- Notes: (1) q - flow rating litres/s/m
 (2) Q is calculated by the probabilistic expression.

$$Q = 0.3 \sqrt{\sum p}$$

where p is the weight of plumbing fixtures in use:

- kitchen sink 0.7
- laundry tub 0.7
- bath shower 0.5
- toilet 0.3
- lavatory 0.7
- outdoor tap 1.0

$$\sum p = 3.9$$

Thence,

$$Q = 0.3 \sqrt{3.9} = 0.6 \text{ litres/s}$$

- (3) Q represents the average flow of a float valve between the limits of 0 and 0,05 litres/s (shut-off and partly open).

The end portion of the distributing main which will supply a small number of consumers is subject to the greatest fluctuations in flow. Over a certain distance along the pipe, fluctuations are less severe therefore water flow gets closer to the averages. Hence the probable flow curves for case A will overlap plotted lines for case B at 800 metres along the extension of the pipe, whereas probable flow curves for case C will only reach average values at 1200 m. (Fig.2)

Comparison of the values obtained for cases B and C reveals the extent of the influence and importance of residential water tanks to the criteria used in determining pipe sizes in distribution networks.

5. Minimum Size of Mains

The minimum size of mains in a water distribution system is determined by norms and specifications. Selection of sizes is usually based in one of the two following hydraulic factors:

- a) velocity limits (0.50 to 1.50 m/s);
- b) loss of head limit (0.003 to 0.02 m/m).

In the North American urban centres, the minimum diameter of mains is usually 6", this choice being essentially due to technical requirements for fire fighting facilities. However, until late in the last century, smaller diameters (100 mm, 75 mm and 60 mm) were still accepted.

Diameters equal or over 30 mm may be adopted for rural areas, since the only requirement is adequate hydraulic behaviour for residential needs.

The maximum admissible pipe extensions for each specific diameter can be estimated on the basis of hydraulic limits of theoretical uniform flow per metre of pipe. Typical data for determining size is shown in Table III.

Table III - Maximum length for plastic pipes, per diameter (For $V = 0.75$ m/s)

D		Q max.	J max	Maximum Length
inches	mm	litres/s	m/m	m
1½"	30	0.6	0.023	150
1½"	40	0.9	0.020	220
2"	50	1.5	0.015	375
2½"	60	2.1	0.011	525
3"	75	3.4	0.009	850
4"	100	6.0	0.007	1500
6"	150	13.3	0.004	3325

(J = loss of head per metre).

A table such as the one above can greatly facilitate design and work of field technicians.

6. Example of Calculation

The following simplified example considers a water main extending for 800 metres starting at a reservoir and supplying 128 connections for 640 inhabitants.

Table IV shows the flow ratings and diameters for each pipe stretch and Table V indicates losses of head as well as pressures.

Table IV - Flow Ratings and diameters

Pipe Stretch	Case A		Case B		Case C	
	Q l/s	D	Q l/s	D	Q l/s	D
AB	1.2	1½"	0.4	1½"	2.4	2"
BC	1.7	1½"	0.8	1½"	3.4	2½"
CD	2.1	2"	1.2	2"	4.2	2½"
DE	2.4	2"	1.6	2½"	4.8	3"
EF	2.7	2"	2.0	2½"	5.4	3"
FG	2.9	2"	2.4	3"	5.8	3"
GH	3.2	2½"	2.8	3"	6.4	3"
HI	3.4	2½"	3.2	3"	6.8	3"

Table V - Pressure

Pipe stretch	Accum. Lengths	Q litres/s	D in.	J m/m	h _f m	Pressure m (1)
AB	100	0.4	1½"	0.013	1.30	8.00(2)
BC	200	0.8	1½"	0.014	1.40	9.30
CD	300	1.2	2"	0.010	1.00	10.70
DE	400	1.6	2½"	0.007	0.70	11.70
EF	500	2.0	2½"	0.010	1.00	12.40
FG	600	2.4	3"	0.005	0.50	13.40
GH	700	2.8	3"	0.007	0.70	13.90
HI	800	3.2	3"	0.008	0.80	14.60
I						15.40

Note: (1) Considering level ground

(2) Minimum pressure accepted

7. Economic models of Distribution Networks

In accordance with the above considerations, some economic models or patterns for distribution network layout can be developed.

In the case of very small communities and population clusters, the generally occurring distribution system is branch-like. (Fig. 4).

In such cases, diameters are determined in accordance with the example given in item 6 above. (Fig. 3). Total extension of mains determines the larger diameters (Table III).

Larger communities have more complex water distribution networks with hydraulic circuits and interconnections.

The conventional or classical solution for a network of this type consists in linking all pipes, the result being the need for a substantial number of special parts (tees, crosses, reducers), and valves. (Fig. 6).

A much simpler solution, already introduced successfully, permits the installation of the secondary piping of minimal diameter without interconnecting them at the crosses (Fig. 6.).

Another even more economic solution permits the installation of mains in alternate streets which means covering 50 per cent of the streets, while supply is made through block loops of a very small diameter (Fig. 7).

In the latter example, each small block loop measuring 240 m in length can supply 240 consumers (Fig. 8). Hydraulic conditions are the following:

$$L = \frac{240}{2} = 120 \text{ m}$$

$$Q = 120 \times 0.004 = 0.48 \text{ litres/s}$$

$$D = 1\frac{1}{4}'' \text{ (30 mm)}$$

$$J = 0.02 \frac{\text{m}}{\text{m}}$$

$$h_f = 120 \times 0.02 \times \frac{1}{3} = 0.80 \text{ m}$$

The examples shown give an idea of the different possibilities for simplification and cost reduction of distribution networks, leaving it to the ingenuity of designers to find the best solutions to benefit the lower-income population.

SUMMARY

The distribution network is the most expensive part of conventional water supply systems, with cost usually exceeding 50 per cent of the total investment.

The application of modest but realistic design parameters and the adoption of less complex model affords substantial cost reduction.

In industrialized countries, the usual approach consists in adopting relatively large diameters for distributing mains, in line with high consumption conditions and firefighting requirements.

In small communities of developing countries, distribution networks may be designed for the exclusive purpose of meeting residential needs under less demanding hydraulic requirements.

The author makes a brief analysis of these requirements and outlines some examples of economical solutions.

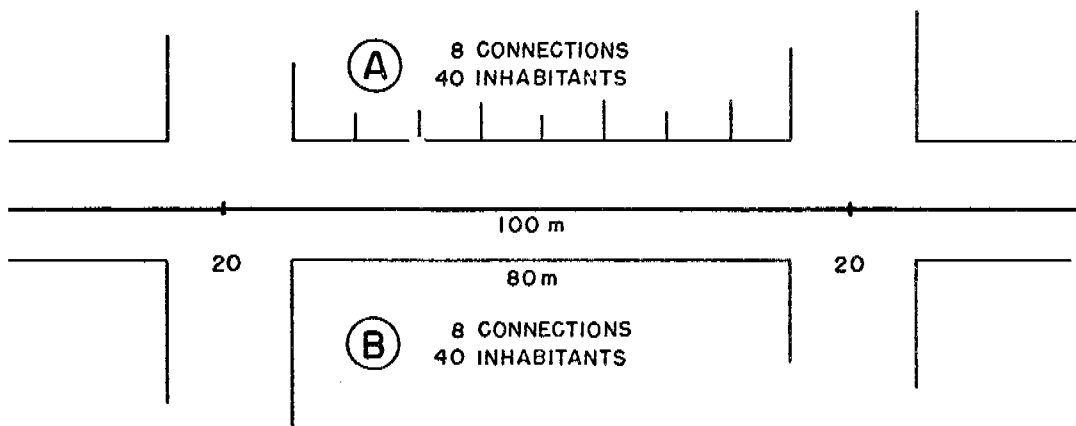
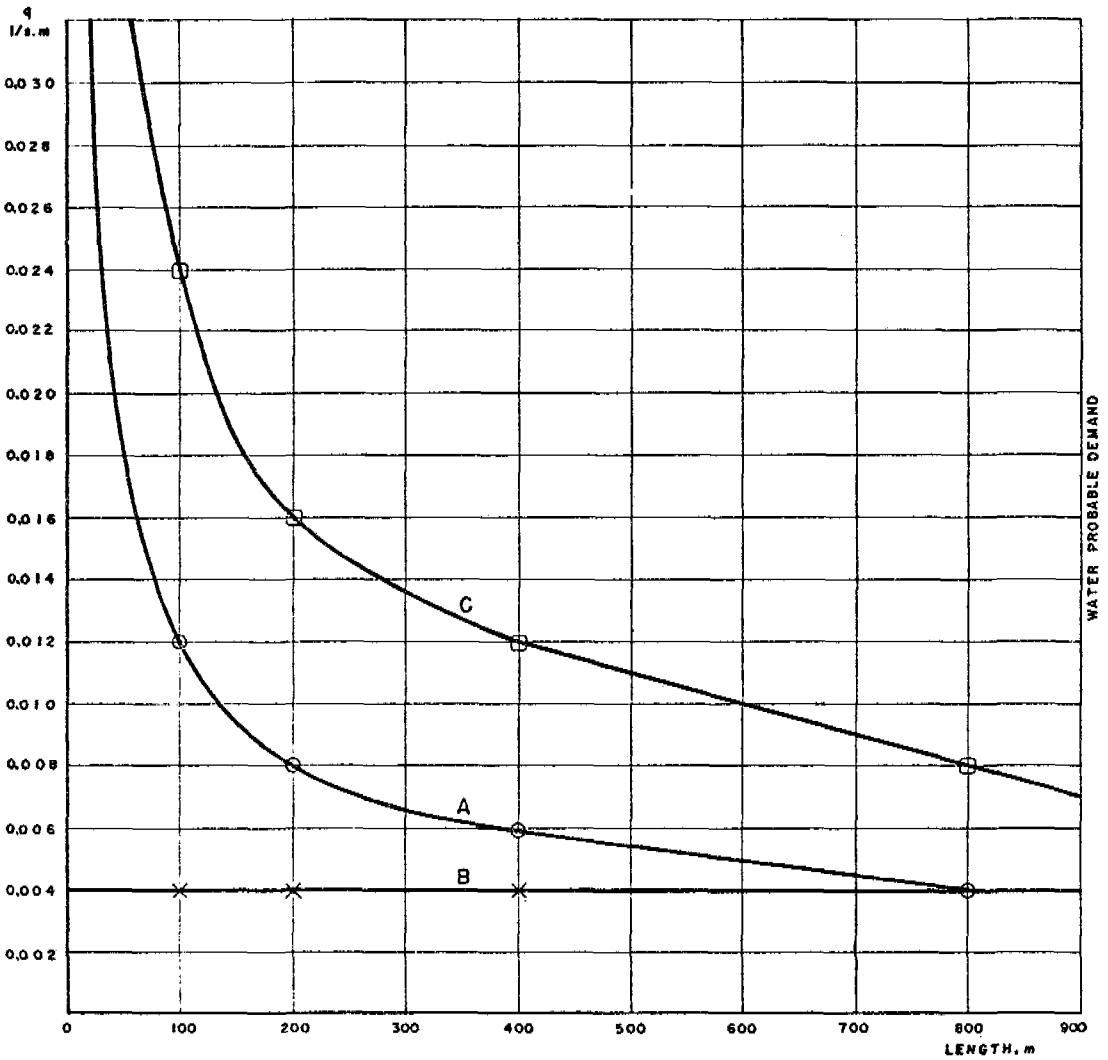


FIG.1

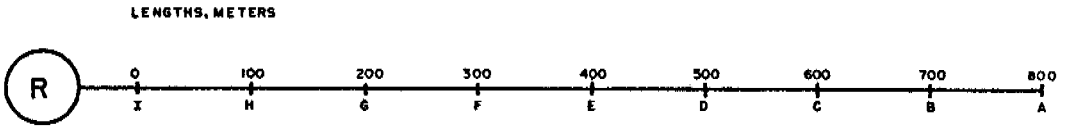
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- A = ONE TAP/CONNECTION, DIRECT SUPPLY (ONE FIXTURE).
- B = INTERNAL PLUMBING WITH ROOF TANK.
- C = INTERNAL PLUMBING (6 FIXTURES) WITHOUT ROOF TANK.

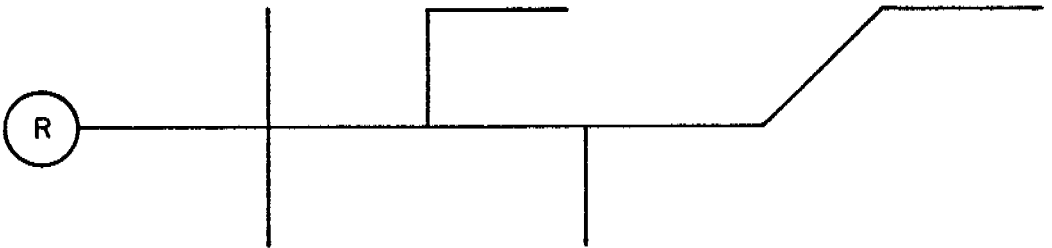
FIG.2

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(LINEAR DISTRIBUTION)

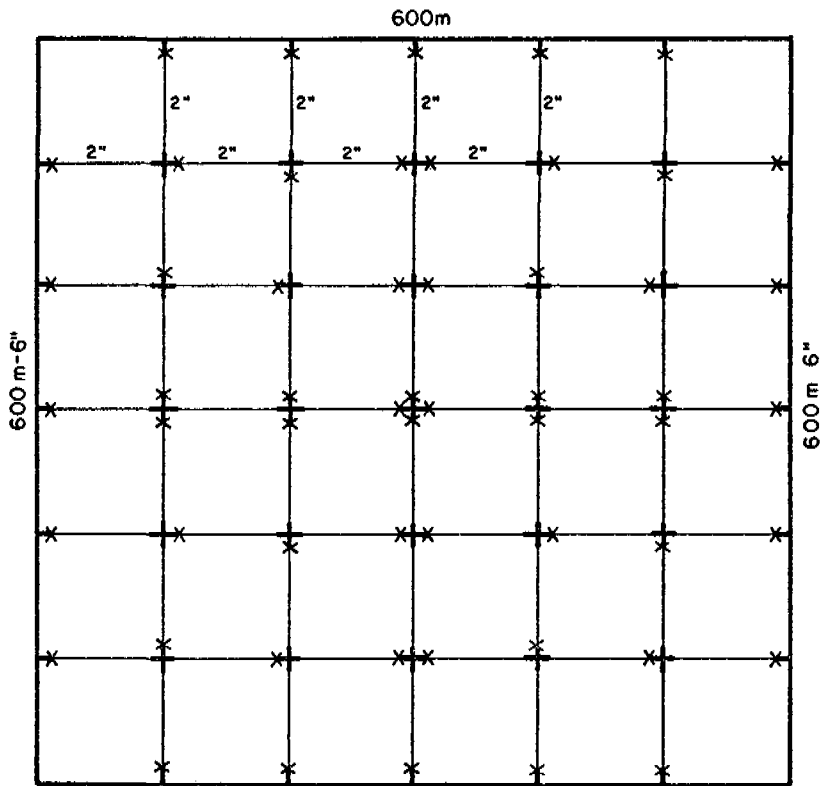
FIG.3



(BRANCH SYSTEM)

FIG.4

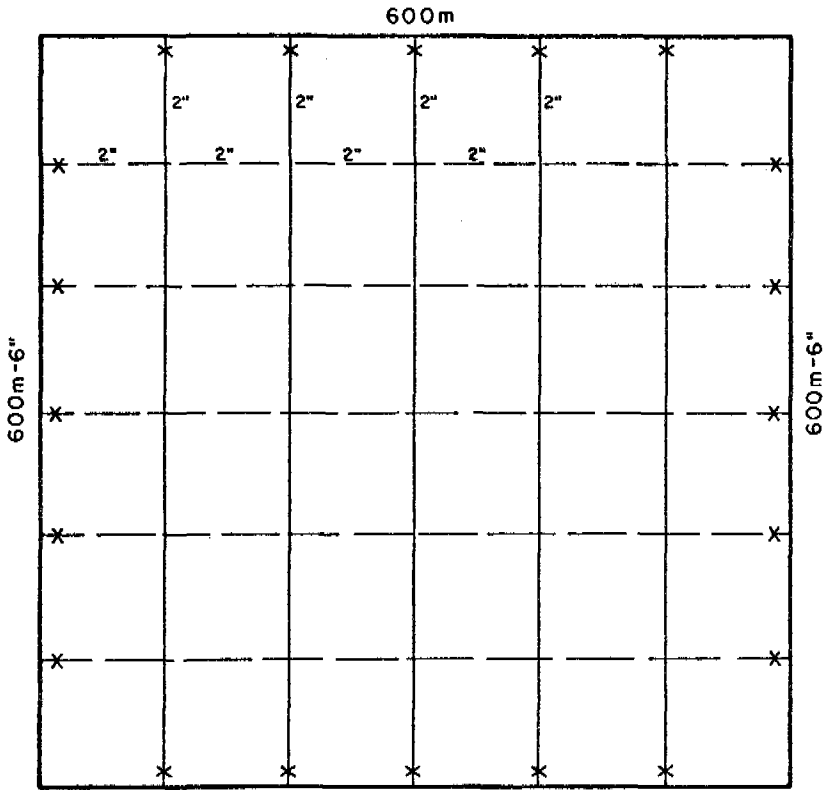
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INTERCONNECTED MAINS

FIG.5

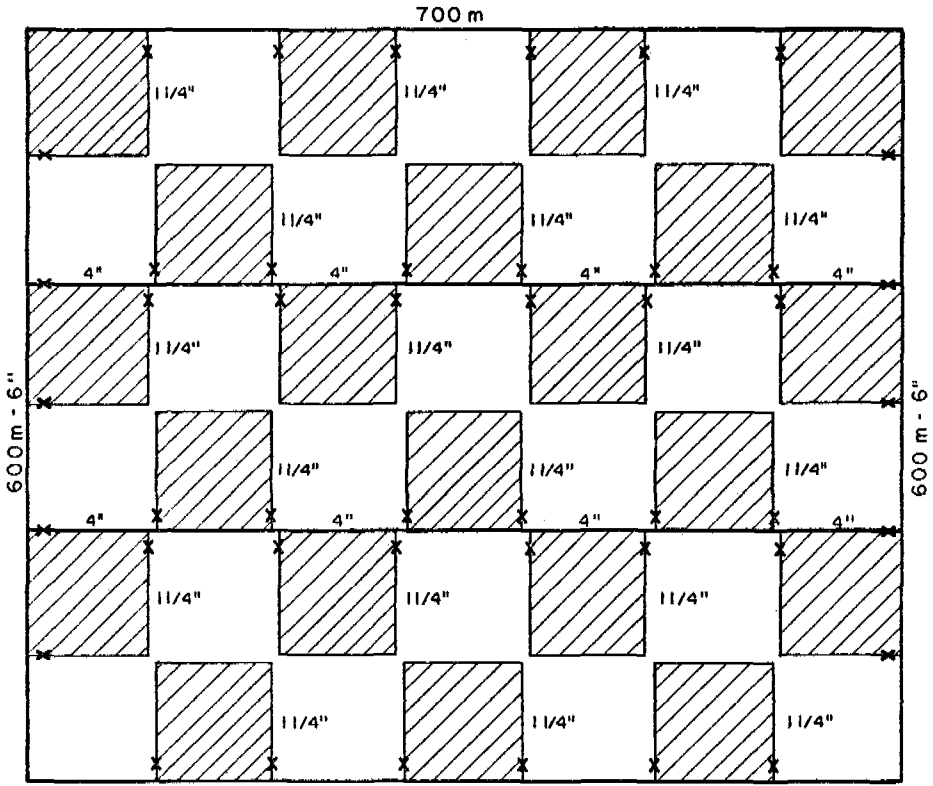
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OVER-CROSSING SINGLE MAINS

FIG.6

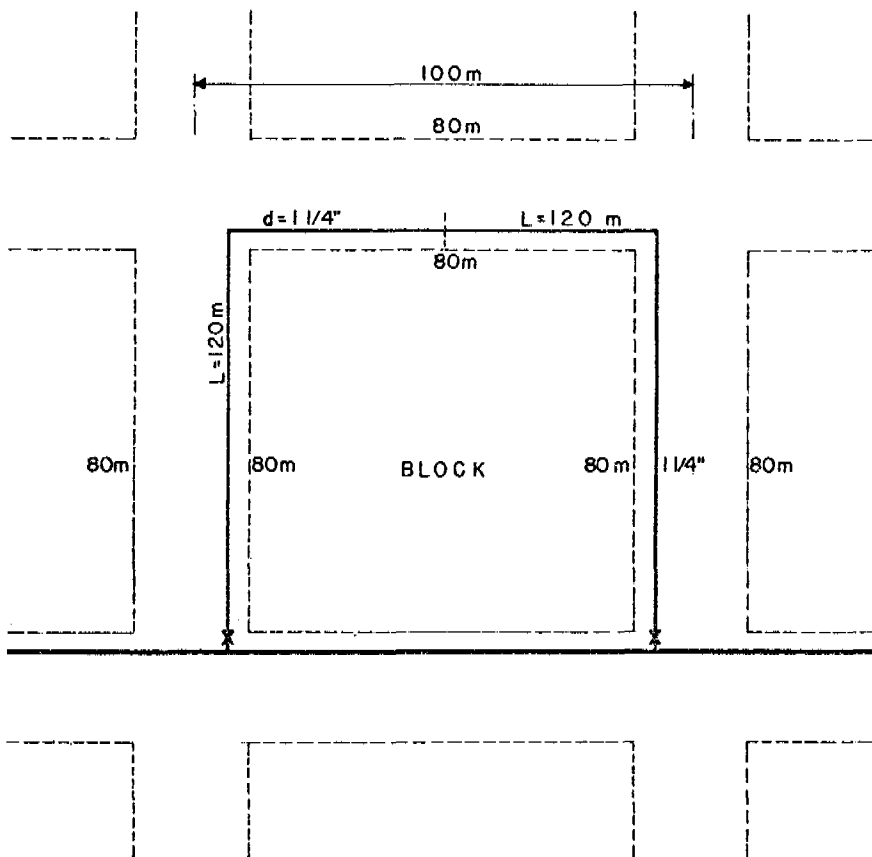
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SMALL LOOPING SYSTEM

FIG.7

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BLOCK LOOP

FIG.8

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