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TRH 10

WATER AND SANITATION IN SLUMS AND SHANTY TOWN.

WATER AND SANITATION IN SLUMS AND SHANTY TOWNS

A Review of Conditions and Some Options for Improvements prepared for the Urban Section, the Water, Environmental and Sanitation Team, and the Programme Development and Planning Division, UNICEF by

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New York, May 1980

This report on water and sanitation in low-income urban areas was originally prepared as one of a series of documents to be used in the Water and Sanitation Workshops held by UNICEF in Asia, Africa and Latin America in 1980 and 1981. Although the document has served that purpose, there have been numerous requests for additional copies which have not been available. Consequently, a slightly edited version of the original document has been prepared by the author in order to respond to this demand. The conclusions and views expressed in this document are those of the author. The fact that there is additional demand speaks of the usefulness of this document to UNICEF Field Staff.

ACKNOWLEDGEMENTS

The major sources for the first draft of this report were the papers of the World Bank Research Project: "Appropriate Technology for Water Supply and Waste Disposal in Developing Countries" of the Transportation, Water and Telecommunications Department, and reports of a UNDP Technical Advisory Group (TAG) managed by the same department of the World Bank. a/

The following people were kind enough to let me have copies of these and other papers and to share their thoughts: Messrs. Middleton (Washington), Reed (London), and Rau (New Delhi) of the World Bank TAG; Dr. Feachem of the Ross Institute, London; Dr. Balance and Mr. Stevens at the WHO Headquarters, Geneva; Ms. Van Wijk Sijbesma of the WHO International Research Center, The Hague; Mr. Howard, OXFAM, England; Mr. Pathak, Secretary of the Sulabh Shauchalaya Sansthan, Patna, India; Dr. Cousins and Mr. Besa at UNICEF, New Delhi.

The first draft was sent to UNICEF Field Staff and to some of the people whose advice had been sought earlier. I would like to thank all of those who took the time and trouble to review the report, Mr. Donohue of UNICEF for giving me an opportunity to revise it, Ms. Glasgow of the UNICEF Water, Environmental and Sanitation Team who made an excellent collation of readers' comments and many editorial suggestions, Ms. O'Connor for editorial help and to Ms. Sweeney for retyping the report at UNICEF Headquarters.

I have attempted to correct technical errors and to incorporate the qualifications and suggestions made by readers. The answer to a question raised by some people is that the report is intended mainly for UNICEF Programme Staff in the hope of providing a general introduction to Alternative Methods of Urban Water Supply and Sanitation and an indication of the context in which programmes and projects will be planned.

Tables A.I, A.II, C, E, F, G, H, and I, and Figures 1, 2, 3, 4, 18a, 20ab, 23a-d, 25cd, 26, 27, and 29g are from World Bank publications. The rest are from sources which are listed either as footnotes or on the illustrations themselves.

David Etherton
New York, June 1982

a/ A Summary of Selected Publications resulting from the research was published by the World Bank in November 1980 and is included in the Bibliography.

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The following definitions are used in the text:

Sanitation	-	system of disposal of solid and liquid wastes; public hygiene
Human and animal wastes	-	excreta and urine
Solid waste	-	garbage/refuse (biodegradable and non-biodegradable)
Sullage	-	domestic wastewater not containing excreta - sometimes called greywater
Storm water	-	rainwater
Effluent	-	outflowing liquid, e.g. from a septic tank or aquaprivy
Sewage	-	human wastes and sullage, (flushed along a sewer pipe)
Conventional Sewerage	-	underground system of pipes carrying sewage to a treatment works where most of the organic pollutants are removed

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Introduction

The title of this study suggests that poor people live in specific city locations for which the caricature label "slum and shanty town" has been used. This may seem to ignore wide differences in people's expectations, incomes, savings, and preferences for investment, and also the complicated land-tenure and ownership characteristics of these areas.

Nevertheless, the worst and most dangerous hazards of poor water supply and sanitation are found in slums and shanty towns, and the principal victims of the diseases caused by conditions in these areas are children.

Water, food, excreta, garbage, mud, dust, domestic animals, vermin and insects have the potential for transmitting disease. A single improvement in the supply, distribution, storage, use or disposal of water alone cannot be expected to reduce the vulnerability of children to disease in slums.

Regardless of the causes of poverty, the need for different types of improvements are perceived in different ways by governments, aid agencies and the people who live in shanty towns. For the parents of a sick child, the priority may be a cure for the disease and the extra income to pay for the treatment, or it may be ownership of the land they occupy. The government may be chiefly concerned to prevent the outbreak of endemic disease or political disturbance, while the specialized aid agencies may claim to have a more objective perception of the type of improvements required to reduce health hazards.

Squatter communities often consider government agencies deaf to their demands and observing that wealthier parts of the city are supplied with free water, they argue that they should have the same right. Where government and aid agencies have attempted improvements in slums and shanties, they have often been disappointed to find that the community has not made the best use of their facilities.

There is wide variation in the definition of urban communities. Some countries limit their urban category to the three largest cities, while others consider any village with a population larger than 5,000 as urban. On the other hand, governments and development agencies usually make a clear distinction between urban and rural projects in arranging their investment priorities.

An oversimplified distinction between the primate city with its veneer of "modern" development ('urban'), and scattered subsistence farms in the countryside ('rural'), leaves out the more complicated process of urbanization and its effect on the size and distribution of towns and villages.

In the countryside, the perceived need for water supply is stronger than for improved sanitation, and here there is some coincidence in the view of governments, donors and the rural population.

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In slums and shanty towns, all perceive the critical need for improved water supply and sanitation, but governments are often reluctant to carry out improvements and to plan for an unprecedented increase in the low-income urban population. In this study, it is assumed that the extension of Conventional Sewerage to these areas is impractical because of its high cost and the typical absence of sufficient water supplies. Although most shanty towns have always had to rely on alternative methods of sanitation, it was until recently assumed by most city agencies that improvements would automatically entail Conventional Sewerage. The need to examine more thoroughly the various alternative systems and ways in which these might be improved has been recognized by some governments and international agencies, notably the World Bank.

The technical aspects of piped water supply are uncomplicated, and in most cases it is economically feasible to extend water services since everyone is prepared to pay a reasonable price for an essential service. It has also been assumed that the distribution of piped water supply from existing or improved central municipal sources to slums and shanties is desirable and usually feasible but that there are also decentralized methods of supply which deserve consideration.

The introduction of independent low-cost water supplies together with alternative sanitation methods in slums and shanty towns poses very complicated problems. At the same time it is clear that improved and increased water supplies may have no appreciable health benefits unless they are accompanied by improved sanitation, and behavioural changes.

This review attempts to bring together current information and opinion about water and sanitation from different points of view and with as much reference to true cases as possible.

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CHAPTER I
EXISTING CONDITIONS

Urbanization, Slums and Shanty Towns

Regional Examples of Urbanization

In 1950, there were only 70 cities with a million or more inhabitants in the world. Today there are about 84 in the industrialized countries, and 74 in the developing world. By the year 2000 there will be 276 such cities in the developing countries alone. a/

Roughly 60 per cent of the population of Latin America is now urbanized, and urban growth rates are expected to remain quite high (more than 3 per cent annually) until the end of the century. Slums and squatter settlements account for 30 per cent of the population of Rio de Janeiro, 50 per cent of Recife, 60 per cent of Bogota, 72 per cent of Santo Domingo, and 46 per cent of Mexico City.

Although only about one fourth of Africa's population now lives in urban areas, that continent today is experiencing the highest urban growth rate in the world: nearly 5 per cent per annum. Urban areas in Africa will probably continue to grow at that rate (and some, such as Abidjan, even faster) until the end of the century. Slums and squatter settlements account for 90 per cent of the population of Addis Ababa, 60 per cent of Accra, 33 per cent of Nairobi and 50 per cent of Monrovia.

East Asia, now nearly 30 per cent urbanized, can expect an urban growth rate of 3.7 per cent in the present decade, and declining growth rates thereafter. South Asia, on the other hand, with more than three quarters of its population still in rural areas, has yet to experience the peak of its urban growth, which is expected to be around 4.3 per cent annually during the next 15 years, and to begin to taper off during the last decade of this century. Slums and squatter settlements account for 29 per cent of the population of Seoul, 30 per cent of Pusan, 67 per cent of Calcutta, and 45 per cent of Bombay. b/

Within each of these regions there are countries such as Korea, the Dominican Republic, and eight African nations, which experienced urban growth rates of more than 6 per cent annually during the period 1965-1970. If this continues, those nations will undergo a doubling of the urban population every 12 years or less.

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a/ Habitat: United Nations Conference on Human Settlements, Global Review of Human Settlements, A/CONF.70, 1A/1, 1976.

b/ United Nations: World Housing Survey, E.75.IV.8, 1974.

General Characteristics of Slums and Shanty Towns

In the next twenty years, over one billion people will be added to the urban populations of the less developed countries. Half of this increase will consist of migrants from the countryside. The natural growth of existing city dwellers will account for the other half. Between one third and three quarters of present city populations live in slums and shanty towns, which are growing at two or three times the over-all urban rate (typical annual urban growth rates are between three and six per cent).

Some precision is required in distinguishing between slums and squatter settlements, as different policies and measures will be required in defining appropriate improvements.

There is little disagreement regarding the definition of slums as areas of authorized (usually older) housing which are physically deteriorating, under-serviced, and badly maintained. Ownership is generally legal and officially recorded, but uncontrolled subtenancies have frequently led to serious overcrowding. Older established slums with populations ranging from 50,000 to one million people are typically located in the center of cities in large well-defined areas such as the casbahs of North African cities, Old Delhi in India's capital, and the bazaar area of South Teheran, or in specific smaller neighbourhoods of 50,000 or less which were built for low-income workers at the time of a city's industrial expansion. Examples include the bustees of Calcutta, Bombay's chawls, the "garden tenements" of Sri Lanka's capital, the vecindados of Mexico City and the central-city slums of European and North American cities. The central location of slums usually provides a favorable location for newcomers in search of urban employment.

As a result of central-area slum clearance, it is now necessary to include another category of slum, located at the periphery of many cities. This refers to isolated areas of high-rise tenements which, through lack of maintenance and the absence of municipal services, have deteriorated at an alarming rate since their construction. There are examples of such housing in the cities of the industrialized and developing world alike.

Attempts to define shanty towns or squatter settlements are complicated by the wide variety of land-ownership and tenure arrangements to be found in different cities. Shanty towns usually begin as illegal settlements on public or private land and their subsequent development and permanence depends on local political conditions. Shanties have been variously established by new migrants, victims of disasters or slum clearance, by the organizers of construction gangs, or by politicians in need of additional urban voters.

Urban squatter settlements are typically located on sites that are unlikely to be developed until all other more suitable land has been used.

At the time of their establishment, many large, older settlements were made on cheap land situated outside municipal boundaries, where official building codes and other restrictions would not be enforced. Other sites are sufficiently inaccessible to avoid official harassment even when they are located within the city limits. They include railway embankments, river valleys, road reserves, land liable to flooding and subsidence, swamps, steep hillsides and even cemeteries. Apart from the question of their legality, such areas are technically difficult to service.

In squatter settlements, the likelihood of demolition and eviction by municipal authorities decreases as the level of development rises and investments are made in more permanent buildings and local commercial enterprises. Examples of the development of squatter settlements over time are seen in some of the barriadas which began some 20 years ago as "invasions" of unoccupied land surrounding Lima, Peru. Today, these are separate municipalities as a result of physical improvements negotiated over the years between the community and the city authorities.

The location of central slums is often an advantage from the point of view of connexion to municipal utility networks. But where such systems are deteriorating and out of date, the question arises as to whether more self-contained innovative methods are more appropriate and, in the long run, cheaper. The same question is even more pertinent in the case of isolated squatter settlements. The location and physical characteristics of squatter sites are a major factor in evaluating possible improvements. The prospects for improving the services to sites which have been avoided by commercial developers and public housing authorities precisely because they would have been so expensive to develop in the normal way, are likely to be as controversial politically as they are complicated technically.

In cases where the majority of the slum population are home owners, or where squatters have gained land tenure, negotiations for the extension of urban utilities and other improvements can begin. However, the usual situation is rarely this simple. Illegal occupation of land by squatters, together with the potential value of slum land to real estate developers affect the likelihood of physical improvements to these sites ultimately benefiting the original inhabitants. Thus poor people are either forced out of areas which are to be developed, or end up selling serviced plots because they have become too valuable to hold on to.

The attitude that slums and squatter settlements have no legitimate place in the city and are to be eliminated still lingers in the planning and policy of many government agencies throughout the world. Repressive acts of slum clearance, which leave the poor in a worse position than they were before, are far from rare but, if nothing else, the sheer volume of slum and squatter population makes this attitude more and more impractical.

Population Density in Slums and Shanty Towns

Like so many other aspects of Slums and Shanty Towns, that of density is complicated. As the following examples show, these areas exhibit the highest concentrations of people and structures of all known housing. Densities are also subject to erratic variation depending on such things as government policy, changing land values and the attraction of a particular area at different times. However, hard as it may be to specify, density is an important consideration in planning water supply and sanitation, not only in terms of the numbers of people to be served, but also in choosing between alterative systems. Those systems or parts of systems which can be planned to respond to the changing population and physical characteristics of slums and shanty towns are likely to be the most effective.

Slums reveal some of the highest population densities and room occupancy rates. The Old City of Kabul, Afghanistan, consists of densely built mud-brick courtyard housing extending from the river plain to the hillsides surrounding the city. Of the total city population of 541,000 in 1975, 37% were living in this housing. There were approximately 15 people per unit, and more than two families in each; between two and three people per room.

In Delhi, India, the average density of population for the older sections of the city is between 98,000 and 148,000 persons per square kilometre and in some areas as high as 270,000 per sq. km. a/ In Casablanca, Morocco, the average density of the medina is 70,000 persons per sq. km., while the upper-income residential neighbourhoods have an average density of only 70 persons per hectare (7,000 per square km.). b/

In Ghanaian towns of 5,000 to 50,000, 20 per cent of the population lived 20 or more to a house. In the three towns with over 50,000 population, this figure rose to 35 per cent. c/ Three quarters of Bombay's families live in one room or share a room with another family, and a 1971 survey revealed that single-room accommodation in chawls housed as many as 20 people.

In at least 20 cities (in developing countries,) there were areas of 700 or more persons per hectare (70,000 per sq. km.), in 1974. d/

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a/ United Nations Habitat, Global Review of Human Settlements, A/CONF.70/A/1, 1976, p. 121.

b/ United Nations World Housing Survey, 1974.

c/ Ibid

d/ Ibid.

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At the early stages of their development, squatter settlements located at the edges of cities often show much lower densities which are similar to local rural housing. However, occupancy rates in these areas tend to change very quickly making corresponding rural sanitation methods inadequate and unsuitable. Room occupancy by one or more families is the rule rather than the exception in most shanty towns.

Water and Sanitation Conditions and Health Hazards

This section deals with typical existing water supply and sanitation conditions in slums and shanty towns, and the diseases associated with these conditions. Although, the health hazards resulting from poor water supply and sanitation should not be considered separately, the methods of obtaining water for different purposes, and of disposal of wastes in slums and shanty towns are considered sequentially in this section.

Water Supply

Many squatter sites are chosen partly because they are close to water. Rivers, lakes, and oceans provide the best conditions for bathing and clothes-washing until they become polluted, and therby a source of intestinal disease and skin infection. These hazards are caused not only by the immediate community, which is likely to discharge all of its wastes into the water, but also by domestic and industrial wastes originating from other parts of the city, oil slicks from motorized water transport, and chemical detergents. Drinking water, whether from lakes, springs, wells or standpipes, is often a major source of disease transmission - particularly where no attempt is made to isolate water supplies from potential contamination by excreta. But safe and abundant supplies of water will help to improve general health, and decrease the likelihood of epidemics.

> "We know that good domestic water supplies in every home are a vital part of the wide-ranging environmental improvements which, together with wealth, have caused a dramatic reduction of infectious diseases in Europe and North America in the last 100 years.
>
> We do not fully understand the role of partial and limited improvements in environmental quality as opposed to comprehensive improvements.
>
> We suspect that replacing dirty water by clean water in the absence of other inputs will often have little effect on health.
>
> We suspect that bringing plentiful water close to or into houses and providing washing and laundry facilities may improve health.
>
> There are many examples in which improvements in water quality are not clearly associated with a reduction in fecal-oral diseases. A possible explanation is that the diseases under consideration were not primarily water-borne but were transmitted mainly by other routes, or that the people with the highest prevalence of diarrhoeal disease (small children) were not using the improved water supply in the same way as adults." a/

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a/ Richard Feachem, Domestic Water Supplies, Health and Poverty, in Water Supply and Management, Vol. 2, 1978.

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Some studies indicate that an increase in water usage alone will drop the diarrhea and shigellosis rates. The Cholera Research Laboratory in Bangladesh is attempting to separate the parts which water quantity, quality and sanitation play in the incidence of worm infestation, diarrhea, shigellosis, etc.

The conclusions of a World Bank research paper on the Measurement of Health Benefits of Investments in Water Supply and Sanitation suggest that such measurements are not likely to yield conclusive results. It advises against investing too much capital in this procedure.

> "Improved community health is generally considered the major benefit of improved sanitation. However, it has so far been impossible to determine precisely how much improvement in health in a given community can be attributed directly or indirectly to a sanitation improvement. Even if a figure for the health improvement could be agreed upon (e.g., x fewer mandays of sickness per year), it is very difficult to assign a meaningful economic value to it. Much of the illness without the sanitation improvement would have been borne by children and other unemployed in the monetary sector." a/

The survival of a large proportion of the low-income population in slums and squatter settlements, despite severe shortages of safe water, indicates that people generally are responsible in their use of water for different purposes when choices are available to them. Unfortunately, there are usually too many unforeseeable environmental conditions to rely solely on common sense decisions as an effective way of improving health. A study in India describes the very careful selection of water supplies by the women living in the "bustees" of different Indian cities. One source of water is frequently used for kitchen purposes, and another for washing clothes. b/ In Bangladesh, two separate quantities of water are kept in the house. In one container is tubewell water, presumed to be of good microbiological quality; this will be used for drinking. In a second jar is surface water which may well contain pathogens, but does not have a high iron content. This water will be used for washing and cooking. c/ Apart from the danger of "water-washed" diseases in this case, the problem is to dissuade children from drinking the water which tastes best but is most likely to be harmful. UNICEF is involved testing water quality and the introduction of simple iron-removal devices in Bangladesh.

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a/ Measurements of the Health Benefits of Investments in Water Supply, PUN No. 21, EWTD, January 1976, World Bank.

b/ T.R. Lee, Residential Water Demand and Economic Development, University of Toronto, 1969.

c/ Briscoe, J., "The role of water supply in improving health in poor countries," Paper presented to the U.S. National Academy of Science Workshop on Effective Interventions to Reduce Infection in Malnourished Populations, Haiti, June 1977.

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Drinking water

Central slums are generally served by a treated water supply, but the pressures of overcrowding create shortages especially as this water must be used for all purposes. Most of the supply systems are as old as the buildings themselves, and require more maintenance than landlords are willing to provide, or than tenants can afford.

In their early stages, shanty towns depend largely on the initiative of community leaders or individuals for water supply. A survey of Klong Toey, a settlement in Bangkok with a population of 30,000 in 1972, provides an example of the range of sources. a/

Source of drinking water supply	Per cent of dwelling units
1. Water purchased from vendors	55
2. Running water from city main to a neighbour's house	30
3. Authorized connexion to city main	3
4. Running water from nearby tap	10
5. Rain water	1
6. Other	1

A study of a squatter settlement in Seoul, indicates a typical set of water supply problems.

> The water was contaminated, expensive, and supplied at only a few places in the community. But to make a bad situation worse, this water was supplied only in the middle of the night, when the demand was low in other parts of the line. Thus to get any water at all for daily needs, the women had to get up around one o'clock in the morning and fill their pails.
>
> (Chan Shin Dong - Squatter settlement in Seoul, Korea). b/

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a/ Susan and David Morell, Six Slums in Bangkok, UNICEF, Bangkok, 1972.

b/ M.B. and H.D. White, Eds. The Power of the People - Community Action in Korea, Urban Industrial Mission, East Asian Christian Conference, 1973.

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The following are typical sources of drinking water found in squatter settlements at different stages of development. An indication is given of the most likely problems in each case.

(a) Springs. The choice of site for squatters is often made on the basis of an existing spring, particularly in the more rural types of fringe settlement. As the population increases, so also does the risk of contamination, especially where springs are left unprotected. Measures can be taken to protect springs from this by the construction of spring boxes.

(b) Open wells. These are likely to present health hazards when they are poorly constructed, unprotected, badly located or too shallow. Fairly simple measures can be taken to improve open wells.

(b.i) Sealed wells and boreholes with handpumps: When properly constructed and maintained, this is one of the best forms of supply, as long as latrines are not polluting the water table. Handpumps are prone to mechanical failure and vandalism, and should be capable of withstanding the abuse to which they are likely to be subjected.

(c) Rainwater collection: This is perhaps the most obvious but least used method. In temporary settlements with no security of tenure, the type of roof material used and the absence of gutters make collection impractical. The suitability and protection of storage containers is also important to prevent contamination of stored water.

(d) Standpipes. Standpipes connected to the municipal supply are probably the most common source of drinking water in those shanty towns that have gained some official recognition. But the number of standpipes is frequently inadequate. A shortage of standpipes can cause heavy wearing of faucets and much time lost waiting for water, as well as the probability that people will turn to other sources. There are also problems with poor connexions and vandalism, causing wastage and the danger of standing pools which soon become polluted. People sometimes wash themselves in these pools and children often defecate close to standpipes. These conditions become critical if the supply is intermittent and therefore subject to a variation in pressure. During low or negative pressure, polluted surface pools can be drawn into the mains, with obvious consequences. Intermittent supplies also imply the necessity of household storage, with its attendant problems. When a person suffering from a disease (such as jaundice) touches the spout of a handpump or standpipe, unless the water is heavily chlorinated, disease can spread.

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(d.i) House Connexions. House connexions provide the ideal safe water supply. These are more likely to be found in central slums than in outlying squatter settlements. Where such connexions are made illegally, the resulting tangle of pipes usually produces a more expensive and less reliable service than would be the case if some form of financial and technical planning had been available.

(e) Official water vendors: In some cities this is the only source of water supply to outlying settlements. It is an expensive service for the water agency and inconvenient for the users. It also necessitates household storage.

(e.i) Private water vendors. This method of supply provides a common source of informal income at many different levels and is liable to price-fixing up and down the scale. Methods of handling and storage are both potential health hazards.

Washing Water

Central slum areas are often served by communal bath-houses and clothes-washing places. In some cultures, these facilities have an important social and religious significance, which is all too easily ignored when Western standards are applied to improvement proposals. In Indian cities, and in some East African countries, there are separate neighbourhoods for those who earn their living washing clothes. Communal washing places sometimes serve as a source of illegal and unmetered connexions, as well as the transmission of disease.

As in central areas, many squatter settlements provide themselves with communal washing places, and with bath-houses and showers. In some cases, shower cubicles are constructed to provide privacy. More often than not, the same standpipes are used for bathing, washing clothes and for drinking water, causing general confusion, much waste, and serious drainage problems.

Sullage and Storm Water Drainage

The provision of water supply in settlements, if not accompanied by adequate sewage and waste-water disposal systems, leaves stagnant pools of domestic waste in backyards and drainage courses. These are the places where mosquitoes breed and children play. Rotting domestic waste and other garbage, together with scavenger dogs, rodents, and flies, are a common feature of slums and squatter settlements.

Whether or not municipal systems are designed to cater separately for waste water and surface stormwater, the most familiar system in central slums is a single open stream of wastewater containing detergents, foodwaste, urine and excreta which, during a heavy rain, floods onto roads and sidewalks. These conditions are almost always the rule in cities whose infrastructure was designed at about the turn of the century. In many cases, the only possible investment since then has been for maintenance, so that the capital investment now required to implement radical overhaul must depend on massive international loans.

In many squatter settlements the absence of anything but the most rudimentary drainage channels intensifies the health hazards already mentioned. The most common method of disposing of wastewater is simply to throw it into the street, where it takes the same course as the rainwater, and commonly ends in a stagnant pool of sewage, or discharges into the nearest stream. Even in climates where there are regular rainy seasons, most squatter buildings lack rain gutters, or any means of rainwater collection (which would ease the drainage problem at ground level) and storm water drains are often rudimentary and inadequate. After a rain, it becomes difficult to move about on foot, and often impossible for vehicles. There are also problems of soil erosion, and the undercutting of house foundations caused by inadequate drainage.

Excreta and Solid Waste

'At 3.00 a.m. in the morning an 18-year-old boy leaves his village 15 km outside Kabul and travels into the city with a donkey-drawn *karachi*. He comes from a family of landless sharecroppers and his landlord has required that he, and three other boys from landless families, undertake the work of bringing nightsoil out to the farm. He arrives in the Old City soon after 5.00 a.m. and he takes his *karachi* in amongst the maze of back streets and covered alleys. It is just getting light and a few men are moving around on their way to work. He goes to a house whose owner had requested him to come the day before. He shouts up at the window to announce his arrival and a few sleepy faces peer out into the cold dawn. A brief conversation takes place during which it is agreed that he will empty the vault for Afs 20. (The price varies from Afs 10 to Afs 50, or $US 0.25 to $US 1.25.) The boy locates the vault opening on the outside wall of the house. In this case the vault is sunk below ground level and projects about 0.5 m into the street. Also the faecal material is very liquid because urine and some sullage have been disposed of with the excreta. Thus the boy is confronted with a pool of thick faecal liquour which he starts to transfer into the *karachi* with a flat spade. The *karachi* has side boards, to contain the liquor, and the top of the side boards are about 1.5 m above the ground. The boy has to lift the liquor with a flat spade up and over the side boards and into the *karachi*. The result is that there is much splashing and spilling and a strong faecal odour overwhelms the street. Twenty minutes later he completed emptying the vault and he moves on to service another 2 or 3 houses before setting off again for his village outside Kabul. He will return to those same houses every 20-30 days; except in mid-winter when the snow in the streets makes it difficult for the *karachi* to gain access. When the boy arrives back at his landlord's farm the nightsoil is mixed with soil and stored in the corners of fields in mounds about 1-2 m high and 3 m in diameter. The landlord will use most of it and any excess he may sell to neighbouring farmers.'[a]

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a/ *Water Supply, Sewerage, Drainage and Solid Waste Systems for Greater Kabul*, Proctor and Redfern International Ltd., Kabul, 1974. The report estimated that nightsoil production in the Old City was 1.6 kg. *per capita* per day, including the dust and ashes which are added by some households. This figure is very consistent with world-wide experience on nightsoil production; see Feachem *et al.*, *Sanitation and Disease: Health Aspects of Excreta and Wastewater Management*. John Hopkins University Press, 1981 (in publication).

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Human Wastes

In areas which are not serviced by municipal systems people handle excreta disposal in a variety of ways. The most common methods of disposal are:

(a) Defecation trenching grounds. This is a common practice in rural areas of South-East Asia. The restricted sites of urban shanty towns, however, make this method impractical in most cities.

(b) "Wrap and carry". This is most common where there are suitable places for dumping close by, such as the sea or swamp land.

(c) Overhung latrines. Many shanty towns are located above tidal flats, weirs, canals, lakes or beaches. Housing is supported on stilts and connected by catwalks. Excreta is disposed of directly below the housing. This method works well enough where the water is sufficiently saline to prevent its being used for drinking and if the current is strong enough to carry the excreta away. Serious problems arise where water is used for other purposes, such as fishing and bathing.

(d) Wet and dry pit latrines. This is probably the oldest and most common method of excreta disposal. Where water is used for anal cleansing there is more chance of polluting water supplies, as excretal bacteria are carried further from the pit. Both wet and dry pit latrines can contaminate groundwater, particularly during rainy seasons. Most pit latrines in squatter settlements are simply holes in the ground. Usually no provision is made for digging out and reusing the pits when they are full, nor for collecting the compost which could be produced by combining excreta with vegetable wastes. The holes fill quickly, especially when all sorts of refuse are thrown indiscriminately in and around the pits.

Many of the alternative excreta disposal methods listed in Chapter III are to be found in squatter areas. Usually they will have been installed individually by wealthier families, although there are cases where communities have invested in communal facilities which make use of septic tanks, for example.

Animal Wastes

In many slums and squatter settlements, cramped housing is often shared with animals. Such animal diseases as diarrhoea, anthrax, tuberculosis, tetanus and listerosis can be transmitted through direct contact, or via soil and dust. The disposal of animal wastes is especially important in squatter settlements. It is difficult to consider improvements when pigs, cows, goats and other livestock wander freely among playing children, open drainage channels, and heaps of rotting garbage.

In India and other countries where livestock still play a traditional role in city life, the problem of disposing of animal wastes remains unsolved. The dairy men who sell milk to the low-income population in many cities often live within the city in sheds above their cattle. A recent by-law now bans cattle from the central Fort Area of Bombay, and the municipality would like to remove all the stables from the city, together with their owners. Unauthorized dairy-cattle settlements, "khatals", pose the same problem in Calcutta. Under the slum improvement programme, cattle waste pits were constructed to prevent cattle wastes from flowing freely into newly constructed sewers and drains.

A distinction should be made between the water buffalo who provide milk and can be fairly well supervised by their owners, and the holy cows of India who roam the streets more or less at will and for whom no such supervision exists.

Garbage/Refuse

Municipal disposal systems are often inadequate and inefficient due to out-of-date plant and vehicles. In cities where garbage disposal is still regarded as a subsidized public service, it is also usually uneconomic.

The fact that older central slums usually do qualify for municipal collection does not guarantee removal. There are always more people per collection point than in other residential areas, and if the municipality fails to collect the garbage, there is nowhere but the street to put it, and nobody willing to find alternatives.

Many squatter settlements are built in the vicinity of garbage dumps and sometimes literally on top of them. In Guayaquil, Ecuador, one of the "suburbio" squatter settlements consisted of individual houses on stilts linked by a precarious network of walkways over tidal mud flats of the River Guayas. Reclamation began as household waste and refuse accumulated under the buildings. In time the municipality responded to popular demand by filling in the main roads with earth and rubble.

In many cities, the sorting and resale of garbage has developed into an important "informal" industry. Rag-pickers, rag-buyers, rag-dealers and processors constitute an industry which the Japanese call the "regenerated resources industry." Pickers are dependent on a dealer, who often provides them with shelter in shanties which are improvised on his land. There are similar communities based on waste collection in India, where even finer social distinctions are made on the basis of the type of work permitted to different castes.

.../

Water-borne (diseases for which water can act as a vehicle of transmission) Cholera Typhoid Leptospirosis (Jaundice and Weill's disease). Infectious Hepatitis Amoebiasis (dysentery) Shigellosis (dysentery) Giardiasis	**Water-based** (diseases for which water is necessary to some part of infecting agent's life-cycle; aquatic host) Schistosomiasis (bilharzia) Dracunculosis (guinea worm) Clonorchiasis (liver fluke) Paragonimiasis (lung fluke)
Water-washed (diseases which a lack of sufficient water supply can aggravate) Scabies Leprosy Trachoma Lice and typhus Conjunctivitis Salmonellosis Ascariasis (Roundworm) Trichuriasis (Whipworm) Enterovirus Paratyphoid fever Skin sepsis	**Water-related** (diseases transmitted by insects which live in or near water) Malaria Yellow fever Dengue Bancroftian filariasis Onchoceriasis (river blindness) Sleeping sickness Arbovirus encephalitis

DISEASES CLASSIFIED ACCORDING TO THEIR RELATION TO WATER
AFTER FEACHEM

Health Hazards

The incidence of disease and the spread of infection within a community are bound up in a number of inter-related factors - one of which is water and sanitation. Many of the diseases which no longer pose serious problems in Europe and the United States have been controlled as a direct result of higher standards of water and sanitation. Others have required more drastic intervention in the form of mass innoculation, swamp-clearance, and the use of insecticides. The majority of the diseases which people suffer from are not necessarily fatal, but contribute to a lowered resistance which, added to problems of insufficient food supply and poor nutrition, make them more susceptible to infection. Improved water and sanitation will reduce the number of diseases which people are likely to get, and give them a better chance of resisting others which might not have as direct a connexion.

This section delineates the various aspects of water and sanitation as they relate to the incidence, transmission, and severity of disease, separating the parts which water quality, quantity and source, and waste disposal can play in the health of a community. (Table A)

Water Quality: water as a means of disease transmission

A number of highly infective diseases can easily be transmitted from person to person through drinking water. Cholera and typhoid are the most notable of these potentially "water-borne" diseases. Inadequate sanitary practices which lead to the contamination of common water supplies by the faecal material of persons who have or have had a disease can often result in its assuming epidemic proportions within a community/a/

This does not mean that supplying pure drinking water will eradicate the disease.

> It is also important to realize that epidemiological conclusions are not universally applicable in this matter: in temperate countries typhoid is almost exclusively water-borne; in the tropics this is less often so and evidence of water spread in the rural tropics is often absent. b/

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a/ Both typhoid and certain strains of cholera are often spread by people who have recovered from the disease and become carriers; a much more serious danger to the community, as these people are not obviously seen to be ill, and also will be more mobile than those who are stricken with the disease.

b/ Ed. Feachem, McGarry, Mara, Water, Wastes and Health in Hot Climates, J. Wiley, 1977.

.../

A good supply of clean drinking water will, however, ensure that diseases which are potentially water-borne will not be spread in this fashion. Some bacteria can be killed off simply by straining water through sand filters, or by chlorination - but by far the best preventive measure is to protect water supplies from contamination in general, and to make sure that persons suffering from disease do not have direct access to communal water supply.

Water Quantity: aggravation of disease due to insufficient supply

The provision of adequate supplies of water - over and above that which is used for drinking - is important both for limiting the possibilities of disease transmission and reducing its effect. Many of the skin and eye infections common to areas where water and sanitation are poor are directly related to personal hygiene and the availability of enough water for bathing, clothes-washing, and the preparation of food. More significantly, many of the diarrhoeas which account for the high mortality rates among children are directly related to shortages of water and its consequent reuse amongst large numbers of people.

No one likes to be dirty. No community questions the need for adequate water supplies, and water connexions are rarely abandoned the way so many sanitation facilities are. Epidemiological tables frequently list health education as a control measure for disease prevention. While it is true that certain connexions between common practice and the prevalence of a particular disease are not immediately obvious except to people who have had medical training, most of the diseases which poor people suffer from are a direct result of conditions which they already know are undesirable, and which they are perfectly willing to alter, given the resources to do so.

Water Source: water as an environment

Most worm infections rely upon an aquatic host (such as a snail or crustacean) at some stage of their life cycle. In order for the worm to multiply, excreta containing the worm eggs or larvae must come into contact with the water in which the host lives and, in order for the "worm burden" which a person carries to increase, they must be repeatedly exposed to the water which has been contaminated in this fashion. Bilharzia and guinea worm are but two of the worm infections which reproduce and spread themselves in this way.

Some worms are ingested in drinking water, while others can bore directly through a person's skin. The most obvious measure against infections of this kind is to break the cycle between worm and host by protecting water sources from faecal pollution. Boiling or filtering drinking water can kill many types of worm, and bodies of water which are known to contain aquatic hosts should not be used for bathing. In some countries, campaigns have been organized to eradicate the hosts themselves from waterways which are heavily used, but this requires much community participation.

.../

A second group of infections is directly related to the consumption of fish and other marine life which can act as host to a parasite or infection. As many of the fish which are eaten by people live in large bodies of water which might not be possible to protect from contamination on a local level, the best preventative measure against disease of this sort is the avoidance of raw foods.

Many of the flies and mosquitoes which transmit disease live in or near water, and each has its own particular habitat, for example malarial mosquitoes can be of the type which lives in large bodies of water, or of the type which lives only in temporary puddles. The latter may be affected by better drainage provisions, but this will not be so in tidal areas, and projects aimed at diverting or altering large lakes are not necessarily within the scope of most communities. Tse-tse flies (which cause sleeping sickness) live in the bush which grows around water-holes, biting people on their way to collect water. Clearing vegetation around water sources can control these flies to a certain extent. Black flies or buffalo gnats (the source of river blindness) breed only in the rapidly flowing water of rivers, and this also requires large-scale programmes to control.

Of particular interest to urban areas (and any area where water storage is common) are the yellow fever and dengue mosquitoes which breed in water jars. Insects of this sort can be effectively controlled by proper disinfection of storage containers.

In most cases, measures which seek to prevent transmission of insect-vector diseases must necessarily be of a large-scale nature, and will require research to determine which particular insects are responsible, what their habitat is, and how a change will affect both them and the other vectors which might live in an area. Any project which affects the physical environment of a community can have significant effects on the local sources of disease, whether the project is specifically designed toward that end or not.

> If onchocerciasis (river-blindness) is a disease of torrents, schistosomiasis is the disease of more slowly flowing water. Whereas Simulium is not an irrigation hazard, schistosomes are the hazard of irrigation. This is partly because fresh-water snails and irrigation engineers have similar ideas of what is ideal.a/

For this reason, there are no definitive solutions to the questions of vector-related disease; every project designed to reduce the health hazards associated with them must be tailored to fit local conditions.

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a/ Ibid.

.../

Sanitation: transmission of disease through faecal pollution

There are certain diseases for which improvements in water supply may have little or no appreciable effect. Hookworms live in damp, contaminated soil, and penetrate directly through the skin of children who play there and people who walk barefoot. Roundworms (ascaris), tapeworms and some flukes also live in soil, and can be spread on dirty fingers or food, as well as by contaminated water supply. In such cases, proper disposal of wastes becomes the central preventative measure. Additionally, a number of the diseases already mentioned depend directly on faecal pollution (whether of water, soil or food) for their transmission. Moreover, garbage piles and other places where wastes collect provide living accommodations for the flies, cockroaches and rodents which carry disease. In all of these cases, the provision of adequate disposal facilities can do much to break the link between disease and its transmission within a community.

A classification of excreta-related infections according to their latency and persistence is given in Table A-I. Table A-II illustrates the potential for the control of excreta-related infection by improved sanitation and personal hygiene.

TABLE II: ENVIRONMENTAL CLASSIFICATION OF EXCRETA-RELATED INFECTIONS

CATEGORY	FEATURES*	INFECTIONS	DOMINANT TRANSMISSION FOCI	MAJOR CONTROL STRATEGIES
I	Non-latent, low infectious dose (< 100 organisms)	Enterobiasis Enteric virus infections Hymenolepiasis Amoebiasis Giardiasis Balantidiasis	Personal contamination Domestic contamination	Domestic water supply Sanitary education Improved housing *Provision of toilets*
II	Non-latent medium or high infectious dose (> 10 000 organisms), moderately persistent and able to multiply	Typhoid Salmonellosis Shigellosis Cholera Path. E. coli enteritis Yersiniosis Campylobacter enteritis	Personal contamination Domestic contamination Water contamination Crop contamination	Domestic water supply Sanitary education Improved housing *Provision of toilets* Treatment prior to discharge or reuse
III	Latent and persistent with no intermediate host; unable to multiply	Ascariasis Trichuriasis Hookworm infection Strongyloidiasis	Yard contamination Field contamination Crop contamination	*Provision of toilets* Treatment prior to land application
IV	Latent and persistent with cow or pig intermediate host; unable to multiply	Taeniasis	Yard contamination Field contamination Fodder contamination	*Provision of toilets* Treatment prior to land application Cooking of meat Meat inspection
V	Latent and persistent with aquatic intermediate host(s); able to multiply (except Diphyllobothrium)	Clonorchiasis Diphyllobothriasis Fascioliasis Fasciolopsiasis Gastrodiscoidiasis Heterophyiasis Metagonimiasis Paragonimiasis Schistosomiasis	Water contamination	*Provision of toilets* Treatment prior to discharge Control of animal reservoirs Control of intermediate hosts Cooking of fish and aquatic vegetables
VI	Excreta-related insect vectors	Bancroftian filariasis (transmitted by Culex pipiens), and all the infections listed in Categories I-III which may be transmitted by flies and cockroaches	Insects breed in various fecally contaminated sites	Identification and elimination of suitable breeding sites

Source: Feachem *et al.* (in press)

* Latency: a latent organism requires some time in the extra-intestinal environment before it becomes infective to man. Persistency refers to the ability of an organism to survive in the extra-intestinal environment.

THEORETICAL POTENTIAL FOR CONTROL OF EXCRETA-RELATED INFECTIONS BY IMPROVED SANITATION AND PERSONAL HYGIENE

Disease category from Table II-1	Impact of sanitation alone	Impact of personal hygiene alone
I	negligible	great
II	slight to moderate	moderate
III	great	negligible
IV	great	negligible
V	moderate	negligible
VI	slight to moderate	negligible

Source: Feachem et al. Appropriate Technology for Water Supply and Sanitation, volume 3: Health Aspects of Excreta and Sullage Management--A State-of-the-Art Review. Washington, D.C., World Bank, 1980.

CHAPTER II

PLANNING IMPROVEMENTS

Introduction

The attention focused on water and sanitation by the announcement of the International Drinking Water Supply and Sanitation Decade (Appendix I) tends to isolate the subjects of water and sanitation, whereas they are only a part of the total physical infrastructure which enables people to live in communities of different sizes.

In slums and shanty towns the lack of adequate water and sanitation makes these services an obvious choice for essential improvements to people's well-being. At the same time, the provision of utilities has much wider implications in terms of political policies related to urbanization and development as a whole.

There are very few countries which have succeeded in reducing the growth of large cities. In the next twenty years, growth and migration in the developing countries is expected to add the equivalent of 276 new cities, each with a population of more than one million. Judging by present trends, most of this growth will result in massive over-crowding of older existing central areas and the addition of new settlements (both authorized and unauthorized) outside the centers.

In the former case, problems of maintaining and extending water and sanitation services will be exacerbated by poor access, and the unpredictable political process as it affects slum clearance and urban renewal decisions. The implementation of improved water supply and sanitation services in newer settlements will be hampered by their distance from existing services, unresolved questions of land ownership and tenure, and the fact that their population characteristics tend to change more quickly than in other areas.

In addition to improving existing housing, governments will continue their attempts to provide new urban accommodation, and it is to be hoped that the provision of water and sanitation will feature more prominently in these projects than it has in the past.

Urban water and sanitation planning is likely to focus on three main areas:

(a) the maintenance and extension of central water sources and supply lines and (where they already exist) the extension of sewerage systems and treatment facilities;

(b) the maintenance and extension of drainage systems and garbage collection services;

(c) the provision of services to new housing areas.

As poor people will continue to account for the majority of new urban populations, it follows that urban housing and water and sanitation programmes will require a different orientation if the present trend of excluding the poor from urban services is to change.

International planning for the International Drinking Water Supply and Sanitation Decade gives understandable emphasis to rural programmes. These areas are the least developed and most neglected in developing countries and still account for the majority of the population. However, in the absence of strictly enforced pass-laws, even the most successful rural development programmes will not prevent a continuous flow of low-income people into urban areas for many years to come.

Shanty towns provide shelter and a setting for informal employment, enabling the poor to survive in cities. Under these conditions, water supply is a necessity. Income, clothing and some form of shelter are high priorities, followed by transportation, health care, and education. Sanitation is likely to remain as rudimentary as the housing associated with shanty towns until conditions for improvement are appropriate.

The description of water and sanitation conditions in slums and shanty towns in the first part of this report emphasizes the vulnerability of their populations to disease and debilitation. UNICEF is committed to participation in efforts to improve the health and well-being of children in these areas, and there is no doubt that more lasting effects will be achieved by attempting to reduce the causes of ill health than by treating the symptoms - especially as many of the children who suffer from the diseases associated with poor water and sanitation can be permanently debilitated, if they survive at all.

Any International Organization's efforts will always be limited by the political realities of the country in which it is working, and the nature of the programmes in which it participates will depend largely on the attitudes of government, both to slums and shanty towns, and to the poor in general. Political considerations will also determine the extent to which low-income communities are likely to participate in the process of improving water and sanitation services. Given both the diversity of conditions and restraints, and the enormous size of the problem of improving service levels in urban areas, only the most flexible approach on the part of intermediaries in developing countries can hope to bring about a change in existing conditions.

This section attempts to relate the international, national and community perspectives which affect the planning of improvements. If the policies and priorities of each group coincide, there is a good chance that projects will be effective; if they are in opposition, their outcome will depend on which group is better organized. In many cities there are separate agencies handling water supply, sewerage public works (which includes the extension of new construction and water and sanitation systems), and solid waste disposal. A knowledge of which government agencies are responsible for the different aspects of water and sanitation services is an obvious first step in planning new projects.

Voluntary agencies and other donors who are unaware (or choose to ignore) the more comprehensive plans which government agencies may have for the city as a whole can create unnecessary problems. It is also important to know which foreign and international agencies are involved in planning water and sanitation.

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Table B indicates typical local and foreign agencies involved in different aspects of water supply and sanitation. The community is affected by every stage of the process of delivering or extending service, yet its opinion and views on the various stages, and its priorities about services in general are rarely solicited by local government officials unless and until the community is needed for political support by these officials.

Internationally Assisted Urban Projects a/

For the international agencies involved in water supply and sanitation, priority is usually given to rural projects, both because the majority of people in developing countries still live in rural areas, and because it is believed that rural development may help to slow migration from the countryside to the already over-populated cities.

While stressing the need for complementary investments in the countryside, the World Bank has stated that it intends to continue its work in urban areas. A recent report on 21 World Bank water supply and sanitation loans (amounting to $890 million for 1979) shows that an estimated 27 million people - of whom 44% are in what the Bank describes as "the urban poverty group" - will benefit directly. Of individual projects, the percentage of "urban poverty beneficiaries" ranges from 11 to 80 per cent. Water supply and sanitation projects financed by the Bank are an essential part of a commitment to allocate at least one third of its urban loans to relieve urban poverty. "The planning process for many of these projects has been reoriented to ensure that benefits to the poor will increase significantly." On the other hand, in a recent attempt to relate the detailed costs of projects to the incomes of those who were expected to benefit, it was admitted that estimates of affordability were the most open to question, as they can only be as accurate as the unit costs and income distribution data on which they are based.

While the urban poor are often mentioned as potential beneficiaries of urban development programmes, the traditional view that poor people can be gradually assimilated into the middle classes and that maintenance and extension of existing municipal service can be made to include them has had to be seriously re-evaluated. The natural growth of the middle classes themselves, combined with the steady deterioration of existing municipal systems, may well take up all of the resources devoted to the urban sector - without the addition of any poor people to the list of beneficiaries. The steady migration of people from the countryside, and the consequent growth of shanty towns in and around the major cities, make any idea of "normal" urban development out of the question. Recognizing this, many agencies have attempted to redesign programmes aimed at poor people to effect minimum improvements for maximum coverage.

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a/ For a more detailed account of International policies see Appendix A, The International Drinking Water Supply and Sanitation Decade.

.../

FOREIGN ←→ LOCAL

FOREIGN

BILATERAL	MULTILATERAL
GOVERNMENTS,	UNITED NATIONS AGENCIES UNDP WHO FAO ILO UNICEF World Bank Regional B nks
National Development Aid Agencies	
Banks	
PRIVATE	
Consulting Engineers Contractors	
VOLUNTARY	NGOs

LOCAL

GOVERNMENTS

Ministry of Finance/Economic Planning
Ministry of Public Works
Ministry of Lands
Ministry of Health and Public Welfare
Ministry of Housing/Physical Planning
Water and Severage Authority/separate agencies
Municipal Authority/Maintenance and Administration
Municipal Development Agency/Capital Development

PRIVATE

Consulting Engineers
Contractors

Universities
Technical Colleges

VOLUNTARY AGENCIES

(PLANNING CYCLE)

DEMAND
PLANNING
DESIGN
FINANCE
MATERIALS
CONSTRUCTION
OPERATION AND MAINTENANCE
REPAYMENT

WATER SUPPLY AND DISTRIBUTION

National Water Supply and Distribution

Municipal Water Supply and Distribution

SANITATION

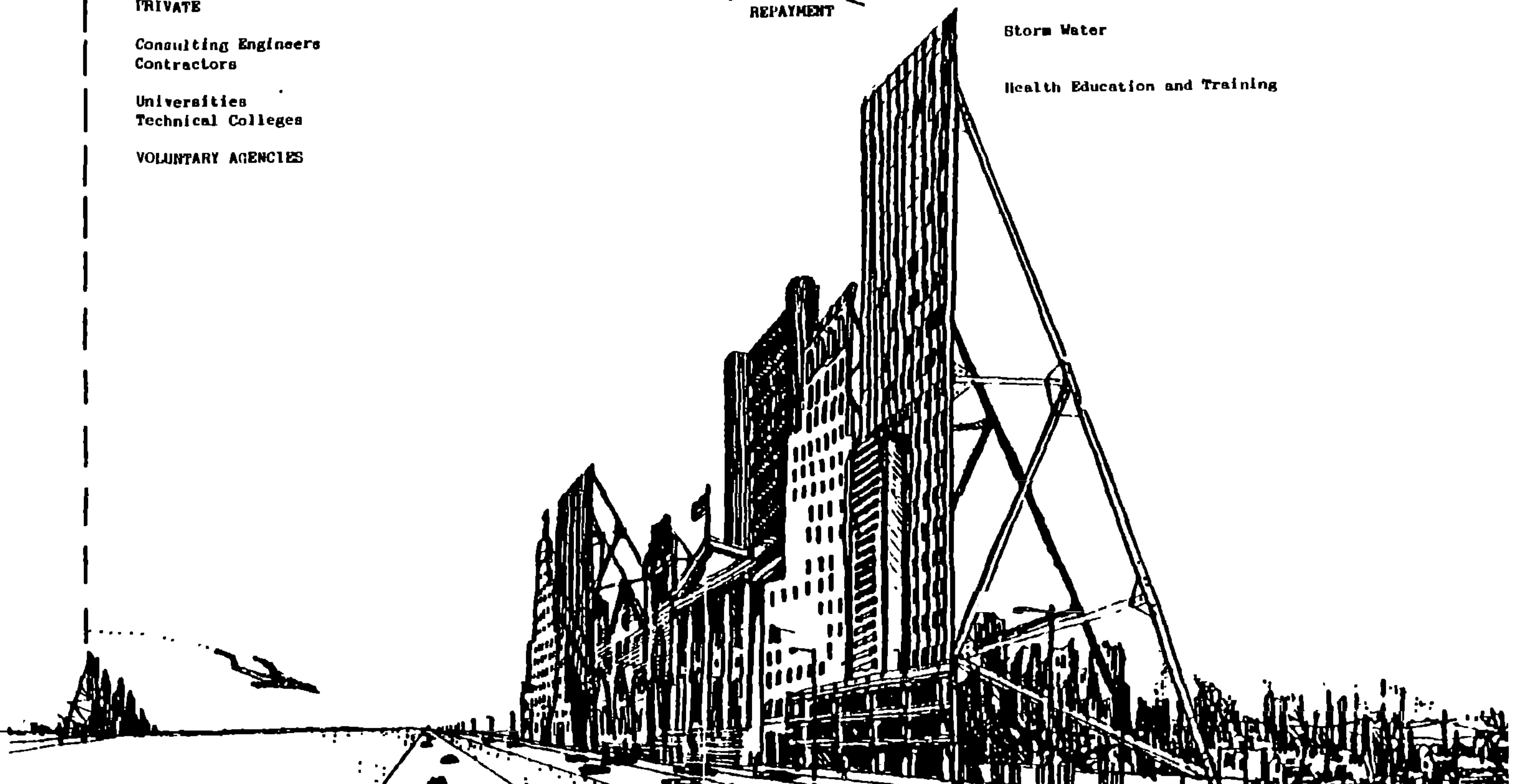
Human and Animal Wastes

Industrial Wastes

Solid Wastes (Garbage/Refuse)

Storm Water

Health Education and Training



TYPICAL LOCAL AND FOREIGN AGENCIES INVOLVED IN VARIOUS ASPECTS OF WATER AND SANITATION

Sites and Services and "Upgrading"

The task of planning new low-income housing is most difficult when there is a shortage of housing throughout the population. Governments cannot finance public utilities and finished houses which middle income families can afford - let alone low-income families. Thus, the idea of providing only the sites and some form of water supply and sanitation has been reintroduced as a means of accommodating poor people.

One of the positive principles of the "site-and-service" idea is a realistic division of responsibility between the municipal agencies who can provide essential infrastructure, and individual households or communities providing their own housing at their own pace. This principle gets lost in site-and-service projects where central planning authorities feel compelled to set rigid standards for all aspects of the process. Site and service projects have been energetically promoted by international lending agencies such as the World Bank, but so far very few of them have gone as far as leaving the provision of housing entirely to the residents. In most cases, land is allocated on the condition that permanent houses will be built within a minimum period of time, even when it is clear that the poorest families cannot afford to do this.

Another approach to the problem which has been slowly gaining acceptance in some countries is "upgrading" in existing communities to provide or maintain minimum service levels. Projects of this sort are aimed at halting the rapid deterioration of services in slums, and also promoting and initiating basic services in shanty towns. Whether the very poor have actually benefited from squatter upgrading projects is debatable, and it is well known that a number of the sites for site-and-service projects have finally come to be owned by wealthier people who then sub-let individual rooms to poor families. The effect of this process on water supply and in particular sanitation, is to make nonsense of the original planning standards; if for example, a six-room house intended for a single family is eventually occupied by six families. It can be argued of course that forty people sharing the latrine designed for a single family represents an overall improvement over the standards associated with many shanty towns. But it is well to keep in mind that inner city areas have become slums as a result of over-crowding and the consequent strain on existing facilities.

> Mathare Valley, the largest shanty town in Nairobi, lived at war with the authorities for the decade after Kenyan independence but has finally achieved a measure of acceptance and its upgrading is one of the most ambitious sections of the World Bank's urban renewal plan for Nairobi. ... Upgrading could have the paradoxical effect of actually harming the people now living there by making it desirable to the middle class who could afford to pay rents five or even 10 times the present going rate.

At Dandora, the World Bank's current site-and-service scheme, a sophisticated computerized allotment of plots meant that they were successfully allocated to people earning the low level of between é20 and é40 per month. However Dandora stunned the experts with the very high standard of building that sprang up. What happened was the creation of a kind of underground legal system whereby some plots have been sold to speculators while the original owner (not allowed to sell for five years by the NCC) remains the legal owner only nominally. Second, an underground capital market has sprung up to finance the building with a flood of money from the rural areas to support (and eventually share the gains of) the lucky relative whose two-roomed house envisaged by the planners has quickly become a six-room lodging house.a/

National Urban Policies and Programmes

The political orientation of governments will determine the emphasis given to urbanization in general, and to different aspects of water and sanitation programmes in particular. No matter which political system or combination of systems applies, most large cities are faced with similar problems of simply trying to maintain the existing systems which are wearing out through serving many more people than they were originally designed to handle.

In some cities which have embarked on internationally-assisted large-scale improvement programmes, special development agencies have been set up to co-ordinate the administrative, financial and technical aspects of the work. The National Urban Development Corporation in Jakarta, Indonesia, the Calcutta Metropolitan Development Association and a similar agency set up in Manila to operate the Tondo Foreshore Redevelopment Project, are all recent examples of national efforts to co-ordinate technical, financial and administrative resources for urban improvements.

Tenure and Land Ownership

The nature of tenure and ownership in slums and shanty towns is often the most complicated issue for governments and agencies involved in improvement programmes. With the exception of countries where private ownership has been abolished, questions of land and building ownership are often crucial in determining the feasibility of implementing any improvements. Even those governments which exercise the right of eminent domain are hesitant to use this right to buy up privately owned land for the express purpose of instituting improvements beneficial to the families living there. If the subsequent provision of service makes the land too valuable (which it is almost certain to do if the site is centrally located), the results will often be worse for the original inhabitants than if no improvement had been made. For low-income families, there is often much more security in illegally occupying land which no one else wants, than in legally occupying a desirable piece of property.

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a/ Brittain, Victoria, The Manchester Guardian, 14 December, 1977.

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In privately owned central slums, there is usually a problem of repayment and maintenance for government-sponsored improvements. If absentee owners can be made to pay for them, subsequent responsibility for repairs can still pose problems, since a series of tenants and sub-tenants, who may only be renting one room, or even a single bed space, have little incentive to maintain facilities. It can be argued that additional charges should be levied against owners for maintenance purposes, but the provision of personnel to perform those tasks will usually still devolve upon government.

When government land is illegally occupied, the government can provide the services it deems necessary, and charge the community as it sees fit. However, unless some guarantee of tenure is given to residents, it is unlikely that they will be interested in maintaining facilities, or even complying with payment schedules. A second difficulty arises when government has other plans for the land, or feels that its occupation is endangering health. Even the most well-intentioned plans designed to induce people to move have run into trouble - especially in cases where resettlements areas are outside the city. Land is usually initially occupied by squatters because of its location. One of the many instances of this is illustrated by a report on government efforts to reduce the number of squatters in Manila:

> "As of October 1973, government records show that out of 22,857 families resettled in three resettlement projects, 47.4% have left, presumably to re-squat in the city." a/

The best-documented examples of improvements to housing and utilities generated as a result of secure tenure are from Latin America, particularly those recorded by John Turner.b/ The provision of tenure to residents of government-owned land does not automatically resolve all of the issues noted above, but some recognition should be given to the commitment low-income families exhibit in maintaining and improving even the smallest plots to which they have secured tenure.

A good case in point are the "garden tenements" of Colombo, Sri Lanka, which became the property of tenants in residence as a result of new housing legislation. Although the municipality has inherited additional responsibilities for the level of service, there has been a decided change in the willingness of the people to make improvements in those areas. There are still unresolved questions about financing the major improvements which tenants cannot afford to make alone - but the standards which have been maintained since the original conversion suggest that community co-operation in future projects will not be difficult to ensure.

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a/ United Natio... ESCAP. Revised Report of the Advisory Group on the Improvement of Slums and Squatter Settlements, Bangkok, 1979.

b/ J.F.C. Turner, Barriers and Channels for Development in Modernizing Countries, Journal of the American Institute of Planners, Vol. XXXIII, No. 3, 1967.

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Standards and regulations

In spite of the overwhelming difficulty which most governments have today in providing and maintaining city services, they tend to retain and enforce regulations and standards which, in most instances, were set under very different circumstances. These standards, though intended to govern orderly urban development, are often so unrealistic that they actually contribute to the proliferation of illegal and disorderly urban growth, both in and outside the city limits.

In the wealthier "modern" parts of cities, water supply and flush toilets in the home are taken for granted. In the countryside, pit latrines and water supplies are outside. In urban shanty towns neither modern nor traditional standards apply. Problems have occurred with projects based on fixed standards and most development agencies at least are now advocating an approach which allows technology and standards to improve gradually.

In many cities, the practical implications of introducing alternative methods of water supply and sanitation would require a complete overhaul of design standards and regulations affecting professional, financial, material and administrative aspects of water and sanitation services, and, in some cases, a repeal of existing health regulations.

Most regulations as they affect development in urban areas were designed to protect the population of the city from the enthusiasm of developers for cutting the costs of their projects where this was seen as detrimental to public well-being. While it is true that poor communities are the most likely to need such protection, many of these regulations are in any case unenforceable in slums and shanty towns and have the added effect of both preventing people from making improvements and limiting their access to official sources of assistance. Some of the illegal conditions in slums and shanty towns are the result of residents' initiative in providing low-cost solutions to water and sanitation problems. Regulations which forbid such solutions can be viewed by the community as an attempt to deprive them of service.

Engineering and plumbing codes of practice determine the type and quality of materials used in the construction of water supply and sewerage installations. In almost every case, these standards have been developed for use in an industrialized urban context, and most of the materials which meet these standards have to be imported. The cities of many developing countries are caught in a dilemma since their partial infrastructure systems were installed under different political and economic circumstances which anticipated neither the scale of urban growth over the past two decades, nor the need to consider alternative systems and standards.

Municipal Agencies

While overall policy and large-scale plans will depend for their impetus on national governments, the day-to-day work in urban areas is usually planned and carried out by the local agencies. There are typically many different municipal agencies involved in water supply and sanitation - from initial construction, to supply and maintenance, to planning new projects. There may be a municipal authority handling maintenance and administration of city services, a municipal development authority for public works, a water authority, a separate sewerage authority, and a third authority in charge of refuse collection.

Until recently, slums and shanty towns have been the least likely and the last communities to receive urban services. That they now claim the attention of municipal agencies is due partly to their increased numbers and visibility and the very real danger of endemic disease, and also to the conditional nature of many international and bilateral urban projects. Such projects usually include the specification of expensive engineering components involving foreign exchange which are required to maintain and extend existing waterworks and sewerage systems with a condition that low-income areas are also served in some way.

The extent to which alternative sanitation is considered in such projects varies from country to country, but it is safe to say that most municipal agencies are too occupied with maintaining existing services to initiate alternatives for shanty towns.

The design and planning of alternative water and sanitation programmes is likely to be most effective if the slum or squatter community is in communication with local government. The most instructive examples of improvement projects have come about as a result of community initiative, and most of the shortcomings of improvements initiated by government are traceable to a lack of community involvement in them. Urban communities are often more articulate than rural ones in being able to state their needs clearly, but they are often unable to break in on official channels and communicate those needs. Often the procedures prescribed for getting help from local authorities tend to prevent rather than encourage active community involvement - either in planning, executing, or maintaining services.

Estimates of total demand, and decisions about which areas are eligible for service, constitute the first of a number of stages involved in water supply and sanitation programmes, (demand, planning, design, finance, materials and construction, operation and maintenance and repayment-Table B), each of which may involve a different agency. Any attempt by community representatives to obtain services depends on a knowledge of which agencies are responsible for which stages of the process, and on the accessibility of officials who are in a position to take action.

Voluntary Agencies

For the majority of the urban poor, access to water supply and effective sanitation is still limited to their restricted share of municipal services, augmented by their own initiative and sometimes the support of local or foreign voluntary agencies. Most voluntary organizations have emphasized rural rather than urban water and sanitation, although there are many such agencies working in slums and shanty towns. For the most part this work has gone unrecorded, and there is wide variation in the extent to which governments have welcomed, tolerated or ignored the intervention of voluntary agencies in these areas.

.../

The multilateral and bilateral project planners are often either scornful of voluntary amateurism, or eager to "replicate" projects. Many successful small projects depend upon an eclectic approach to problems which is not easily broken down into formulas. Sometimes, projects which have succeeded by gradually building up confidence in a community are destroyed by an overload of funds and inappropriate publicity. Both responses are understandable, but the delicate balance between the different issues, - amateur eclecticism versus professional rigidity - requires some consideration.

As voluntary agencies follow their recent trend away from relief work toward more forward-looking development, the possibility of their acting as intermediaries in bringing the needs of poor communities to the attention of government agencies is increased. The Urban Industrial Mission (UIM) of the World Council of Churches is committed to improving communication between Governments and poor people, and both local and foreign agencies are involved in specific projects in slums and shanty towns aimed at providing alternatives to the traditional problems of these areas (e.g., Oxfam (UK), Ahmedabad Action Study Group (ASAG,India), ADAUA (Switzerland), and GROUP 8 (Tunisia).

The Community: Perceptions and Participation in Water and Sanitation Projects

> ... It is easier to change technology than to change behaviour, and it is more difficult to determine cultural acceptability than technical feasibility.a/

Perceptions

People's attitudes toward sanitation, development, planners, and the role they themselves are willing to play in improvement schemes will vary according to their income, culture, education and experience:

> One man ... said that he just did not feel comfortable responding to nature in the home. To him, this was an act that could not be satisfactorily carried on within the confines of a house because it was something that was rated as unclean and he felt compelled to get away from living quarters to carry out such functions. (Member of a rural community in the USA)

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a/ Cross-Cultural Aspects of Sanitation Norms, John O. Belcher and Pablo B. Vazquez-Calcerrada, presented in the seminar "Community Development in a Sociological Perspective" of the Third World Congress of Rural Sociology, Baton Rouge, Louisiana, August 1972.

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For people who set very precise priorities on the way in which their limited incomes are spent, the deciding factor in their response to proposed improvements will be costs. However, when the means can be found to make changes, very few people will have no opinion at all about what is or is not needed - and often they have spent as much time thinking about the subject as the planner who prepares a detailed analysis of proposals:

> Marciala: This woman is interested in the latrines only if the materials are given free. But if they only want money from her, she is not interested because she does not have money yet to do it. Also there are many people from outside who come in to do studies because they need money and they look for anything to study to collect for the investigation. Her ancestors lived for many years in spite of the lack of hygiene and she noticed now, in spite of so much hygiene, the youngest people are dying; for that reason she prefers to live like the pigs ... in order to live much longer.
>
> Ninfa: She does not see it (a latrine) as necessary because she has a large plot of land that is sufficient for this purpose. She says that for the people in the center of town, yes, it is necessary. However for those who live far from the center with a great deal of "bush" there is no need for any of that.
>
> Catalina: She did not have any idea what latrines were. I explained it to her and she said that if they are going to build them for free, she would like one very much. If not, she would still like one but probably they could not get one because her husband does not have enough money. If she could get one she would like the "sit-down" with water and a red cement floor. (Members of a Rural Community at Chan Kom, Mexico)a/

Conventional Sewerage and water supply offers maximum convenience to the user who expects to do more than pay for installation and maintenance. The high cost of these conventional systems covers professional design, construction and guaranteed maintenance. Most lower-cost alternative systems, by contrast, actually require more time and attention of the user. Bearing this in mind, it is unlikely that squatter communities will make the best of improved facilities unless they have been involved in at least the choice of an appropriate system.

The following statements reflect a range of values held by planners about the part which poor people could or should play in the process of achieving improved water supply and sanitation:

> 'There is no question in my mind that community participation implies a process or a programme which has been designed by an external agency which, for some reasons, often legitimate, would like the client population to be involved. This desire to involve the people may spring

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a/ A Behavioral Case Study: Chan Kom, Mexico, Dr. Mary Elmendorf and Mike McGarry, 1978, in "Appropriate Technology for Water Supply and Waste Disposal in Developing Countries," IBRD P.U. Report No. RES 23, May 1979.

.../

from many motivations. For some, it is an extra-rational value assumption: i.e., a programme is better if the people are involved in it. For others, it is politically or socially symbolic: it can be considered as a "people's programme" if people are involved in it. For still others the motivation is material: project costs may be reduced if there is participation of the people.' a/ (An Urban Programme Officer-UNICEF)

'No matter how much we have learned about the engineering details of alternative sanitation systems and the related health aspects, unless these findings can be translated to the target population in a way they can understand and accept, this is mostly an academic exercise.' b/ (Director of the Ross Institute of Tropical Hygiene, London)

'To increase significantly sanitation service levels in developing countries, several actions are required by Governments, designers, financing agencies and users. Users, last but not least, must be provided with information which permits them to make an intelligent decision on the choice of technology available to them to solve excreta disposal problems. Most of the low-cost technologies useful for rural and urban poor are most successful if the benefiting community participates in the selection of the technology and is motivated and trained in self-help construction and operation and maintenance of the facilities. As a consequence, designers need to be assisted by professionals in sociology, health education or similar disciplines to ensure that the solution adopted is acceptable to the community and is within the competence of the user to maintain. At the same time, institutional support should be organized.' c/ (Senior World Bank Advisor)

'"Self-Help," which (together with "community participation") has tended to become the development planner's surrogate for sound programme design, has a major role in sanitation programme development. The two major objectives of self-help are:

- to reduce system costs by having the householder undertake part of the system construction, operation, and maintenance; and

- to achieve householder commitment through involvement, thereby improving the chances of adequate system usage and maintenance, thereby realizing investment benefits.' d/ (Member of the World Bank Technical Advisory Group)

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a/ UNICEF. William J. Cousins, Community Participation in Urban Development: The Next Step. A paper prepared for the Seminar on Improvement of Living Conditions in Traditional Housing Areas within the Walled City of Delhi, sponsored by Max Mueller Bhavan, New Delhi, February 1980.

b/ Dr. David Bradley, quoted from the World Bank Seminar on Appropriate Technology, January 1978.

c/ Sanitation - Convenience for a Few or Health for Many, John M. Kalbermatten, Senior Advisor, Water and Wastes, Transportation and Telecommunications Department, World Bank, Washington, D.C. (Calcutta, February, 1980).

d/ Aspects of Low-Cost Sanitation in Africa, Geoffrey H. Reade, World Bank, Technical Advisory Group (TAG), Calcutta, February, 1980.

.../

Professional planners, engineers, consultants, and organizers do what they do because they enjoy doing it - and are paid to do it. Poor people have similar priorities, and will give up their free time to participation if they need something badly enough. There is no evidence to suggest that low-income people have any more free time than anyone else - and they are usually very aware of the fact that they are being asked to devote their time to something which professionals take for granted in their own lives, namely, water supply and sanitation.

The purpose of adequate water supply and sanitation is health and convenience. Health and convenience, being ends in themselves, need not be vehicles for turning every citizen into a community organizer or an expert in the fine points of low-cost latrine technology. On the other hand, if the need for improvements to water and sanitation are widely recognized in a community, it may well organize itself on the basis of achieving specific objectives. Within any community there will always be "natural" organizers, planners, engineers or plumbers. Strengthening the natural abilities and preferences of such people through training will help to ensure that improvements which are instituted through community projects will be sustained beyond the initial period of enthusiasm.

Other considerations such as income, culture, education, land tenure and the political context will determine the extent to which low-income communities are willing and able to participate in obtaining improvements.

Participation

Four discernable types of action may lead to improvement and change in slums and shanty towns:

(a) Autonomous. The community takes action without any outside assistance, at the initial development of a shanty town where land, materials and utilities are obtained through the informal sector.

(b) Imposed. Action imposed on low-income communities by governments ranges from slum clearance to restrictions preventing additional building or connexions to existing utilities, to improvement operations in which the community is obliged to participate.

(c) Paternalist. This type of action is likely to correspond to a donor's perception of which improvements are required. It is often initiated as a political maneuver and also as the charitable act of voluntary agencies in the absence of government programmes.

(d) Co-operative. The ideal conditions for improvements occur when government is able to provide essential utilities which have been requested and which community members are willing to help install and maintain. Many international and some local voluntary agencies are attempting to move towards more co-operative approaches to improve existing conditions.

The way in which water and sanitation improvement programmes come about is rarely limited to one type of action alone. The process is a dynamic one, rather than the oversimplified "top-down" or "bottom up" development routes.

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Although there is an implied link between urban communities which need services and the official agencies which provide them, the lines of communication between government and low-income communities are subject to frequent breakdown. In Belo Horizonte, Brazil, the women of the comunity took their own initiative after unsuccessfully appealing to the municipal water authority:

> The inhabitants of the Favela 31 de Marco formed a legally constituted co-operative to put their self-help efforts on a firm footing. After hearing that it would take 18 months to obtain piped water from the municipality, they built their own artesian well and provided a piped connexion to every household in 9 months. Since the majority of the women were employed as washerwomen in a neighbouring middle-income suburb, the co-operative constituted a union and established a laundromat, with automatic washing machines. Each woman pays 1 cr. per load and the money is used to pay the electricity bill and machine maintenance.a/

There are many such examples of communities obtaining their own water supplies. In Nairobi, Kenya, one of the squatter villages in Mathare Valley obtained its water supplies from a nearby gas station which was served by metered city water mains. The community made its own illegal connexion, charged its members for supplies and then repaid the gas station each month.

In spite of these and many more examples of direct action, there are many cases where communities are less well organized or where they may have become frustrated by repeated resettlement and the failure of central authorities to provide utilities. Under these conditions the chances are that intermediaries will play an important part in helping to formulate demands for improvements, as illustrated in the case of a resettled community in Colombo, Sri Lanka.

> Meanwhile the residents made several attempts to get organized, but internal conflicts, misunderstandings, differences and the absence of an organized common aim stood in its way. Every time the people met the Powers they were showered with a heap of promises and assurances which were never fulfilled.
>
> The community lost faith in the agencies and retreated to accept their "destiny." This resulted in disintegration of any available effort and the core resident leadership also gave up hope.

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a/ D. Gosling, Housing Case Study in Brazil, Architectural Design 1, London, 1975.

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Then in September 1979, a few Buddhist and Christian clergymen living in the neighbourhood got together and discussed with the people why their efforts had not been recognized. This time they learned how to agitate without antagonizing the Powers. Petitions, discussions and interviews were backed up by the clergymen who gave wide publicity to the awful conditions. News bulletins and features in the dailies created strong public opinion. The MP (Member of Parliament) saw an inherent threat to his authority and acceptance in that community. On the other hand the government officials were on pins. They were genuinely interested in helping this community and had nothing against it. However their involvement in other urgent priorities in the city gave them no time at all to attend to the needs of the community. They decided to counter the folly by taking immediate action, taking a little time off from other engagements.a/

The role of the intermediary is always sensitive, sometimes precarious, and often dangerous - particularly in an authoritarian context, if their work is perceived to extend beyond the bounds of charity:

The following are examples of timely community action - initiated in some cases by intermediaries and often followed by government action and planned expansion with foreign assistance.

In Manila, timely community action was initiated by intermediaries and followed by government action and planned expansion with foreign assistance. The Tondo Foreshoreland is a strip of landfill of some 130 hectares, reclaimed by the Philippine government as part of a plan to expand Manila's port facilities. After the Second World War, the land was occupied by refugees, and the victims of several fires who settled on the site. The original settlers were joined by successive groups of rural migrants until Tondo became one of the largest squatter settlements in South-East Asia, with a population of almost one quarter of a million. In the early 1950s laws were passed authorizing the sale of lots to bona-fide occupants and since then the story of the Tondo community has been retold in many different ways. The following excerpts are quoted from a chronology of community action published by the Urban and Industrial Mission of the World Council of Churches. They are included here to give some background to the World Bank's site-and-service and upgrading project, which was launched in 1976.

1965 First serious attempt to organize part of Tondo around an issue, undertaken by Protestant and Catholic clergy and social workers of the Vistas Community Center.

1969 Establishment of the Council of Tondo Foreshoreland Community Organizations concerned with the land problem.

1970 Twenty-one local organizations unite to form the nucleus of Zone One Tondo Temporary Organization (ZOTTO), through the initiative of the Philippine Ecumenical Council for Community Organization (PECCO) and invites an organizer, an ordained minister.

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a/ The Catholic Messenger, Colombo, Sri Lanka, 11 November 1979.

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1972 Martial law is declared and squatter clearance established as a high priority.a/

1974 Technical seminars bring people and urban planners together to compare the government plan for renewal with the people's own plan. Reports of the findings are submitted to the Tondo Foreshoreland Development Commission, recommending a sites and services scheme with maximum retention of present locations by foreshoreland residents.

The first World Bank project at Tondo was initiated in 1976 and the second in 1979. The total cost is approximately $134 million for 16,297 serviced sites. Waterborne sewage and water supply to individual households is provided for all but 5,066 improved plots (13%), which will receive standpipes and an alternative form of sanitation.

The Municipal Authority's need for community participation, not only in implementation, but also at the planning stage, was stressed in an assessment of the first stage of the Calcutta Slum Improvement Programme carried out with an Indian Government grant of 80 million Rupees (approximately $10 million) between 1971 and 1974.

In the bustee programmes themselves where physical improvements were made (water supply, drainage and latrines), the whole approach was initially rather paternalistic and encountered opposition from the residents. Later, sociologists were inducted by the Authority primarily to enable physical improvement works to be carried out unhampered by the local residents. b/

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a/ "Fifteen days after Martial Law was declared in 1972, "Letter of Instruction No. 19" directed the removal of all illegal construction, i.e., those built without permits on public or private lands, on grounds of public health, safety and peace and order, and the transfer of all of the displaced families to government resettlement projects. As of October 1973, government records show that out of 22,857 families resettled in the three resettlement projects, 47% have left, presumably to re-squat in the city; and that there are still about 95,271 squatter families in the Manila area. United Nations ESCAP. Revised report of the Advisory Group on the improvement of slums and squatter settlements, Bangkok, 1975.

b/ United Nations, ESCAP, 1975, op. cit.

.../

Since many technical improvement projects have apparently failed because of lack of community interest, lending agencies such as the World Bank and other donors are giving increased attention to "the social aspects of water and sanitation." Unfortunately the work of anthropologists and social workers is too often divided from that of engineers, and the community is consulted after the plans have been made.

The question is whether we are ready to start where they are and go where they want to go. If so, hopefully we can take the next step in community participation. This step calls for two radical changes on the part of both the urban poor and the intervening developmental agencies. These changes are perceptual and organizational. The perceptual changes means a shift from viewing the urban poor as being "marginal" sources of problems, or, at best, beneficiaries of services. This means a corresponding change in our perceptions of ourselves. People in development agencies must see themselves no longer as "friends philosophers and guides" but as professionals and partners".a/

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a/ Dr. W.J. Cousins, Paper prepared for a Seminar on Improvement of Living Conditions in Traditional Housing Areas within the Walled City of Delhi, New Delhi, 1980.

Health Education and Training

Water is life - for rice, for maize, for cotton, for sugar cane, for man himself - and water is the home of bilharzia.

What is this disease? It is a parasite that gets into the body from infected water and that settles particularly in the bladder, liver and other organs, piercing them, sucking at them, till they become like a bleeding sponge. It multiplies enormously in the body, and soon produces lassitude, anemia and bleeding; particularly virulent parasites kill you. It is transmitted through infected water thus: a person with bilharzia passes out the eggs of the parasites in his urine, and larvae get into a kind of water-snail, where they live comfortably until they kill it and swim out into the water or the canal or pond. They live in the water until the warmth of a human limb attracts them. They burrow into the skin, shed their tails, and are carried up in the bloodstream to the lungs whence they get into the liver and bladder and lay eggs which are passed out into the water again.

The next problem was how to mount the attack, how to bring our weapons into action. The people must be ... made to see the cercariae in the water, made to see its progress through the body. An all-out propaganda campaign, using every trick and device of mass communications, must be instituted. Not a few tattered posters hanging in the railway station, inaccurately drawn and impossible to understand. Show the people the bilharzia worm alive and wriggling. Give them film shows, bring in microscopes that project the magnified slide on the wall. Let them fish a bucket out of the river, let them prepare the slides themselves, let the whole village see a great worm, three feet long, swimming across the wall of the village hall. Tell the children too. If they can't follow the film reduce the matter to a fairy story. I wrote a play for them, the horrid tale of Bill Harzia, and dressed myself up as a (fairly) terrifying demon, in a goggle-eyed gas mask and a white sheet, all puffed up by an inner tube round my shoulders.a/

The general purpose of health education is to promote good health by disseminating useful information. This can mean:

(a) The provision of information not generally accessible to people without medical background; i.e., connexions between various diseases and their source.

(b) The broadcast of timely information on potential hazards, vaccination programmes, and health-care facilities.

(c) A stimulus to communities to organize themselves to effect improvements, and change conditions which promote disease transmission.

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a/ Hassan Fathy, Gourna, A Tale of Two Villages, Ministry of Culture, Cairo, 1969.

Obviously, most diseases can only be significantly controlled if the physical conditions which promote them are changed. In most industrialized countries water and sanitation-related diseases have been controlled through improved water and sanitation services, and not because of significant awareness on the part of the public as to the nature or cause of those diseases.

> It must be admitted at the outset that public health education of the conventional sort is the least fruitful of public health efforts, and that the number of conspicuous examples of water supply improvements instigated by such agencies (with the exception of the People's Republic of China) is painfully small ...
>
> Two types of failure (of health education and improved facilities) are common: one is the lack of response to hortatory statements about poor water - it does little good to warn against polluted supplies unless the family knows where to draw better water. The other is the neglect of improved facilities installed by well-intentioned geologists, engineers or administrators - the unused clean well, the broken standpipe faucet, the clogged drain.a/

Telling people what they already know about their living conditions but cannot easily change is insulting, and can only harm the credibility of the teller. There are, however, instances of traditional habits which affect disease transmission that could and would be avoided if the connexion between those habits and resulting ill health were made clear. It is also generally true that facilities which are provided to communities will have a better chance of being used and properly maintained if there is already an established sense that these facilities will improve health and are worth the extra effort and expense they may entail. (Figure 1)

Recent health education programmes related to low-cost water and sanitation have been focussed on rural communities. Although many innovative projects have been launched the results have often been disappointing. In an excellent review of 800 documents selected from 10,000 references, only a handful of urban cases is included.b/ Even so, many of the rural programmes and techniques described could equally well be considered for use in slums and shanty towns.

From all points of view, sanitation is more of a problem in concentrated urban areas, and it is here that efforts to introduce improvements are most likely to be effective. Urban communities are often less conservative and more receptive to change than country people. And the more mobile and enterprising shanty-town population often retains its links with the country-side and can be expected to pass on new information.

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a/ Gilbert F. White, Water Supply Service for the Urban Poor: Issues, PU Report No. PUN 31, August 1977. World Bank, Washington.

b/ Christine van Wyjk Sijbesma, Participation and Education in Community Water Supply and Sanitation Programmes, WHO International Reference Centre, Voorburg, The Netherlands, March 1979.

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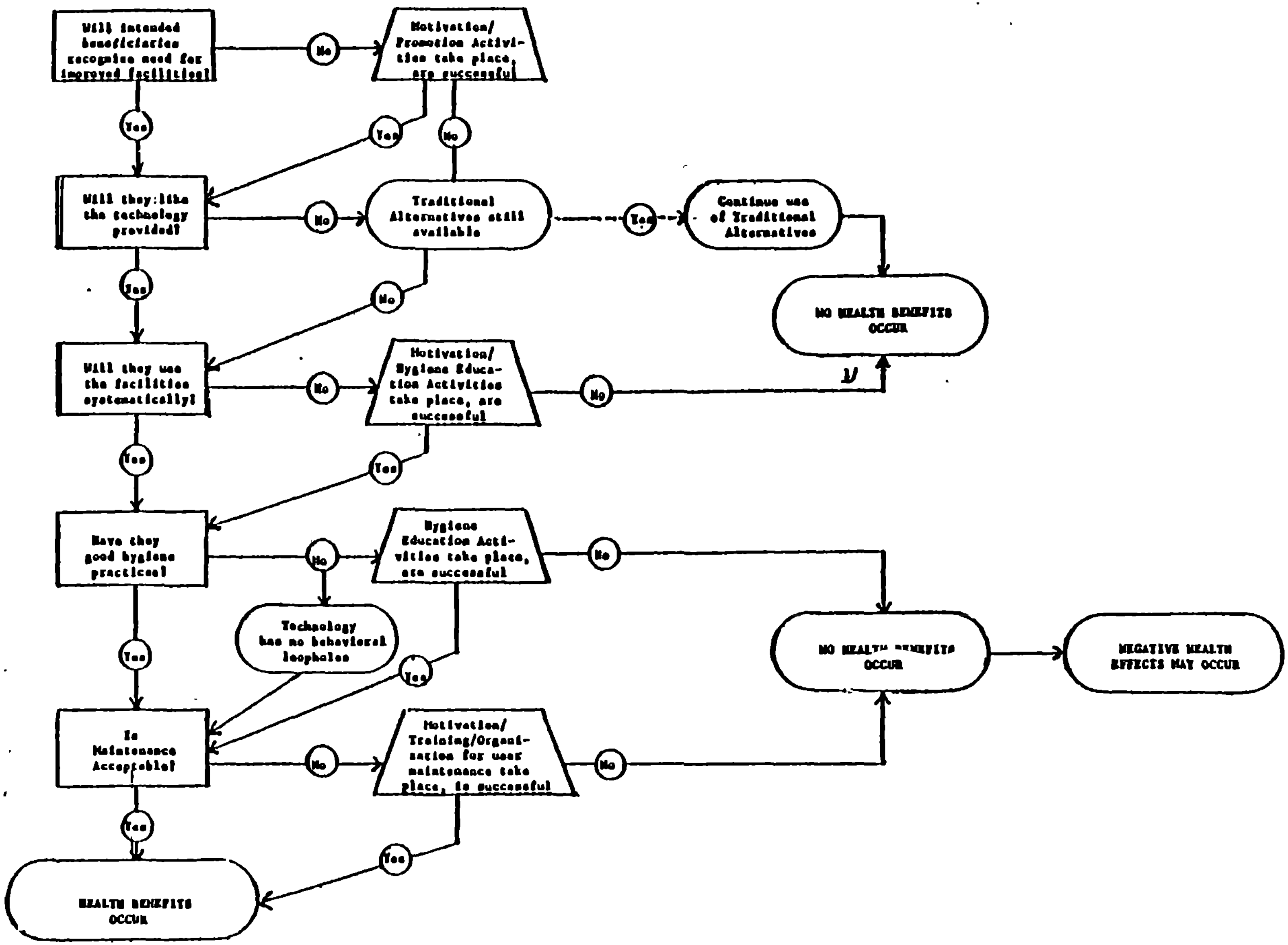
From SOCIAL AND BEHAVIOURAL ASPECTS OF WATER SUPPLY AND WASTE DISPOSAL PROJECT WORK

Heli Perrett

IBRD Projects Advisory Staff June 1979

THE PROCESS OF ACHIEVING HEALTH BENEFITS IN WATER/WASTES PROJECTS DIRECTED TO THE POOR



1/ Except where the partial or seasonal use of traditional alternatives is not significant from a health standpoint. For instance, project facilities may only be used for drinking water and cooking, but cl washing and bathing continues at the traditional source. In these and similar instances, health benefits will still occur.

In some of the most impoverished settlements, the evidence of TV antennae alone suggests that some people are more willing to invest in television sets than, say, a new roof. Aside from questions of priority, it may also be inferred that where there is no security of tenure, a portable TV set is in fact a safer investment. Similarly most households have transistor radios. Newspapers are as widely read in slums and shanty towns as in any other parts of a developing city and the assumption that this section of the population is less well-informed is generally inaccurate.

The use of the media - radio, TV and printed material - is therefore appropriate as a means of relaying information about health. Schools, markets, community centres and bars, all of which are likely to belong to the informal sector with its notoriously swift channels of communication, are ideal places at which to publicize the benefits of improved water and sanitation.

Health education is a relatively "safe" subject for governments. By promoting or permitting health education in an otherwise illegal shanty town, recognition and tenure are not implied. On the other hand, health education makes no sense to the community unless there is a reasonable chance of obtaining improved services. The need to seek the advice and co-operation of the women of the community in promoting health is clear, though this is often neglected. Women usually know the best sources of water suitable for different uses, and they spend most of their time in the worst conditions, where the connexion between improved sanitation and health is most easily perceived. It is no coincidence that women have been the instigators of demands for improved water supply in many cities. Health education has much potential for effecting large-scale improvements. The following examples from India and China illustrate the need for imagination on the one hand, and an appropriate social structure on the other.

India. The work of the Safai Vidyalaya a/ at the Gandhi Ashram, Ahmedabad, India is an outstanding example of effective health education. This private voluntary organization was established on the basis of a programme initiated by Mahatma Gandhi to "liberate thousands of Harijans from the degrading task of cleaning latrines manually and of carying nightsoil on their heads to disposal depots." This programe, known as Harijan Sevak Sangh, is operated in every Indian state.

The Safai Vidyalaya is directed by Shri Ishwarbhai Patel who also acts as Honorary Advisor to the Government Panchayat and Health Department, giving assistance in the implementation and monitoring of government-funded water and sanitation programmes. The most important of these programmes is the conversion of some 123,941 bucket latrines to sanitary latrines since 1964. The work of the Safai Vidyalaya itself is described in a report requesting funds from UNICEF for a van and equipment to be used for its programmes in the countryside:

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a/ Safai: purity, cleanliness; Vidyalaya: Institute, school.

.../

It conducts camps and training classes of kisna, students, sanitary inspectors and overseers, sweepers and scavengers and others to bring home to them the importance of sanitary habits. Village camps organized by the National Service Scheme of the universities and colleges are actively co-ordinated by the Vidyalaya. It also undertakes practical training by constructing latrines, smokeless ovens, soakage-pits, cattle sheds, compost pits, disposal of wastewater, etc. It also inculcates the habit of converting cowdung and other refuse into manure. In addition the Vidyalaya is engaged in:

- conducting training courses;
- educating and guiding the workers of various construction organizations;
- guiding municipalities, Gram Panchayats, etc., in formulating programmes of sanitation;
- arranging exhibitions of charts and implements, etc.;
- conducting seminars, shibirs and conferences;
- publishing or getting published literature, posters, slides and documentary films;
- educating the cultivators in the proper use of cow dung and producing manure through pits; "Wealth from Waste" is the slogan carried to the villages;
- doing research in bettering the implements required by the sweepers and scavengers and help in their production. (See Figure 21, following page 66.)

Since 1976, the Safai Vidyalaya has conducted an average of 127 sanitation camps each year and the participants have constructed some 7,550 sanitary latrines, 9,275 soakage pits and numerous ovens, bathing platforms, house ventilators and paniyaras (brick receptacles for water pots).

The Institute buildings are located in a compound adjoining the Gandhi Ashram in Ahmedabad. The classrooms contain numerous posters and a collection of one-quarter full-size models of many different types of latrine and other sanitation devices. The models, which are realistically coloured, can be taken apart to show the function and construction of each part. The same latrines are constructed life-size in the compound and these are built in such a way that the function and details of construction can be easily understood.

This unusual alliance between an effective voluntary organization and the State Government has important implications for health education and training. For its part, the voluntary agency avoids the red tape in which many government programmes are tied, but receives funds to carry out work it wishes to promote.

China: Sanitation programmes are promoted through mass campaigns originating from the Epidemic Prevention Stations. The best known national mass campaigns were against the Four Pests (mosquitos, flies, rats and lice). The Stations are responsible for the prevention of infectious diseases, including parasites, occupational diseases and promotion of Environmental Health through the county hospitals, commune health centers and brigade health stations. The sanitation programmes depend heavily on the peoples' financial

.../

support and participation. Each activity is repeatedly described and discussed with the people and promoted through a variety of media, including the radio, manuals, wall posters, group meetings, home and meeting place visits and personal contacts.

> Health Centres are located within the communes to provide health and family planning services and to train barefoot doctors and health aides. Environmental sanitation activities are centred at the production brigade level and, along with other duties, are the responsibility of the barefoot doctors who receive four months' basic training and a month-long refresher and up-grading course each year.a/

Training

Health Education and Training may emerge as the two aspects of this subject which will have the most impact on improved water and sanitation in proportion to the total funds likely to be invested.

It is widely admitted that no technical innovations are possible without community interest, but a change of attitude on the part of planners will also be necessary if any improvements in the field of sanitation are to be successful. There is often a hortative overtone to programme documents: "Decision-makers, planners, and engineers need orientation, technicians and operators need to be trained, and householders need to be informed". Decision-makers and planners will be more effective if they are willing to ask more questions and inform less.

Widely differing skills are required to initiate, plan and implement water and sanitation programmes and, while their ultimate effectiveness appears to depend more upon political commitment and community interest than a lack of any particular skill, government-supported institutional frameworks to bring these skills together and direct them in a co-ordinated manner are rare.

Most developing countries do have limited cadres of planners, sanitary engineers, surveyors, accountants and draughtsmen who have been trained to work in the modern sector but - apart from the fact that the modern sector already employs most of these people - very few of them have had training which focuses on the specific problems of slums and shanty towns.

Discussing the influence of conventional engineering practice on sanitation design in developing countries, the effects of Western-oriented training are emphasized in the following excerpt:

> ... Too few civil engineers working in tropical climates have received any tr-ining in tropical sanitation. Expatriate engineers have been trained in their own temperate countries where sanitation is synonymous with

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a/ Michael McGarry, Excreta Treatment and Re-Use in China. Summary of Working Group discussion at an Oxfam-Ross Institute Conference held at Pembroke College, Oxford, U.K, 1977.

.../

conventional sewerage; and local engineers are either trained abroad, where they receive the same prejudice, or at home, where because the engineering curriculum at most tropical universities is western-urban oriented, they are similarly indoctrinated. There is thus an overwhelming prejudice of training in favour of conventional sewage as the only realistic system of sanitation ... Conventional training in sanitary engineering has thus provided tropical developing countries with many hundreds of engineers with severe "tunnel vision" - the result has been unimaginative designers producing unimaginative designs which few communities can afford to implement. It is rather as if all the world's automobile engineers were to design only Rolls Royces when what is needed is Volkswagens - or even bicycles.a/

Opinions will always differ as to what part foreigners should play in any aspect of development, but it is fairly clear that professionals - whether foreign or local - who can adjust their vision to include slums and shanty towns and begin to put that vision to work on solving some of the unprecedented problems posed by them, are in great demand.

In most cases neither the public nor the private sector is willing to assume responsibility for improvements in slums and shanty towns, with the result that very few people acquire the experience necessary to plan programmes or the training in implementation. The municipal agencies are typically committed to maintenance and extension only in the modern sector, and both the water and sewerage agencies and private developers tend to view projects in slums and shanty towns as a financial risk.

In a review of the research undertaken by the World Bank on alternatives to water-borne sewage disposal, it is noted that "several actions are required by governments, designers, financial agencies and, last but not least, the users, if sanitation service levels are to be increased in the developing countries".b/

Designers are urged to acquaint themselves with the various alternatives to water-borne sewage and to widen the scope of waste-disposal master plans to provide different service standards for different socio-economic groups. Financing agencies are urged to pay engineers for the work performed in the preparation of projects, rather than on the basis of construction costs "Engineers are competent and, if necessary, will acquire additional skills to design such projects, provided they are not penalized by lower fees (due to lower construction cost) for having designed a low-cost appropriate solution."

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a/ Duncan Mara, The Influence of Conventional Practice on Design Capabilities, in Sanitation in Developing Countries, Ed. A. Pacey, Wiley, U.K., 1978.

b/ Kalbermatten, Health for the Few - Convenience for the Many, Calcutta, 1980, op. cit.

.../

The report also suggests that designers be assisted by professionals in sociology, health education, or similar disciplines "to ensure that the solution adopted is acceptable to the community and is within the competence of the user to maintain."

In many countries without a politically backed commitment to improve urban sanitation, the work of sanitary inspectors and health wardens is limited to enforcing standards related to activities of the modern sector. In former colonies many of these regulations were actually intended to "protect" an expatriate population from the hazards of poor sanitation elsewhere in the city. Many of these regulations linger on and in many cities the work of municipal inspectors is purely bureaucratic. There is a clear need to review not only the appropriateness of the standards on which the regulations are based and also the type of training which health wardens receive.

Within low-income communities themselves there is a clear case for improved training opportunities in plumbing and construction skills. The extent to which such skills could be used to maintain utilities installed by municipal agencies would often depend on a revision of regulations and mutual changes in attitude regarding maintenance responsibilities on the part of the authorities and the community. If this were possible, such training could go a long way towards easing the burden of maintenance and improving service levels.

The voluntary organization "Agua del Pueblo" is preparing a curriculum for a six-month course to train local people in the skills required to extend potable water and latrine services to low-income communities in Central America. The training will use an occupational analysis methodology with modular units including: topography, hydraulic design, community promotion and organization, health education, project administration and the preparation of project budgets.

The group which may benefit most from training programmes is the women of the community, who are most often the ones left to deal with broken water pipes and inoperable drains. They are also the traditional water carriers, and may therefore have more incentive to bring about improvements to existing services. A voluntary organization which specializes in vocational training, OIC International (Opportunity Industrialization Centres) reports the graduation of Ghana's first female plumber in one of its eleven projects in African countries.

CHAPTER III

TECHNICAL OPTIONS - WATER AND SANITATION

INTRODUCTION

Of the many considerations in choosing suitable alternatives to centrally treated sewerage systems is the extent to which members of small communities themselves would be able to install and maintain their own independent systems.

Given the necessary legislation and a certain amount of design and planning cooperation from outside, the technology involved in constructing many of the systems described here is relatively uncomplicated and within the scope of most local communities.

A common characteristic of most of the alternative methods of excreta disposal is that they have evolved and are still commonly used in rural communities. A question which will remain unresolved until more cases are recorded is the extent to which these mainly rural techniques are applicable at higher urban densities. Answers to this question have implications for the detailed design of individual or communal latrines, their location in relation to the housing layout and their future extension and improvement. These design and planning considerations are difficult for a community to solve on its own.

Many of the relevant questions to be asked in selecting suitable sanitation technology are effectively illustrated in a series of algorithms published by the World Bank (Figures 1-3). However, the Bank cautions that these should 'not be used blindly in place of judgement, but as a tool in the decision-making process.'

Building and Planning regulations in some countries may still exclude many of these systems in urban areas. Yet pit latrines, for example are probably the most common form of sanitation in urban shanty towns and it is clear that significant improvements can be made in the design and location of pit latrines enabling them to be used at fairly high densities. In fact, of all the alternative systems discussed in recent World Bank literature, the Ventilated Improved Pit (VIP) and Pour Flush latrines emerge as the two systems which can be safely recommended until better alternatives are possible. a/

The literature is more cautious in recommending systems in which the efficiency of bacteriological decomposition depends on careful use and maintenance of a latrine.

Even if there is no guarantee that all pathogens are killed off in composting, for example, it seems more realistic to consider improvements rather than ignoring methods which are likely to remain in use for many years in some countries.

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a/ Some of the reviewers of the first draft of this section found that too wide a range of sanitation systems were presented especially as many of them were untested for use at high densities and indeed some that had been tested were found to be unsatisfactory. Instead of leaving out such cases I have incorporated readers' comments in the description of each system as a basis for further discussion.

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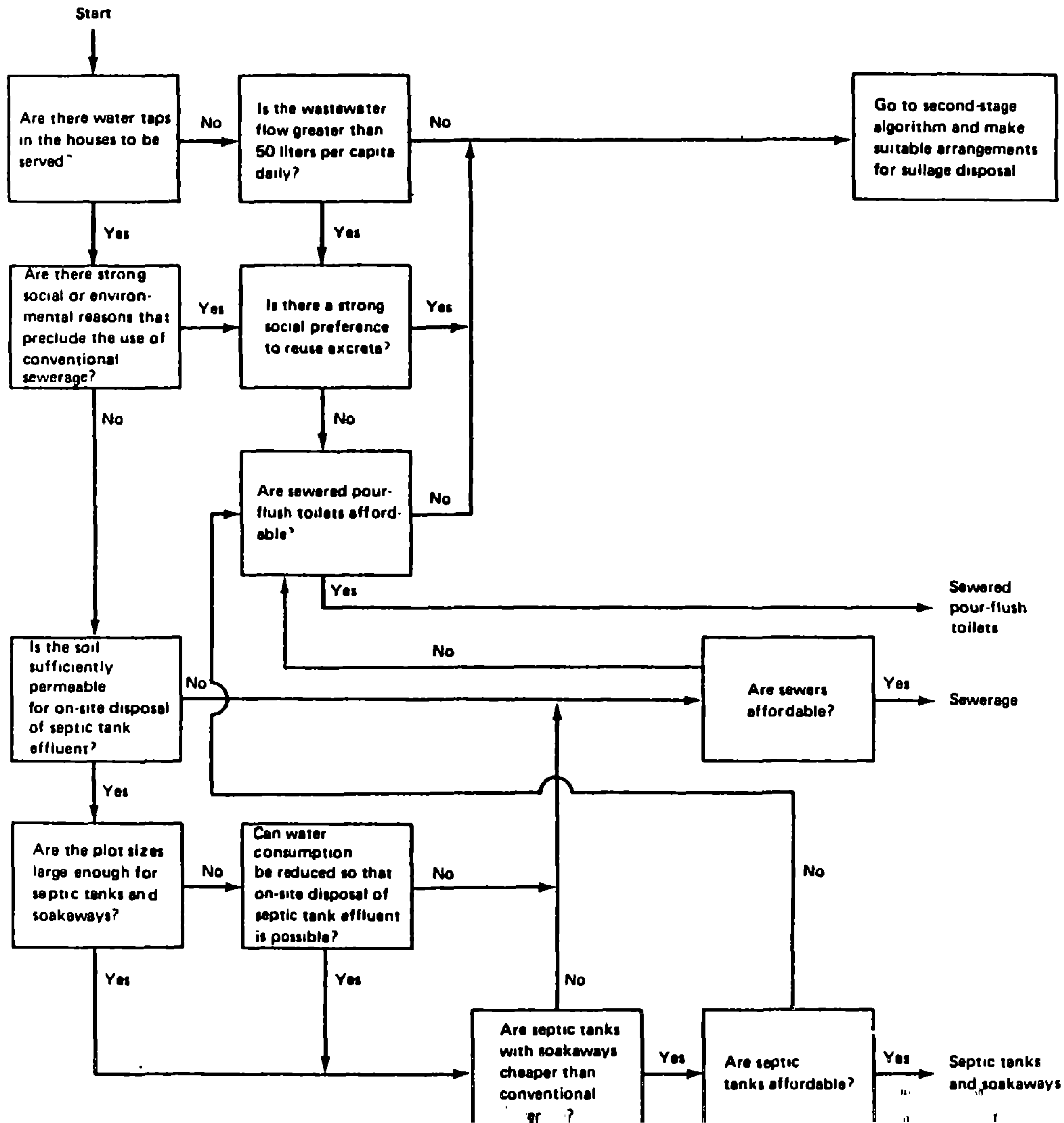
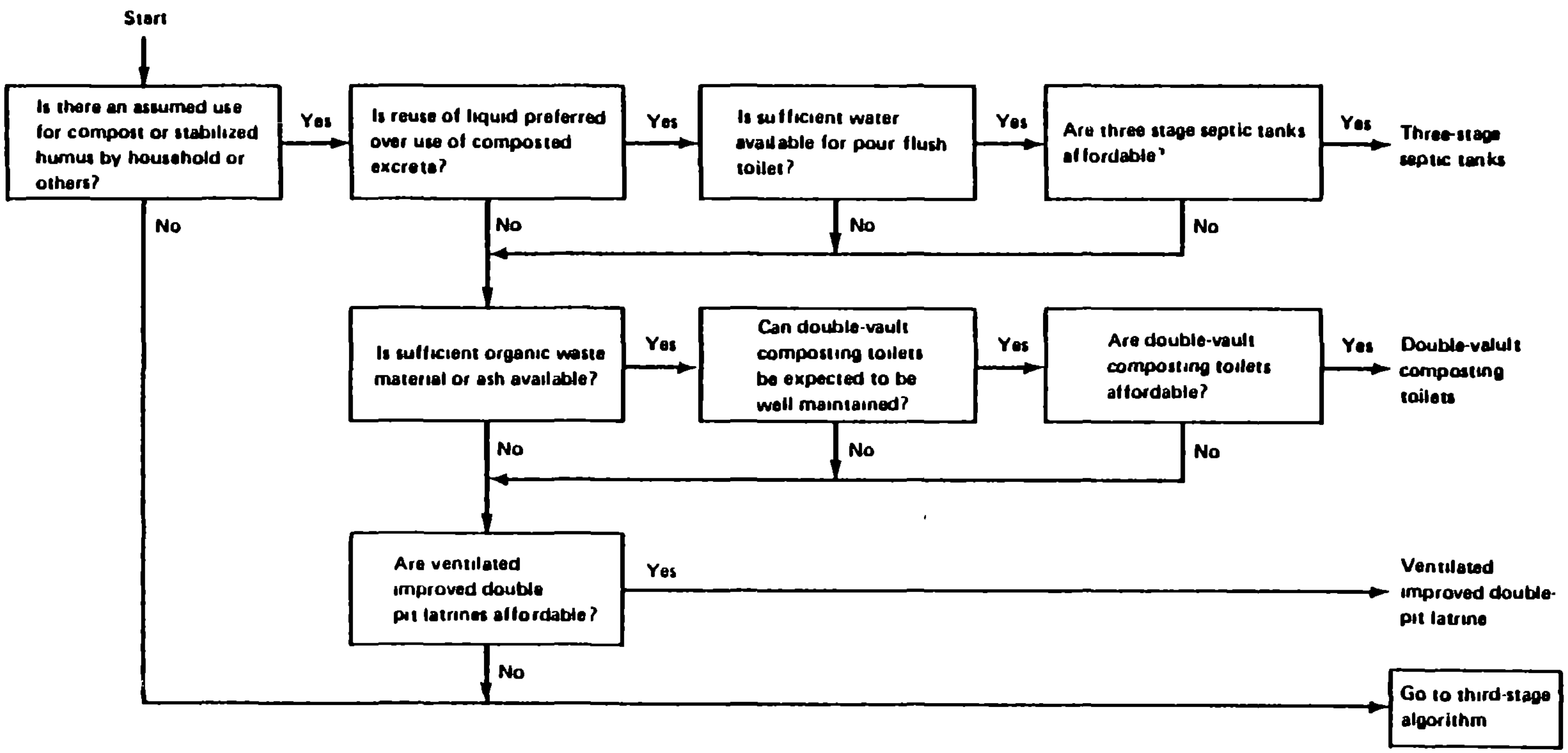
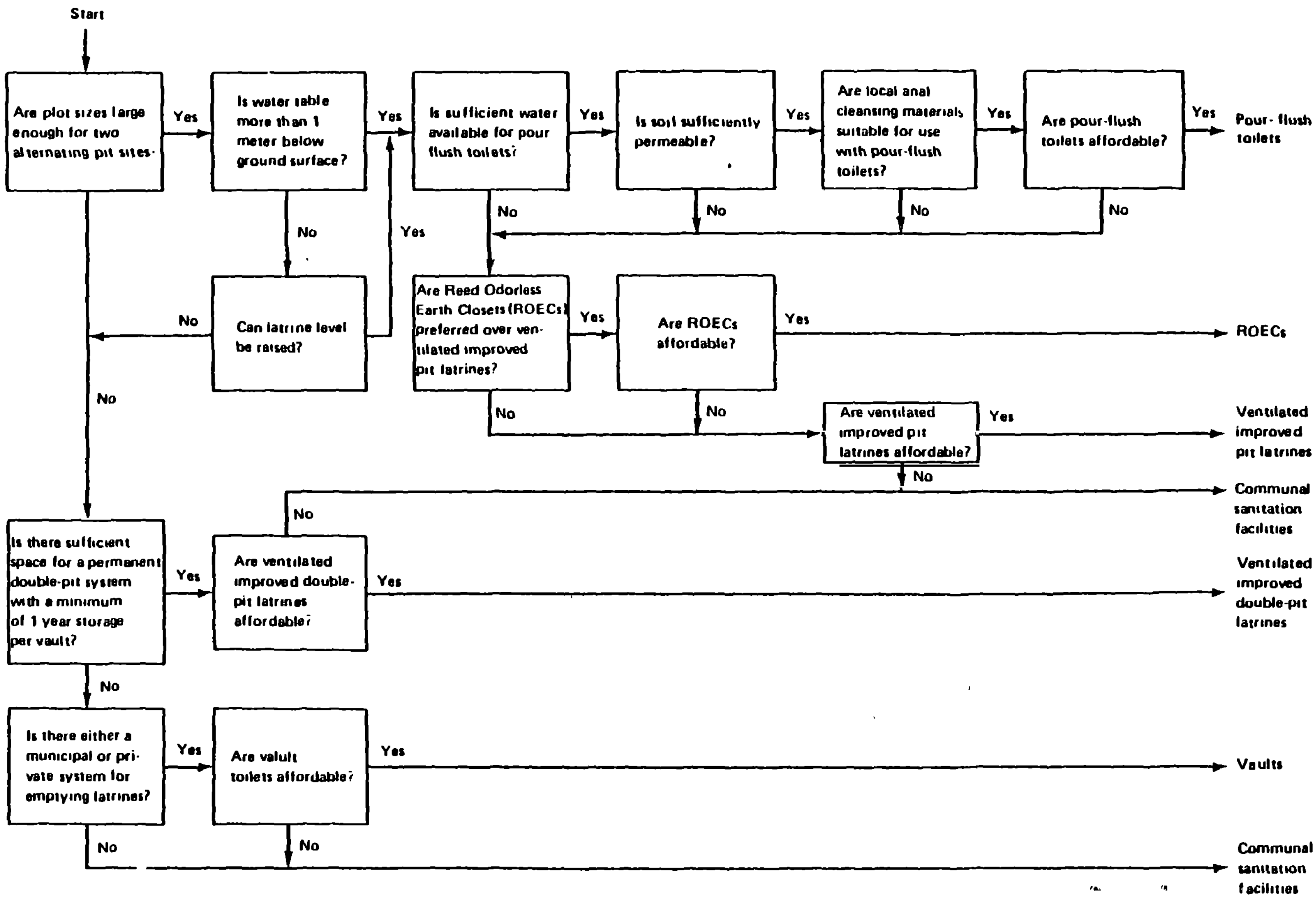


First-stage Algorithm for Selection of Sanitation Technology



Second-stage Algorithm for Selection of Sanitation Technology



Third-stage Algorithm for Selection of Sanitation Technology

Water suppy and distribution

Introduction

In all villages and poor city quarters the wells and water points are surrounded by a vast morass, caused by the overflow of the water. The pump rooms had their floors paved and sunk two steps below ground level, to make sure that no water could escape and muddy the ground outside. The overflow was drained away through an underground trench, provided with an inspection chamber for keeping it clear of obstructions, and it finally went to feed fruit trees in the neighbourhood square. The pump would be inside a small domed room provided with seats round the wall where the women could sit and chat while waiting their turn.

Once the water was taken back to the house, the girl would carry it upstairs and empty in into the reservoir on the roof. Here there would be one or two Ali Baba jars embedded in the roof and connected with one another by galvanized iron pipes. They would be situated in the shade, but where they could receive a draft to keep the water cool, and they would be glazed inside to prevent loss of water. An unglazed pot that allows the water to seep through to its outside surface and evaporate cools the water more but the loss is not worth while and it is well not to have water constantly oozing out onto the mud roof. a/

The basic physiological requirements for drinking water have been estimated at 2 litres per person per day. The minimum amount of water for cooking and washing is said to be 20 litres per person per day. If livestock are to drink from the supply, cattle need about 30 litres a day, and smaller livestock about 5 litres each per day.

It has been suggested that an appropriate design criterion for urban slums is: handwashing - 1 to 2 litres, shower - 10 to 20 litres, and bath - 100 to 200 litres. The quantity of water actually required for personal washing and bathing is difficult to establish. Although Western standards may seem extravagant in this context--handwashing - 5 litres, shower - 100 litres, and bath - 300 litres-- it is also true that a great deal of water is wasted when people wash at open hydrants or standpipes.

Levels of water supply significantly affect the choice of sanitation on the one hand, and the method of disposing of extra wastewater on the other. Typical water consumption levels and corresponding sanitation options are suggested in a World Bank Table (Table C). As mentioned elsewhere, it is possible and usually appropriate to consider a sanitation sequence which will provide initial health benefits and the possibility of further improvement and convenience.

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a/ Hassan Fathy, Gourna - A Tale of Two Villages, Ministry of Culture, Cairo, 1969.

Water supply Service level	Typical water consumption (lcd)	Options for Excreta Disposal 1/	Options for Sullage Disposal 1/
Standpipes	20-40 2/	Pit latrines Pour-flush toilets 3/ Vault toilets 3/	Soakage pits
Yard taps	50-100	Pit latrines Pour-flush toilets Vault toilets Sewered pour-flush toilets Septic tanks	Soakage pits Stormwater drains Sewered pour-flush toilets Septic tanks
Multiple tap in-house connections	>100	Sewered pour-flush toilets Septic tanks Conventional sewerage	Sewered pour-flush toilets Septic tanks Conventional sewerage

1/ The options are not listed in any order of preference.

2/ Consumption depends on standpipe density.

3/ Feasible only if sufficient water carried home for flushing.

WATER SUPPLY SERVICE LEVELS AND ASSOCIATED OPTIONS FOR EXCRETA AND SULLAGE DISPOSAL IN URBAN AREAS.

Unlike sanitation, which often has a low priority for a community, the need for water supply is never questioned. Apart from cost, the most important factor affecting the use of water beyond minimum requirements is convenience. If supplies of pure water are restricted (either because of cost, distance, or shortage) polluted sources will tend to fill the gap between an acceptable minimum and perceived needs.

The use of increased supplies of pure water will also be affected by factors which are not directly related to availability. Color, hardness, turbidity, taste and smell may lead people to use supplies which appear to be more acceptable, but which may in fact be dangerous.

Before reviewing the various technical possibilities for improving the supply and distribution of water, the question of disposal of waste water must be mentioned. Polluted open drains are the rule, not the exception, in slums and shanty towns. These drains, if they are more than earth ditches, will have been designed originally to dispose of stormwater. When they become blocked they provide breeding grounds for mosquitoes and often cause flooding. Conditions are worst at the highest building densities, and where toilet facilities are inadequate. For this reason, any plans to increase water supply must give priority to parallel improvements in drainage.

Water from a Centrally Operated Source

Water for slums and shanty towns is generally assumed to come from the same source which supplies the city as a whole, in which case extensions to the distribution network are envisioned. These may terminate in house or courtyard connections, or public standpipes, depending on the standards required. In some cases the distance of the housing area from the existing network may call for tanker distribution and organized sales by vendors. Various methods of distribution from city sources have been thoroughly investigated by the World Bank and many such solutions are being tested in "sites-and-service and upgrading" projects financed by the Bank. a/

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a/ The World Bank has been studying mathematical models for the most effective layout of secondary water distribution systems. These were based on realistic conditions in six different urban areas selected for improvements. The calculations include total pipe length and diameter, and cost depending on a number of variables, e.g., *per capita* usage, spacing of standpipes, storage, etc. (EWTD *Design of Low-Cost Water Distribution Systems*, PU Report No. RES 11a, January 1979, World Bank).

Similar studies were commissioned by the USAID and the IBRD from the Department of Urban Planning at the Massachusetts Institute of Technology. These were concerned with alternative planning layouts related to services as an exercise in the physical planning of sites and service projects. (Caminos, H., *A Method for the Evaluation of Urban Layouts*, Industrial Forum, Vol. 3, No. 2, Montreal, December 1971).

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Household connexions may be essential to obtain any noticeable health benefit from improved water supply. Depending on building densities, the cost of household connexions has been estimated at between two and three times the cost of public standpipes. However, when individual families are responsible for their own maintenance, there is generally less wastage. Because house connexions reduce the peak flows of communal supplies, smaller pipe diameters can be used for connexions.

At public water points, water taps are usually the first part of the system to break down. If maintenance is assumed to be the responsibility of a municipal authority, there can be long delays before repairs are carried out. When this happens residents often remove the taps, causing wastage and the danger of standing pools of polluted water. Sets of spare washers and a spanner provided to a well-organized community could help to solve this kind of problem, but only if accompanied by changed perceptions of responsibility.

There are many simple methods of making physical improvements to the design and drainage of the area surrounding public water points (Figure 5). The following standards have been suggested for public standpipes:

(a) One standpipe within a walking distance of less than 200 m.;

(b) The number of persons served by one standpipe should not be more than 250-500 people;

(c) The volume of water drawn daily from a public standpipe should be in the range of 20-60 litres/capita/day. a/

Examples of different distribution methods and standards of water supply in recent projects financed by the World Bank are:

Sudan: Each standpipe on a Port Sudan project is rented to a kiosk owner. The water is metered and sold at a standard rate to the kiosk owner, who resells it at controlled prices.

Kenya: The Nairobi City Council will provide water kiosks in a number of low-income areas. Operators will be licensed and water charges to the kiosk will be reduced by half the normal tariff, enabling the vendor in turn to reduce his prices.

Liberia: The current $35 connexion charge is to be abolished and a subsidized progressive structure will be introduced. About 100 standpipes and 50,000 feet of piping will extend the service to slum areas.

Cameroon: For the upper 40-50 per cent income group in Douala and Yaounde, and the upper 30 per cent in smaller towns, house connexions are proposed at 10 persons per connexion; yard connexions are proposed which will serve 30-35 per cent of the urban population with an average of 50 people per connexion, and for the rest standpipes at 500 people per standpipe. The costs will be subsidized by commercial and industrial customers.

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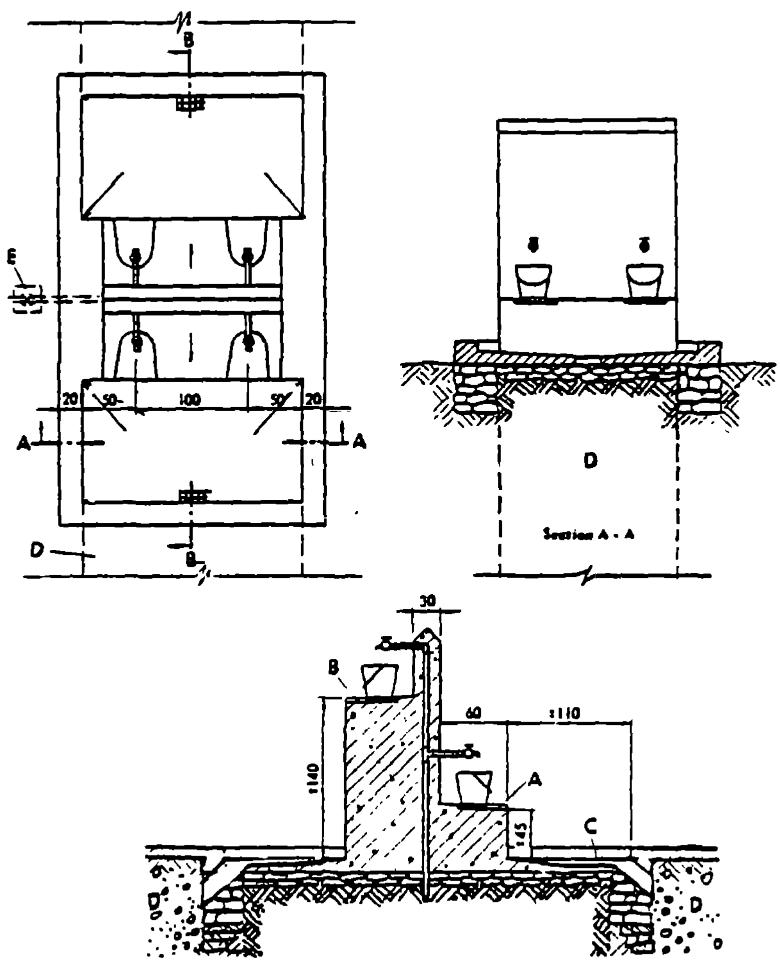
a/ WHO Public Standpost Water Supplies (Draft), Technical Paper No. 13, WHO International Reference Centre for Community Water Supply, September 1979.



Measures are in centimetres.

A = Platform level at about knee height
B = Platform level at about shoulder height
C = Hard-surface floor
D = Soakage pit :

E = Control valve

Possible design of public water point. (From Wagner and Lanoix).
& MODIFIED

* SOAKAGE PITS SHOULD BE OFFSET OR LOCATED AWAY FROM THE PLATFORM TO AVOID SUBSIDENCE & DAMP AREAS

* SEE ALSO J. ANDRIOU'S CONSULTANT REPORTS TO IBRD WHICH INCLUDE SKETCHES OF IMPROVED WATER POINTS

<u>Philippines</u>: At Pateros, a poor area in Manila, a pilot project proposes to bring water to the area by road tankers filled at pump stations during off-peak hours and discharged into large storage tanks. Most families will be within 300 metres of a distribution point and each family will be allocated 8 litres per head daily, at a price lower than that charged by vendors. By 1982 no household should be more than 200 metres from a standpipe and a supply of 20 litres available for each person. a/

<u>Panama</u>: The Government provides water distribution design layouts and specifications, and some materials, to communities larger than 500. The communities provide manual labour accounting for about 40% of total costs. b/

Intermittent Service and Dual Systems

Although discussion of municipal water sources is outside the scope of this review, there are two methods of limiting the distribution of scarce water supplies which directly affect low-income communities. First is the widespread practice of intermittent service, which supplies almost half of all urban water consumers in the developing countries. Although this may be the only type of service which the water authority can provide, it encourages household storage and the attendant risks of contamination. In some cities which provide intermittent service, water-borne diseases are endemic. (This is in part due to the increased reliance on other water sources, which are often polluted.) It also leads to wastage, leakage, system contamination, meter deterioration and valve malfunction.

The second and less common practice is that of providing water from different sources for different uses. Untreated sea-water is used in a separate pipe system for flushing in Hong Kong, and the city of Calcutta has been operating a dual water system which provides intermittent supplies of treated water and a continuous flow of unfiltered water.

Maintenance and Wastage

Losses from leakage and wastage (excluding evaporation losses from large surface reservoirs) may amount to as much as 40 per cent of bulk supply. This should be reduceable to something in the order of 25 per cent through reduction in leakage, the introduction of balancing reservoirs (to maintain system pressures and reduce the need to leave intermittently-served faucets open), and through a more complete and systematic metering of consumers. c/

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a/ <u>Urban Edge</u>, Vol. 3, No. 4, 1979 (Summary of IBRD Projects).

b/ United Nations Centre for Housing, Building and Planning, <u>Ad-Hoc Expert Group Meeting</u>, Nassau, Bahamas, February 1977.

c/ J.D. Herbert, <u>The Supply and Pricing of Public Utilities</u>, A/CONF/70/RPC/RP/20, Habitat Paper, United Nations, 1975.

Municipal water agencies are compelled to repair a broken water main more promptly in a wealthy neighbourhood than a leaking connexion in a shanty town. It would be unrealistic to expect a water agency to send a repair team every time a shanty town standpipe malfunctioned but, on the other hand, people are often prevented from making simple repairs themselves, when this is viewed as "tampering with public property."

Leakage is important to remedy but improvements take time, money, and trained personnel, none of which can easily be spared when more pressing demands have to be met by the water authorities. If water authorities could be persuaded to delegate some of their responsibilities to local repair people, and the community concerned could organize itself to provide these people, some of the problems of maintenance in slums and shanties would be resolved.

Cost of Water Services

In one Central American city, low-income families are paying seven times as much for water per litre as middle-income families, and five times as much as high-income families. In Bauchi State, Nigeria, poor people pay 20-30 per cent of their income to water vendors. The World Bank indicates that in general, the *per capita* cost for water in urban areas is $120.00 for water from house connexions, and $40.00 for water from standpipes ($US, 1978). For a family earning as much as $500.00 a year, this would represent 12.5-24 per cent of their income.

Many water authorities could provide a higher level of service with the resources they already have. The high cost of house connexions for the poor could be cross-subsidized by industrial and commercial users, or they could be built into the overall tariff. Also the cost of water for luxury use (e.g., lawns and pools) could be higher.

> A more equitable social policy would provide inexpensive access via social (yard or patio-shared) connexions, providing for a minimum consumption for everyone of 5 m per month. There is a trend to keep the basic charge low and to raise the tariff on consumption beyond the minimum. A low tariff for 5 m was introduced in Gabon in 1973 and in the Ivory Coast in 1974. The social connexion concept in which several neighbours draw water from the same source is also successfully operating in the Ivory Coast. Cameroon is now looking into implementing a similar system. a/

Alternative, Decentralized Sources of Water Supply (Table D)

Considering the inaccessibility and isolation of many slums and shanty towns, surprisingly little attention has been given to independent sources of water supply for these areas. The use of groundwater sources which might become polluted by pit-latrines certainly justifies a cautious approach, but should not rule out the possibility entirely.

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a/ Kalbermatten - Calcutta Seminar, *op cit*. World Bank Studies on the subject of pricing include: *The Costs and Benefits of Water Metering*, June 1977, PU Report No. PUN 29, and *Pricing as a Means of Controlling the Use of Water Resources*, March 1976, PU Report No. PUN 21.

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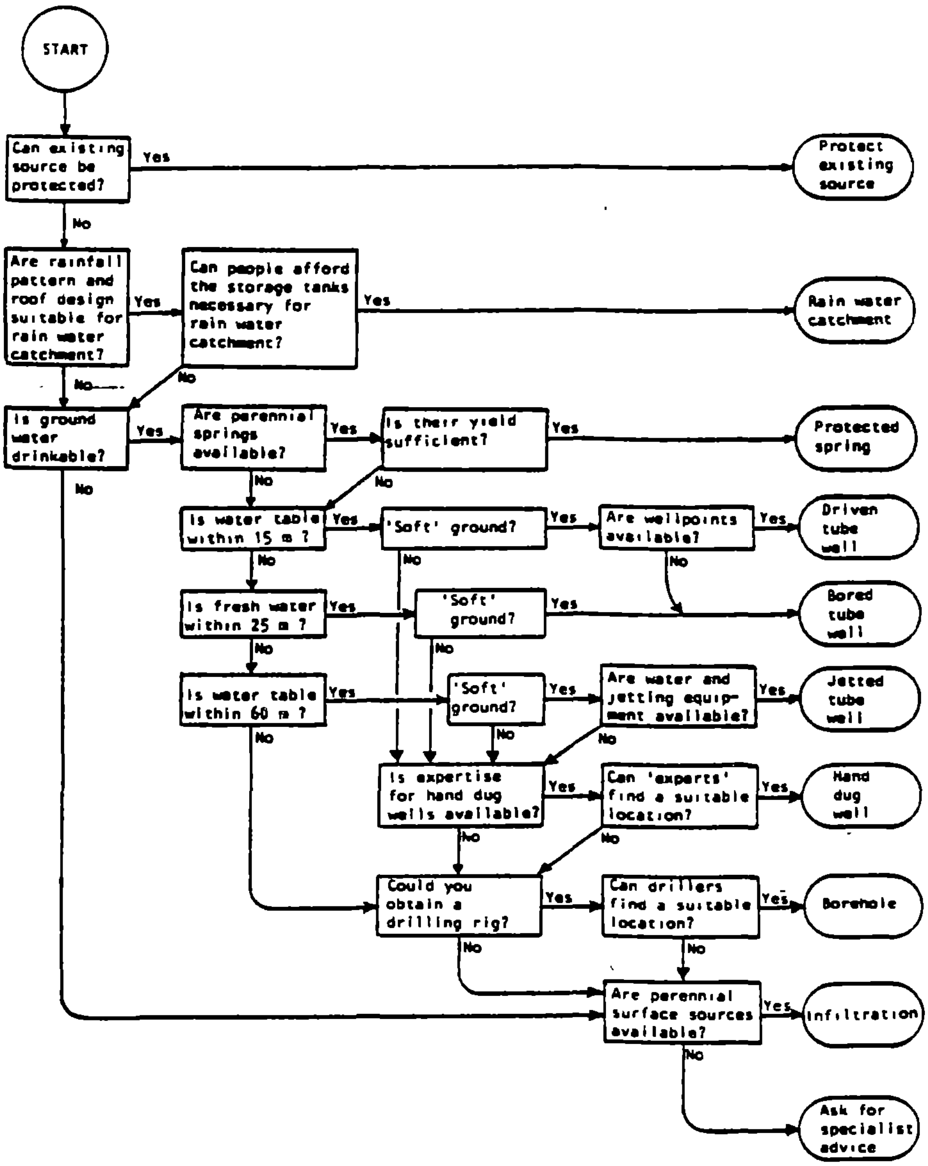

Choosing a source of water. Follow the arrow corresponding to your answer to the question in each box.

From SMALL WATER SUPPLIES
Feachem and Cairncross

Ross Institute Bulletin No. 10
London January 1978

The water supply of some cities consists entirely of deep tubewells, overhead storage tanks and distribution lines. In other cases, squatter settlements have become established municipalities with independent supplies. This section considers a range of smaller-scale water sources, including springs, wells, rainwater storage and various methods of treatment usually associated with rural communities. a/

Since improvements have a better chance of success if they take existing conditions as a starting point, some of these methods may be able to provide an intermediate step between inadequate polluted water and household connexions to the city water supply.

Springs

In many cases the springs used for water supply in shanty towns are so polluted that they must be closed down or diverted. They can be protected (if pollution is not being introduced farther upstream) by the construction of "spring boxes" and by improving the drainage of the surrounding ground (Figure 6).

Wells b/

The feasibility of sinking wells to provide independent water supplies to specific slums and shanties will depend on hydrogeological conditions, ground pollution (especially where pit-latrines and seepage pits are in use), housing densities, and accessibility.

Wells are already the source of water for many shanty towns and new settlements. Where deep tube wells have been provided by a municipal water authority, the operation and maintenance of the principal elements - pumps, storage tanks and distribution network - is likely to be more reliable than cases where a larger number of shallow wells and standpipes are provided.

Simple wells can be greatly improved in many cases simply by constructing a headwall fitted with rollers or other means of lifting water so that people do not have to lean over the well when drawing from it. Drainage problems can be taken care of by building a concrete or brick apron sloping away from the well and leading to a soakaway.

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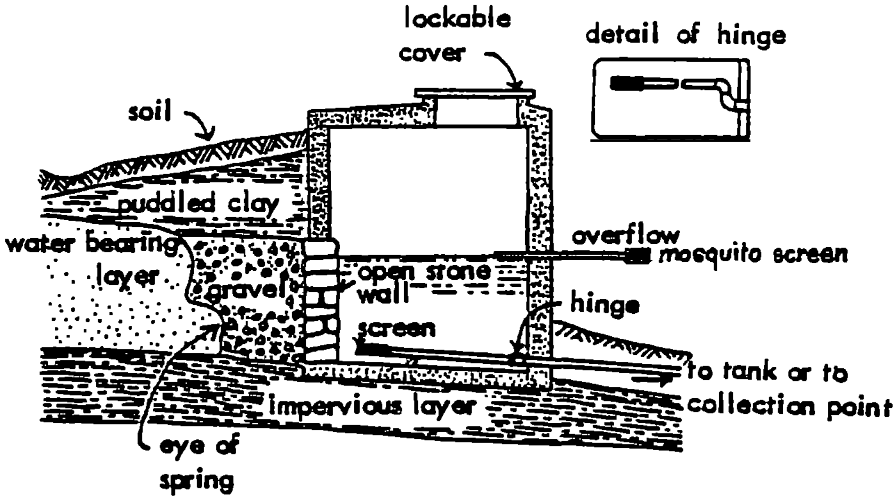
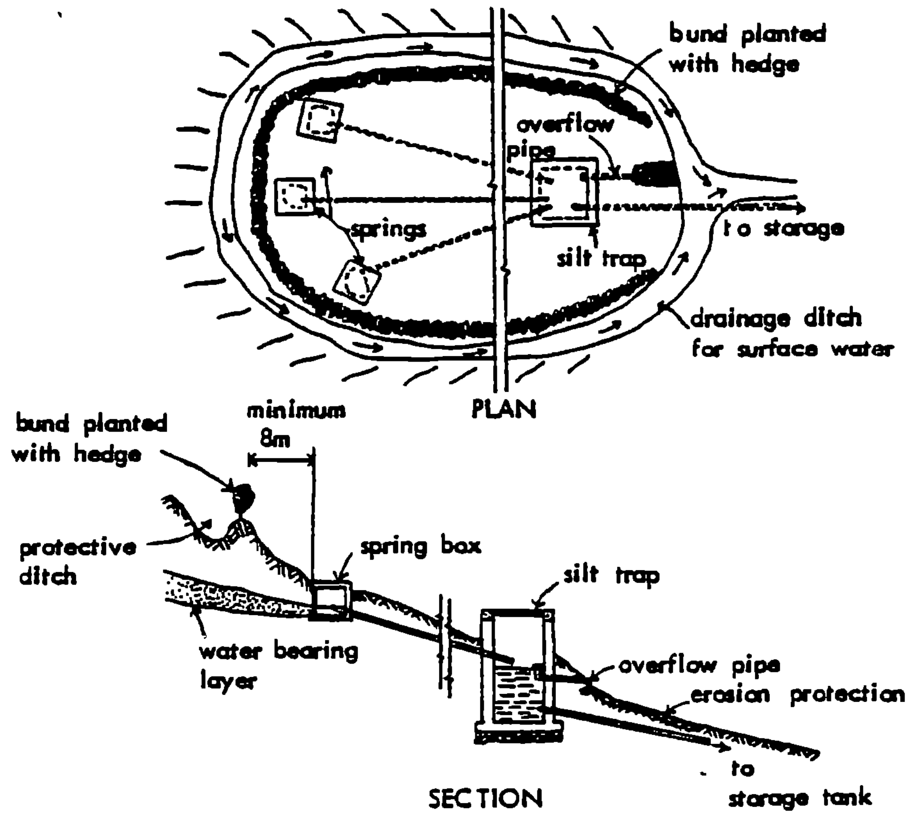
a/ Sandy Cairncross and Richard Feachem, Small Water Supplies, The Ross Institute of Tropical Hygiene, London, 1978, is the main source of information for this section.

b/ Technical information on driven, bored, jetted, dug and drilled wells is available in other manuals (VITA, 1970; Watt and Wodd, 1977; USAID, 1969). ITDG Wells Manual, Ross Institute, Small Water Supplies, Bulletin No. 10, 1978.



A spring box; the inset detail shows a hingemade with two pipe bends, enabling the screen to be lifted above the water for cleaning.

* DAMMING A SPRING OUTLET BACK IN THE HILL CAN FORCE WATER OUT ELSEWHERE
* DANGER OF PATHOGENS ENTERING THE SPRING BOX FROM POLLUTED NEIGHBOURING AREAS
* A DRAIN SHOULD BE LOCATED BELOW THE WATER SUPPLY INLET



Three protected springs connected to a silt trap.

In densely populated areas, where the likelihood of contamination is higher, it is advisable to cover the wellhead entirely and to introduce a handpump for drawing up the water (Figure 7), as well as making improvements to drainage. Similar, fairly low-cost improvements can be made to the areas surrounding public water points (Figure 5).

Other methods of obtaining water where the ground is insufficiently permeable to supply wells are infiltration galleries, river intakes and underground catchment tanks (see Ross Bulletin No. 10). It is unlikely, however, that these methods will be suitable for most shanty towns, except perhaps in the early stages of occupation of the outer fringes of smaller cities.

Raising Water

All mechanical devices have moving parts which require maintenance and repair.

(a) Buckets with lifting gear. Pulleys, windlass, rollers and counterbalanced levers are all susceptible to breakage. They are, however, the most easily repaired of water-raising devices, being mechanically the simplest.

(b) Handpumps. The handle is the part most likely to break, and it may be worth while, when installing a handpump, to invest in a good handle initially to save on future repairs. In deep wells, some skill and care is required when removing the cylinders of the pump. Most handpumps cannot pump from depths greater than 60 metres.

(c) Windpumps. Manufactured windmills tend to be expensive; homemade ones are rarely strong enough. In areas where wind is intermittent, storage tanks with at least seven days' capacity are required. Most windmills like a handpump drive a piston in a cylinder. If possible they should be combined with a handpump for use on windless days.

(d) Hydraulic rams and solar pumps. The ram uses the energy of a large flow of water to lift a small proportion of the total volume. Solar pumps are suitable for arid areas. They can pump as much as 6 litres per second. Such pumps have been installed in rural West Africa by a French manufacturer.

(e) Diesel and electric pumps. In proposing any type of mechanical pump it will be necessary to know who will be responsible for operation and maintenance, whether there is a reliable supply of fuel, and whether spare parts are readily available.

Rainwater catchment

The economics of artificial catchment are determined by the reliability and rate of rainfall, the surface area available for catchment, and the cost of surfacing materials.

In Jamaica, a catchment unit was planned with an open reservoir lined with an exposed synthetic rubber sheet and an artificial catchment, three quarters of which was aluminum sheet, the remaining quarter being polythene covered with gravel. The design was based on the two consecutive driest years in the

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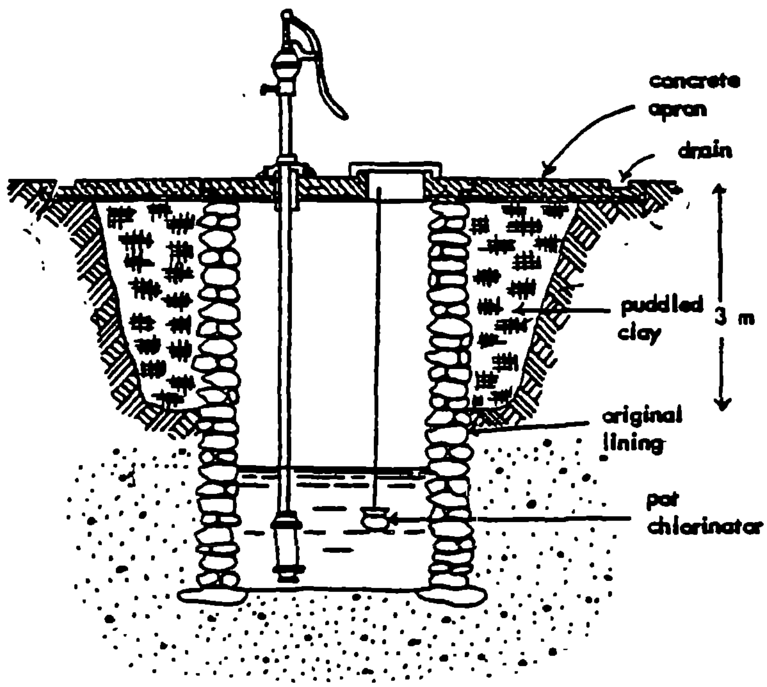
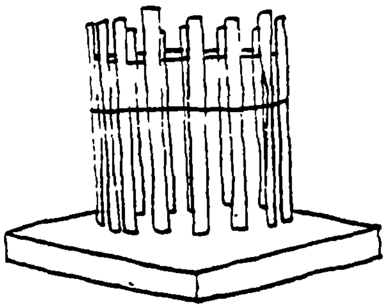
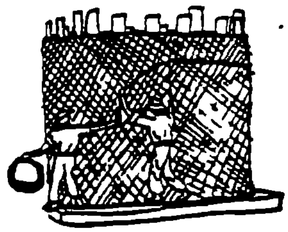


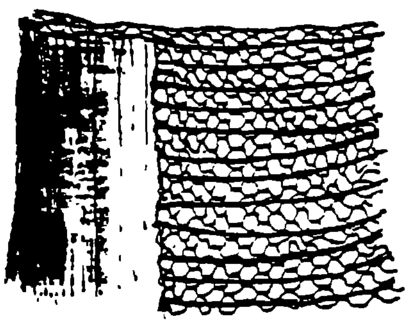
Improving an existing well. (After Wagner and Lanoix).



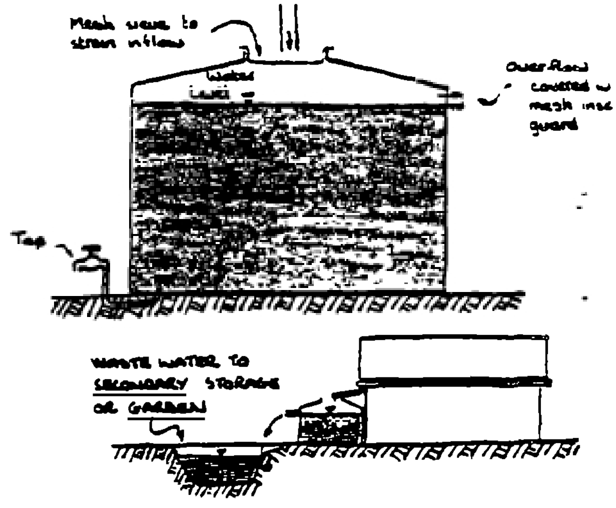
Inside former of vertical planks.



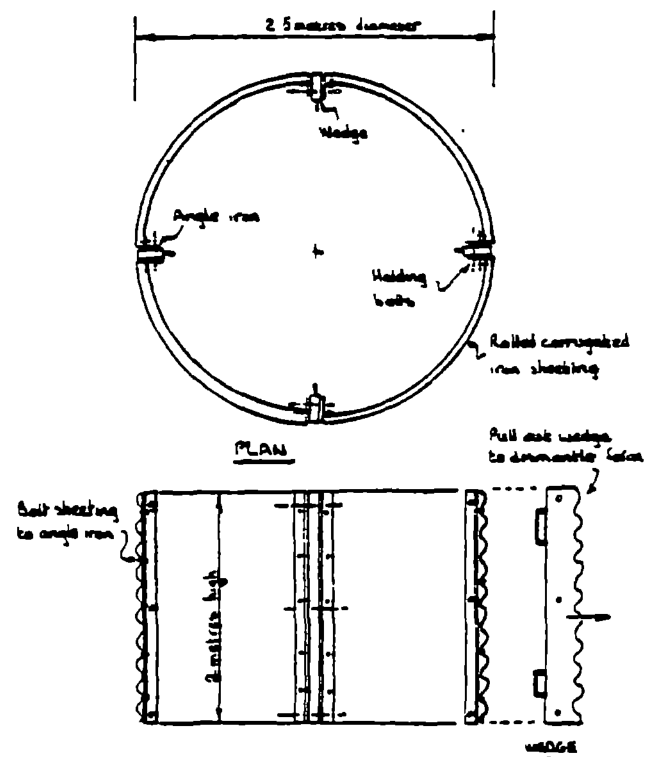
Netting and a spiral of wire.



The plaster build-up.



CROSS SECTION OF HOUSE AND TANK.



Formwork made from circular, corrugated galvanised iron, held by angle iron lengths fastened to the ends of the sections, which are bolted together through removable wedges. The corrugations help to hold the mortar in place and assist the builder wind on the correct number of wires.

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1. *Wire reinforced cement mortar water tanks – a construction handbook for fieldworkers.* To be published by I.T. Publications.
2. *Ferro-cement – Application in Developing Countries,* 90pp. Available free of charge from:

   Board on Science & Technology for International Development (JH 215), Office of the Foreign Secretary, National Academy of Sciences, 2101 Constitution Avenue, WASHINGTON, D.C. 20418, U.S.A. An excellent introduction to the potential and uses of ferro-cement.

THE US FARM BUREAU PROVIDES DETAILS OF AN
* IMPROVED FILTER FOR THIS TYPE OF TANK

Wire-Reinforced Cement-Mortar Water Tanks

S.B. Watt, Civil Engineer and Water Consultant

30 years for which there were monthly records. It was calculated that a catchment area of 15 acres (0.6 hectares) including the surface area of the reservoir area capable of holding 700,000 gallons (2,650,000 litres) would provide a minimum steady supply of 125,000 gallons (473,000 litres) per month. a/

The structural strength of brick or masonry tanks is improved by building them partly underground or by constructing an earth embankment against the walls. In either case the roof of the tank should always be at least 0.3 m. (1' 0") above ground level to prevent surface water running back into the tank.

Although they are a rare feature in most shanty towns, the trunk of an average baobab tree holds about 1,000 litres of water; a large one might hold five times as much. With holes cut in the side for drawing off water these trees can provide useful storage in arid areas.

All new storage tanks should be cleaned and disinfected before use.

Water collection and Storage in the Home

Rainwater

The collection of rainwater by individual households depends on clean roofs and gutters and the design of suitable low-cost storage containers that will keep the water clean and keep mosquitoes out. Bituminous materials impair the taste of water, and standing pools on flat roofs encourage mosquitoes. A polyethylene-lined tank that incorporates a sand filter has been developed in the Sudan. In southern Africa tanks of up to 100,000 gallons' capacity have been built using a cement and sand mortar reinforced with heavy gauge wire (Figure 8). b/ In the USA and Jamaica, prefabricated PVC bags have been used to line thin-gauge steel grain bins to form watertight storage tanks. c/

Although it is usually impractical to purify all of the water which is used in the home, it is self-defeating to drink pure water but use contaminated water (which may contain schistosome larvae-the worms which cause bilharzia) for laundry and personal washing. Also, as mentioned previously, a readily available supply of water which may be polluted is more likely to be used than a purer, but more inconvenient or limited supply of water.

Water Containers

These must be kept clean and regularly rinsed with boiling water or washed out with a bleach solution (one part liquid bleach to five parts water) and rinsed with pure water. Alternatively, a small quantity of bleach can be added regularly to the water in the container. Each container should have a

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a/ D. Maddocks in Appropriate Technology, Vol. 2, No. 3, London, 1975.

b/ UNICEF has financed rainwater containers constructed of bamboo mats and cement mortar at Madura and Kendari, Indonesia.

c/ Maddocks, Ibid.

.../

close-fitting cover. Containers should have small mouths so that cups and hands cannot be dipped in the water. The best way to draw off water is from a tap at the bottom of the container.

Atomized Water

The use of atomized water as a means of reducing the quantity of water used for personal hygiene was investigated 30 years ago by Buckminster Fuller. His Fog Gun combined compressed air and atomized water with solvents which could provide a one-hour pressure bath with only half a litre of water. Using an even less complicated atomizer, the same quantity of water would give 100 hand washes (Figure 9).

In 1965 the United Nations conducted an experiment in a Lima barriada where five families were provided with washing sprays. The families were recent arrivals from the rural area. There was no piped water in the settlement and water had to be obtained from a vendor. It is reported that the sprays were successfully used for two years. a/

More experimental work still has to be done to establish the bacteriological effects of washing this way compared with the more common methods. There would also be some difficulty in persuading a squatter that he should take a one-litre spray shower after using, say, 600 litres to clean his employer's car.

Water Treatment for Small Communities b/

Treatment should only be considered if it can be afforded and reliably operated. It is always preferable to find a source which provides naturally pure water and then to protect it from pollution. The following treatment methods can be considered for small communities: storage and sedimentation, filtration, disinfection and aeration. The removal of salt and fluoride at the scale of small communities is likely to be very expensive.

(a) Storage and Sedimentation

Simple covered storage for a minimum of two days will kill schistosome larvae and some other bacteria. Water quality will be improved by allowing silt and other harmful organisms to sink to the bottom of a storage tank. This process may not remove many of the harmful organisms, but silty water does become clearer and easier to filter when it has been allowed to stand for a few days (Figure 10).

(b) Filtration

This process can remove up to 99 per cent of the bacteria and viruses in water as well as some of the other sources of disease such as cysts, ova and schistosome larvae, if the filter is properly designed. Sand, burnt rice

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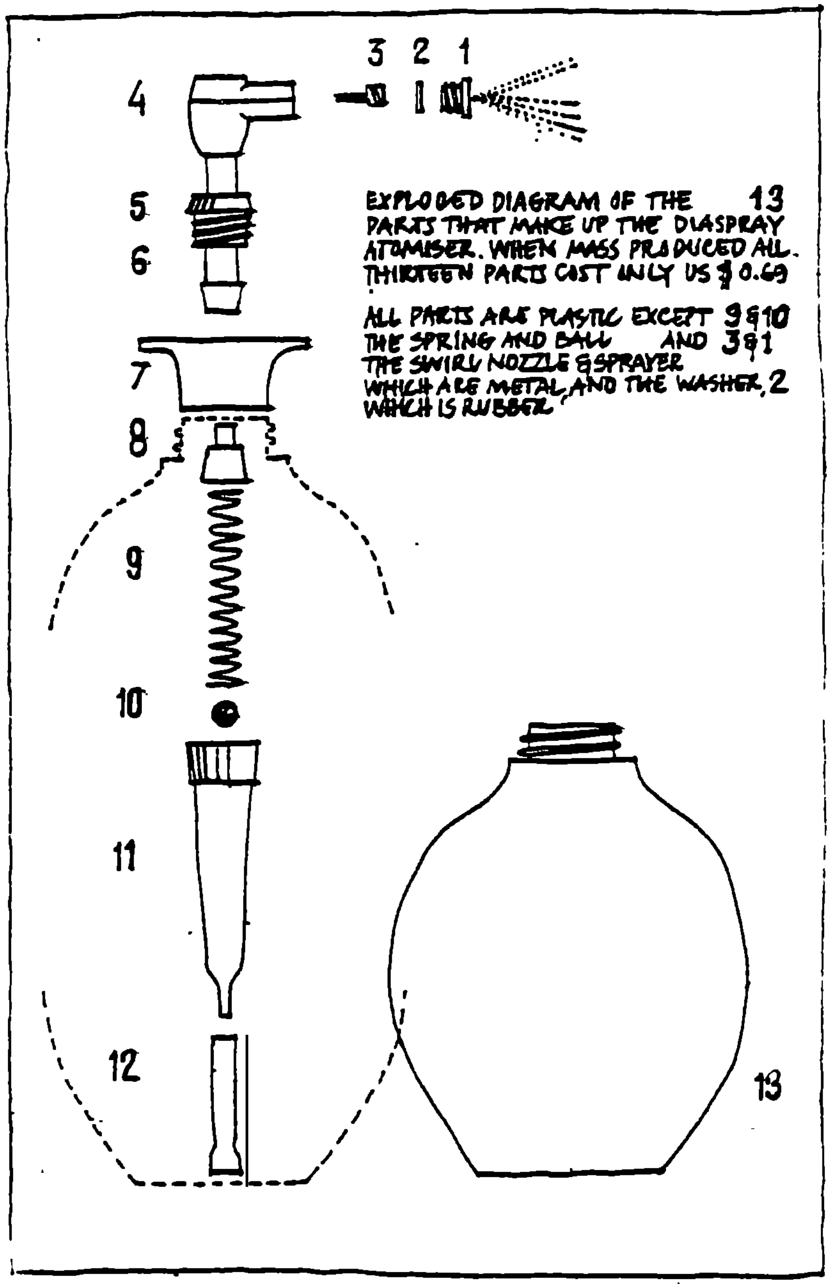
a/ Report by the Habitat Programme Preparation Group, submitted to UNEP, 1973. Mimeo.

b/ This section is based on: Feachem and Cairncross, Small Water Supplies, Ross Institute Handbook No. 10, London, 1978.



THE DIASPRAY ATOMISER

husks and other material of uniform particle size can be used as filtering media. The slow sand filter consisting of a large tank containing a bed of sand through which the water is strained to drains leading to an outlet (Figure 11), is the simplest low-cost method. The filter does not work by a simple straining process, however. The sand grains in the top layers become coated with a sticky deposit in which bacteria and microscopic plants multiply. These form a fine straining mat which kill most of the micro-organisms that pass through it.

(c) Disinfection

Water supplies are commonly disinfected by chlorine in gas, liquid, or powder form. Within half an hour chlorine can kill bacteria, schistosome larvae, some rhiruses and, at higher doses, amoebic cysts. There is little danger to health from excessive dosing, but, if too much chlorine is added, the unpleasant taste may drive people to use more heavily polluted water instead. Dirty or cloudy water is not suitable because it will simply absorb the chlorine. Chlorine should never be applied before slow sand filtration has cleared the water. The main problem of disinfecting small-scale water supplies is maintaining a constant supply of chlorine. Three low-cost methods of dispensing controlled doses of chlorine are illustrated (Figure 12).

(d) Aeration

Some chemical impurities such as iron and manganese, which impair the taste of water, may be removed by aeration. Aeration is also effective in driving off H S gas, which has a highly offensive odor. A simple device constructed of 200-litre steel drums, stones and sand is illustrated (Figure 13).

Water Treatment in the Home

Appropriate methods for domestic purification include:

(a) Canvas filters. A simple canvas bag will remove some of the pathogens and will clear the water enough for chemical disinfection.

(b) Household sand filters. Smaller versions of those described above are suitable for individual household use (Figure 14). Alternative filtering materials such as coconut husks can also be used.

(c) Ceramic and Paper Filters. Porous porcelain hollow "candle" filters or paper cartridges impregnated with silver are available for filtering water. Such filters may be produced by local manufacturers.

(d) Chemical disinfectants. Iodine or chlorine can be used to purify filtered water (see above).

(e) Boiling. Opinions differ as to how long water must be boiled to make it safe for drinking. In any case, this is an expensive process which is unlikely to be appropriate for households with low incomes. It takes about 1 kg of wood to boil one litre of water.

(f) Solar stills. An inexpensive method of purifying brackish or saline water using solar radiation has been proposed for use in tropical rural areas. Individual or collective solar stills can be simply assembled using a

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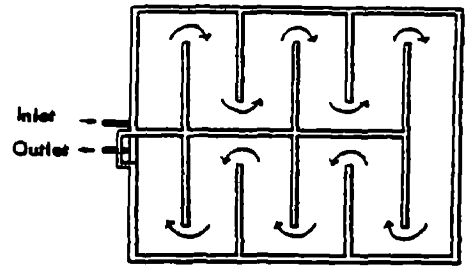
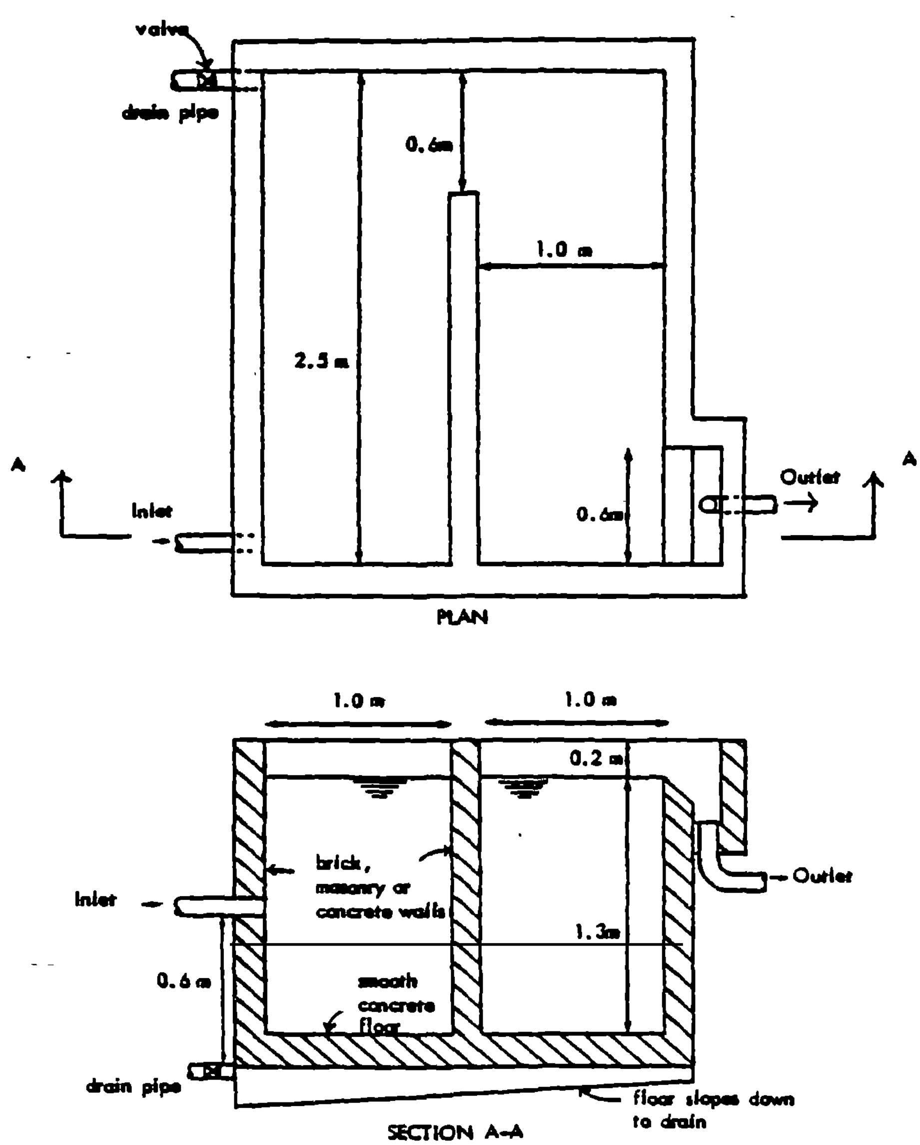
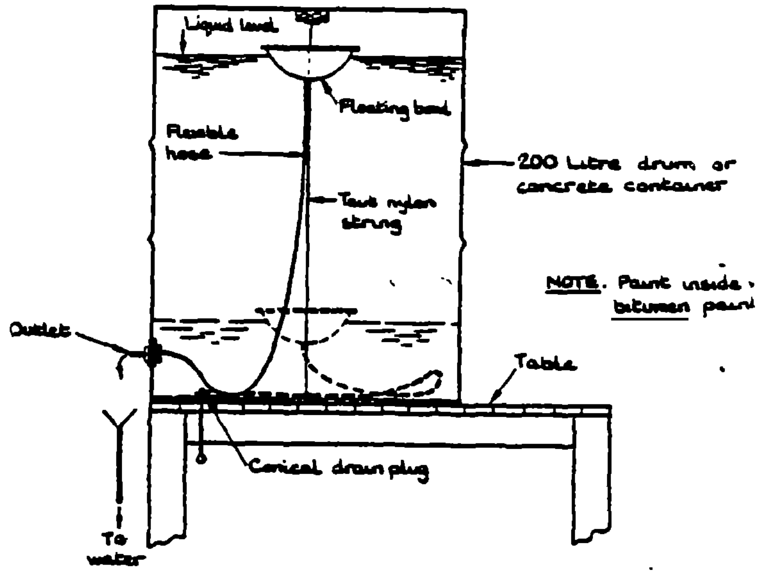


Method of combining six small sedimentation tanks.



A simple sedimentation tank for flows up to 2,000 litres/hour.



Floating bowl chlorinator, to feed chlorine solution at a constant rate. (From McJunkin).

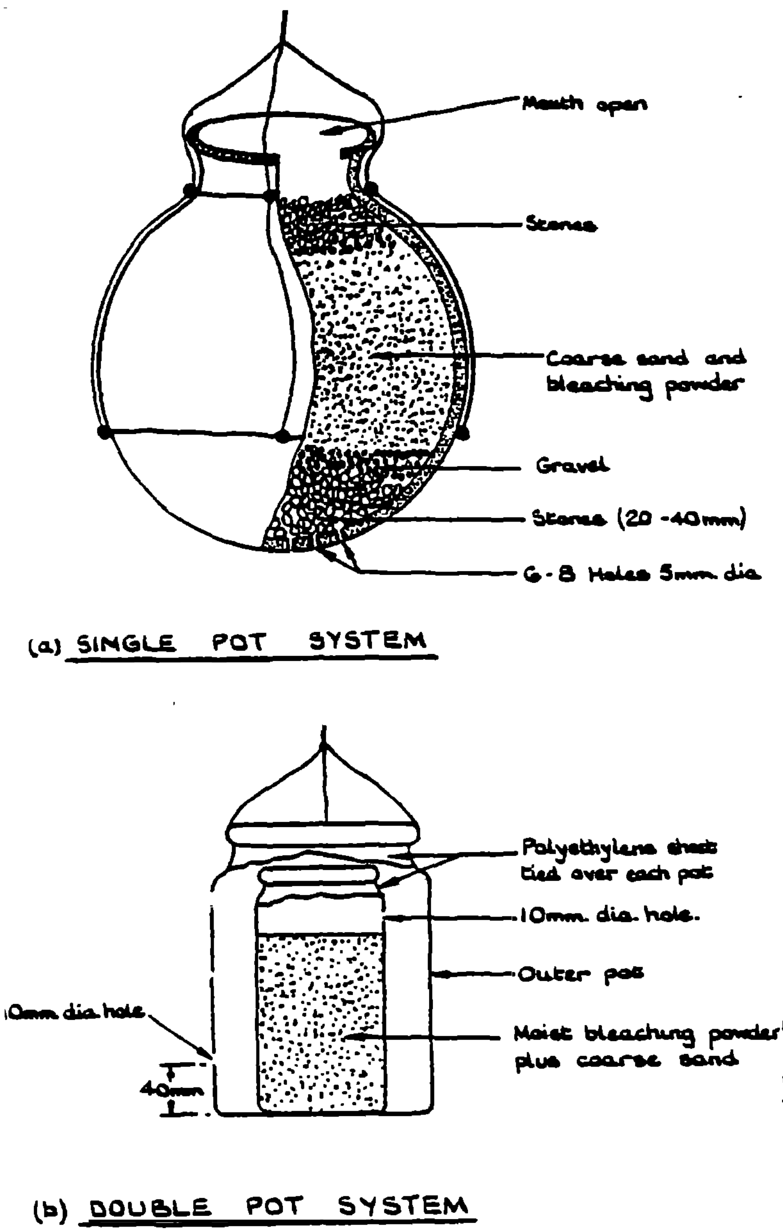
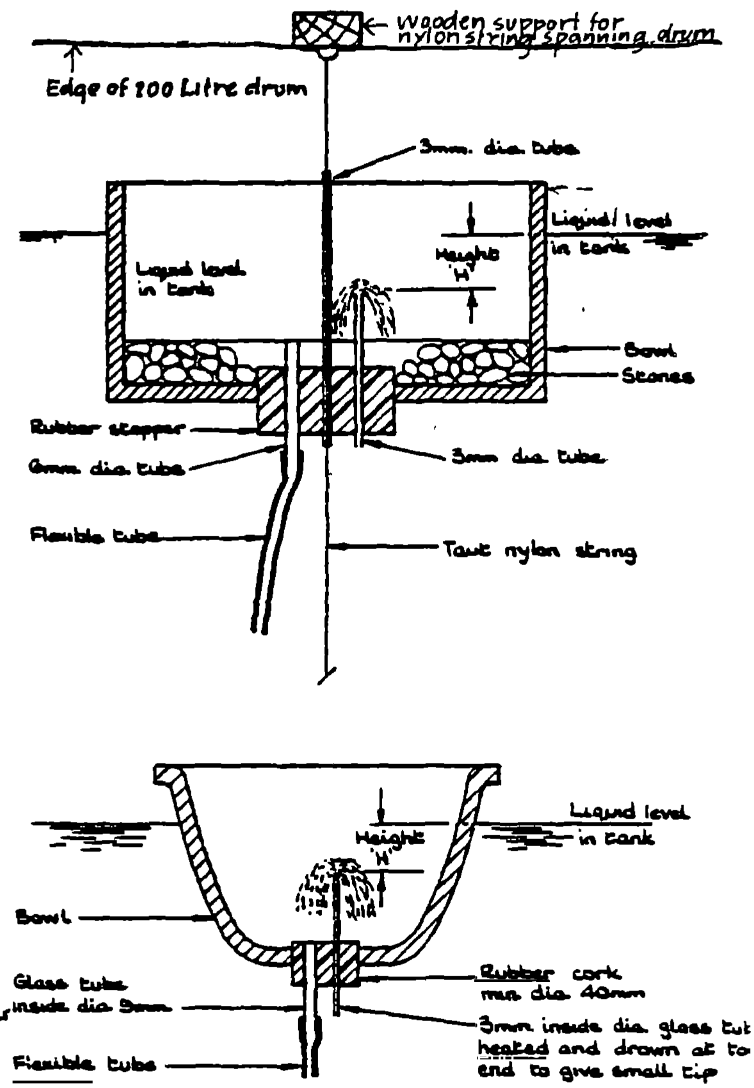


Fig. 28. Pot chlorinators; two alternative designs.



Detail of floating bowl; two alternative arrangements. (From McJunkin).

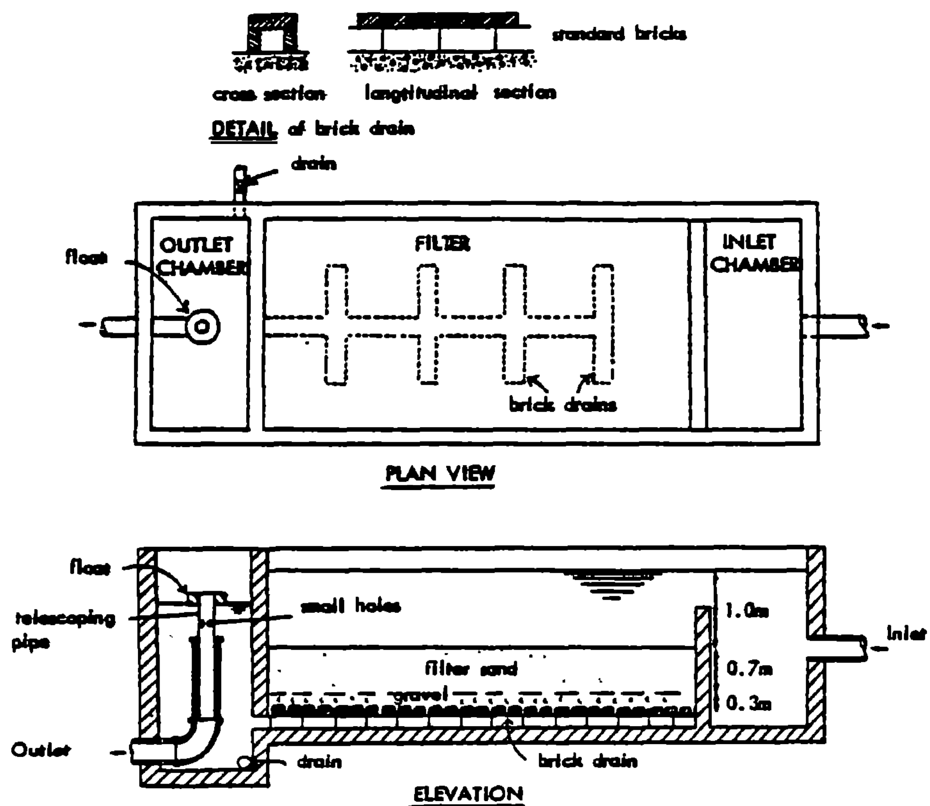
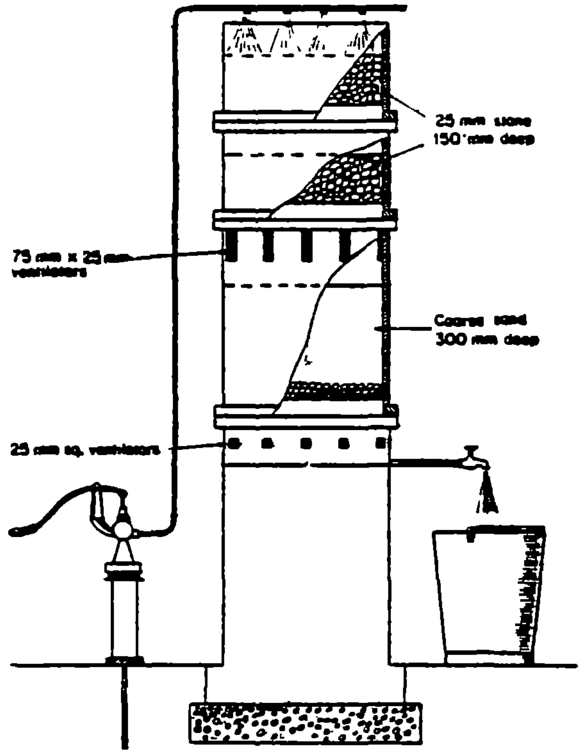


Fig. 27. Slow sand filter.



A hand operated unit for iron and manganese removal. (From Pickford).

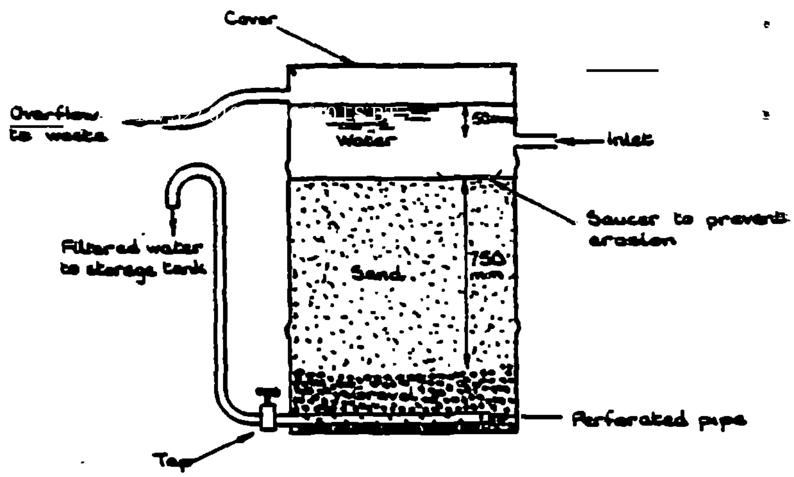
* ONLY WATER CONTAINING IRON IN THE FORM OF FERROUS BICARBONATE CAN BE REMOVED USING THIS SYSTEM OF AERATION & COARSE SAND FILTRATION OTHER IRON FORMS : EG. FERROUS SULPHATE COLLOIDAL OR ORGANIC IRON CANNOT BE REMOVED

* THE WATER MUST BE SETTLED FOR 1/2 → 1 HOUR BEFORE FILTERING, OTHERWISE THE SYSTEM WILL CLOG.

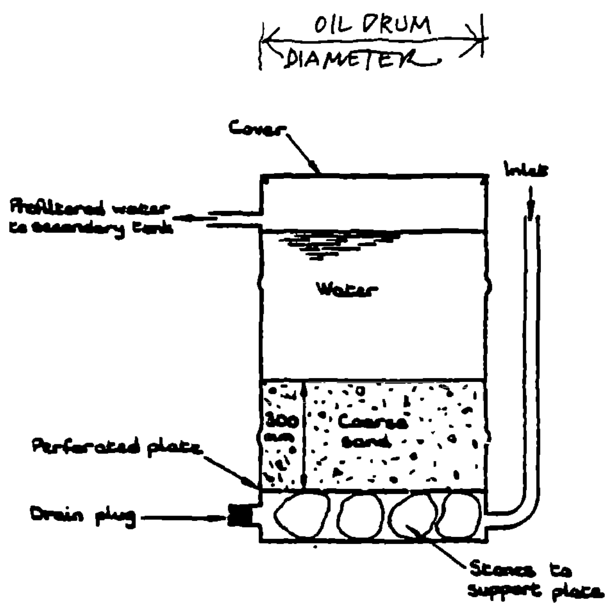
* IT MUST BE POSSIBLE TO PUT THE HANDPUMP UNDER PRESSURE

* UNICEF HAS DEVELOPED AN IRON REMOVAL PLANT SUITABLE FOR USE WITH THE BANGLADESH NEW No 6 HAND PUMP

[DETAILS NOT YET RECEIVED]



A household sand filter, capacity 1 litre/min.



Upward flow filter.

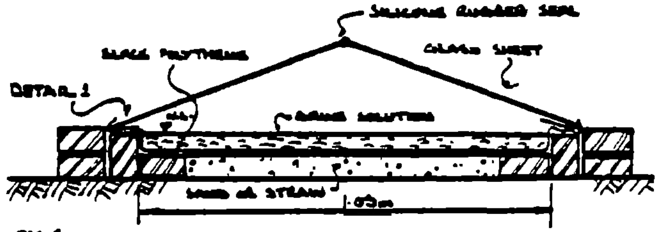


FIG 1

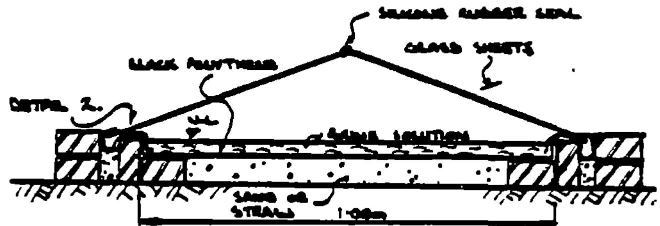
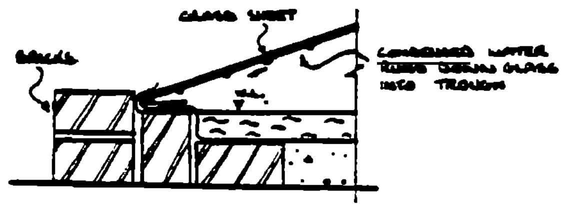
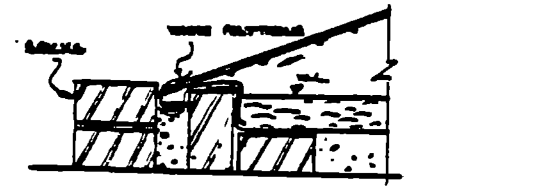


FIG 2



DETAIL 1 DISTILLED WATER RUNS OFF IN GLASS TROUGH



DETAIL 2 DISTILLED WATER IN WATER SEAL TRAP

REFERENCES

1. R.U. Morse, W.R. Read & R.S. Trayford. *Solar Still Operation in Australia.* 1970 International Solar Energy Conference Paper No. 5/34.
2. P.L. Cooper. *The Maximum Efficiency of Single-Effect Solar Stills* submitted for presentation at the 1973 International Solar Energy Conference. Private communication.
3. Y.H. Hamid, A.A.R. El Agib, O.B. Abu Haraz: *Prospects of Solar Desalination of Saline Underground Water in the Sudan,* published by the Department of Mechanical Engineering, Faculty of Engineering and Architecture, University of Khartoum, 1971.
4. *A Solar Desalination Experiment-Training Report,* an I.S.E.R.E.R. publication, 1972.

flat basin which contains the saline water, and a curved transparent plastic cover which permits evaporation and then condenses the water vapour on its underside. The purified water collects in troughs at the side of the basin and is stored in a container below. A daily production of 3-4 litres per square metre of still can be obtained in the right climate. It is doubtful whether this method could supply a reliable drinking water supply in high-density squatter settlements, although it could provide a useful supplementary source for agricultural use. In the Sudan a still unit 1 metre long by 10 metres wide produced 30 litres per day (Figures 15a, b).

Bacteriological Analysis of Drinking Water

The seriousness of the water-borne and water-washed routes of disease transmission, and the high cost of disinfection once disease has broken out, point to the need for sound methods of analysing supplies and establishing relevant bacteriological standards. If ways could be found to combine bacteriological analysis with health education so that people could be shown why and how water is unsafe, they might request improved supplies, and avoid unhygienic practices. Like many other technical services, laboratory analysis of water is not normally available to poor communities. But relatively simple low-cost methods of sampling and testing are available, and would provide a useful addition to the type of assistance offered through environmental health programmes. a/

Membrane filtration, for example, consists of filtering a known quantity of water through a filter paper with a pore-size that is smaller than the bacteria which the water is being tested. The paper is transferred to an absorbent pad soaked in nutrients. The bacteria then is allowed to grow on the surface of the filter paper so that it can be analysed. The National Environmental Engineering Research Institute in Nagpur, India, manufactures filter papers at about one tenth the European price. b/

Sullage and stormwater drainage

One of the weaker links in previous attempts to improve sanitation in slums and shanty towns has been the disposal of sullage and stormwater. Sullage is water which has been used for cleaning and preparing food, cleaning the house and utensils, laundry, and for personal hygiene.

A potential connexion between wastewater disposal and excreta disposal has been described as the "threshold of sewerage:" that is, the point at which sufficient wastewater is generated to justify the construction of a sewer. Unfortunately, the combined inadequacy of drainage and solid waste disposal in most slums and shanties often results in the unplanned formation of open sewers. In wet climates, the threshold is reached without having to wait for an increase in piped water supplies, and often without adequate means of disposal.

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a/ Duncan Mara, Bacteriology for Sanitary Engineers, Churchill-Livingstone, Edinburgh, 1974. Millipore Corporation, Biological Analysis of Water and Wastewater, Application Manual AM 302, available from Millipore Intertech Inc., P.O. Box 255, Bedford, Mass. 01730, U.S.A.

b/ NEERI Membrane Filter, Technical Digest No. 14, February 1971; available from NEERI, Nehru Marg, Magpur 20, India.

Since most drainage channels are open and unprotected, children and animals are apt to defecate in them. Refuse also finds its way into open drains, and, as they become blocked, any addition of water will cause flooding. Even in central slums where drains have been constructed, they become so quickly blocked by the solid wastes that they frequently overflow into the streets.

Economic as well as technical constraints will usually determine what improvements are feasible in a given area. The relative value of wastewater disposal systems will have to be weighed against other priorities. In some cases, water supply may be the biggest single concern of a community. Usually, however, there are strong links between all of the aspects of sanitation, and (where possible) integrated, but modest improvements, which deal with several problems, are likely to have wider-reaching effects than a single, higher-cost improvement.

The following section separates the various conditions which define the problem of wastewater disposal.

(a) The source and quantity of water supply will determine the volume of water to be disposed of, and the probable location of its disposal. If water is readily available people will tend to use more of it, and to dispose of the resultant wastewater in and around their houses. If, on the other hand, water must either be carried long distances or used at the source, most (but not all) of the disposal problem will occur at that source.

(b) The method and effectiveness of excreta disposal will determine whether wastewater can or should be treated as a separate disposal problem, and the extent to which wastewater will need treatment if reused. Sewerage systems are the only systems which can receive unlimited amounts of wastewater. Wastewater cannot be added to dry systems such as vault toilets or composting latrines, and wastewater containing chemicals (laundry detergents, for instance) will upset the bacteriological process of decomposition in many wet systems.

(c) Climate and soil conditions will determine how much water can be accepted into the soil before saturation points are reached and also the probability of wastewater mixing with and being carried along by stormwater. In areas where high regular rainfall coincides with a high water table, it is usually impossible to separate wastewater from stormwater. Where sanitation is inadequate, there is an increased likelihood of water pollution and the spreading of sewage which is floated along by the water. In hot, dry climates with sandy soil, wastewater can more easily be disposed of by constructing seepage pits, either in conjunction with excreta disposal, or separately.

(d) The method and effectiveness of refuse disposal will determine (along with excreta disposal methods) the course and composition of stormwater. Unless refuse is disposed of properly, it is likely that any drains which do exist will become blocked by garbage which is thrown or washed into them. Where there are large volumes of running water, blocked drains will cause overflows and (in unpaved areas) create new channels of escape, as well as standing pools in which insects can breed.

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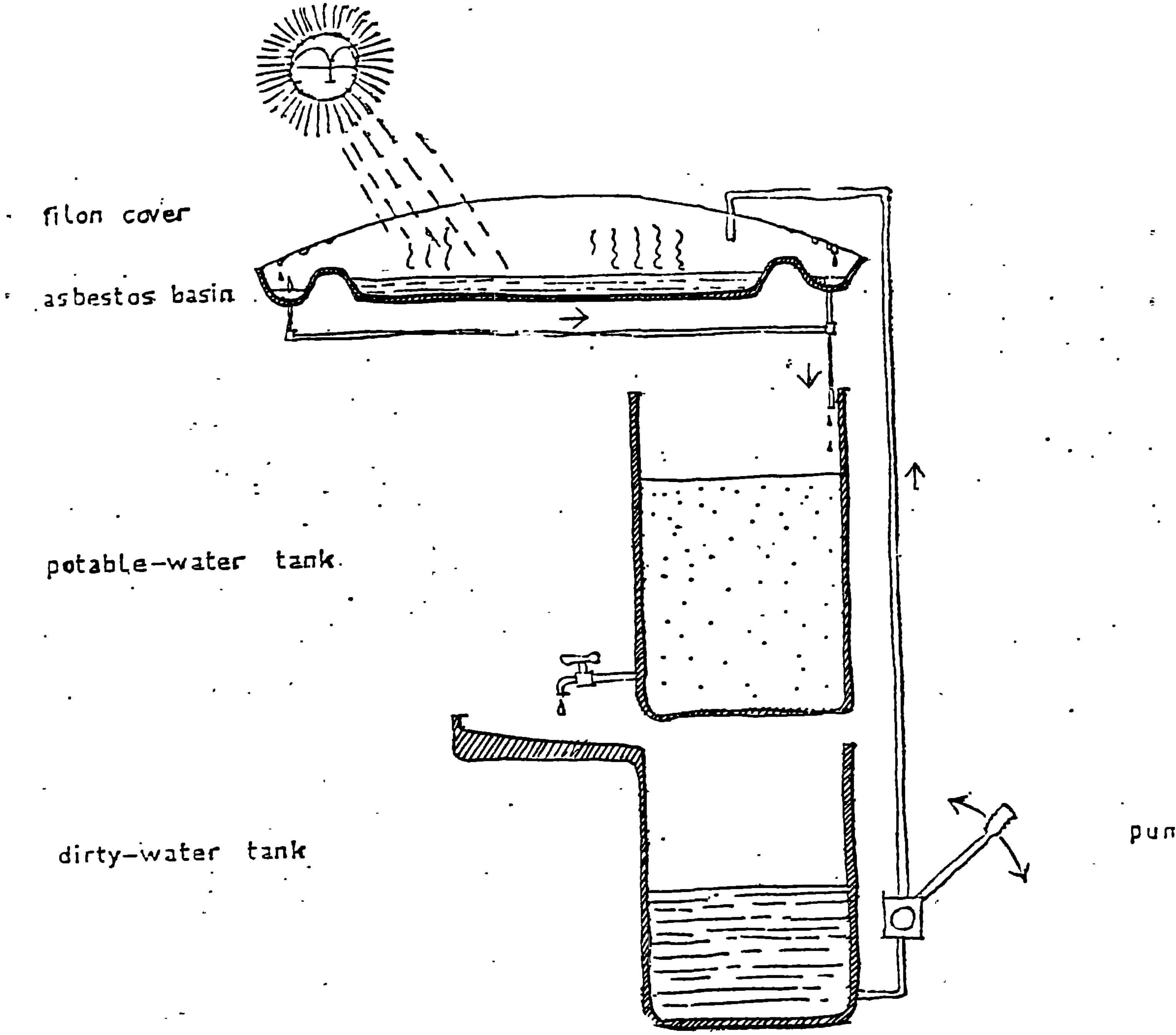
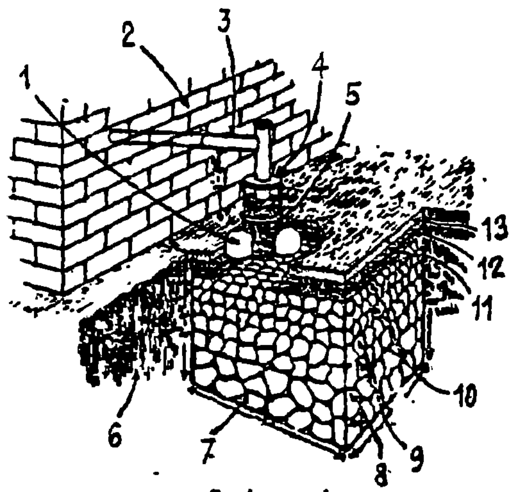


A proposal for re-cycling used water utilizing a roof-type still. Purified water is stored in a PVC tank; run-off is collected and returned to the still via a hand-pump. By this way only minimal amounts of polluted or saline water are added to the system, reducing the amount of sediment collection in the basin.

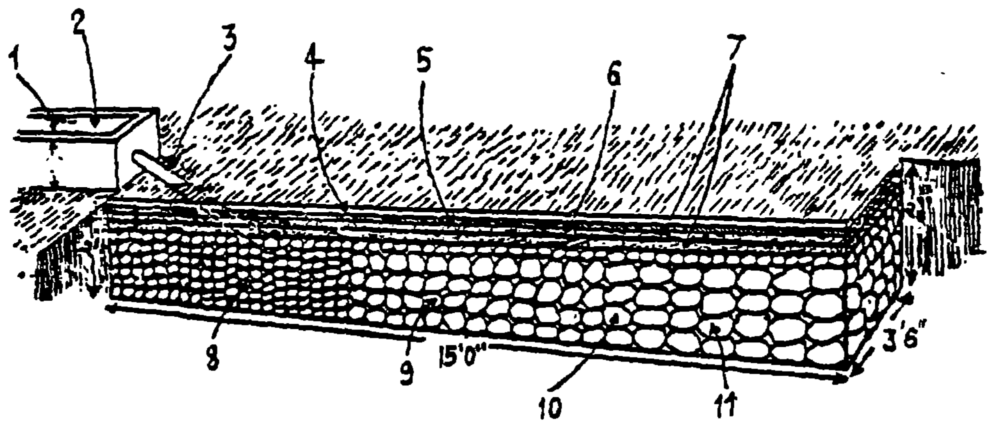
In addition, the polluted water that is used to wash out the still-basin can be re-used to flush the toilet.

RECIRCULATING SOLAR STILL
ORTEGA "ECOL OPERATION" McGILL UNIVERSITY
CANADA



Soakage-pit

(1) Big stones around the earthen pot. (2) Wall of the house. (3) Gutter. (4) A container having a hole in the bottom and cover with handle. (5) An earthen pot with holes in the bottom. (6) Portion of earth that has been scooped out. (7) Inside construction of the soakage pit. (8) Round pieces of stone 5" to 6" in diameter. (9) Round pieces of stone 4" to 5" in diameter. (10) Round stones of 3" diameter. (11) Vegetation that do not putrefy. (12) Thick gunny cloth. (13) Wet Earth.



Soakage channel

1. Handle of the cover. 2. Cover over the sullage tank. 3. Pipe to let water into the soakage channel. 4. Small pieces of bricks. 5. Wet mud as mortar. 6. A piece of gunny cloth. 7. A layer of vegetation that does not decompose. 8. Round pebbles of 3"—4" diameter in the 5 ft. portion. 9. Round pebbles of 4" to 5" in the second 5 ft. portion 10. Round pebbles of 5" to 6" diameter in the third 5 ft. portion and a layer of pebbles of 3" to 4" diameter over the whoule. 11. Underground soakage channel.

As it is not always possible to make simultaneous improvements to all forms of waste disposal, it may sometimes be necessary to improve wastewater and stormwater drainage separately. The following measures may be considered:

(a) Combined sullage and excreta disposal. The ideal means of disposing of increased sullage from households is in combination with anaerobic excreta disposal systems such as aqua privies and septic tanks. The resulting effluent may then be carried by small-diameter sewers to seepage pits, filters, or stabilization ponds. Self-topping aqua privies are intended to receive sullage (Figure 26) and some septic tanks are designed with additional compartments, which allow sullage to bypass the excreta tanks (Figure 27).

(b) Drainage Channels. Where they do not exist, the design and construction of wastewater drains should be considered. In other cases, protection and improvement of existing open drains is necessary. The most important aspect of effective drainage is the exclusion of solid wastes from drains. In very wet climates, there may be an advantage to planning new drains which correspond to the routes of well-used footpaths and using removable paving slabs to cover the channels. The paving will serve a double function, and if enough people appreciate the need for a dry footpath, there may be less likelihood of the drain covers being removed by residents, as they often are. The unauthorized removal of drain covers has in the past prompted some municipal authorities to cover drains with in-situ concrete. This is an expensive measure, which can be counter-productive if no provisions are made to clear the drains when they become blocked, and if the original layout of the drains has not anticipated future building development.

(c) On-site discharge and treatment. In cases where it is impossible or inappropriate to combine sullage disposal with excreta disposal, and where there is insufficient sullage or rainfall to warrant a comprehensive drainage system, wastewater can be disposed of locally. This will be necessary around communal washing areas or if some buildings have continuous water supplies. Depending on soil conditions and available land, soakage pits and channels (Figure 16) or various types of sand filter (Figure 14) may be suitable.

(d) Off-site discharge and treatment. In many areas, soil conditions are such that disposal of wastewater by absorption into the ground is not feasible. Where no connexion to a sewerage system is possible and land is available, waste stabilization ponds can be constructed to receive wastewater as well as excreta. Other ponds can be designed to incorporate the treated water for use in aqua-culture, or treated effluent and stormwater can be used for agricultural purposes.

The reuse of wastewater from slums and shanties will be problematical so long as there is any danger of raw excreta mixing with stormwater and treated effluent. The extent to which pathogens survive in food which has grown in contact with treated wastes is also open to question. Careful studies to determine the extent of the hazard in each particular area will be necessary before the reuse of wastewater is attempted.

Studies made by NASA in America (among others) have shown that water hyacinths are particularly effective in absorbing the impurities of both chemical and organic wastes. In most countries where they grow, they are generally considered to be more of a nuisance than an asset. The richer the wastes, the more profuse the hyacinths, and unless they are regularly cleared they tend to block drainage channels and cause flooding. Given the necessary organization and market, water hyacinths could provide an effective form of waste treatment as well as a saleable by-product to be used as animal feed or fertilizer.

Special Measures: Among many factors which complicate the problem of drainage in slums and shanty towns several deserve special attention.

(a) Refuse. Efficient collection of refuse is necessary to avoid drain blockage.

(b) Excreta. The provision of at least some communal toilet facilities may dissuade people from using drainage channels. A simple composting urinal is illustrated (Figure 17).

(c) Children. Special sanitation programmes and facilities are necessary for children.

(d) Animals. Measures to control the wanderings of stray animals may sound fanciful. But, without some form of control, open drains and standing pools will continue to be polluted.

Excreta disposal

Introduction

The connexion of central city slums to existing or extended Conventional Sewerage networks may sometimes be feasible. However, there are many problems which make this an increasingly unrealistic proposition. Amongst these are the age and condition of existing sewers, the inaccessibility of many older, high-density slums (particularly those built of permanent materials), complicated land and building ownership conditions, and the willingness or ability of owners and tenants to pay for connexions. In one West African city where residents could not afford the cost of the connexions, it was necessary to subsidize an adequate number of connexions to prevent serious corrosion of the new sewer.

With or without direct subsidies, it is assumed here that extensions of Conventional Sewerage to slums and shanty towns is usually limited by inadequate water supplies and also too costly.a/ Therefore, apart from its inclusion in cost comparison tables at the end of this section, conventional sewerage is not discussed in this report. However, some references are made to small-bore effluent sewers (Figures 18, a,b).

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a/ It has also been pointed out that Conventional Sewerage does not necessarily guarantee health benefits. Viruses and bacteria can be transmitted by aerosol droplet formation generated by cistern-flushed toilets; the pathogen removal efficiency of some sewage treatment works is variable; and seweage effluent is a major environmental source of drug-resistant bacteria.

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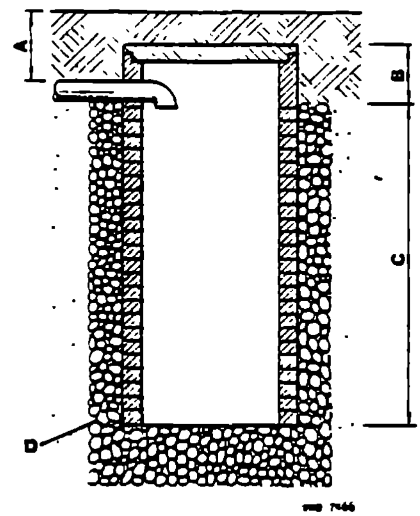
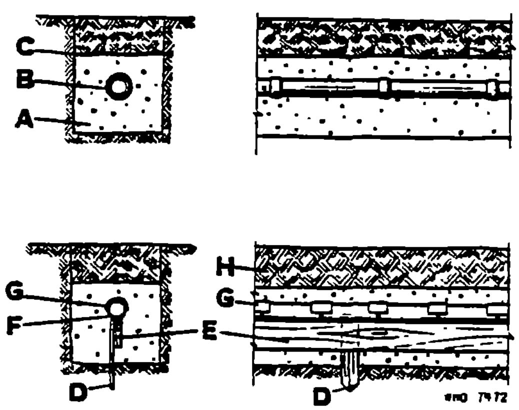
FIG. 62. SEEPAGE PIT



A = Variable depth of soil
B = Cement joints
C = Open joints
D = Rock fill, 15 cm (6 in.) or more

FIG. 63. ABSORPTION TRENCHES



A = Coarse gravel surrounding pipe
B = Bell and spigot pipe
C = Building ·/. tar paper
D = Wooden stakes supporting grade board E
E = Longitudinal boards, nailed to stakes and laid at exact grade selected for absorption lines
F = Absorption tile pipes resting over grade boards
G = Tar paper covering upper half of open joints
H = Earth-tamped backfill

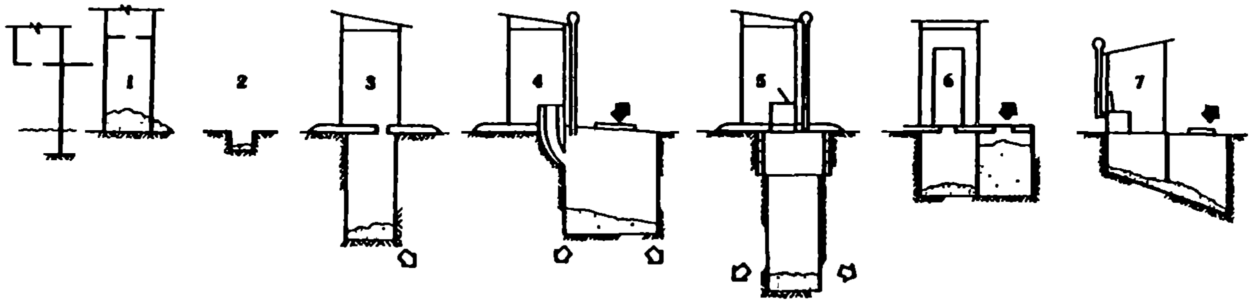
FROM · WAGNER & LANOIX · WHO · 1958

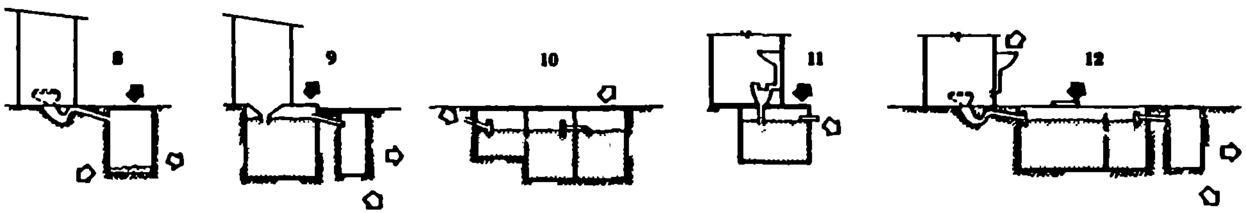
Generic Classification of Sanitation Systems

18a

Sanitation system

- On site
  - Dry
    1 Overhung latrine
    2 Trench latrine
    3 Pit latrine
    4 Reed Odorless Earth Closet
    5 Ventilated improved pit latrine
    6 Batch-composting latrine
    7 Continuous-composting latrine
  - Wet
    8 Pour-flush latrine, soakaway
    9 Pour flush latrine, aquaprivy, soakaway
    10 Pour flush, septic tank, vault
    11 Sullage flush, aquaprivy, soakaway
    12 Sullage-flush, septic tank, soakaway
    13 Conventional septic tank
- On site or off site
  - Wet
    14 Low-volume cistern-flush, soakaway, or sewer
    15 Low volume cistern flush, aquaprivy, soakaway, or sewer
    16 Low-volume cistern flush, septic tank, soakaway or sewer
- Off site
  - Wet
    17 Conventional sewerage
  - Dry
    18 Vault and vacuum tank
    19 Vault, manual removal, truck, or cart
    20 Bucket latrine
    21 Mechanical bucket latrine

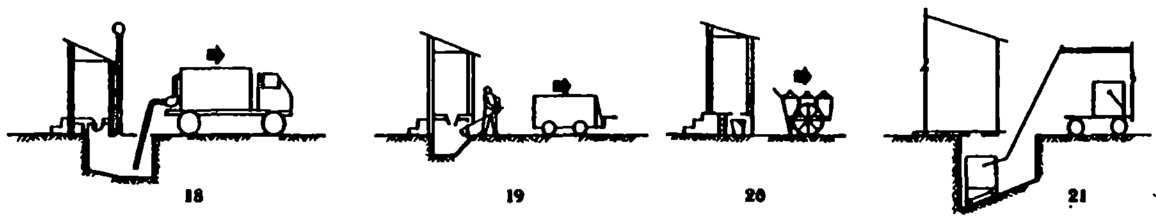




13 Same as 12 except conventional cistern-flush

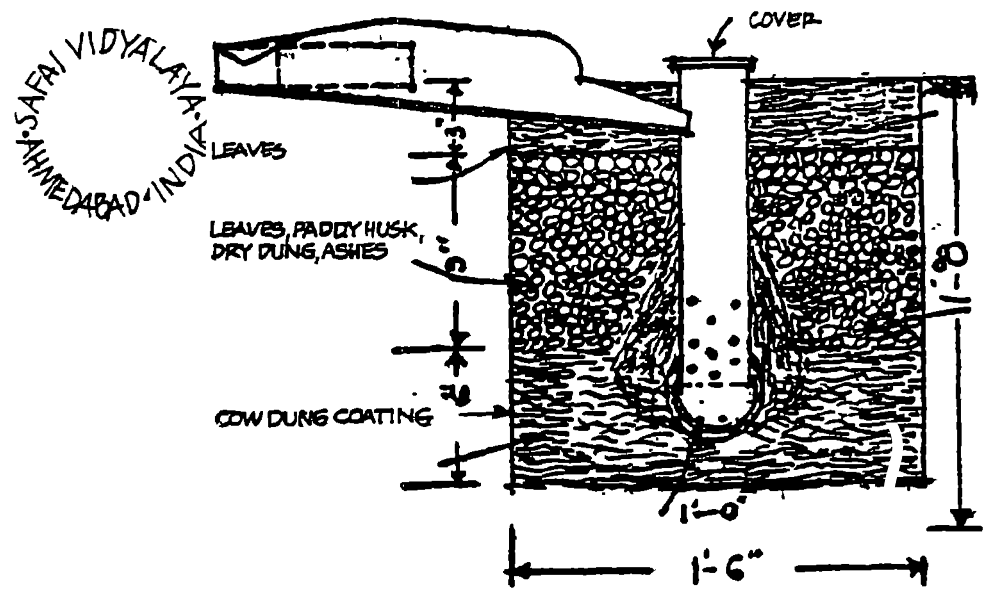
14, 15, 16 Same as corresponding configuration in 8 to 12, except for elevated cistern with low volume-flush.

17 See standard manuals and texts

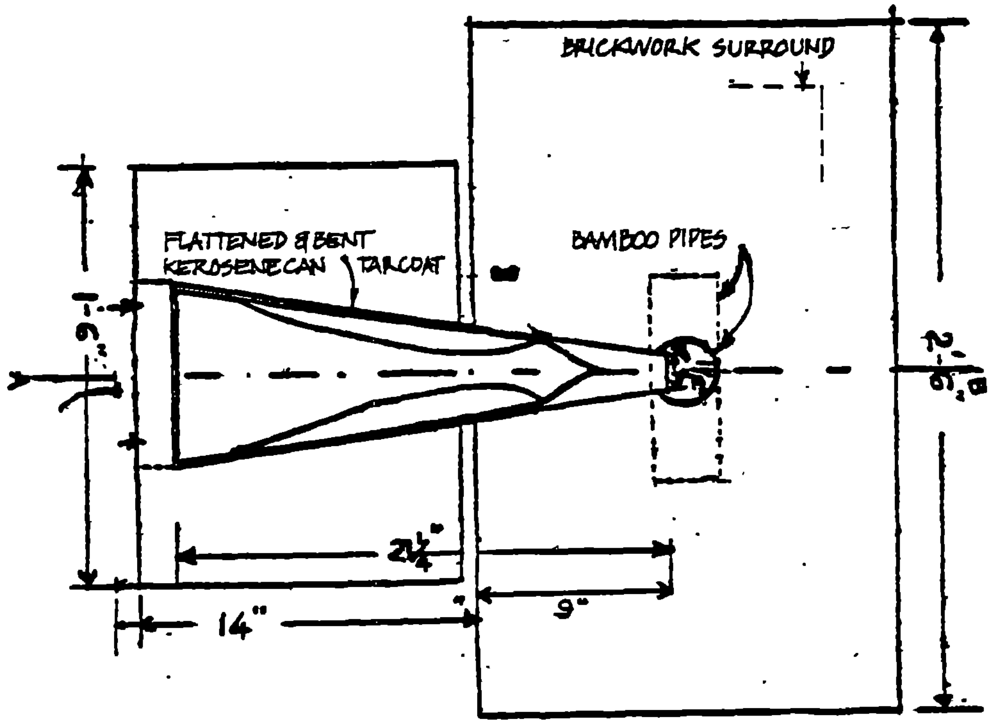


Movement of liquids, movement of solids.

Source The Wo. Bank, Water Supply and Waste Disposal, Poverty and Basic Needs Series (Washington, D.C., September 1980)



Pit of the urinal showing the manner of placing waste matter



Plan of a (kachcha) stench-free urinal with pit and pan

The various alternatives to Conventional Sewerage systems described here are listed under titles which refer to their best-known features (these titles are also used fairly consistently in the literature on the subject). In most cases the titles refer not to complete systems but to parts of a system, e.g., "pour-flush," which indicates a convenient method of flushing excreta away while providing a water-seal using small amounts of water. Similarly, "vault toilets" refers to a container in which excreta is stored prior to collection.

Some of the alternatives discussed emphasize different aspects of the biological decomposition process. a/ Both aerobic and anaerobic process can take place in some systems, while others rely on only one. Thus, composting latrines emphasize the useful residue of an aerobic process, while biogas plants are designed to make use of a by-product (methane gas) of an anaerobic process.

Figure 19 illustrates the division of human waste disposal into six stages: deposition (the act of defecation), collection, transportation, treatment, disposal and reuse; and then lists under each stage the various methods available. b/

Among the important points emerging from recent research in alternative excreta disposal systems are:

(a) Technical feasibility. Although there is still a lack of knowledge as to whether various systems are applicable at the high housing densities (500-1000 people per hectare) of many shanty towns c/ , the inconclusive results of a wide variety of small pilot projects have served to illustrate

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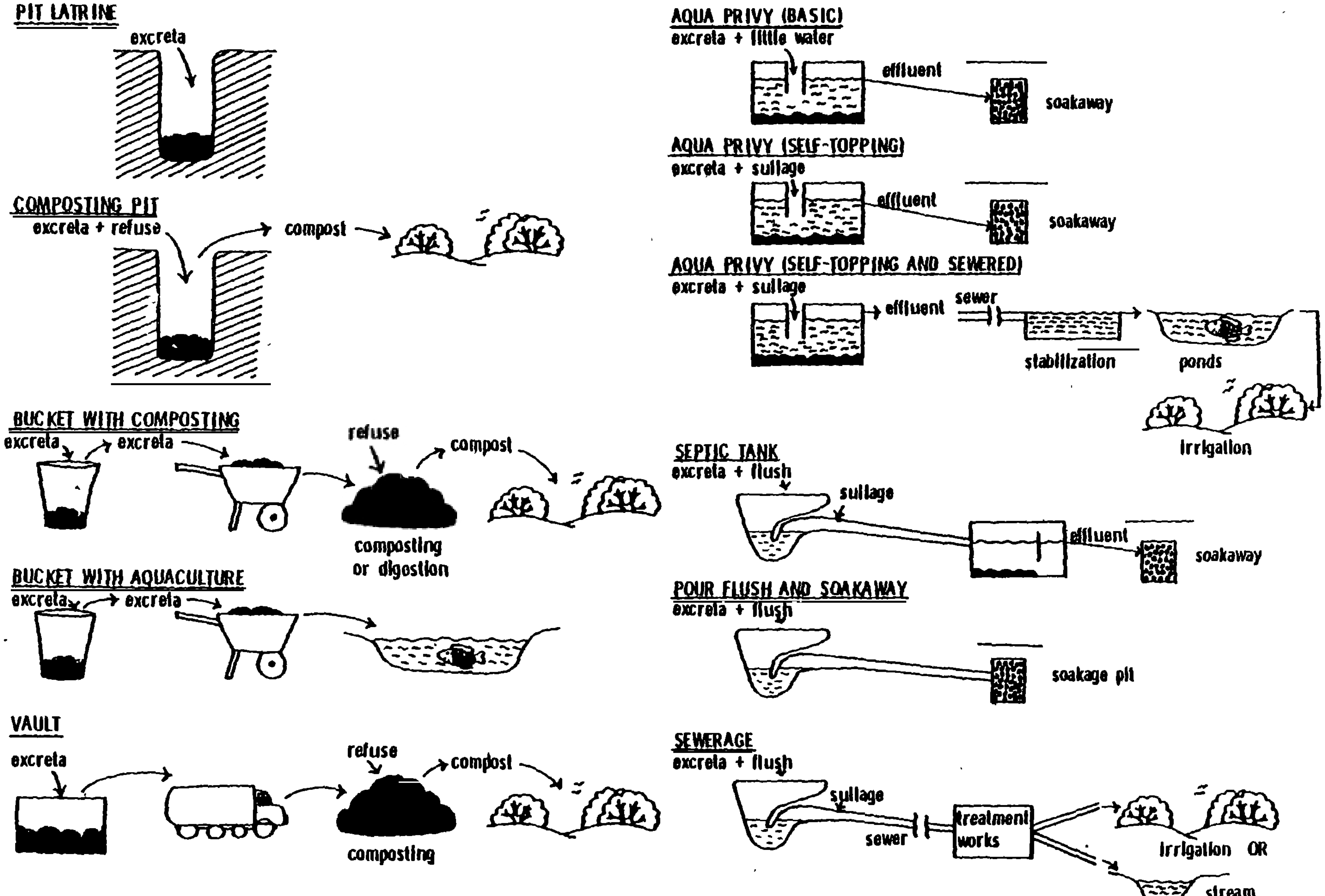
a/ The natural biological process of decomposition can take place in two ways: Aerobic Decomposition, where oxygen reacts with the carbon content of the organic matter, producing mainly heat and carbon dioxide as a by-product and leaving a residue. (This process occurs naturally at or close to the surface of land and water.)

- Anaerobic Decomposition, where, in the absence of oxygen, methane-forming bacteria convert the carbon content of the organic matter, producing mainly carbon dioxide and methane gas and leaving a residue. (This process occurs naturally well below the surface of land and water.)

b/ Feachem and Cairncross, Small Excreta Disposal Systems, Ross Bulletin No. 8, The Ross Institute of Tropical Hygiene, London, 1978.

c/ Many recent pilot projects have been undertaken in fairly low-density peripheral shanty towns (e.g., Tanzania, Botswana and Zambia). There are relatively few examples of case studies from Latin America or from Francophone African countries.

From SMALL EXCRETA DISPOSAL SYSTEMS
Feachem & Cairncross
Ross Institute Bulletin No.8
London January 1978



Pictorial representations of various excreta disposal systems

(a) 'Dry' or nightsoil systems.

(b) 'Wet' or sewage systems.

the diversity of existing conditions, and the limitations of seeking "optimum" solutions, especially where this would rule out all but the most expensive systems. A number of systems which were formerly considered unsuitable for urban application (e.g., pit latrines) have been reconsidered in the light of the improvements which can be made to them.

(b) Graduated improvements (Figures 20a,b). Systems which are planned to permit progressive improvements have been gaining wider acceptability. Examples of progressive sequences are: the conversion of dry pit latrines to pour-flush systems; single pits to double pits; and the introduction of septic tanks and small-bore sewers for effluent disposal, as water supplies increase. Although plans for progressive improvements do not always live up to the original intentions of the planners a/, the sheer magnitude of the waste-disposal problem in most shanty towns argues for attempts of this sort especially as the alternative is no disposal system at all.

(c) Community participation: In differing degrees, alternative methods of excreta disposal require more attention from the user than Conventional Sewerage. If community members can become involved in making choices, planning and construction, the new systems may be cheaper to build, better maintained and also provide an opportunity for introducing health education.

In view of the many references available for details of different technologies b/ , this review simply lists the most common alternatives under the following headings:

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a/ At a pilot project in Madras, India, one pit was initially constructed with a "Y" for a second pit, to be constructed later. The second pit has not been constructed in any of the 35,000 latrines built so far. The community feels that the second pit is not as necessary - moreover it involves additional cost. During an interview, one poonamali scavenger expressed his deep satisfaction, even with the existing pit, because he did not have to handle raw sewage any more. Also, he could earn extra money by emptying filled pits and selling the compost from them. He reported that, except for the topsoil, there was usually no odor from the compost. Report of the International Seminar on Low-Cost Techniques for Disposal of Human Waste, Calcutta, 18 February 1980.

b/ Wagner and Lanoix, Excreta Disposal for Rural Areas and Small Communities, WHO Geneva, 1958.

Rybczynski, Polprasert and McGarry, Low-Cost Technology Options for Sanitation, Vol. IV of World Bank Study, IDRC, Ottawa, 1978.

Ross Institute Bulletin No. 8, op. cit.
Ishwarbhai Patel, Safai Margdarshika (A Guide Book on Sanitation). National Committee for the Gandhi Centenary, Delhi, 1970.

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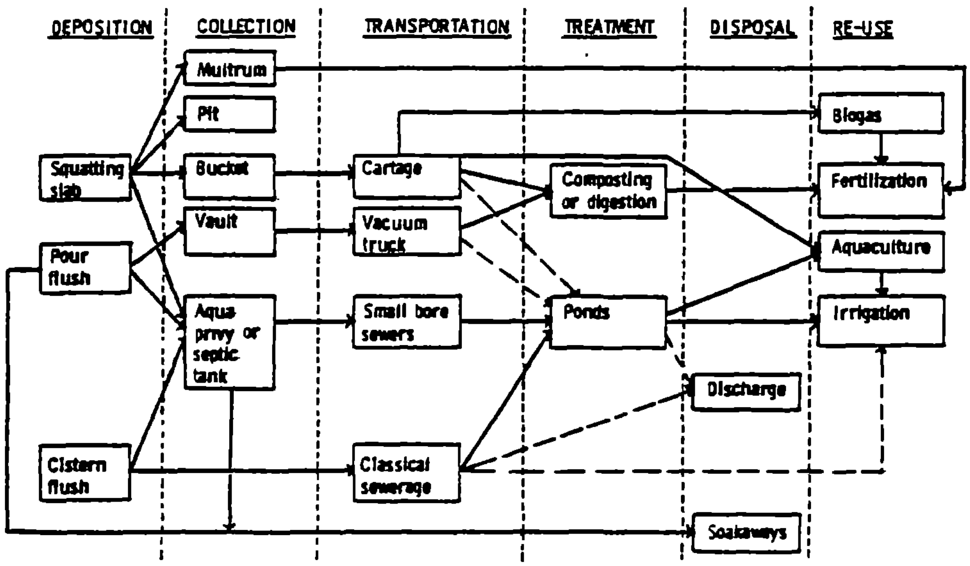
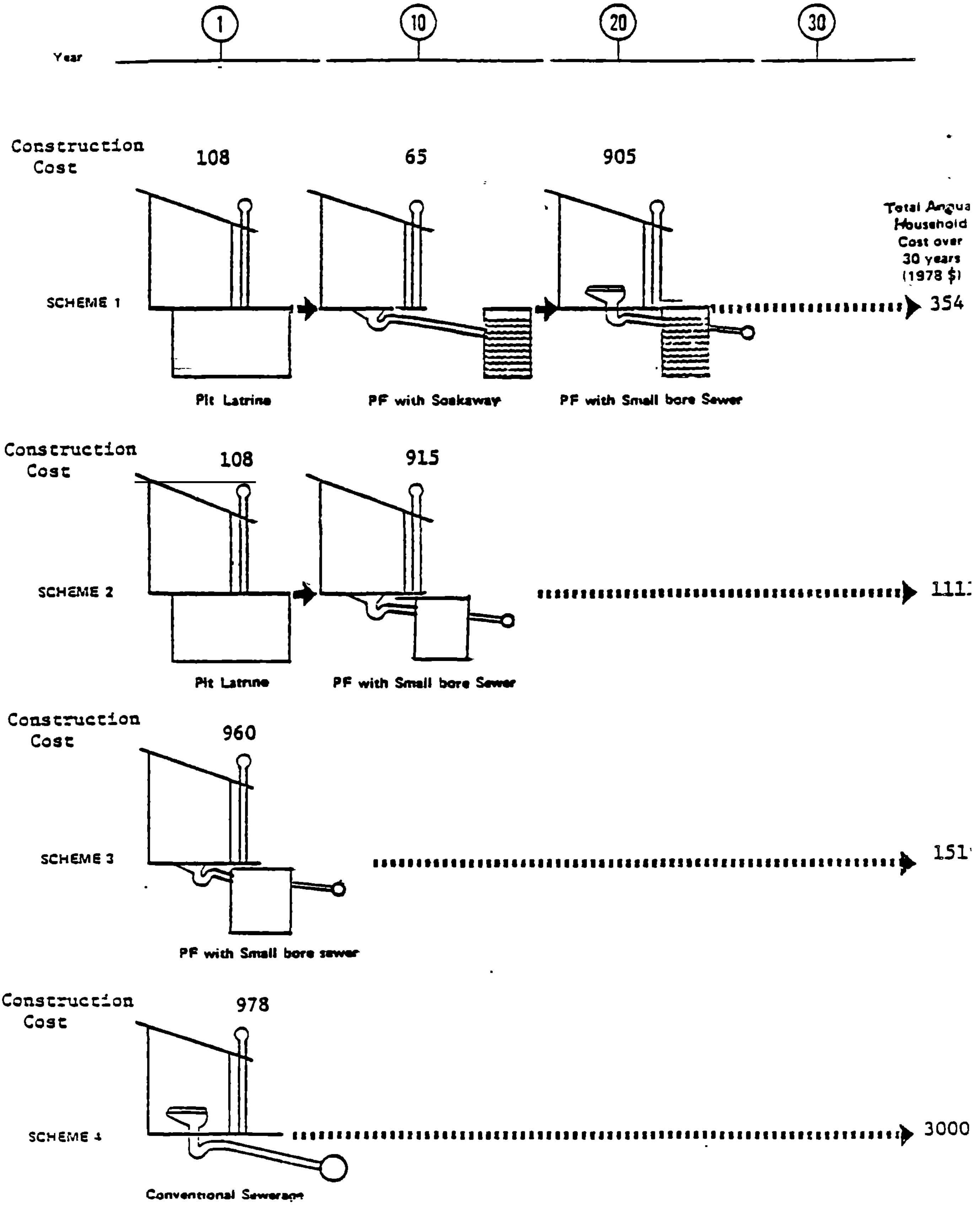
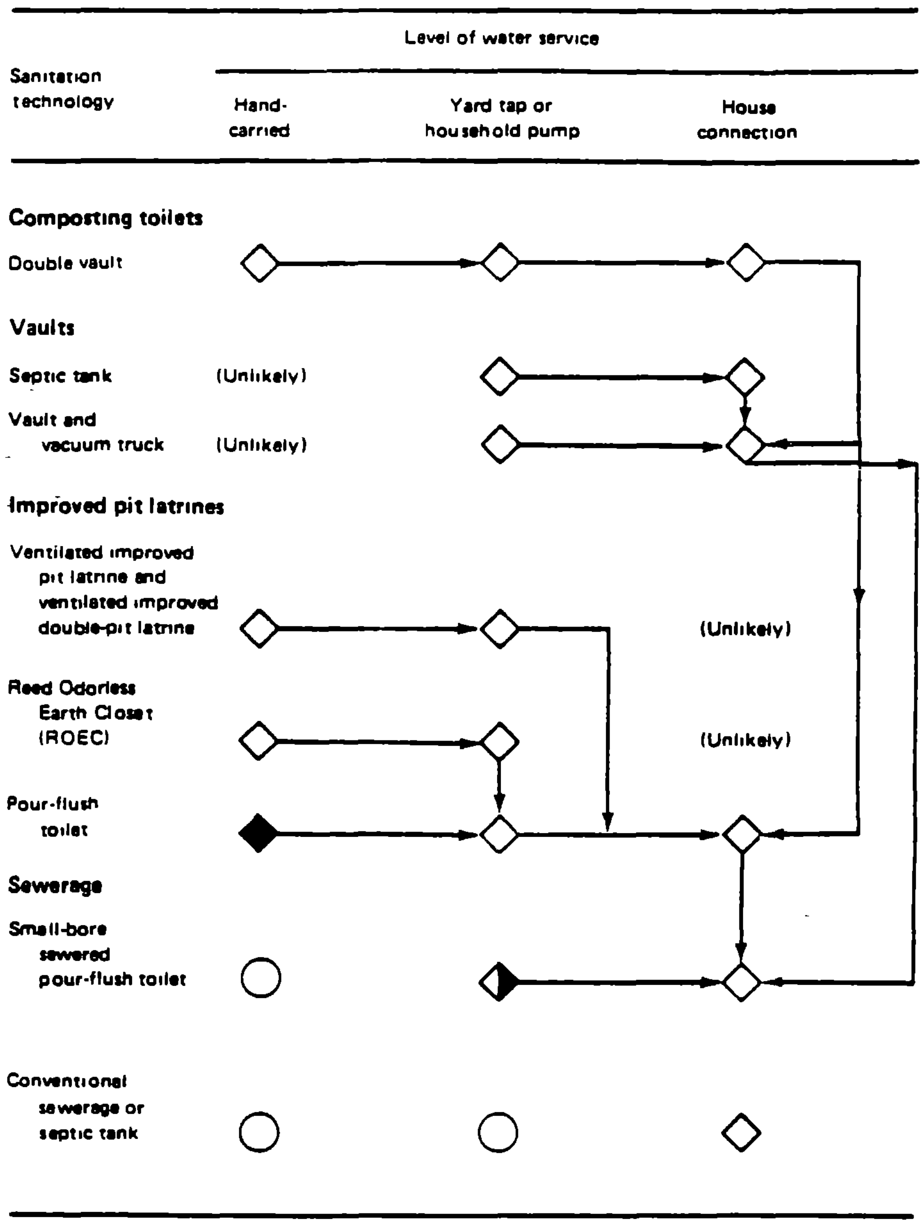


. The elements of an excreta disposal system and the various ways in which they can be combined.

From SMALL EXCRETA DISPOSAL SYSTEMS
Feachem & Cairncross
Ross Institute Bulletin No.8
London January 1978

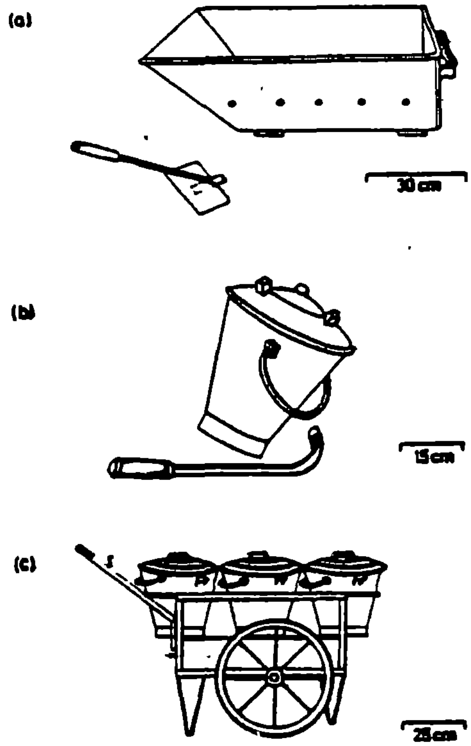


SAMPLE SANITATION SEQUENCES **20b**

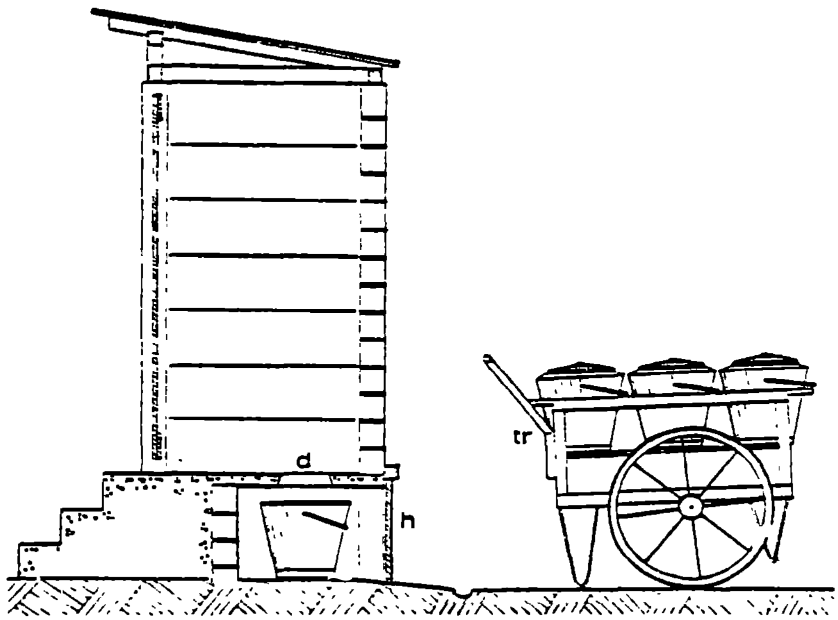


◇, Technically feasible; ◆, feasible if sufficient pour-flush water will be hand carried;
○, Technically infeasible, ◈, feasible if total wastewater flow exceeds 50 liters per capita daily.

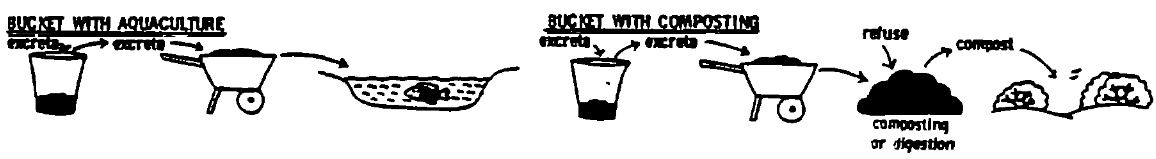
Potential Sanitation Sequences **20**



Cartage equipment: (a) nightsoil container made from 24 gauge galvanised iron sheet, and scraper; (b) nightsoil bucket and scraper; (c) wheelbarrow for three to six buckets. (Designs by Department of Social Welfare, Ahmedabad).



Bucket latrine with hand-cart for transport of buckets. The hand-carts and the lidded buckets are of an improved design typical of several produced in India (e.g. Ahmedabad, Department of Social Welfare, Nagpur, NEERI). The latrine, however, is not of improved design: the hatch (h) should be fly-proof and better drainage should be provided to cope with spillage



(a) Description;

(b) Constraints and limitations;

(c) Improvements and modifications which have been suggested and, in some cases, tested;

(d) Country examples; and

(e) Possible applications in slums and shanty towns.

This is followed by a list of factors affecting the choice of suitable technologies, and cost comparisons drawn mainly from World Bank sources. (See p. below)

Bucket Latrines

Description

(a) Defecation into a bucket which is removed at regular intervals. This is a common system of excreta disposal in the slums of many Asian cities where nightsoil is collected for reuse. Cleaners or sweepers are employed to remove the buckets and transport the contents to composting trenches.

Constraints and Limitation

(b) "Even today, after 13 years of freedom, it is a common sight to see a scavenger moving with a heavy load of nightsoil on his head carried in a bamboo basket, ... the matter trickling over his face and body ... No sooner a scavenger with a headload comes into sight, men start pulling out their handkerchiefs, the ladies the "pallas" of their saris and cover their noses". a/ .

The system is unsatisfactory from almost every angle: problems of odor, insects, spillage, and generally unsanitary conditions at collection and transfer points are evident.

Improvements and Modifications

(c) A programme was launched by the Mahatma Gandhi, designed to eliminate head-cartage of nightsoil in India (Bhangi Mukti). Methods included the supply of better implements, such as scrapers, buckets, wheel barrows, hand gloves, rubber shoes, etc. (Figure 21).

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a/ Report of the Scavenging Conditions Enquiry Committee, Ministry of Home Affairs, Government of India, 1960; in Ishwarbhai Patel, op. cit.

.../

Figure . A sectional view of a latrine with a small vault, typical of many parts of East Asia Removal of excreta is by means of a dipper with a long handle. Transport is primarily by buckets suspended with a yoke slung over the man's shoulder, but for transport from cities out to farms where the excreta are re-used, the buckets are emptied into a tank on an ox-cart or truck

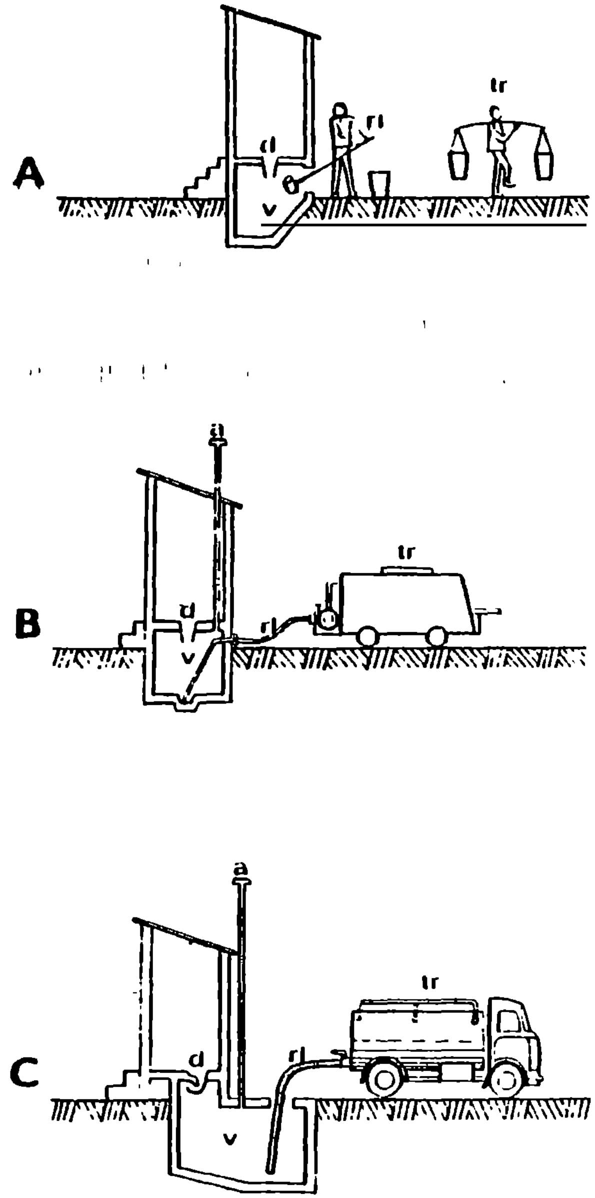


Figure · Incremental improvements made to latrines with vaults and to the cartage system serving them. The vaults are emptied (A) by a dipper, (B) by a hand-pump on a simple cart; and (C) by a vacuum truck. In each case, (d) is the defecation area, (v) the vault, (a) is the air vent, (rl) is the means of removal of excreta, and (tr) is the transport mode

Country Examples

(d) India: Of the total urban population in India, one third still use bucket latrines and one third have no toilet facilities at all. A recent national programme is under way to eliminate all bucket latrines and to replace them by "sanitary latrines." The UNDP Global Project previously referred to (GLO/78/006) is assisting government in preparing feasibility studies for providing all of the population with low-cost water-seal latrines in 110 towns in 7 States in India. The work of the Safai Vidyalaya at Ahmedabad and the Sulabh Shauchalaya Sansthan at Patna has done much to promote the conversion of bucket latrines in India. (See p. below)

Possible Applications

(e) There is little to be said in favour of bucket latrines unless the problems of handling and transportation can be overcome. In addition, as labor costs increase, this system may prove more expensive than better alternatives such as the pour-flush latrine connected to a soakage pit.

Vault Toilets

Description

(a) These are sealed containers which receive excreta, urine and only as much water as is needed for anal cleansing. The vault may be at or below ground level, and its capacity will depend on the size and the number of people using it. Vault toilets differ from other systems in that their contents are emptied at regular intervals (2-4 weeks), (Figure 22). The wastes are disposed of in various ways, including composting, dilution and treatment, and by incineration. Conservancy tanks, cesspits and privy vaults are in the same category.

Constraints and Limitations

(b) The worst aspects of the system occur when vaults are emptied manually and when inadequate precautions are taken to protect the workers and to avoid spillage and contamination during removal and transportation.

Improvements and Modifications

(c) Most improvements which involve mechanical methods of removal are costly and require good municipal organization. As an intermediate improvement, animal-drawn carts with small tanks and manually operated diaphragm or vacuum pumps would be feasible. In countries where it is culturally acceptable, vault latrines could be converted into composting latrines, so that the people involved in collection would no longer be transporting raw sewage.

which are also used for garbage); flooding (where the water table is too high); and structural stability. The sides of a pit may cave in if it is dug in sandy or unconsolidated soil and, unless the pit opening is reinforced, a superstructure which is too heavy may sink. If there is no squatting plate, or the hole is too large, children can fall into the pit.

Improvements and Modifications

(c) Two improved versions of the standard pit latrine have been developed and field-tested. The first is the Ventilated Improved Pit (VIP) latrine, which incorporates a specially designed vent pipe topped with a gauze screen, and is essentially odour and insect-free (Figure 23a). The twin-pit VIP latrine (Fig. 23b), has the advantage of continuous usage, and is therefore more suitable to high-density areas than the single pit version.

The second design, the Reed Odourless Earth Closet (ROEC), has a displaced pit (Figure 23c), which could make the latrine more socially acceptable, since the excreta cannot be seen.

Country Examples

(d) Vaults are used extensively in Asian countries.

(i) Japan. Less than a third of the urban population is served by water-borne sewerage, the majority relying on publicly operated nightsoil collection. In Kyoto, municipal nightsoil collection serves a population of 600,000 within a service area of 326 km. sq. Using more than 200 vacuum trucks, collections are made twice a month, directly from household vaults. The nightsoil is transported to transfer stations or directly to the municipal treatment plants.

(ii) Taiwan and Korea. In the major cities, hand cartage has been replaced by sophisticated methods of mechanical collection, including vacuum trucks.

Possible Applications

(e) Vaults provide a flexible and hygienic form of sanitation for urban areas (in that they can be emptied mechanically) and are suitable for medium-rise buildings where excreta can be flushed down a vertical pipe into a communal vault, at or below ground level.

However, the introduction of any system in slums and shanties which relies on large vehicles for its effectiveness must take into account the accessibility of these areas, as well as the cost of purchasing and maintaining a sufficient number of trucks.

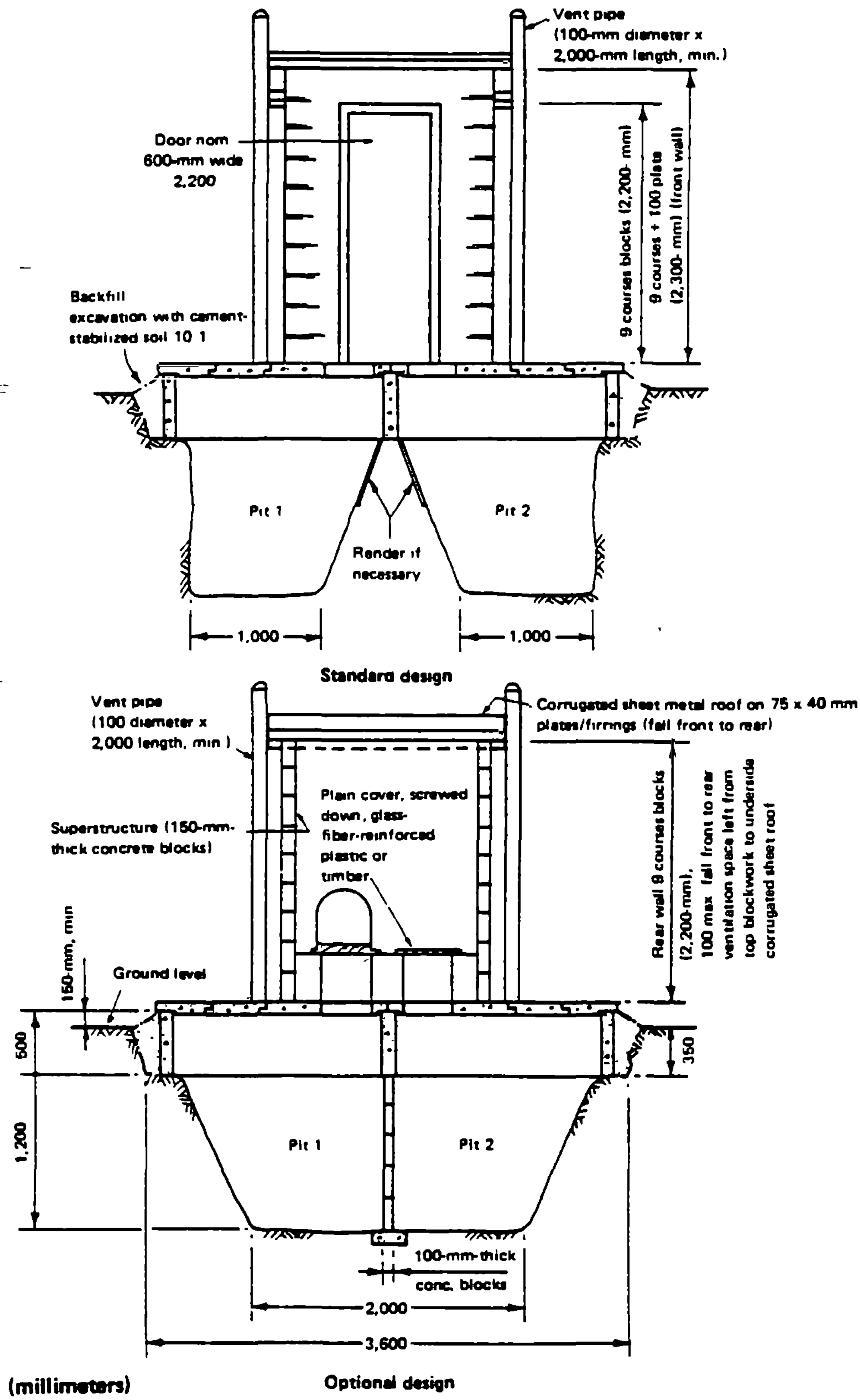
Pit Latrines

Description

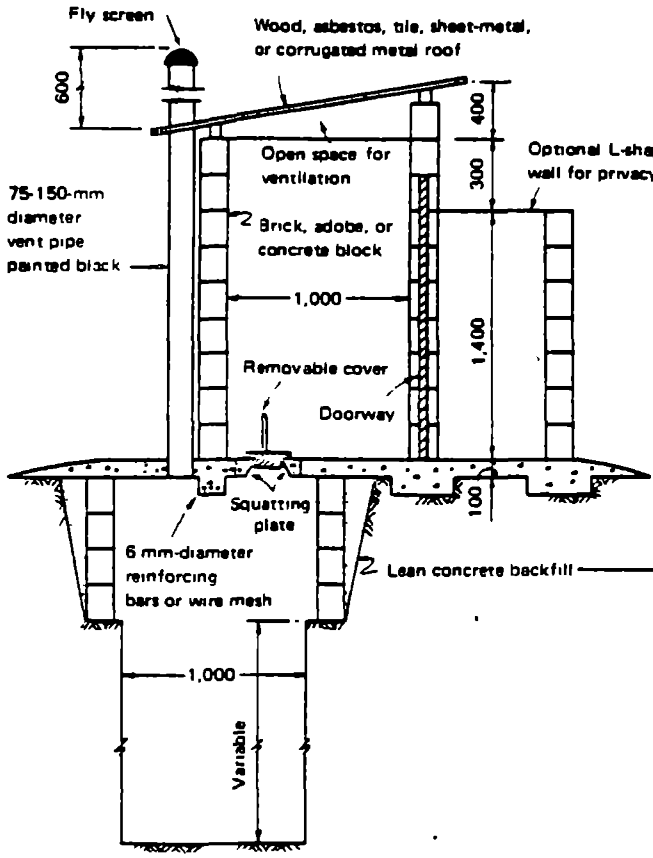
(a) A pit latrine is a hole dug in the ground covered either with a squatting plate or a slab provided with riser and seat. Pit latrines are the simplest, cheapest and, in one form or another the most commonly used excreta disposal method in shanty towns.

Constraints and Limitations

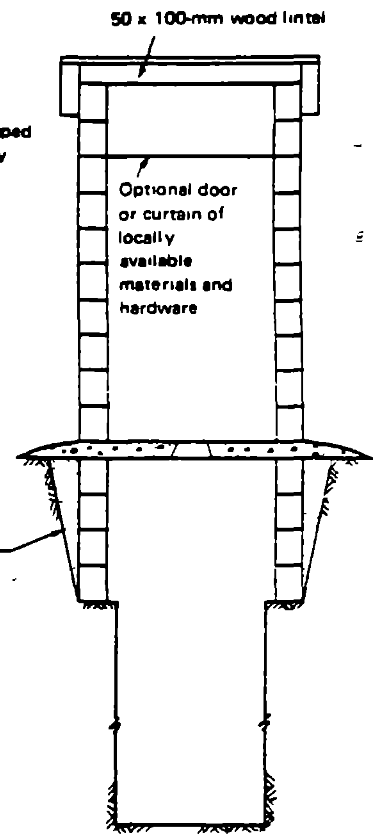
(b) In areas where wells and springs are used as a water supply, the biggest problem with pit latrines is the possibility of groundwater contamination. Studies have been made to determine acceptable spacing of latrines, and recommended distances from wells. Many of these are quoted in Wager and Lanoix '58, which concludes that there is no arbitrary rule of thumb governing the safe distance between pits and water sources. Generally, the more porous or fissured the soil, the greater should be the distance between the latrines and wells. It is generally accepted practice to keep a minimum distance of 10 metres and to increase this to up to 30 metres in gravel and sand. Other problems include over-filling (in the case of single pits where there is no emptying programme and where too many people use too few pits



Source: Adapted from R. Carroll (1979).

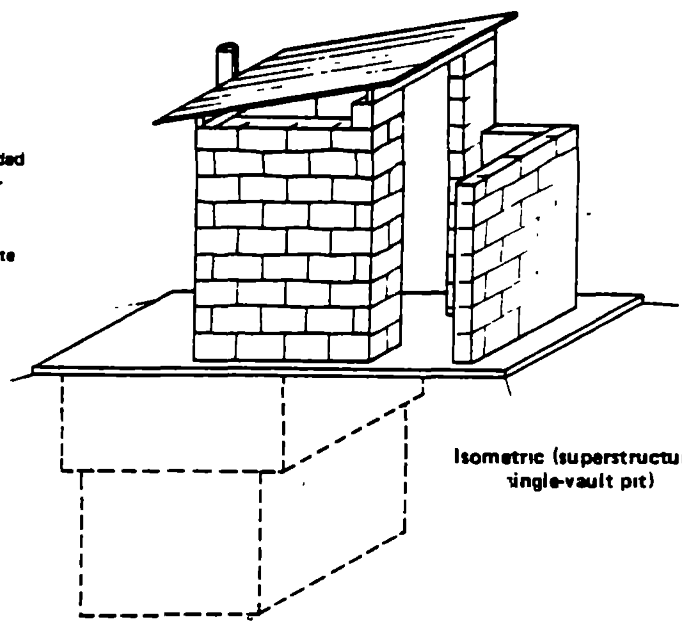


Side view (section)



Front view (superstructure; L-shaped wall and vent not shown)

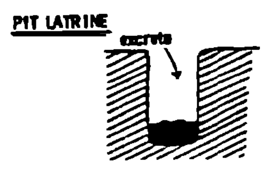
Note Side view Pedestal seat or bench may be substituted for squatting plate. An opening for desludging may be provided next to vent Dimensions of the bricks or concrete blocks may vary according to local practice. Wooden beams, flooring, and siding may be substituted for concrete block walls and substructure



Isometric (superstructure ...ingle-vault pit)

Ventilated Improved Pit Latrine

(measurements in millimeters)



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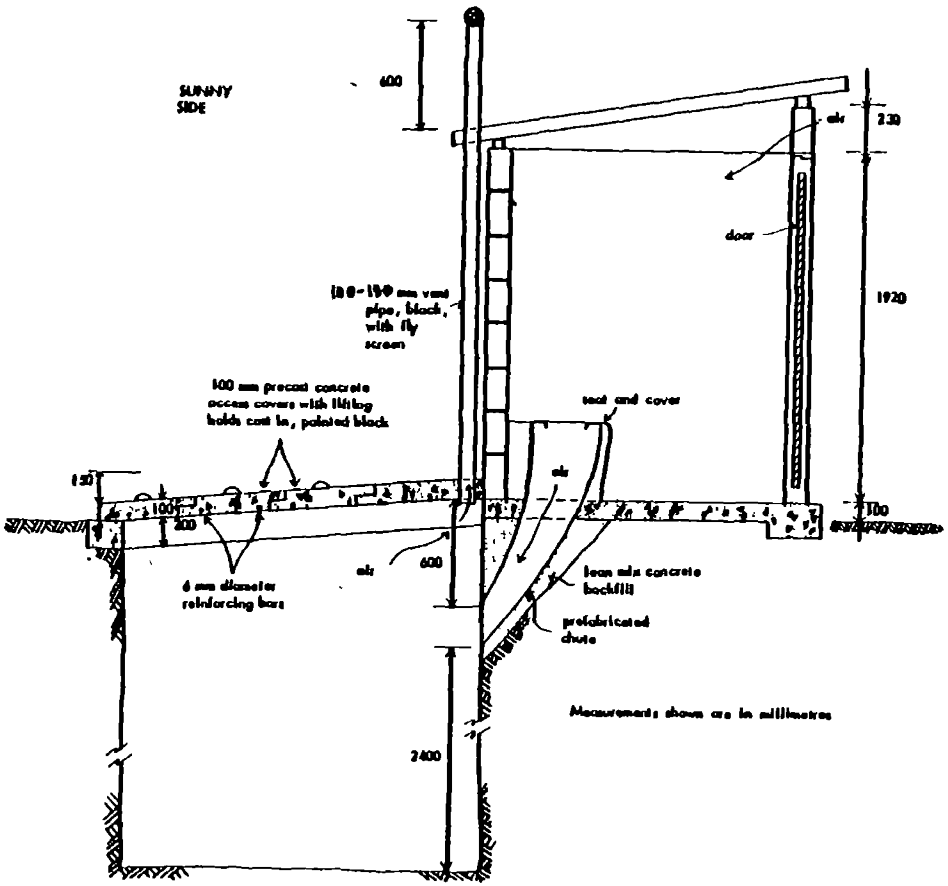

Fig 22 A ROEC pit latrine. (From a drawing by R. A. Boydell)

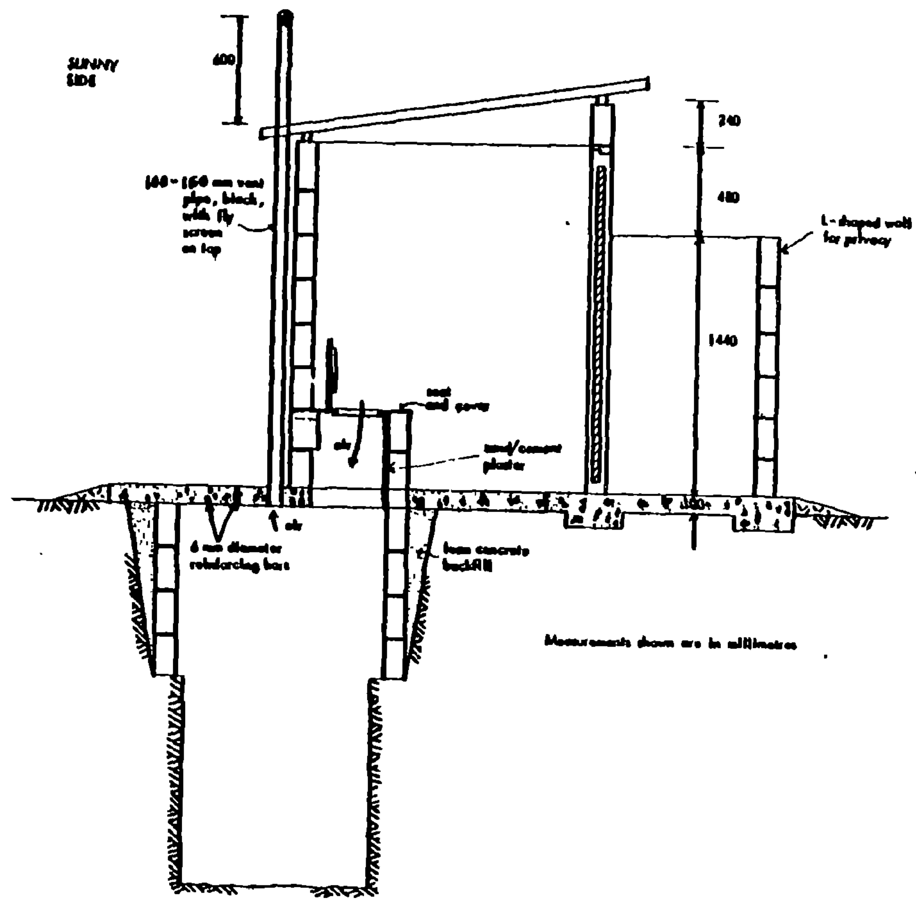

Fig 16. Supported pit latrine with ventilation. (From a drawing by R. A. Boydell).

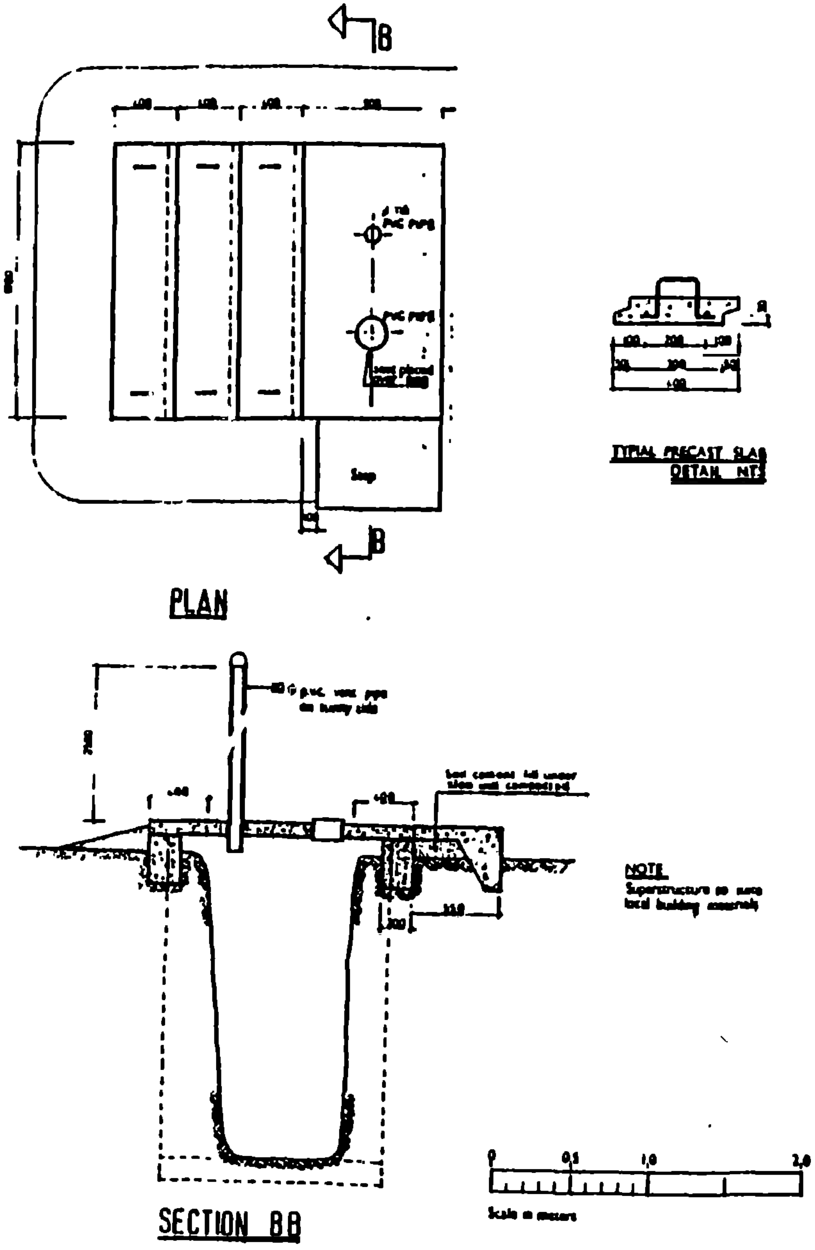

FIGURE X

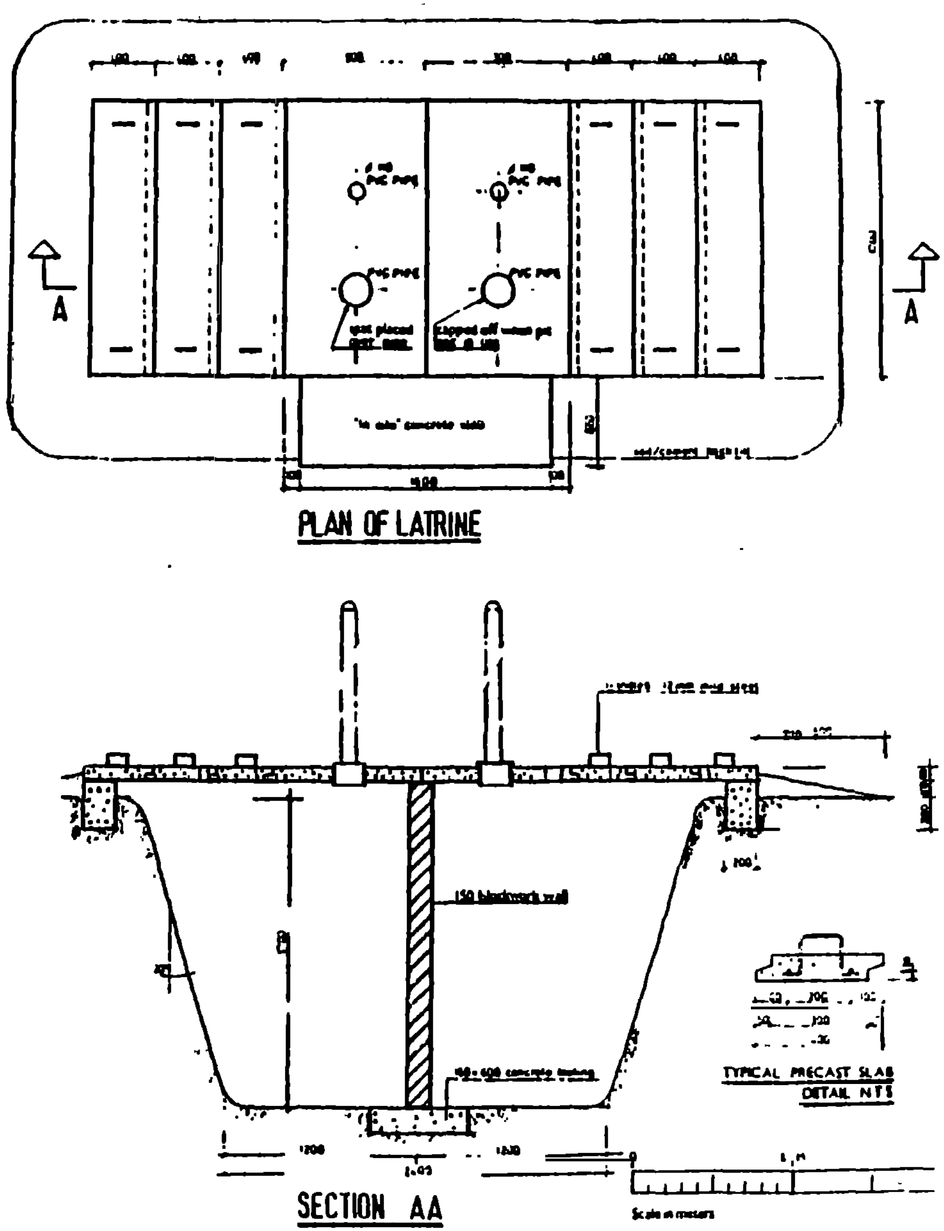

FIGURE VI

(d) Zimbabwe. Although simple pit latrines are to be found in shanty towns in many countries, the single pit VIP was developed in Zimbabwe in the 1970's. Its chief component, the external vent-pipe, had been used in similar latrines in South Africa since the 1940's.

(e) Tanzania. Pit latrines were used for the first World Bank assisted sites-and-service project in Dar es Salaam. Experiments with black-painted vent pipes placed on the sunny side of the latrine have successfully reduced smells, and a screen is placed over the pipe reduced the number of flies and insects. The ventilated pit latrine (VIP) appears to be low-cost, trouble-free and hygienic, and is being tested at 100 sites.

(f) Although simple latrines and even the VIP and ROEC are not ideal in very high-density urban areas, they will continue to be used where alternatives are impractical. Even the simplest improvements to them will be worthwhile. Their overwhelming advantage over other systems is their efficiency, low cost and simplicity of construction.

Composting Latrines

Description

(a) Composting latrines depend on aerobic decomposition, reducing human excreta, kitchen waste, ashes and other organic matter to useful compost. They range from the single dry-pit latrine, to the Vietnamese Double Vault Composter. More sophisticated systems use electrical elements to accelerate the process in cold climates. There are discontinuous, alternating, continuous and compact systems a/ (Fig. 24a & b).

Constraints

(b) Composting latrines must be carefully monitored because decomposition will cease if temperatures fall below a certain minimum. Continuous composters have particular problems in that the danger of raw excreta mixing with the humus is increased, and flies can also become a problem if openings are poorly covered. In all composting systems, water must be kept at a minimum, and the addition of toxic substances strictly avoided.

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a/ Discontinuous: WHO Single-Vault Compost Latrine (Wagner and Lanoix modified, Gotaas, Bangalore, 1956)
Arrhenius (Royal Veterinary College; Uppsala, Sweden)
Joansuu (Finland), Western Pacifi (WHO, 1960)
Alternating: WHO Double Vault Latrine (Wagner and Lanoix, 1958)
Gopuri (Bombay, India, 1966); Sopra Sandas (Maharastra State, India)
Vietnam Double Vault; Kern (U/S/A., 1970); Snurr Toa (Norway)
Continuous: Kanagwa (Japan); Farallones (Farallones Institute,)
Clivus Multrum (Sweden, 1965); Humusdrum Sweden/U.K.)
Sodertalje (Sweden); Toa-Throne (Sweden); Cadu A and B (Sweden); Scanplan (Sweden, 1970), Shore (London, 1973
Compact: Mullbank (Sweden); 390 Bioloo (Sweden); Biolett (Sweden)

Source: Winblad, Simbeye, Kilama, Alternative Waste Disposal Methods, Final Report, Tanzania National Scientific Research Council, Dar Es Salaam, February 1978.

Another possible improvement to the conventional pit latrine incorporates a stone-lined smoke box, which is located to one side of the latrine and vented through the pit. In the description given in Village Technology in Eastern Africa a/, grass is burned in the smoke box and the smoke directed into the pit to rid it of flies and odours. An "incinerator" unit connected to a pit latrine or series of latrines could perhaps be used in slums and shanties both to improve the latrine and also to provide a method of refuse disposal for those areas.

General recommendations for pit latrines include the following:

(i) Lining. The walls of the pit (at least the top 16-23") should be lined with bricks, stones, concrete, wood or bamboo to prevent cave-ins. A cylindrical lining will provide the best structural stability. Alternatively, a tapering pit with a ring-beam at the top can be constructed. Any wood which is used should be tarred or treated with insect repellent to increase its life.

(ii) Base. The base of the latrine should be made of a hard, durable material to prevent animals and surface water from entering the pit and hookworm larvae escaping. The base of the latrine will serve as a foundation for the floor and superstructure, and should extend well over the opening of the pit.

(iii) Floor. The latrine floor should be constructed to fit tightly on the base. Tile or smooth concrete is preferable; wood can be used, provided that holes and cracks are kept at a minimum. Ideally, the floor should be impermeable, and constructed so that it slopes towards the hole to facilitate cleaning. Slabs made of plastic, fibreglass, etc., should be carefully supported.

(iv) Hole. This should be large enough to minimize soilage, but small enough to be safe for children. Keyhole-shaped openings have been found to be most efficient in this respect, and latrine slabs with raised foot-rests are also recommended.

(v) Vents. A latrine which is fitted with a vent pipe leading directly from the pit to the outside is most likely to be free of flies and odours. The vent should be located on the sunniest side of the latrine and painted black to absorb heat. This will create an air current which will carry away odours. Flies that have entered the pit will be attracted up the pipe by the light. A flyscreen at the top of the pipe will prevent their escape.

(vi) Superstructure: Apart from providing privacy the superstructure should allow enough light in for people to see, but not enough to encourage flies. It should be sturdy enough to provide shelter, but not so heavy as to cause it to sink.

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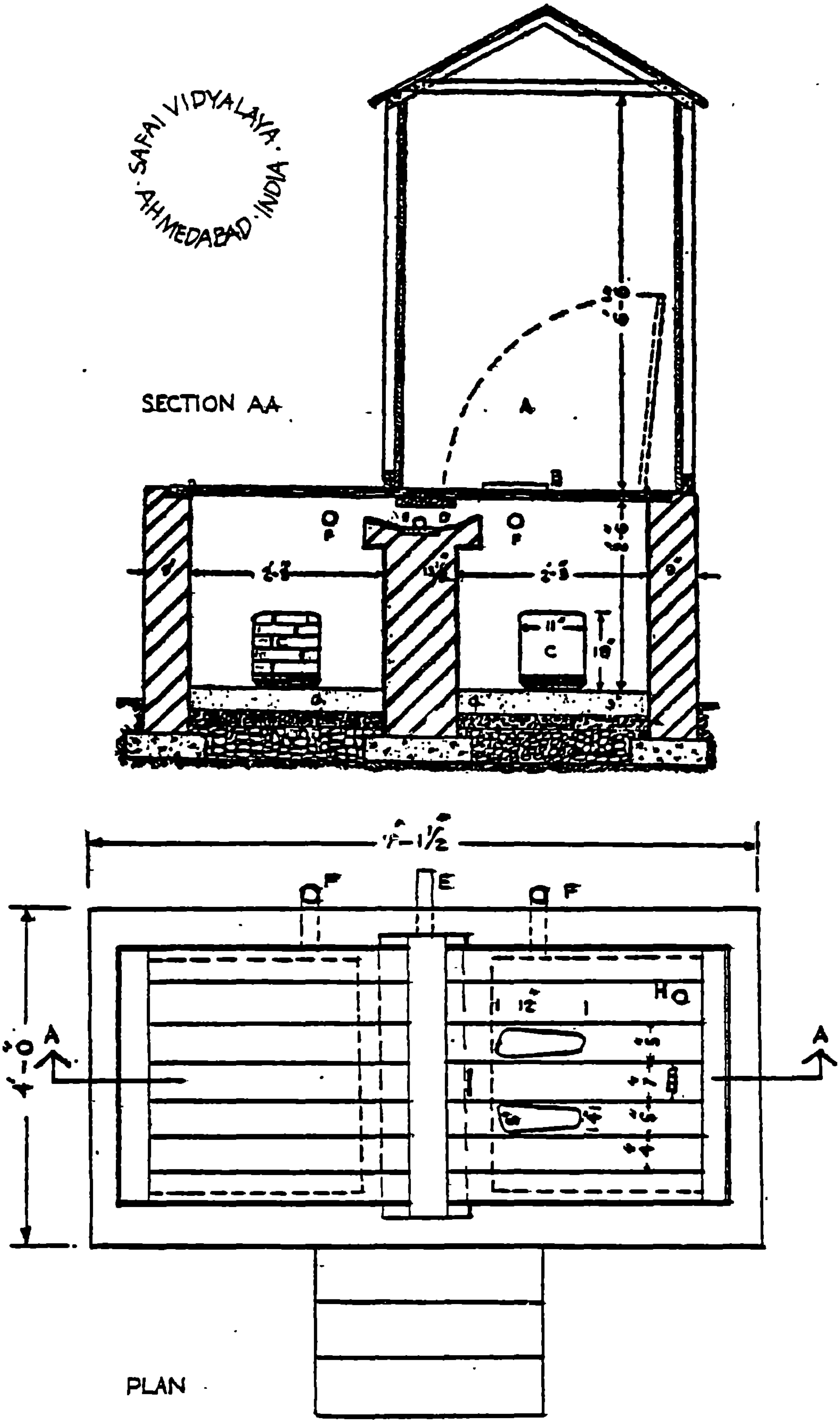
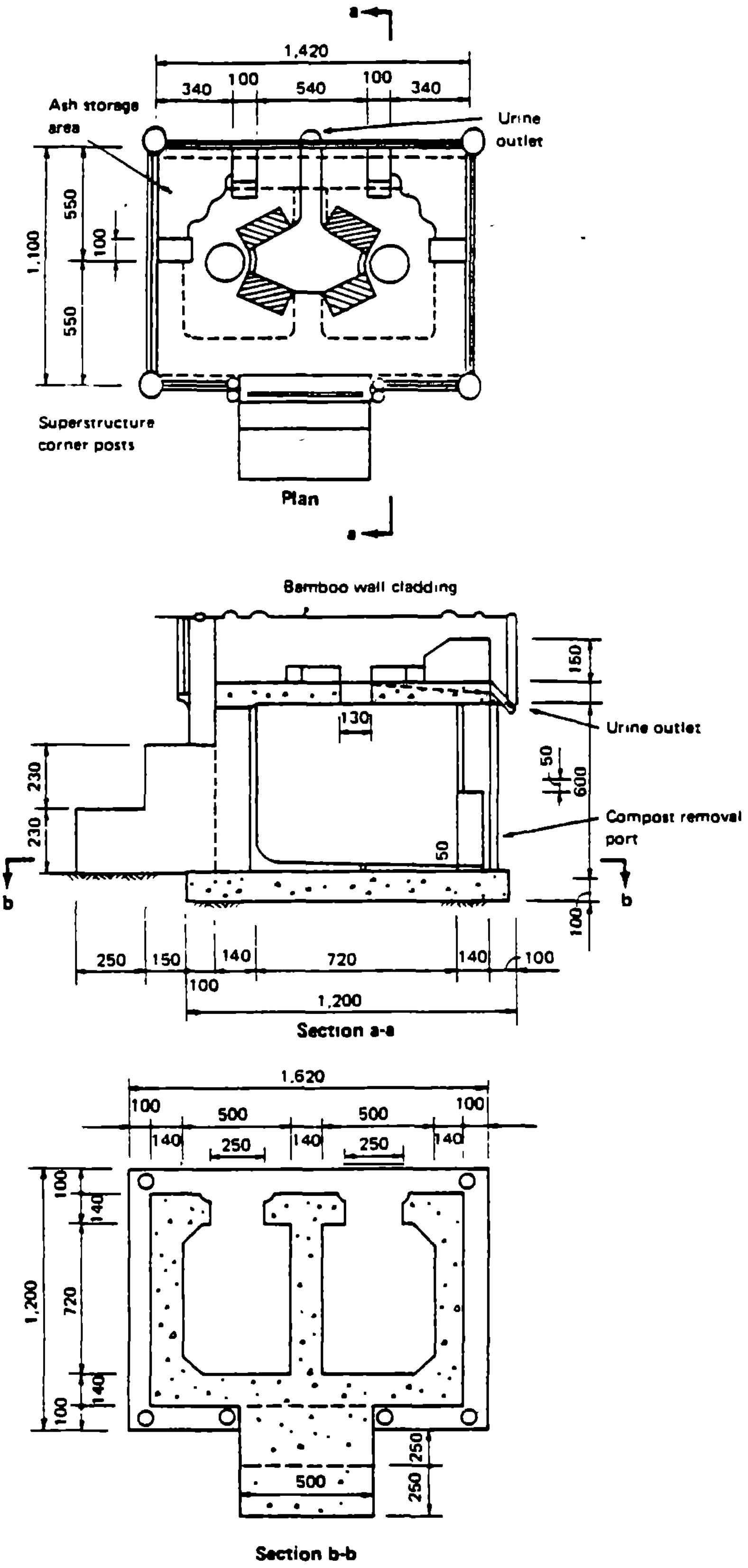
a/ J. McDowell, ed., Village Technology in Eastern Africa, Report of a UNICEF-sponsored Regional Seminar on "Simple Technology for the Rural Family", Nairobi, 14-19 June, 1976.

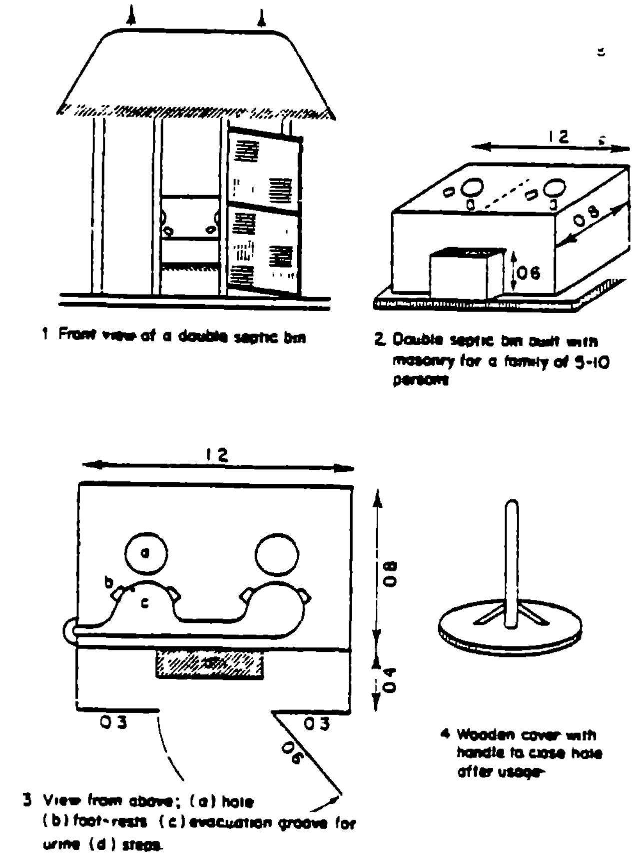


Gopuri Latrine

A. A tin or wooden enclosure around the seat. B. A seat of wooden planks on the tank. C. A window in the rear for removing manure. D Sloping gutter between the two tanks. E. Outlet for water and urine. F. Air-inlet pipe. G. A layer of rubbish and earth at the bottom of the tanks. H. Hole in the wooden plank for gas-pipe.



Double-vault Composting Toilet Used in Vietnam (millimeters)



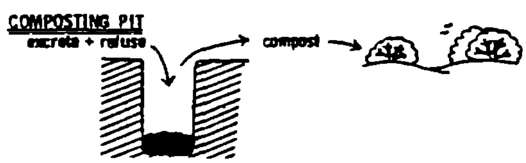
1 Front view of a double septic bin

2 Double septic bin built with masonry for a family of 5-10 persons

3 View from above; (a) hole (b) foot-rests (c) evacuation groove for urine (d) steps

4 Wooden cover with handle to close hole after usage

A double septic bin latrine as used in countryside of northern Vietnam



Improvements and modifications

(c) Most of the composting latrines listed in note (a) above, represent improvements and modifications of some kind.

Country examples

(d) Algeria. Communal decomposition systems have always been used in rural areas and are still used in some high-density towns in hot, dry climates. In the town of Ouargla, with a population of 12,000, human and domestic wastes are composted in individual household units. The population density within the walled part of the town exceeds 500 persons per hectare. a/ In the desert towns of Mzab Valley, also in Algeria, the same system, combined with regular collection, has provided a continuous supply of fertilizer for the oasis gardens associated with each town since the tenth century.

Viet Nam: The double septic bin is not regarded as the ultimate solution to sanitation problems in Viet Nam, but as a means of providing family latrines in the countryside and in urban areas which lack favourable conditions for alternatives. In the countryside the campaign to "build septic bins in order to increase the supply of fertilizer" has produced considerable health benefits especially in villages which have combined it with other preventive measures against disease. Quang An village near Hanoi completed its latrine programme in 1966. In the following year there were no cases of typhoid or polio; diarrhoea cases dropped by 85 per cent and the incidence of worm infections fell by 50 per cent as compared with the incidence recorded at the beginning of the programme in 1962. Figures collected over a larger area showed a reduction of diarrhoeal disease of one half between 1961 and 1965 in an area where double septic bins were being installed. b/

China: In Shanghai, a metropolitan area of 10.7 million people, the Cleaning Department is responsible for the disposal of city waste. The ten district departments are each divided into sections, each with a number of nightsoil collection tanks into which households dump their nightsoil. The collection tanks are towed by trucks to wharves and the nightsoil placed in storage tanks. An insecticide (Dipterex) is applied to the contents at a rate of 2g/m to kill fly larvae. From the tanks the nightsoil is dumped into 10 T capacity boats after a week of storage and delivered to commune and production brigade storage tanks located along the waterways. Here it is stored for a further two weeks under plastic sheets and then pumped to the boats of the production teams. Team members collect the soil from the boats by bucket and apply it directly to the fields. In this way 10,000 tons of excreta are collected daily from the city and delivered to different communes in rotation. c/

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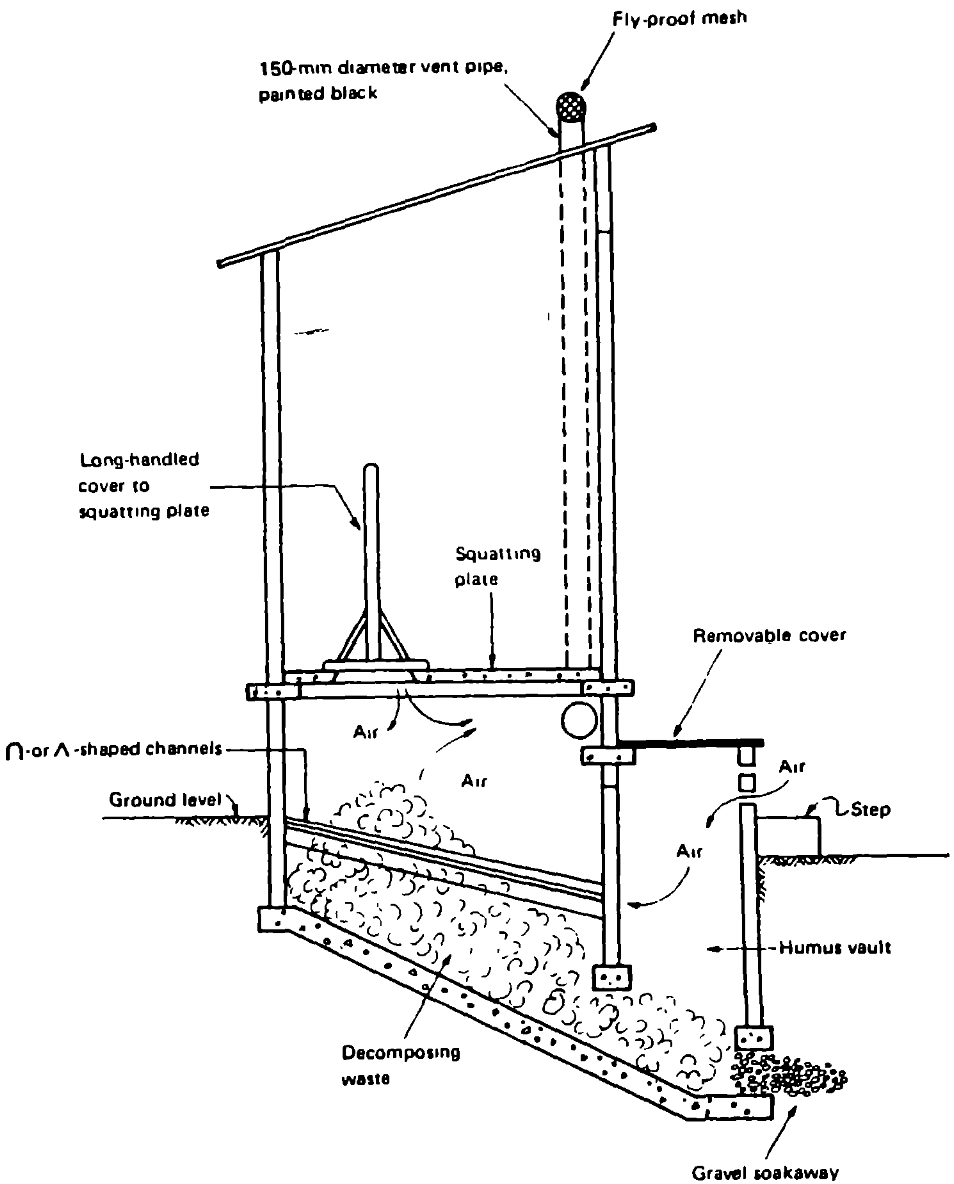
a/ L. Asklund, et al, Ouargla - rapport fran en algerisk okensteu, Department of Architecture, University of Lund, Sweden, 1972.

b/ Joan D. McMichall, The Double Septic Bin in Vietnam, in Sanitation in Developing Countries, Wiley, Chichester, U.K., 1978.

c/ FAO, China: Recycling of Organic Wastes in Agriculture, Soils Bulletin No. 40, Rome, 1977.

"Multrum" Continuous-composting Toilet



Source Adapted from a drawing by U Winblad

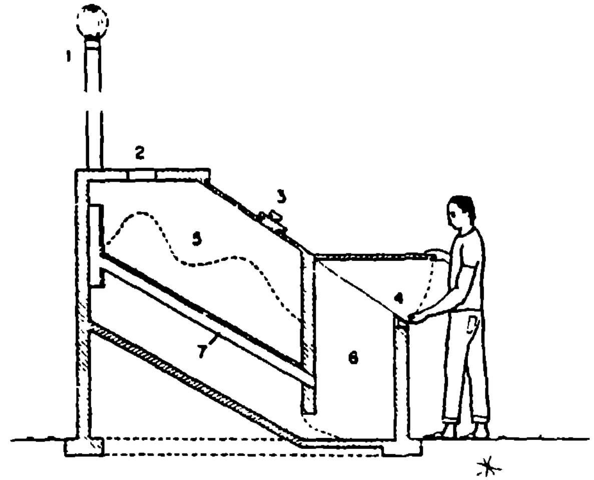


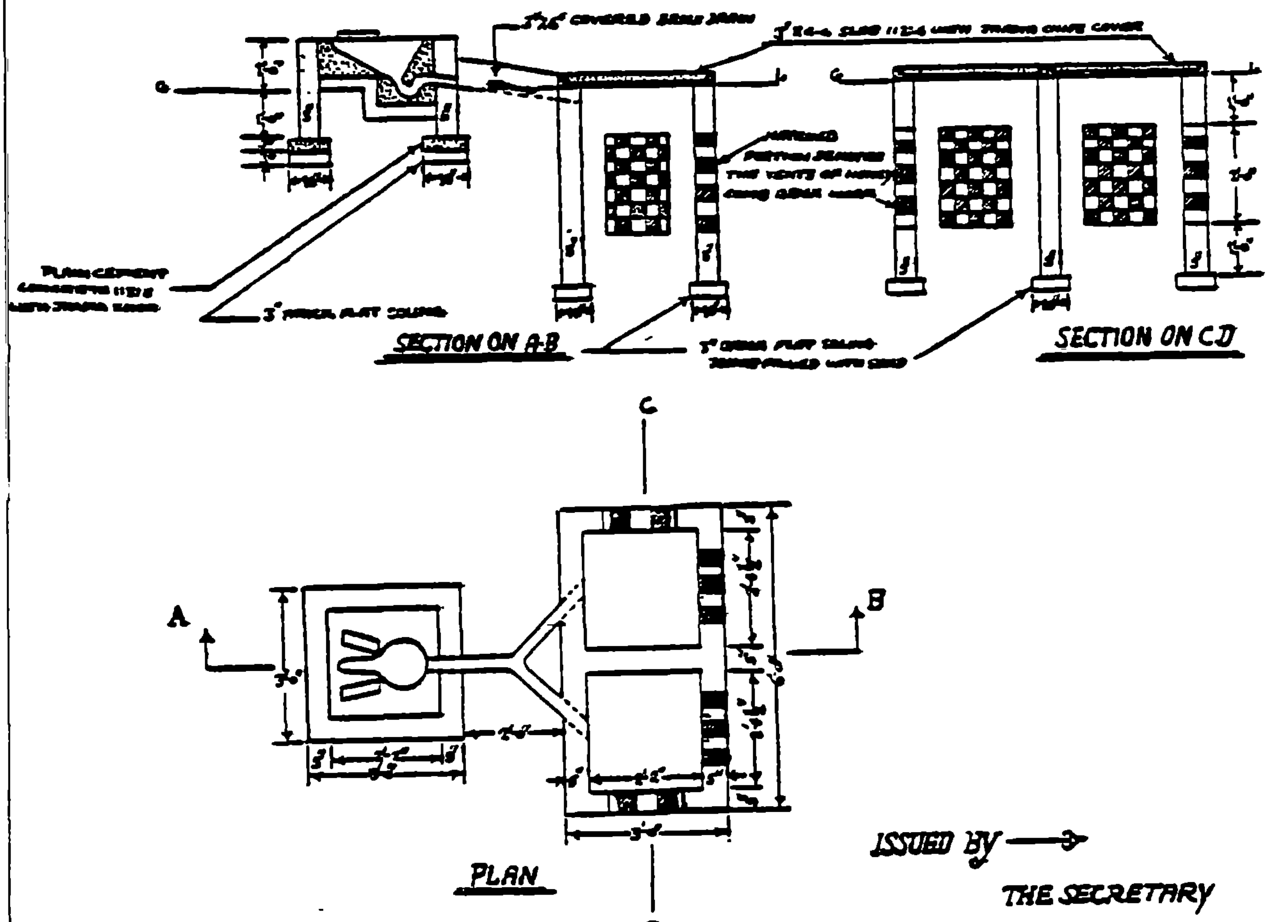
Figure The Minimus composting toilet on trial in Manila, Philippines. The details shown are. (1) vent pipe, (2) squatting plate, (3) garbage hatch, (4) fertilizer removal hatch, (5) composting chamber, (6) fertilizer chamber, (7) air ducts. The privy compartment at first floor level is not shown. (Illustration by Witold Rybczynski)

U. Winblad reports that this continuous "multum" type toilet could not be made to function properly despite careful attempts at user education. <u>Its use is therefore not recommended.</u> (MARA/IBRD NOTE)

Sl. No. 1.

TYPE PLAN OF ONE SEATED SULABH SHAUCHALAYA UP TO PLINTH LEVEL WITH TANK OF 6'-0"X3'-0"X4'-0" SIZES HAVING TWO CHAMBERS FOR DOMESTIC PURPOSES

SCALE 1"=2'



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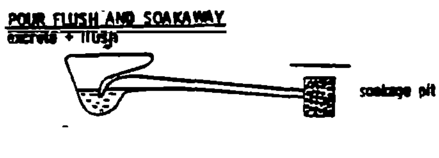
THE SECRETARY

SULABH SHAUCHALAYA SANSTHAN, PATNA (BIHAR).



Possible Applications

(e) The effectiveness of composting latrines depends upon careful operation and maintenance, which may require special education programmes. Although the results of pilot projects in Tanzania and Botswana have suggested that continuous composting toilets are not suitable for wide use in either the urban or the rural tropics, a/ systems based on this principle continue to be used in many countries.

Composters use no water. They can dispose of human and other organic wastes at the same time, and require no energy to run. It may be possible to introduce composting latrines in slums and shanty towns where they could serve as a receptacle for otherwise uncollected garbage. Whether or not the compost which is produced by this process is actually used or simply dumped, it is far less dangerous to health than raw sewage.

Pour-Flush Latrines

Description

(a) These consist of a toilet bowl with a water seal, set into a latrine slab. Excreta are hand-flushed into a seepage pit, or septic tank. (Figure 25) b/. (Only 1-3 litres of water are required for flushing as opposed to 9-20 litres for conventional cistern flush toilets.) Odors are eliminated and the latrine may be located in the home at or above ground floor level.

Constraints and Limitations

(b) One problem is that users may not have (or use) enough water to flush the bowl clean. In addition, the trap can become blocked if solid cleansing materials (e.g., corncobs, coconut husks, mud balls, etc.) are used. There are also potential health hazards from groundwater pollution where seepage pits are used.

Improvements

(c) Amongst the possible improvements are better quality bowls and traps and the introduction of double-seepage pits. (Figure 25b-d)

Country Examples

(d) India: The double seepage pit developed for programmes in India simplifies the collection process by allowing time for excreta to decompose before being collected. It can also provide a pathogen-free humus for agricultural use. Pour-flush latrines have been used extensively in recent programmes in both India and Sri Lanka (e.g., Sulabh Schauchalaya Santhan, Patna, India).

In addition to the construction and operation of public latrines in Patna, the Sulabh Shauchalaya Santhan (SSS) has carried out a successful programme of latrine conversion since 1970, and the local government has now embarked on a state-wide programme based on the work of the SSS. Following the conversion of some 400 dry latrines for the Municipality of Arrah in 1973, the Bihar Government made the SSS responsible for latrine conversion throughout the State and issued an ordinance banning the construction of new "service" (i.e. bucket latrines emptied by hand) latrines.

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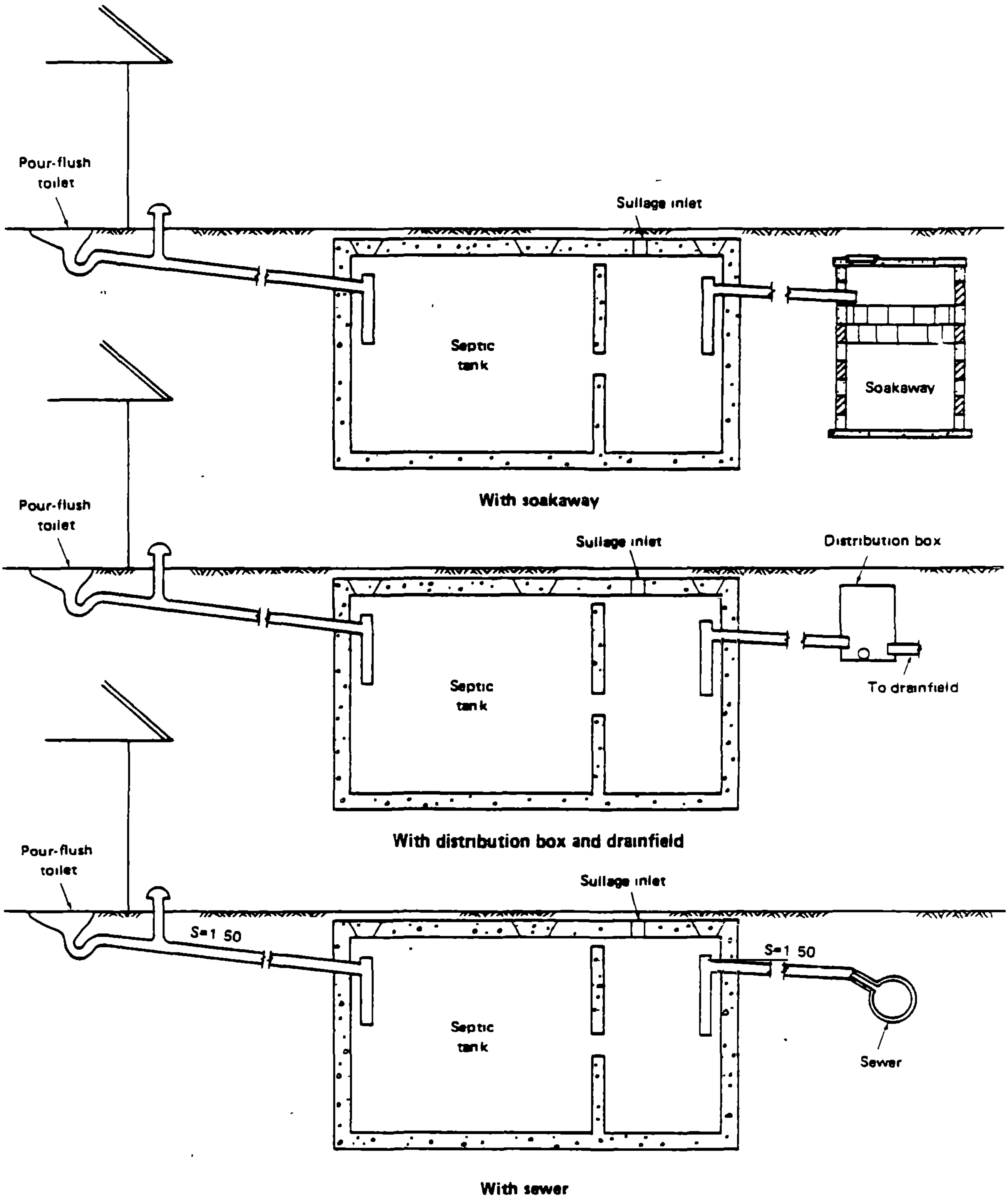
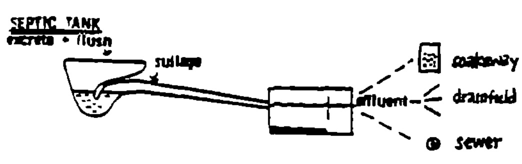
a/ WHO Regional Office for South-East Asia, Conversion of Bucket Privies into Water-Seal Latrines, Report of National Seminar, Patna, Bihar, May 1978.

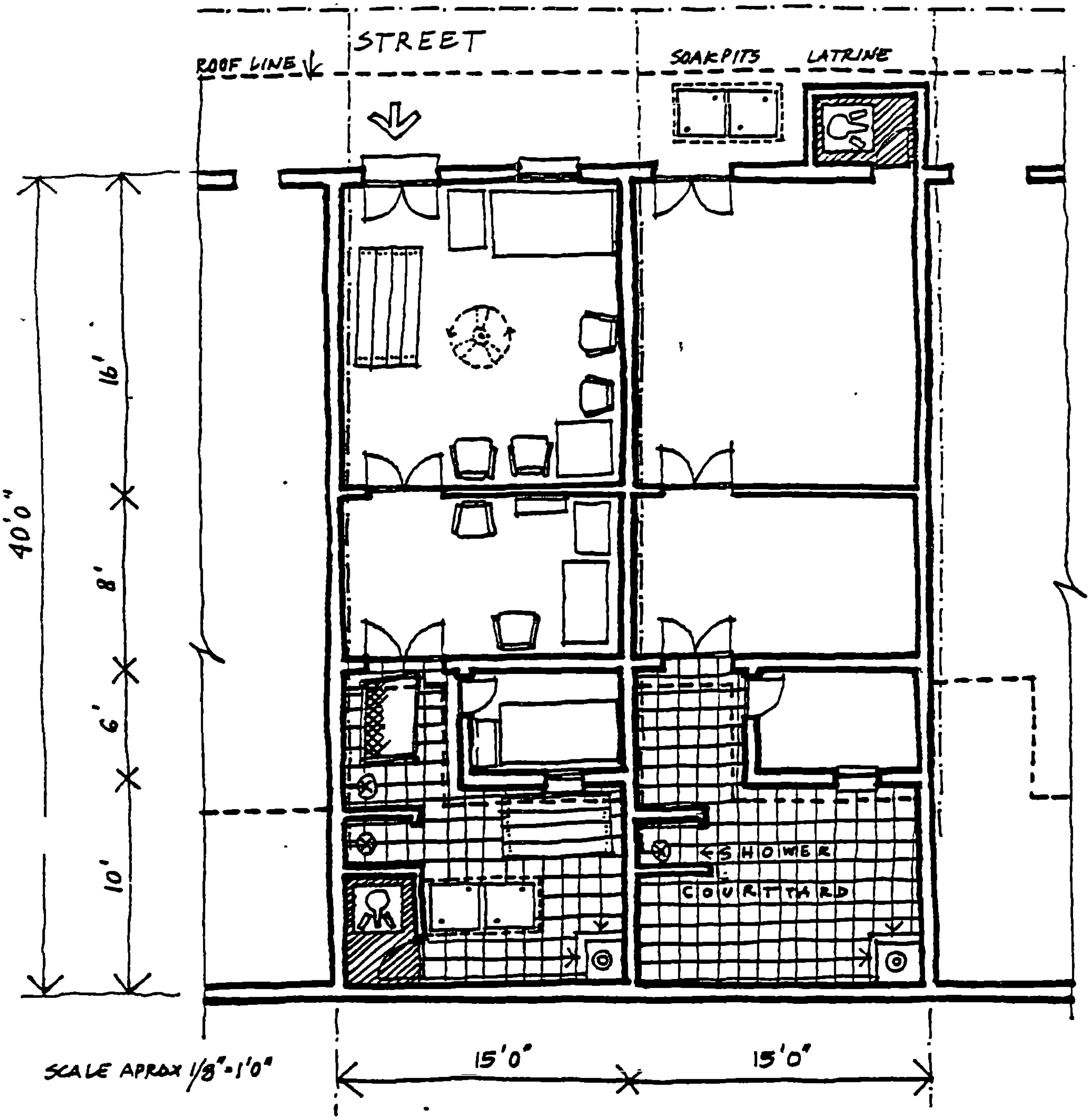
b/ R. G. Feachem, et al 'Appropriate Technology for Water Supply and Sanitation,' Volume 7: "Alternative Sanitation Technologies for Urban Areas in Africa," The World Bank (1980).

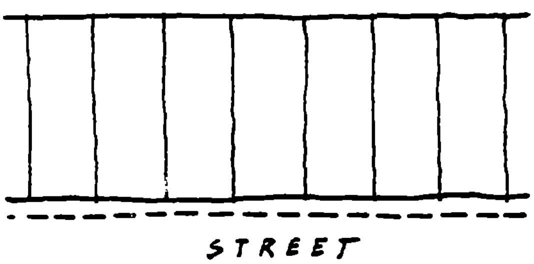


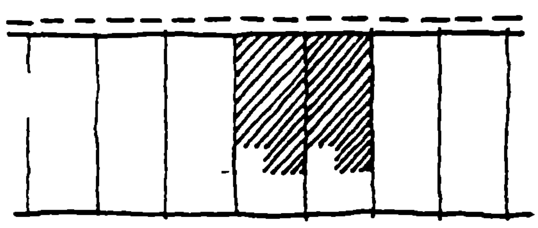
S = Slope.

Pour-flush Toilet – Septic-tank Systems









NB.

WATER SUPPLY PIPES LOCATED 4'-6' ABOVE COURTYARD FLOOR LEVEL

WATER TAPS

COURTYARD SLOPING TO DRAIN

POUR-FLUSH LATRINES AND SOAK-PITS
INSTALLED IN PRIVATE HOUSES BY
THE SULABH SAUCHALAYA SANSTHAN

PATNA, BIHAR, INDIA, 1980.

The SSS has developed a pour-flush latrine with a water-seal pan and a slab connected to two pits, each 3 ft. square and between 4 and 5 ft. deep. The top of the leaching pit is at or just below ground level. In 1977 the average cost of this type of latrine was Rs. 400 ($50), depending on site conditions. The operational arrangements adopted by the SSS for household conversion are summarized in the report of a seminar held at Patna in 1978:

SSS carries out a house-to-house survey of dry latrines, and provides the motivation for the house owner to apply for his latrine conversion. The Government gives a grant of Rs. 200 and a loan of Rs. 200 to the house owner for the conversion, through the municipal committee of the area concerned, the loan being repayable in 15 installments. The SSS takes over, for and on behalf of the applicant ensuring compliance with all the formalities to secure the grant and loan.

It submits to the municipal committee an agreement in standard form signed by the house owner agreeing to repay the loan and an authorization to the SSS to receive the grant and loan on his behalf. He also signs an agreement to entrust the work to the SSS which liaises with the local body to get the application processed.

The agency thereafter arranges to collect the necessary materials and carries out the conversion work with its own trained masons and labour. The house owner is given a work progress card specifying the dates of commencement and completion of the work and also a warranty card on completion for trouble-free service of the converted latrine for five years, any defects being rectified at the expense of the SSS.

The SSS provides a well-organized yet flexible service without the involvement of any state agency. It has been criticized for its "rule-of-thumb" assumptions regarding soil conditions and the size and location of leaching pits relative to sources of water. Tests are in progress in some of the housing areas where conversions have been made. A visit to some of these houses confirms that it is possible to install this type of latrine system even in the smallest courtyards. (Figure 25b)

(e) Since "pour-flush" refers to a component, rather than an entire disposal unit, it can be used either as an improvement to a standard pit latrine, or as part of a more comprehensive system. It is particularly suitable where water is used for anal cleansing. Pour-flush latrines can satisfy the desire for an indoor toilet at low cost and, because they have a water seal, dispose of the problem of odour and insect breeding at the same time. They can also be used to dispose of household waste-water, provided there is some method of effluent disposal, such as a septic tank or small-bore sewer capable of handling it.

Aqua-Privies

Description

(a) The aqua-privy in its simplest form consists of a squatting plate above a small septic tank, which discharges its effluent to an adjacent soakaway. The excreta undergoes anaerobic decomposition, which reduces it to about one quarter of its original volume. The squatting plate has an integral

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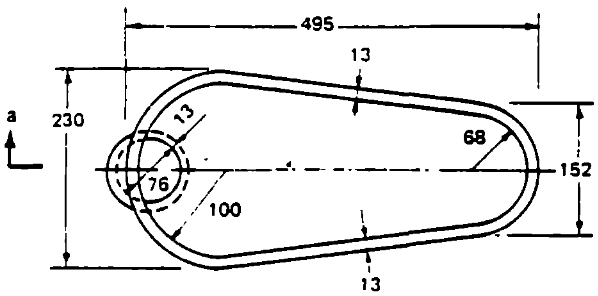
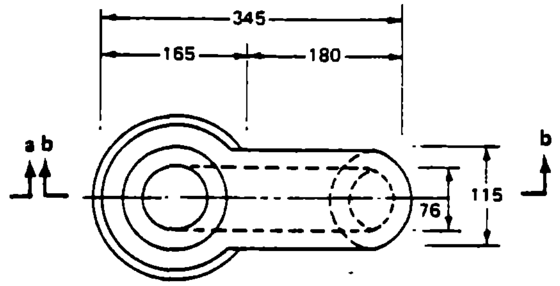
(millimeters)

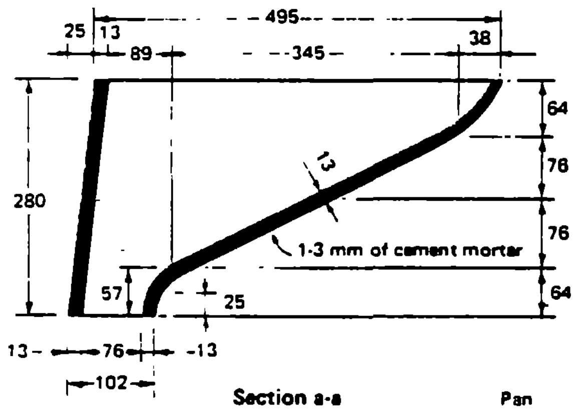
A Cement mortar or ceramic pan



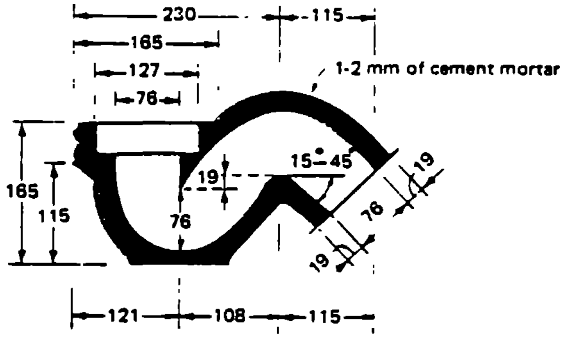
Plan of squatting plate (pan)



Plan of water-seal unit (trap)

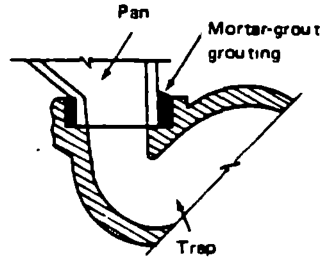


Section a-a

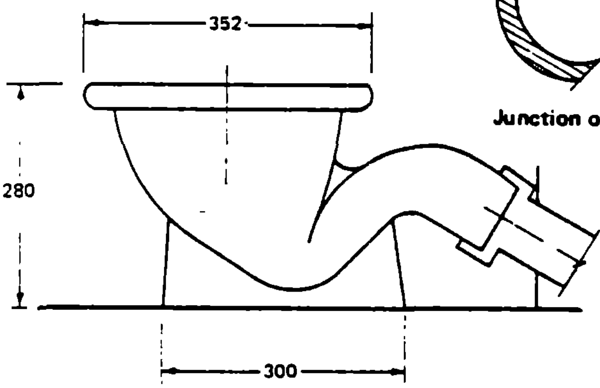


Section b-b

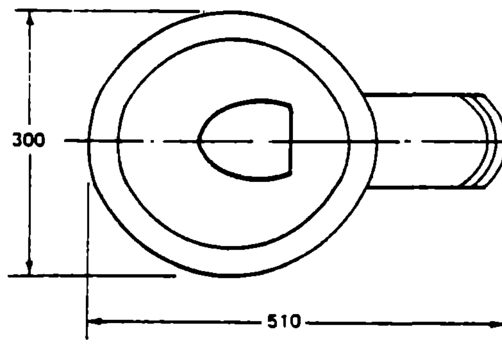
B. Ceramic pedestal



Junction of pan trap

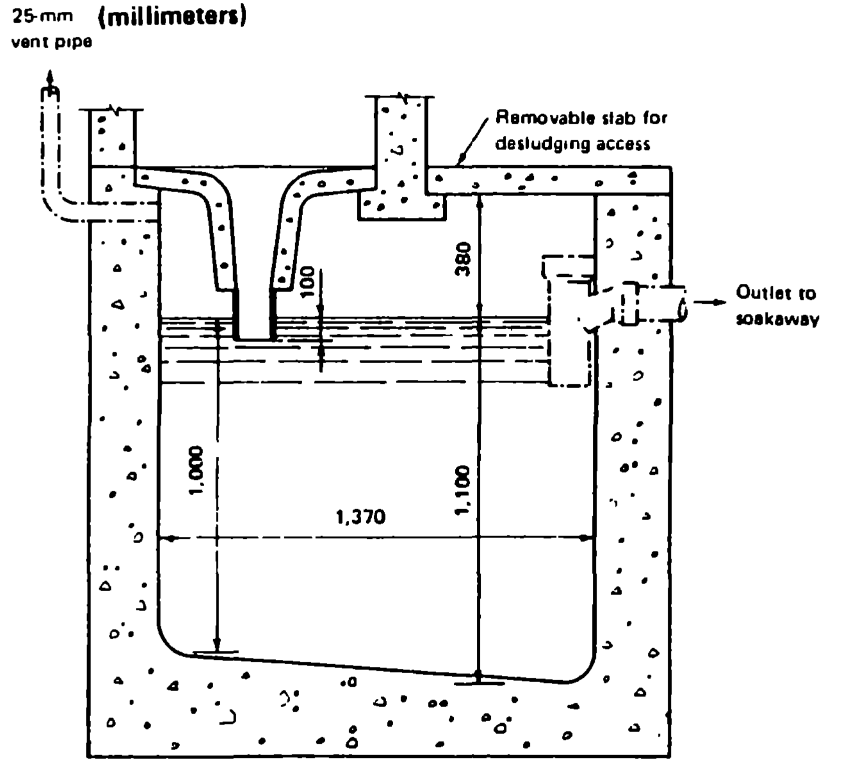


Side view

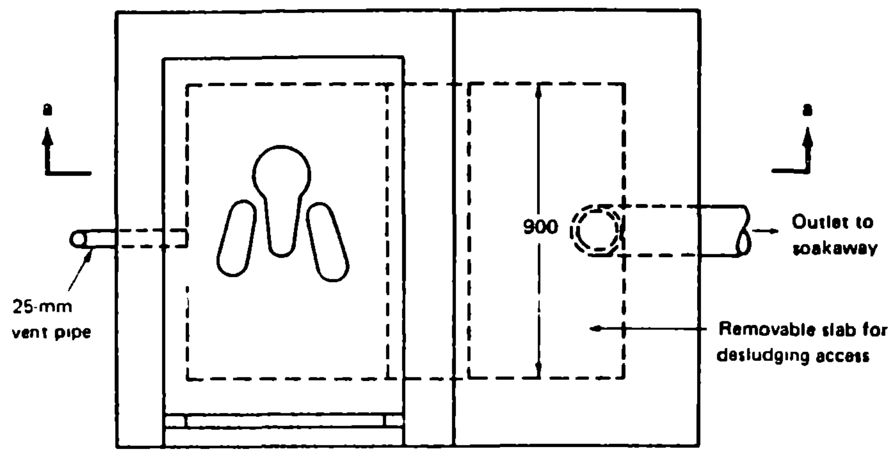


Top view

Source A, adapted from Wagner and Lanoix (1958).
B adapted from CIMDER Colombia.



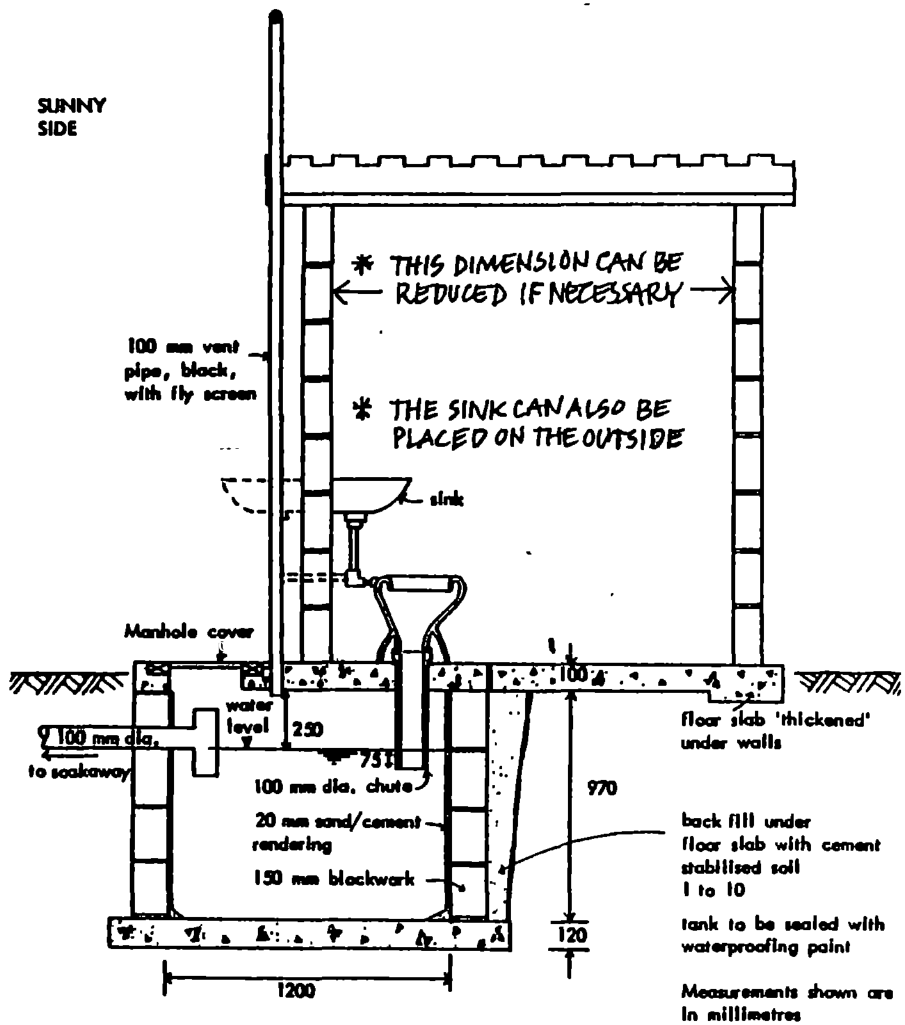
Section a-a



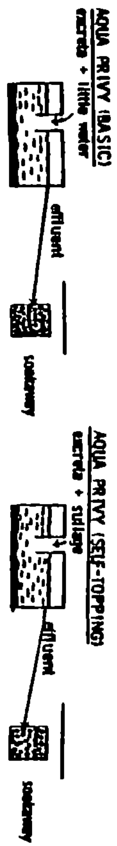
Plan

Source Adapted from Wagner and Lanoix (1958)

Conventional Aquaprivy



Self-topping aqua privy. It will usually be preferable to have a large sink on the outside wall rather than a small one inside. The sink need not be connected to a water supply but if not, water must be nearby to encourage the use of the sink for washing clothes. The seat may be replaced by a squatting slab. (From a drawing by R. A. Boydell).



drop-pipe which is submerged into the water in the tank to form a simple water seal. Only a small volume of added water is required to clean the entry funnel and to maintain the fluid level (Figure 26).

Constraints and Limitations

(b) Although aqua-privies are less prone to blockage than pour-flush latrines (because they use a straight pipe rather than a trap), problems of odour and insect breeding can easily occur if the water-seal is not maintained. If the only source of water is from public standpipes or wells, people may be reluctant to carry it to the latrine unless it is also used for anal cleansing. Aqua-privies require a water-tight tank, which can make them more expensive to construct than other systems, and they must be desludged periodically - depending upon the size of the tank and its usage.

Improvements

(c) Several suggestions have been made towards improving the conventional design of the aqua-privy, so as to overcome the problem of losing the water-seal. The simplest is the addition of household wastewater into the aqua-privy to ensure its receiving sufficient quantities of water ("self-topping aqua-privy"). Similarly, aqua-privies can be linked in series and, as an additional insurance, a communal washing facility constructed at the head of the sequence to provide additional water. The addition of wastewater to the aqua-privy system will usually require a small-bore sewer to dispose of the effluent.

Country Examples

(d) Aqua-privies have been tried in several African countries in a variety of projects. They have for the most part been unsuccessful, and in one country became so troublesome as to be banned altogether.

Possible Applications

(e) While it is conceivable that the "self-topping" aqua-privy connected to a small-bore sewer could work in high-density areas which have an adequate water supply, the problem of maintaining the water-seal remains. The only comparative advantage of the straight-pipe over a trap is that it is more difficult to block.

Septic Tanks

Description

(a) This is a water-tight settling tank, normally located underground and away from the toilet itself. All household wastes are flushed into the tank and digested anaerobically. A liquid effluent flows out of the tank continuously and must be disposed of through a soakage pit or drain field, while the sludge which settles to the bottom of the tank must be removed periodically (Figure 27). The conventional single or double compartment tank works well in low-density housing areas, at say, 100 people per hectare.

Constraints and Limitations

(b) The drawbacks of any septic tank system start with the relatively high cost of initial construction, as the tank must be made water-tight. However, the tanks lend themselves to mass production, and could be produced as a local industry. Also, there must be a sufficient quantity of water available for flushing the system and, where it is not connected to a sewer, the area of land and type of soil suitable for effluent disposal must be taken

.../

into account. Finally, septic tanks require regular desludging. The frequency will depend on the capacity of the tank, and the number of people using it.

Improvements and Modifications

(c) Septic tanks can receive wastes from individual dwellings or from communal latrines. An emergency communal latrine introduced by Oxfam, U.K., comprises two butyl rubber tanks, each of 18,000-litres capacity, which can be packed together with plastic squatting plates and pipework in a conveniently small volume. The septic tanks are placed on the ground, which facilitates desludging (Figure 30c). A modification of the simple Septic Tank consists of the addition of a third compartment which receives sullage directly from the house and settled wastes (effluent) from the first two compartments (Figure 27). This would produce a more pathogen-free effluent and reduce its long-term infiltration rate. Thus, the area of the drain field could be reduced and the system used at higher densities (200-300 people per hectare).

Country Examples

(d) Septic tanks are used in Europe and the U.S.A. in low-density housing areas outside the range of waterborne sewers. They are common in similar areas of former colonial towns and cities throughout the world. In Taiwan, for example, septic tanks serve the majority of the population. In Pingtung, 57 per cent of the population is served by septic tanks and the remainder depend on nightsoil collection.

Possible Applications

(e) Septic tanks provide a high level of convenience and efficiency. They can be linked to elements of other systems, such as pour-flush latrines, and shared by two or more households, for example. Their application in slums and shanty towns is likely to depend on costs and the type of effluent disposal which is feasible in each case. The use of small-bore sewers to dispose of effluent may be appropriate in higher density areas.

Waste Stabilization Ponds (and Protein Production)

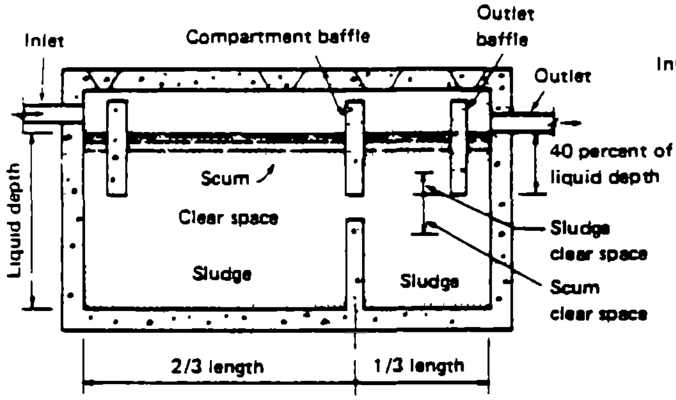
Description

(a) One of the aims of treating wastes is their conversion into a resource which conserves both water and nutrients. Stabilization ponds are a widespread and proven method of treating sewage and nightsoil. Treatment depends upon a series of ponds in which natural biological processes take place. In their simplest form, stabilization ponds require no mechanical equipment. They are inexpensive, easy to construct, simple to maintain, and achieve very low survival rates of excreted pathogens. In hot climates, they are especially efficient as the rate of decomposition is accelerated (Fig. 28).

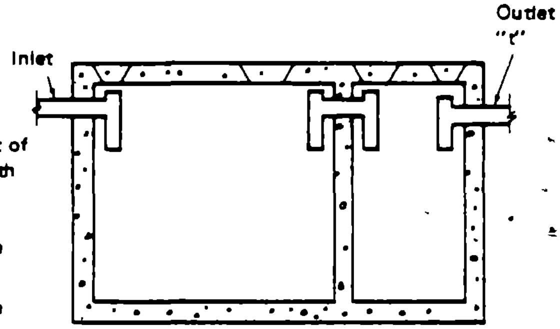
Constraints and Limitations

(b) The potential problems with this system of treatment include the transportation of wastes to the ponds (especially where manual collection is involved) and the protection of ponds. Children, animals, and garbage must be kept away from the ponds to ensure their continued stability. Another obvious question (especially in high-density urban areas) is the availability of land for use as waste stabilization ponds. Anaerobic ponds should be located as far away from housing as possible.

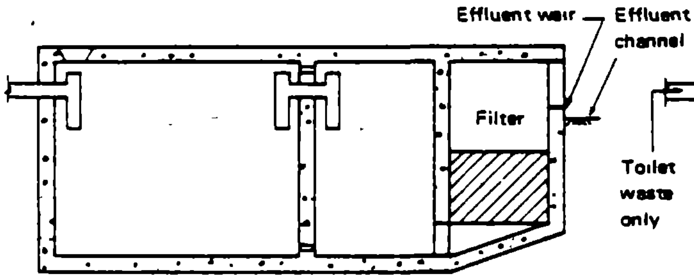
(millimeters)



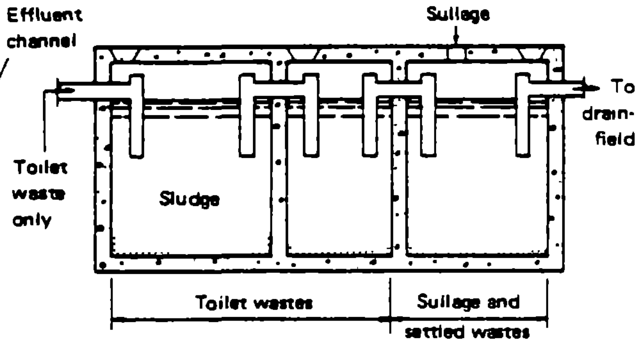
Conventional two-compartment septic tank with baffle walls



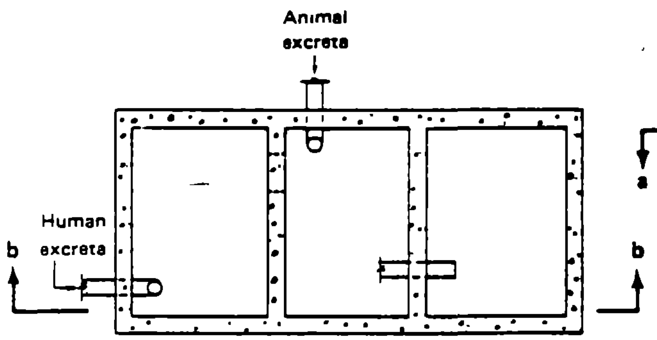
Conventional two-compartment septic tank with inlet connector and outlet "t"



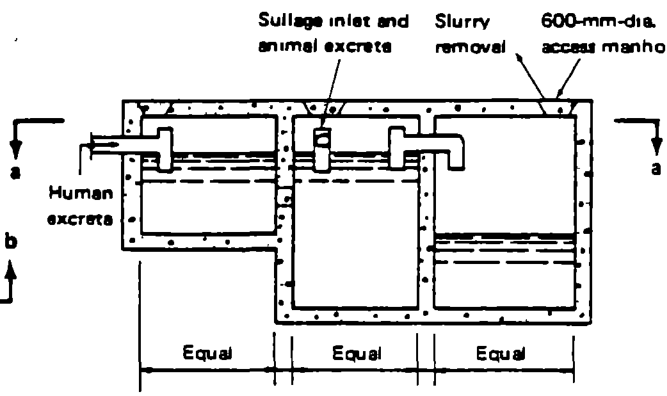
Two-compartment septic tank with upflow filter



Three-compartment septic tank

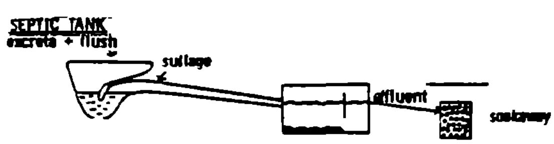


Section a-a



Section b-b

Three-compartment septic tank for resource recovery



Modifications/Country Examples

(c/d) Brazil: Stabilization ponds have been in operation since 1971 at an experimental station established as part of the Plano Nacional de Saneamiento (PLANASA) with assistance from CIDA. The Agricultural and aquacultural re-use of treated effluent is a major subject of research and the programme also includes aerated lagoons, oxidation ditches, upflow filters (for septic-tank effluent) and bio-filtration.

India: A well-developed sewage treatment demonstration plant with a stabilization pond treating 270,000 litres a day forms part of the Public Health Engineering Department at Guindy, Madras. Effluent from the pond is fed into a fish pond of 650 m with a depth of 1.0 m. The inner slope of the embankment is pitched with cement slabs to check erosion by wave action, prevent the growth of weeds and discourage mosquito breeding at the water's edge. The final effluent from the pond is stored in a sump and pumped to irrigate coconut palms. A tube-well has been sunk close to the plantation to monitor groundwater contamination.

Similar studies have been made in Israel, and new projects are under way in Hong Kong, Kenya, Malaysia, Peru and Thailand.

Asia: Carp and Tilapia grown in fishponds have long been a major source of animal protein in many Asian countries, and in Java latrines are often built directly above such ponds.

Possible Applications

(e) Low-cost treatment of sewage in stabilization ponds is feasible and appropriate, provided that sufficient land is available. The further possibilities for algal harvesting, fish culture, duck breeding and agricultural irrigation make this system particularly attractive, although much care is required to ensure that food grown under these conditions is safe to eat.

Not enough is known about the transfer of pathogens through fish to consumers. Although fish do not act as an intermediary host for the vast majority of human parasitic agents, transmission can occur through fish scales or intestines. Fish grown on sewage should never be eaten raw. European practice is to keep fish in clear water for two to three weeks before harvesting.

Bio-Gas Plants

Description

(a) Any organic material which is allowed to decompose produces methane gas: human faeces, cow dung, ground nuts, paddy husks, oil cake, dry leaves, etc. Bio-gas plants capture and control the gas which is produced by a natural biological process. Most plants consist of a digestor which receives the organic wastes, and a receptacle for the gas, placed above the digestor. Many versions have been developed, including ingenious contraptions using the rubber inner tubes of car tires and used oil drums (Figures 29e,f), and the more permanent, low-cost Chinese type, covered with a brick dome (Figure 29 abcd). Family and communal latrines can be built to discharge directly into the digestor.

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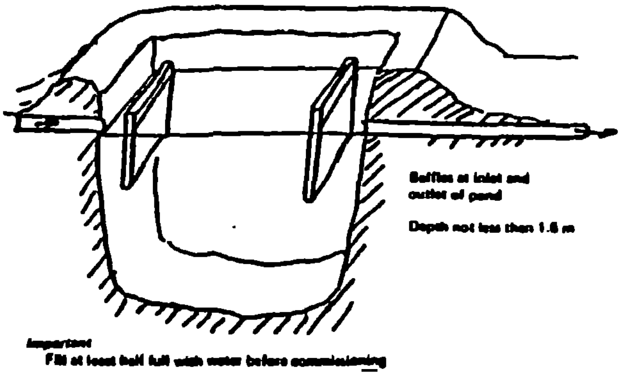
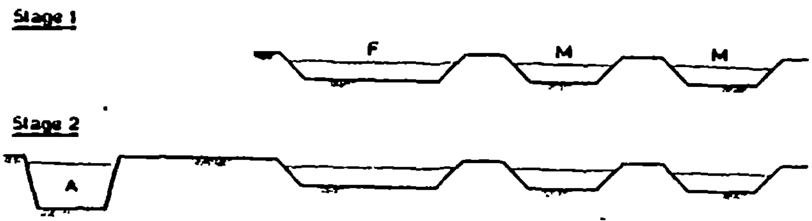
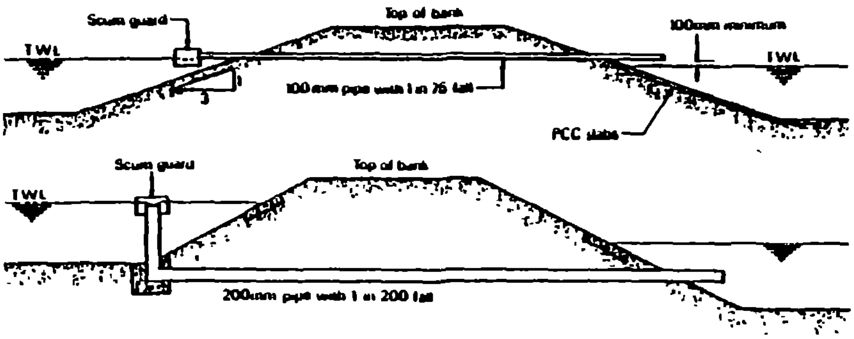
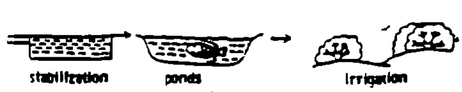


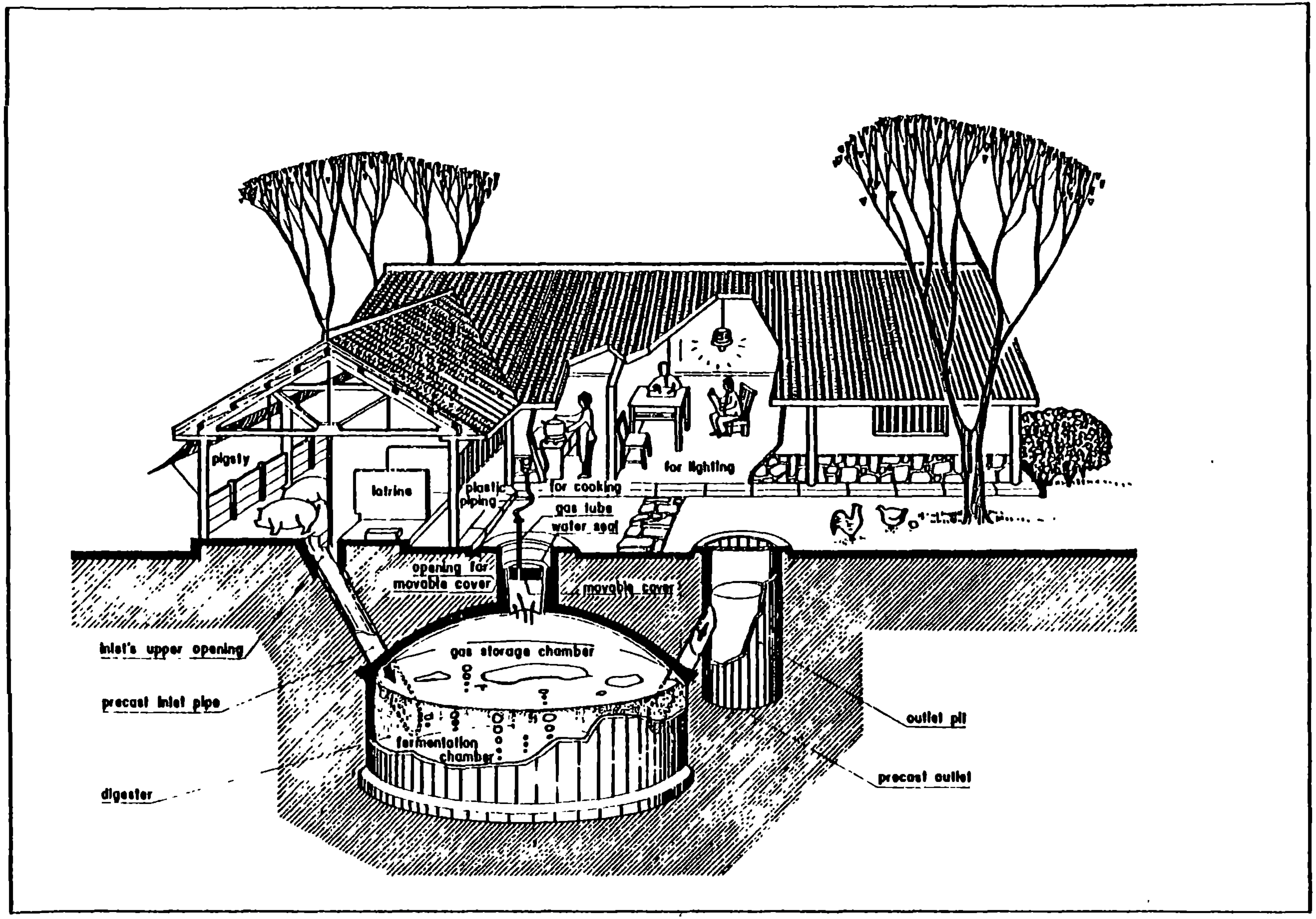


Stages in the development of a waste stabilization pond system: F = facultative pond; M = maturation pond, A = anaerobic pond or septic tank For small populations, septic tanks may replace the anaerobic pond. (From Mara).



Two examples of simple interpond connections. (From Mara). PCC. Pre-cast concrete





The placement of a typical 'three-in-one' biogas unit in a Chinese household.

The design and construction and function of the various parts
There are many designs of biogas pits, such as those in Figures 3-2 and 3-3

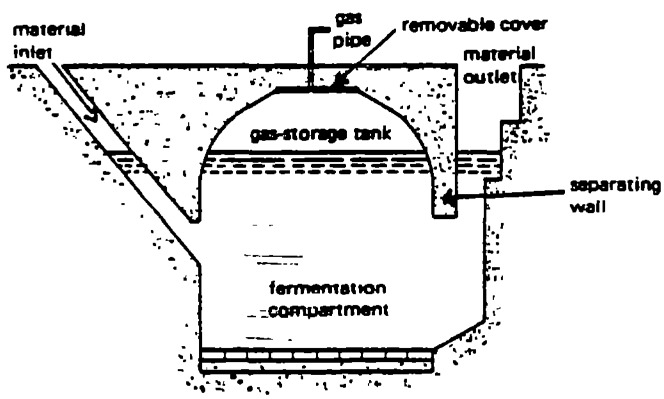


Fig. 3-2. Diagram of a circular biogas pit.

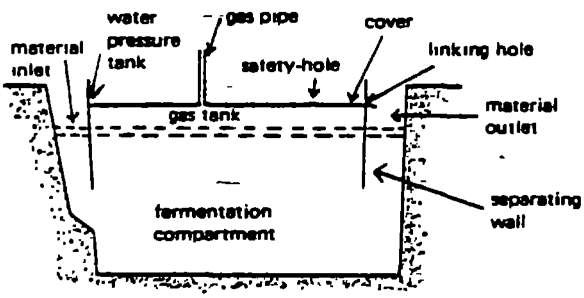


Fig. 3-3. Diagram of a rectangular biogas pit.

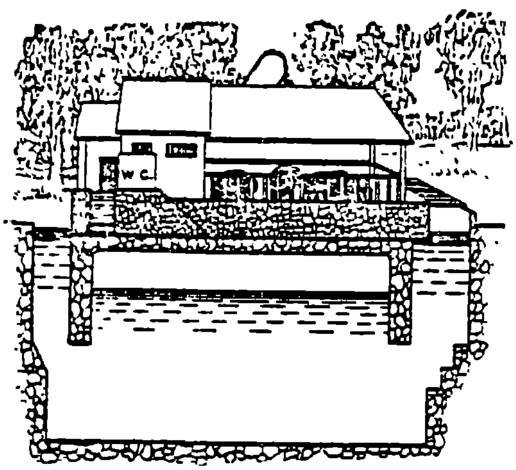


Fig. 3-1. Toilets and pigsties built above a biogas pit.

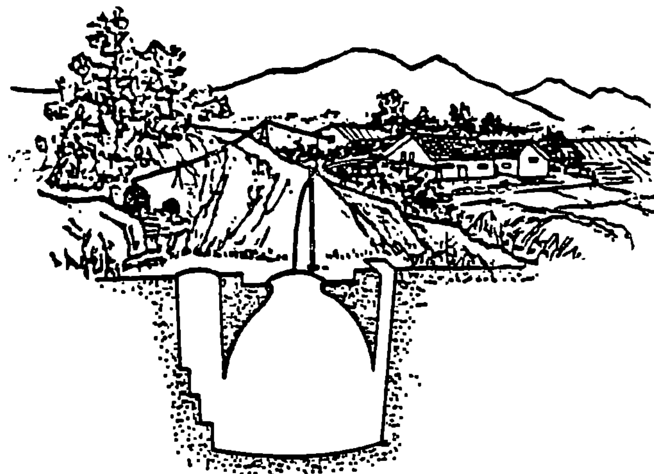


Fig. 4-19. A pit in sheer rock.

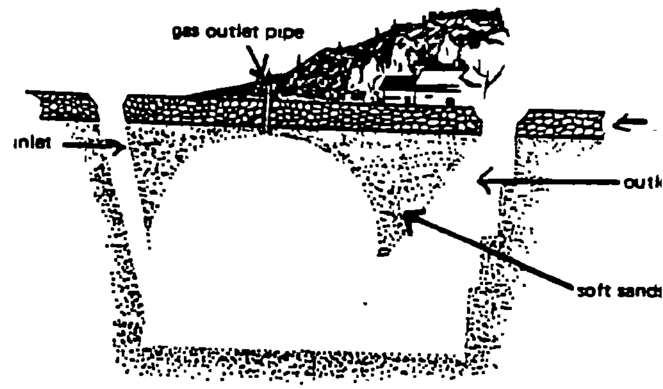


Fig. 4-20. Biogas pit carved out of soft sandstone.

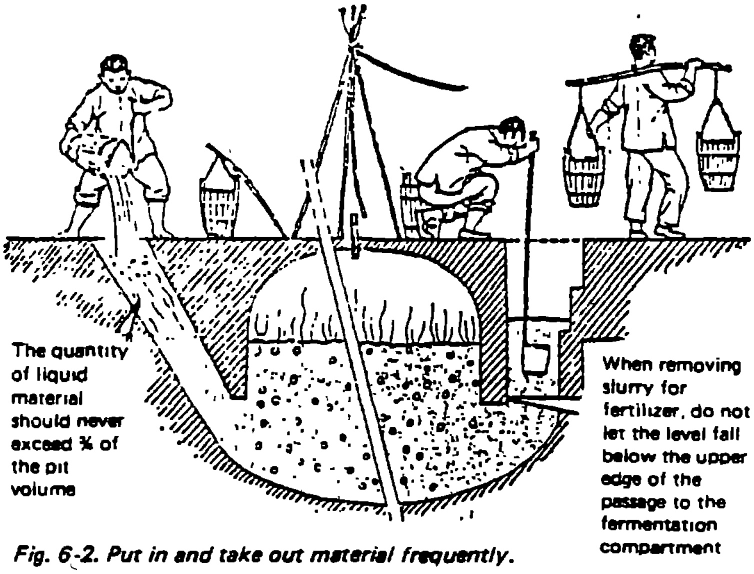


Fig. 6-2. Put in and take out material frequently.

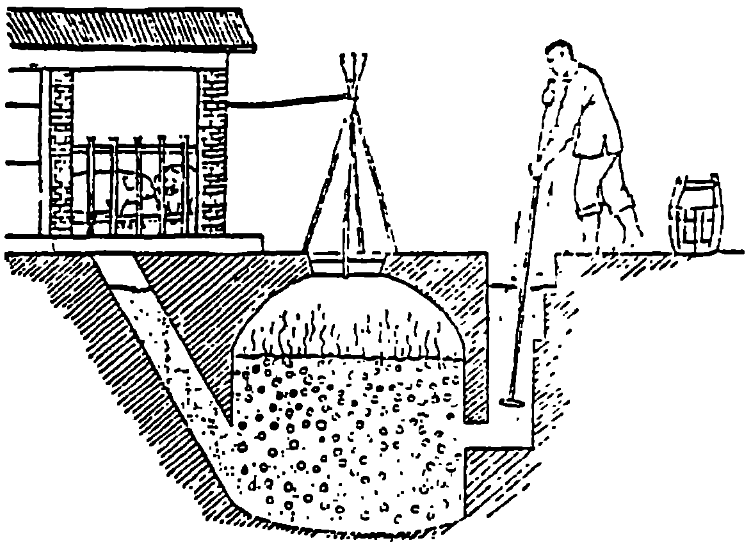


Fig. 6-1. Stir liquid fertilizer frequently.

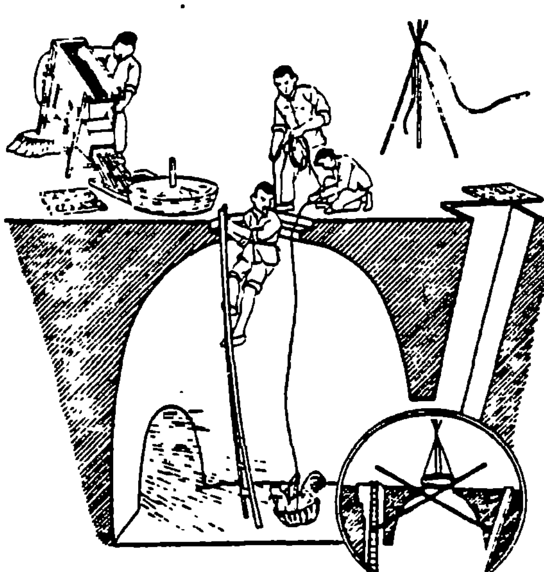


Fig. 8-1. Take care that there is no trace of gas left in the pit, by flushing it out with air (left above), and by checking for air purity with an animal; then be sure to fasten on a safety belt before entering (courtesy Mianyang Science & Technology Committee).

Fig. 4-23. Fitting a removable cover.

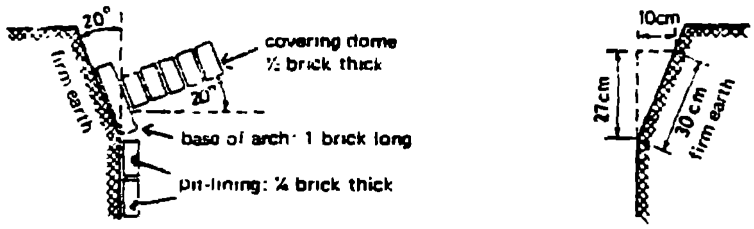


Fig 4-9. Forming the inclined surface at the base of the arch for a pit cover of 3 m diameter.

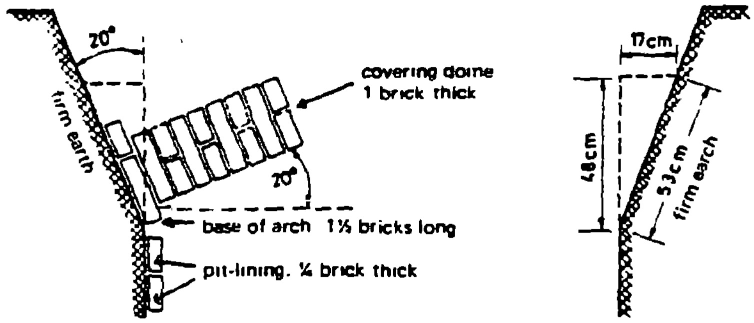


Fig. 4-10. Forming the inclined surface at the base of the arch for a pit ~~c~~over of 4 m diameter.

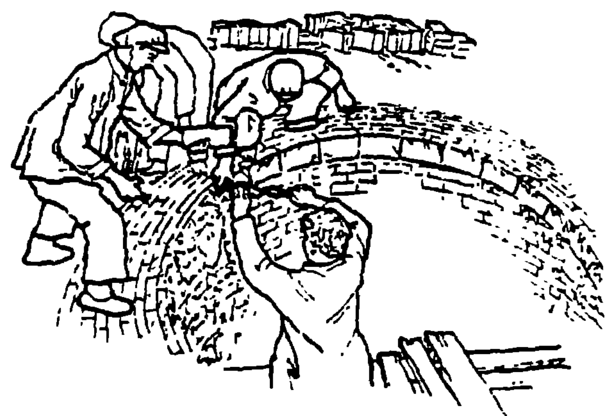


Fig. 4-11. Bricking a dome without support.

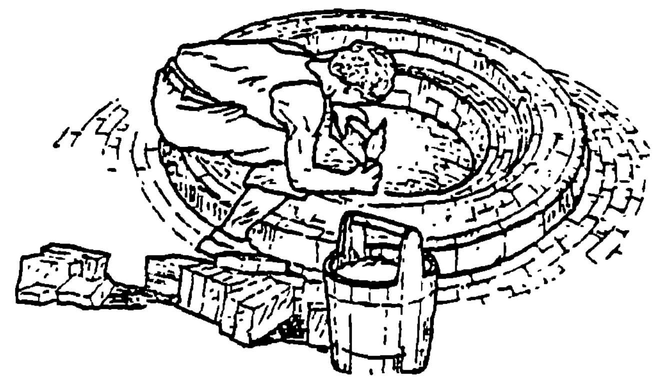
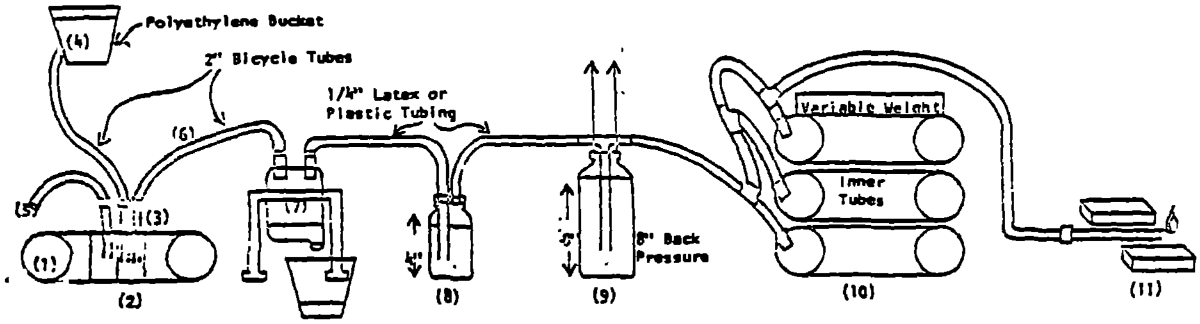


Fig. 4-12. Bricking the mouth of the pit without support.



(1) Main Chamber of Digester

(2) The Plastic Cylinder

(3) Inlet, Gas, and Effluent Pipes

(4) Inlet Feeding Bucket

(5) The Effluent Outlet

(6) The Gas and Scum Outlet

(7) Scum Collector

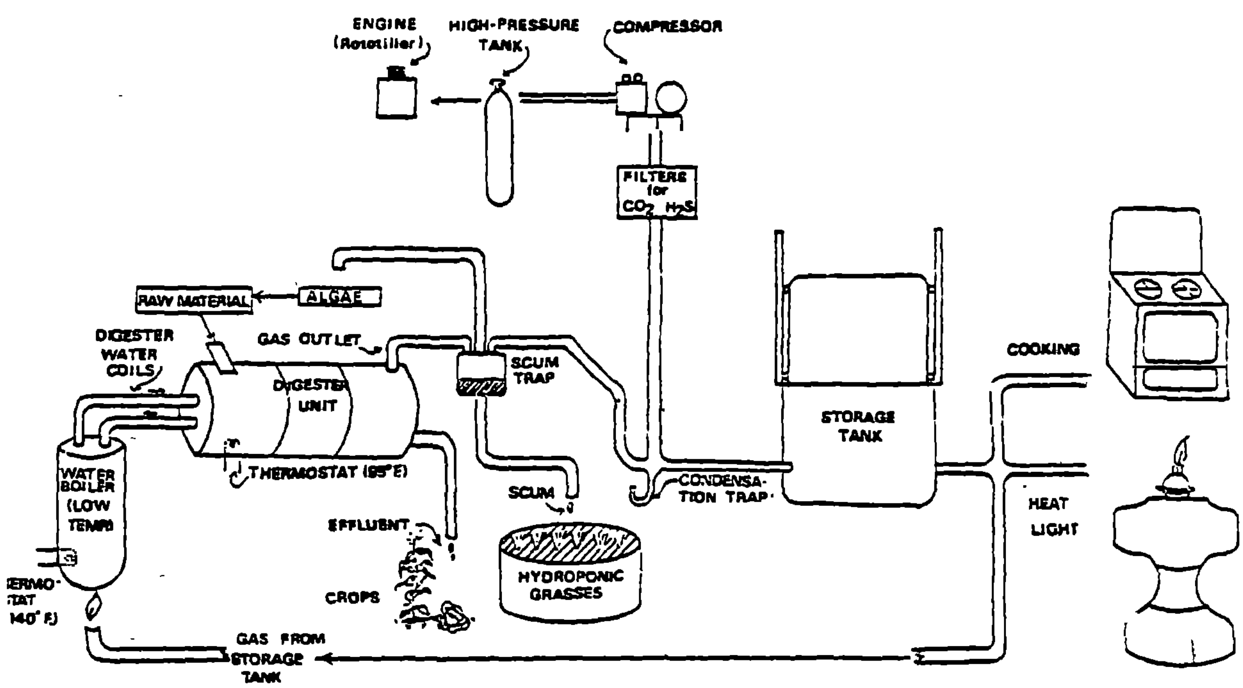
(8) Gas Yield Indicator

(9) Pressure Releaser

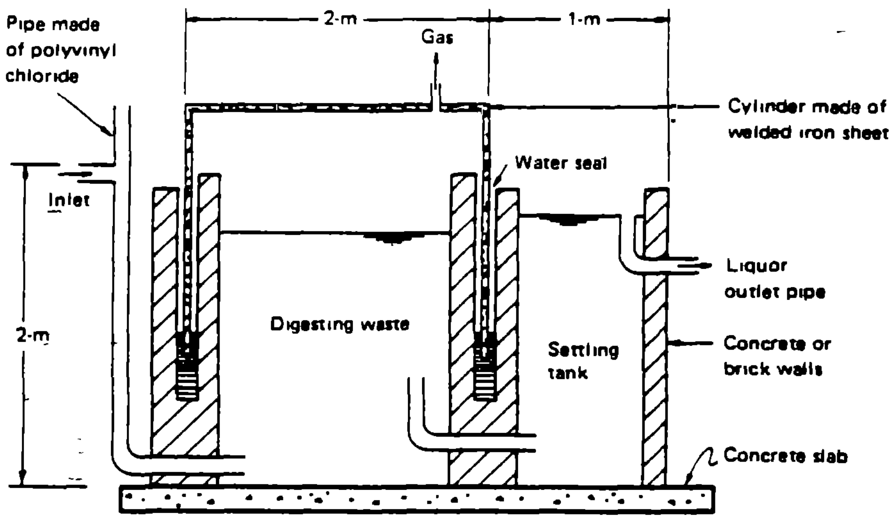
(10) Inner Tube Storage

(11) Burner

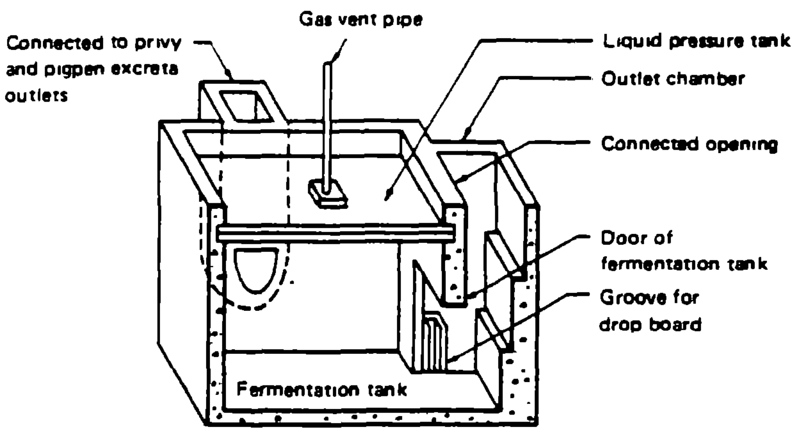
e DIAGRAM OF INNER TUBE DIGESTER



f Integrated Organic Digester Operation (Using 50 gallon drum for digester)



**Biogas plant
from South Pacific**



**Biogas plant
from China**

Sources: South Pacific, Solly (1976), China, McGarry and Stainforth (1978)

Constraints and Limitations

(b) There are several disease-causing organisms which can pass through a bio-gas plant unharmed to reach soil and crops and eventually be ingested by man. Although many parasites may be destroyed or removed by the decomposition process, it is not certain that effluent from bio-gas plants is free from all disease-causing organisms. a/ Control of the proportion of different types of waste entering the digestor, of viscosity and temperature inside the plant, and gas pressure are very important to ensure the efficient working of the system, which requires efficient organization and maintenance. Cultural compatability is a determining factor in the successful operation of such systems.

Improvements and Modifications

(c) Modifications and improvements are described in the Chinese examples below. Research and development of bio-gas technology is being carried out in many countries, and a BIO-GAS Newsletter is published by the Division of Industry, Housing the Technology of ESCAP/UN in Bangkok, Thailand.

(d) China: b/

The first Chinese attempts to convert organic wastes into bio-gas date from 1958. Following a massive and well-organized campaign to promote the technology, there were reportedly almost a million bio-gas plants in operation in 1977. In one county in Hebei Province, 40,000 out of 56,000 households had bio-gas plants.

In FuShan, Guangdong Province, a city of 140,000, nightsoil is placed in 45-cu.-m capacity tanks (170T/day). The tanks are 10.5 m long, 2.4 m wide and 2.3 m deep, constructed below ground in two rows of 16 in. each. They are interconnected with pipelines, have a common drain, and are provided with gaslight covers fitted with water seals. The tanks are connected with the gas holder into which gas is pumped. The tanks are filled with nightsoil to a depth of 1.9 m. The nightsoil then undergoes anaerobic digestion in the tank for 22 days, during which time methane is produced. The gas is stored in a sausage-shaped bag made of 0.2 mm-thick HYpolen laminated with neoprene and reinforced with nylon and with a PVC inlet and outlet. The bag rests on a water surface to ensure detection of leaks. About 230 m 3 of gas are produced daily, although the output is reduced in winter. The gas is used to generate electricity. The sludge from the tanks is sold to the commune members at $2.10 per ton, while the effluent is led through a pipe to a boat for transport to the fields.

The following benefits of bio-gas plants were listed by members of production brigades:

(i) The sludge obtained from bio-gas plants is richer in nitrogen than sludge obtained by conventional composting. Anaerobic digestion is reported to increase the ammonia content by 120 per cent, and the amount of quick-acting phosphorus by 150 per cent. The plants are regarded as "miniature manure factories."

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a/ McGarry, op. cit.

b/ The main source of information for this section is: 'Recycling of Organic Wastes in Agriculture.' FAO Soils Bulletin No. 40, Rome, 1977.

(ii) Bio-gas sludge is free from the offensive odour normally associated with manure pits or heaps, and fly nuisance is minimized. The parasites normally present in manure are killed during the process of digestion and storing of slurry.

(iii) Bio-gas plants conserve local fuel, wood or imported coal and kerosene, and upgrade into an excellent organic fertilizer the vegetable refuse which would otherwise be burned inefficiently and the animal and human wastes which usually constitute a health hazard.

(iv) Bio-gas can be used to power internal combustion engines and as a substitute for diesel oil in small electric generators.

(v) The gas provides a clean and convenient fuel for household cooking and a good light for reading. The rice straw which is otherwise burned as fuel is saved for use as fodder or for making silage. Bio-gas saves time in cooking and thus reduces the house-keeping load for women.

(vi) Bio-gas plants are complementary to piggery development.

Five designs of bio-gas plants are reported in China. In one design, the gas holder and digestor are combined in one unit. The gas holder is the brick dome-shaped cover of the digestor itself. Local materials are used in the construction; i.e., bricks, lime and a small amount of cement for rendering. A 10 m capacity plant is reported to cost $US 24.

To construct a plant, a round hole 3 m in diameter and 3 m deep is dug. The digestor portion extending from the base to a height of 2 m is well compacted using an earth-lime (95 : 5) mix. The gas holder portion, the brick dome-shaped cover of the digestor, is then constructed leaving spaces for the inlet and outlet pipes which are 60 cm in diameter and are at the same level just above the ground. They are covered with concrete slabs to avoid mishap. The gas flows through a polyethylene tube to the point of consumption from the gas outlet (55 cm upper diameter, 45 cm lower diameter) is situated at the top of the gas holder.

Some of the advantages of this type of construction are the absence of steel reinforcing bars; minimal maintenance costs (as there are no moving parts); and easy temperature control, because the plant is below ground.

However, this type of plant is difficult to use in colder regions. Also there is decreased efficiency in the production of gas if the sludge lacks liquidity to balance the acid and methanogenic bacteria. Other problems are sand accumulation, the build-up of scum, control of the dilution of human and animal wastes, and variable pressures. This system depends upon on an efficient collection system.

A ten-cubic-metre capacity plant can generate about 5 m of gas daily - a sufficient volume to supply a Chinese family with enough fuel for cooking and lighting. The gas is similar to natural gas: a/ 60-70% methane, 30-35 per cent carbon dioxide, some hydrogen, nitrogen and traces of hydrogen sulfide. It has a calorific value of about 5000 Kcal/m .

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a/ Natural gas contains 98 per cent methane.

.../

Bio-gas programmes in China are regarded as part of the over-all social reconstruction programme and are supported through national conferences, the training of technicians, the manufacture of simple gas stoves and lamps, rubber or plastic pipes and pressure gauges, and through the design of differently shaped fermentation pits.

India: The first attempt to build a digestor to produce gas from cow dung appears to have been in Bombay in 1900. Studies by the Indian Agricultural Research Institute led to the development of simple digestor models suitable for village households which could provide heat and light in rural villages.

In India, the Gandhi Samarak Nihidi has been active in promoting bio-gas plants. There were 56 plants in operation in the State of Maharashtra alone in 1976. The Safai Vidyalaya at the Gandhi Ashram in Ahmedabad has a full-size demonstration gas plant and there is one in operation in the Ashram itself. Although there are said to be some 40,000 individual plants in use in India there are cultural explanations for the limited popularity of bio-gas plants. Pigs, which contribute 30 per cent of the raw material for Chinese waste systems, are not eaten by the majority of the Indian population. They are kept only by the sweeper class as scavengers. Cows, on the other hand, produce 800 million tons of manure a year, 30 per cent of which goes to waste and 40 per cent of which is burned directly as fuel for cooking.

Possible Applications

(e) With careful treatment of the digested slurry and good management, bio-gas digestors may be appropriate as a community-operated system for waste disposal, and as a source of cheap energy.

Communal Latrines

Description

(a) Communal latrines may be feasible in high-density slums where access is limited, in cases of emergency or natural disaster, or where there are large numbers of itinerant squatters. Communal latrines are often combined with public water points where bathing and clothes - washing facilities are also provided. The latrines usually consist of separate blocks or rows of squatting plates for men and women. Excreta is automatically or hand-flushed into a septic tank or sewer. The effluent from septic tanks or aqua-privies can discharge into a soakpit or be carried away by small-bore sewers. In China, communal latrines are sometimes directly connected to bio-gas plants, and in some countries the nightsoil from public latrines is collected in vaults or buckets for disposal.

Constraints and Limitations

(b) Problems with communal latrines occur where there is no organized system of maintenance. If the water supply in an area is inadequate, flushing and cleaning of latrines can become a problem, and de-sludging must be carried out on a regular basis. In addition, distance from the home, poor lighting, ventilation, and maintenance will discourage people from using the latrine, especially at night and in bad weather. Questions of privacy and cultural acceptability must be addressed before considering the use of communal latrines which are also inconvenient for children, old people and the sick.

(c) Some ingenious automatic flushing devices have been introduced in the hope of reducing the amount of water needed for cleaning the latrines. The Oxfam emergency sanitation unit can be quickly delivered and assembled regardless of terrain. The most effective improvements involve organizational changes aimed at better maintenance.

Country Examples

(d) Nigeria: The first "Comfort Station" was built under the direction of the Ibadan Wastes Disposal and Drainage Board ten years ago. This was a communal facility consisting of 10 toilets, 8 showers and a clothes washing section built entirely by self-help labour on land donated by the Egboni family for the use of the 200 extended-family members. The latrines discharge directly into a two-chamber aquaprivy consisting of a main digestion chamber and a settling tank (Figure 30a). Effluent from the settling tank is piped to an existing drain. An elevated water storage tank with a capacity of 1,200 gallons makes a landmark of the station. It replaced four "Salga" pit-latrines a/, three of which were located on the site of the new latrines. Water was previously obtained from standpipes and a few dug wells. The population density of this inner city area was about 114 persons per acre. The station was handed over to the family by the Drainage Board in 1970, giving them full responsibility for its maintenance.

Acting as executing agency for the UNDP and the government, WHO commissioned a study and project proposal for a Master Plan for Wastes Disposal and Drainage from international engineering consultants. Their report recommended that the Comfort Station solution should be extended as a demonstration project at 25 other sites in the inner city where conventional sewerage was not feasible at the time.

Following the construction and use of a number of Comfort Stations, a two-year study of nine stations was made to find out how well the latrines were working and to design a health education programme. A number of points from the study may be useful in considering the suitability of communal latrines in other places.

(i) Previous conditions were very bad as was the level of household hygiene. People were not aware of a link between health and environmental sanitation although they were aware of the symptoms of water-borne diseases.

(ii) Of the 55 per cent of the respondents who said they had not taken part in the construction of the stations, 24 per cent said they had not been told about the project.

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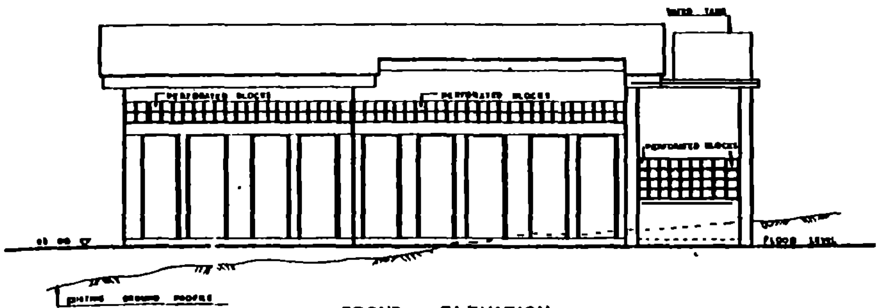
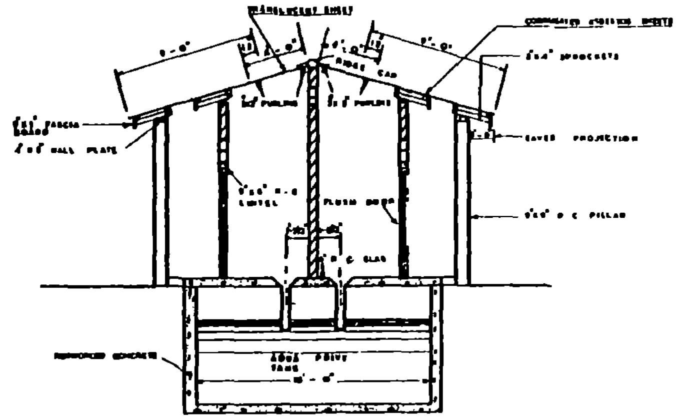
a/ "Salga" latrines are used through the inner core of Ibadan. They consist of a circular pit, 3-4' in diameter by 30' deep, located within the family compound. Nightsoil collected from individual rooms in plastic containers or banana leaves is placed in the salga next morning. Where space permits, two pits are dug side by side.

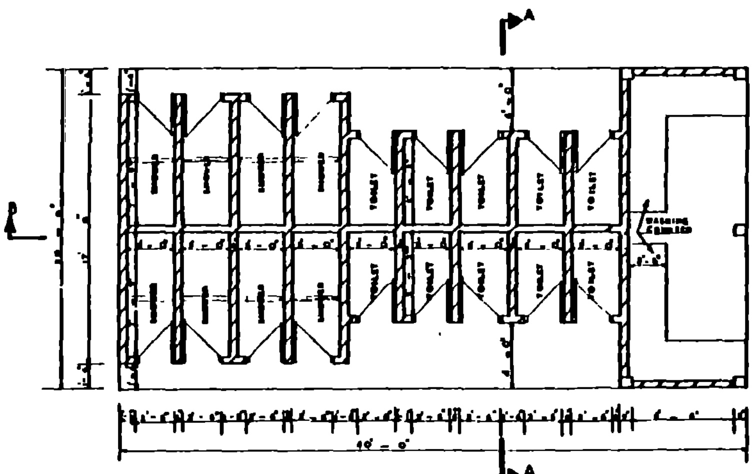
'COMFORT STATION' IBADAN NIGERIA



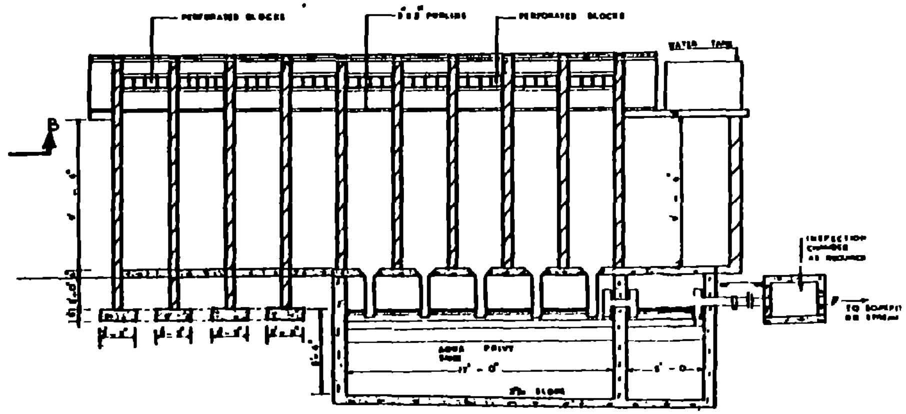
FRONT ELEVATION



SECTION A A



PLAN



SECTION B B

50a

(iii) The use of chamber pots instead of the station was admitted by 62 per cent of those interviewed (it is unclear from the source whether this applies to night or daytime use).

(iv) Preconstruction problems were related to mistrust of government officials due to previous experiences with taxation and public health inspectors. Fear of government appropriation of the land donated by families for the stations caused an unwillingness to donate land.

(v) Construction problems were caused by a shortage of free labour and building materials, and post-construction problems by high electricity and water bills, intermittent water and electricity supplies, and a high degree of dereliction through lack of maintenance.

The findings of the survey led to an education programme designed to improve the use of the Stations. The programme included committee meetings and general assemblies of extended families, informal group discussions, family visits, etc.

In the station with the best record of use and maintenance, it was found that a retired Public Works Department Officer had continued his educational function in a private capacity. a/

India

NOTICE

This public convenience is public property. It is our duty to abide by the rules and co-operate to keep it clean and beautiful.

RULES

- Service charge 5 paise.
- Users should take care of their articles. If they want to leave anything in our custody a charge of additional 2 paise is levied.
- Latrines are kept clean. In case it is not ask the caretaker to get it cleaned.
- Hand washing powder is supplied to clean hands.
- Use of clay is strictly prohibited.

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a/ In WHO/IRC Participation and Education in Community Water Supply and Sanitation Programmes - A Selected and Annotated Bibliography, Bulletin No. 13, July 1979.

- We do not take care of cycles, rickshaws or any other vehicle. One should keep these at their own risk. The management shall not be responsible for theft or loss.

- Persons having no money are allowed free.

- In case of complaints please refer the matter to the Secretary Sulabh Shauchalaya Sansthan Patna.

A visitor to Patna, the state capital of Bihar, would be struck by an attractive architectural motif which is repeated at all the prominent public places in the town. There is no mention in the tourist guide of these pale turquoise structures with their ornate oriental fascias separated from the rest of the facade by a striking orange dado stripe.

Mr. Bindeshwar Patak, Secretary of the Sulabh Shauchalaya Sansthan (Sanitary Latrine Society) has succeeded in building public latrines comprising 2,324 seats in Patna since he founded his voluntary organization in 1970. He joined the Gandhi Centenary Celebration Committee in 1969, working in the Bhangi Mukti (bucket-latrine conversion) section of the organization. He discovered that what people wanted was "concrete, result-oriented action and not mere sermons." His suggestion to the organization that they should actually undertake latrine conversion work was rejected so he resigned and set up his own agency.

After successfully converting a dry pit latrine in the home of an Advocate and City Counselor, the SSS convinced the Municipal Corporation to authorize the construction of public latrine at the Gandhi Maidan - "the dirtiest place in the town as hundreds of people used it as an open lavatory." The Corporation gave a 100 per cent grant and a site for it on public land. A 24-seat latrine was built. On this site there are now 48 seats, a public bath, a demonstration workshop, and the head offices of the SSS.

The latrines and baths provide round-the-clock service: they are located near railway stations, bus stops, markets, hospitals, offices and other busy places frequented by the city's pavement dwellers, rickshaw pullers and visitors from the countryside.

Each group of latrines has a supervisor who collects 10 paisa from each person who is entitled to use of the latrine, a handful of blue soap powder, and a bath. Those who bring their own soap pay only half price, and there is no charge for women, children, "poor people and beggars." The supervisors and cleaners work in eight-hour shifts and the payments are used for maintenance and to pay for bleaching powder, phenol, soap powder cans, brooms, etc. Approximately 6,000 people use the set of 48 latrines at the SSS headquarters each day. Daily income from 34 different locations in the city amount to Rs.Ñ1570 ($ 196), i.e., approximately Rs. 55,000 per month and Rs. 700,000 annually.

They consist of pour-flush mosaic bowls with an integral trap, set in a concrete squatting slab and discharging into alternating seepage pits. The channels, which are diverted to the next pit when its neighbour is full, are cement-rendered brickwork. They are covered but can easily be cleaned. The seepage tanks are covered with reinforced concrete slabs with lifting rings enabling easy removal by two people.

A visit to any one of these latrines between 5 and 7 p.m. on any day of the week leaves no doubt that they are well used. They are also maintained with almost military efficiency (Figure 30b).

Bangladesh: The war which gave the country its independence in 1971, combined with a series of natural disasters to create large refugee settlements in Dacca. In addition, squatters were relocated from the centre of the city to three large camps. The British voluntary organization, Oxfam, had developed a communal latrine unit for use in emergencies, and a number of these were installed in the camps near Dacca.

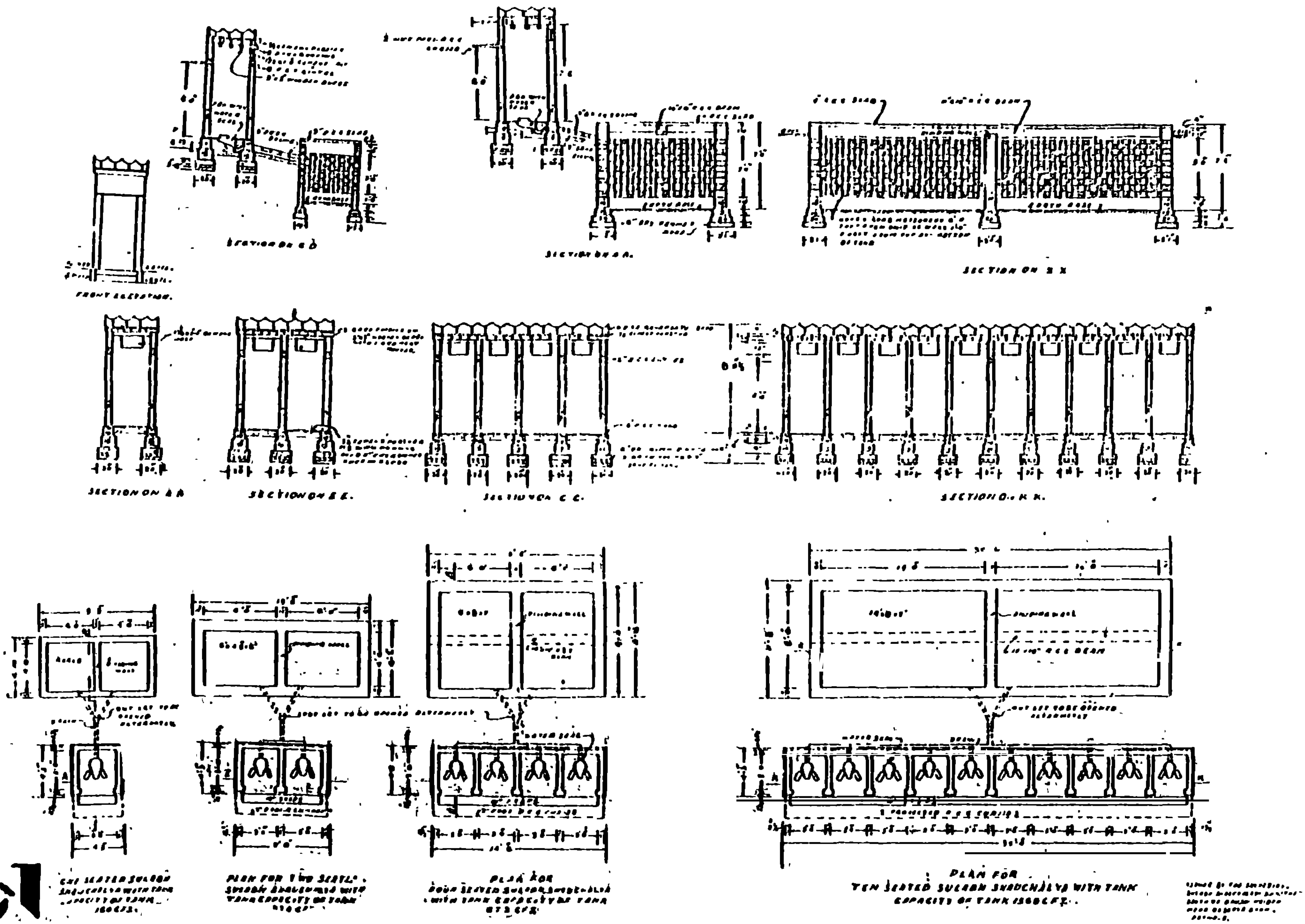
The latrine unit, which is assembled from the contents of a wooden crate measuring 2m x 2m x 1m and weighing approximately 500 kg., can be installed in a day and provide sanitation for 500 people. In 1975 each unit cost é1,350, with an estimated working life of 5 to 10 years. It consists of 20 glass-fibre squatting plates connected in series to two 21,000-litre flexible reinforced butyl rubber sedimentation tanks, which provide an 8-10 day retention time under anaerobic conditions. These tanks may in turn be connected to a percolating filter to further improve the effluent.

The squatting plates are connected by plastic pipes of the push-fit type which require no jointing nor special tools. A 20-litre flushing tank is located at the head of the parallel rows of latrines. Desludging of the rubber tanks is carried out by lowering the flexible sludge pipe over a trench or sludge pond next to the tank.

The advantages of this system are its transportability and easy assembly at any site where water is available. Although it is easier to maintain since the pipes and tanks are above ground, it does require more careful maintenance than most permanent community latrines and the tank compound must be protected.

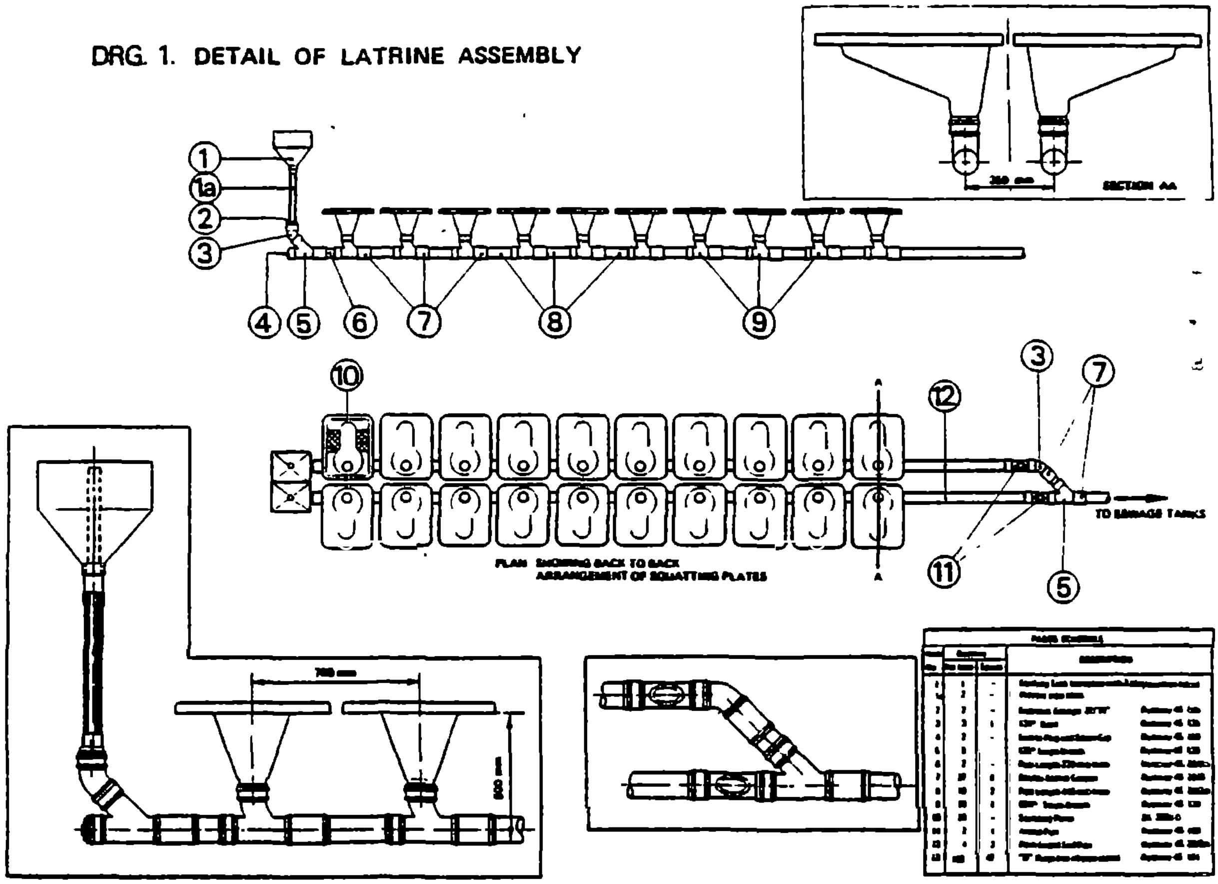
Oxfam has never claimed more than temporary use for these latrines, yet there may prove to be a wider application for them. The sanitation conditions of most refugee camps are not so different from many shanty towns, and, given the same publicity, they would easily qualify as disaster areas. Even if the maintenance of communal latrines is often initiated by private voluntary agencies, there is a good chance that the community will gradually assume more responsibility if the latrines are popular.

Oxfam has also developed a more permanent communal latrine which c n be built with local materials. The construction elements are designed as multiples of a single latrine and aquaprivy tank which can be built below or above ground (with steps constructed from the same elements) depending on site conditions (Figure 30c).

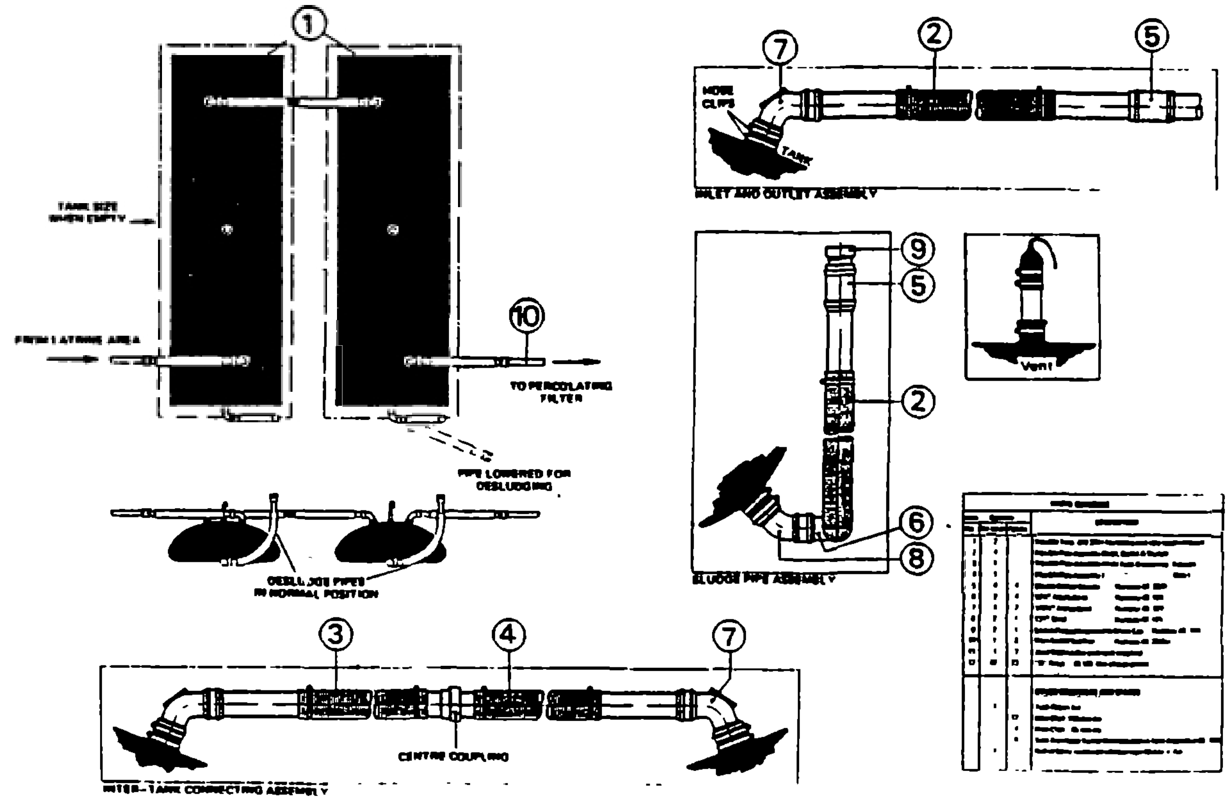


WATER SEALED 'POUR-FLUSH' LATRINES WITH LEACHING PITS
SULABH-SHAUCHALAYA SANSTHAN
BIHAR, INDIA

DRG. 1. DETAIL OF LATRINE ASSEMBLY



DRG. 2. DETAIL OF SEWAGE CONTAINMENT TANKS



Another interesting proposal for communal latrines has been made by Oxfam for Saidpur, a town of over 100,000 in the north of Bangladesh. The town has no underground drainage system and only five of the forty tons of excreta produced each day are actually collected for treatment. The rest are "dumped in open ditches or drains or are consumed by pigs, dogs or rats, or are just left to dry out and become the dust that is blown and trodden around the town." There is, however, a piped water system under construction, and the Bangladesh Railway is responsible for some aspects of the town's sanitation. The core of the town is built on land owned by the railway and this area is served by "railway drains." The collection and disposal of excreta and garbage and the maintenance of the drains are all effectively dealt with by railway employees.

Oxfam has proposed a sanitation project for the town council which includes the construction of public latrines at strategic locations, a system for the collection, removal and disposal of excreta; improved sullage and storm water drainage, and solid waste disposal.

Communal latrines at first-floor level would be discharged directly into the tank cars. The lower level of the buildings would be used for showers, laundry and washrooms.

The collection and disposal of human and solid wastes is based on the railway - and it is noted in the proposal that well-maintained railway communications and plant are common throughout the Indian subcontinent. At selected points along the railway loop lines could serve as loading stations. The excreta and refuse would be brought to these points in well-designed carts and transferred into railway tank cars (Figure 30d).

Haiti: Port-au-Prince accounts for 70 per cent of the country's urban population. Here public latrines are provided as a means of collecting local urine for export.

Japanese investors. Haitian doctors and the Rand Research and Development Corporation are collaborating in a production system to extract a clot-dissolving drug from urine. Prefabricated heavy aluminium pissoirs are manufactured in Miami at a cost of $US 3,500 and installed in schools, factories and the public market. Attendants collect the urine every six hours and send it to a local factory for crystallization and shipment to the United States, where it is processed to make Urokinase. For an estimated investment of $80,000, some 350,000-500,000 gallons of urine a year is expected to recover the capital costs in 3-5 years. a/

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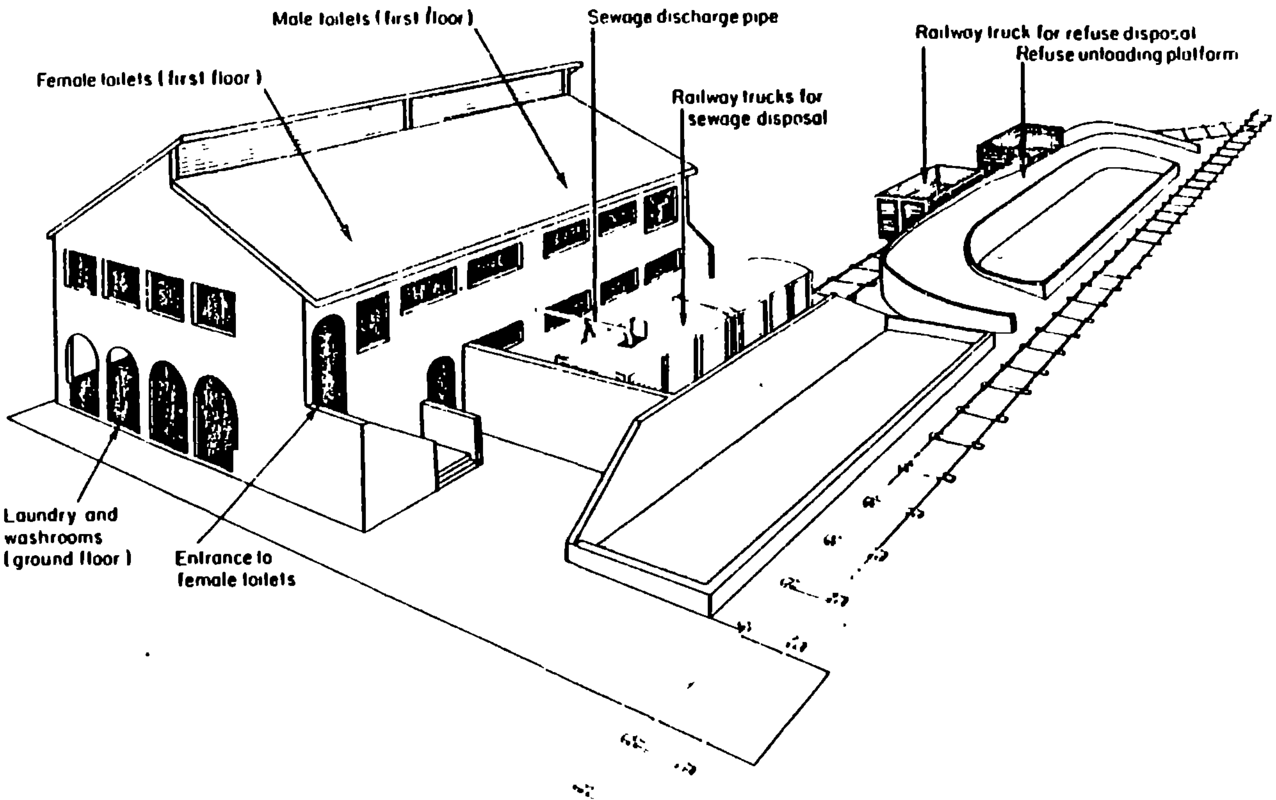
a/ World Bank, Socio-Cultural Aspects of Water Supply and Excreta Disposal, PU Report No. RES 15, September 1978.



g : Proposed public latrine facility for Saidpur, Bangladesh. The latrines are on the upstairs floor, and sewage is removed by means of the metre-gauge railway. The ground floor houses laundry and ablution facilities

(e) Considering the difficult site conditions of most central slums and the lack of sanitation in many shanty towns, communal latrines may still have to provide an intermediate solution until individual toilets become feasible. If poor maintenance is seen as the most common failure of communal latrines, the preceding examples show the organizational diversity of four apparently successful projects, i.e.:

Lagos	-	municipal construction and community maintenance; no charge to users.
Patna	-	construction and maintenance by local private organization; users charged.
Dacca	-	construction and maintenance paid for by foreign voluntary agency; no charge to users.
Port-au-Prince	-	multinational drug company finances construction and maintenance.

Technical Options: Suitability

Following is a general outline of the more important factors that will determine whether specific methods of excreta disposal will be suitable to a given situation:

(a) Water Supply: Systems which require water will depend for their effectiveness on the quantity of water which is readily available. Where water supply is inconvenient, intermittent or expensive, such systems will have to be more carefully considered.

(b) Organization: All waste disposal systems require a minimum amount of maintenance. The degree to which maintenance can be organized by a community will determine which options are feasible.

(c) Cost: Systems which require large amounts of capital should always be investigated to determine their potential translation into self-help labour-intensive systems. Where this is impossible, graduated improvements should be considered.

(d) User Density: Any system which is over-loaded will eventually break down. In high-density areas it is often advisable to plan for a series of graduated improvements which will reach as many people as possible as soon as possible.

(e) Cultural Factors: All systems depend on acceptability to the user for their effectiveness, and some will require specific user education.

(f) Soil and Climate Conditions: Systems which are not wholly contained require careful study to determine the potential effects on the environment.

(g) Land: Systems which require large land areas will have to be weighed against other possible land-use priorities.

(h) Ownership: The type of tenure which a community has or expects to have to a site will determine whether temporary or permanent improvements should be considered.

Technical Options: Cost Comparisons

Comparisons between alternative systems according to their potential cost to users will depend upon the particular circumstances involved, but certain very general statements in terms of absolute costs can be made. For example, a sewer system is more expensive to construct than are pit latrines, or systems which rely on mechanical collection and treatment will have greater recurring costs than those which employ on-site disposal and no treatment.

Other generalizations are less certain. The list below attempts to outline the more obvious factors which will affect costs and is followed by several tables from World Bank sources of cost comparisons for alternative systems (Tables E and F).

(a) Construction: Costs of construction will vary depending on the degree to which users can participate in construction, and the necessity of relying on purchased components.

(b) Maintenance: Costs will be determined by the need for specialized maintenance which cannot be supplied within the community, and the potential stress to which a system is likely to be subjected.

(c) Collection and Treatment: The equipment necessary to a system for collection and treatment, as well as the number and type of employees envisioned can vary the ongoing costs enormously.

(d) Financing: The degree to which outside financing is necessary for any one of the aspects of a waste disposal system can add to the overall cost of that system.

(e) Institutional Costs: Systems which are operated wholly or in part by a municipal authority, or depend upon water supplied by that authority may be subject to additional costs.

Systematic attempt to compare the costs of four low-cost sanitation systems was reported at a conference of the Institute of British Civil Engineers in 1977. The systems chosen were: full sewerage and water supply (FSW); sewered aqua-privies with standpipes or household water supply (AP); house vault and vacuum truck collection (VT); and community blocks connected to a sewerage system (CB). The analysis shows what families of different incomes living at four different population densities would have to pay for each system. Costs are broken down to show the proportion allocated to treatment, collection, plot installation and operation and maintenance. Not surprisingly, full sewerage and water supply (FSW) is most expensive

.../

	Mean TACH	On-site Costs	Collection Costs	Treatment Costs
Low Cost				
Pour-flush toilet	18.7	18.7	-	-
Pit privy	28.5	28.5	-	-
Communal toilet	34.0	34.0	-	-
Vacuum truck cartage	37.5	16.8	14.0	6.6
Low-cost septic tanks	51.6	51.6	-	-
Composting toilets	55.0	47.0	-	8.0
Bucket cartage 1/	64.9	32.9	26.0	6.0
Medium Cost				
Severed aquaprivy 1/	159.2	89.8	39.2	30.2
Aquaprivy	168.0	168.0	-	-
Japanese vacuum truck	187.7	128.0	34.0	26.0
High Cost				
Septic tanks	369.2	332.3	25.6	11.3
Sewerage	400.3	201.6	82.8	115.9

1/ To account for large differences in the number of users, per capita costs were used and scaled up by the cross-country average for six persons per household.

Financial Requirements for Investment and Recurrent Cost per Household
(1978 $)

	Total Investment Cost	Monthly Recurrent Cost	Hypothetical Total Monthly Cost 1/	Per cent of Income of Average Low Income Household 2/
Low Cost				
Pour-flush toilet	70.7	0.5	2.0	2
Pit Latrine	123.0	-	2.6	3
Communal facility 1/	355.2	0.9	8.3	9
Vacuum truck cartage	107.3	1.6	3.8	4
Low Cost septic tanks	204.5	0.9	5.2	6
Composting Latrine	397.7	0.4	8.7	10
Bucket cartage 1/	192.2	2.3	6.3	7
Medium Cost				
Sewered aquaprivy	570.4	2.9	10.0	11
Aquaprivy	1,100.4	0.5	14.2	16
Japanese cartage	709.9	5.0	13.8	15
High Cost				
Septic tanks	1,645.0	11.8	25.8	29
Sewerage (Design Population)	1,476.5	10.8	23.4	26

1/ Assuming investment cost is financed by loans at 8% over 5 years for the Low-Cost Systems, 10 years for the Medium-Cost Systems and 20 years for the High-Cost Systems.

2/ Assuming average annual income per capita of $180 and 6 persons per household.

Average Annual On-site, Collection, and Treatment Costs per Household
(1978 $)

WORLD BANK : WATER SUPPLY AND WASTE DISPOSAL
POVERTY AND BASIC NEEDS SERIES · SEPTEMBER 1980

Alternative Sanitation Technologies:
Financial Requirements for Investment and Recurrent Cost per Household
(1978 U.S. dollars)

Technology	*Total investment cost*[a] (1)	*Monthly investment cost*[b] (2)	*Monthly recurrent cost* (3)	*Monthly water cost* (4)	*Hypothetical total monthly cost*[b] (5)	*Percent of income of average low-income household*[c] (6)
Low-cost						
Pour-flush toilet	70	1.5	0.2	0.3	2.0	2
Pit latrine	125	2.6	—	—	2.6	3
Communal toilet[d]	355	7.4	0.3	0.6	8.3	9
Vacuum-truck cartage	105	2.2	1.6	—	3.8	4
Low-cost septic tanks	205	4.3	0.4	0.5	5.2	6
Composting toilet	400	8.3	0.4	—	8.7	10
Bucket cartage[d]	190	4.0	2.3	—	6.3	7
Medium-cost						
Sewered aquaprivy	570	7.1	2.0	0.9	10.0	11
Aquaprivy	1,100	13.7	0.3	0.2	14.2	16
Japanese vacuum-truck cartage	710	8.8	5.0	—	13.8	15
High-cost						
Septic tanks	1,645	14.0	5.9	5.9	25.8	29
Sewerage	1,480	12.6	5.1	5.7	23.4	26

[a] *Including household plumbing as well as all other on site and off site system costs.*

[b] *Assuming that investment cost is financed by loans at 8 percent over 5 years for the low-cost systems, 10 years for the medium cost systems and 20 years for the high-cost systems.*

[c] *Assuming average annual income per capita of $180 and 6 persons per household.*

[d] *Based on costs per capita scaled up to household costs to account for multiple household use in some of the case studies*

financially and economically. Sewered community blocks (CB) are the least expensive, while the costs of vaults and vacuum trucks (VT) and sewered aqua-privies (AP) are intermediate. a/

Solid Wastes (Refuse, Garbage)

Solid wastes are usually incinerated or used as landfill. The need to save and reuse waste material is usually better understood and more widely practised by poor people than by the municipal authorities responsible for waste disposal.

Types of recoverable and recyclable materials include paper, ferrous and non-ferrous metals, glass, and organic wastes. It is possible to transform all of these into such potentially useful products as building materials, and to make compost of most organic wastes. Automated recycling plants, which have been developed in Europe, North America and Japan, will undoubtedly be proposed for the developing world's growing cities.

Bearing in mind that a large proportion of the urban poor already derive an income from sorting and recycling waste, and that most squatter settlements are indeed built with waste products, it may be necessary to seek solutions which are more labour-intensive than the Western ones, but which also provide recycled materials at prices that the low-income population can afford.

Within squatter settlements, the problem of waste disposal can be improved in a number of ways, depending upon the level of community organization. Measures include improved access to allow municipal collection, better sorting procedures, improved collection, and the production of bio-gas and fertilizer from organic wastes.

The following examples describe municipal and community involvement in solid-waste disposal:

Shanghai: About 3,500 tons of domestic garbage are available daily from the city. This is collected by truck from fixed points and loaded into 40-50 ton capacity boats. The garbage is deposited with communes which produce compost.

In smaller cities the garbage is sometimes composted at treatment sites, and then sold to the communes. In Fu Shan, Guangdong Province, 60 T of garbage are treated at three sites in closed compost bins. The bins are closed and have ventilation holes at their bases. During fermentation (25 days) parasites are killed by the high temperatures attained in the process (70 degrees centigrade). b/

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a/ Hensen, J. A. and Therkelsen, H. Alternat've Waste Removal Systems for Urban Areas in Developing Countries, Technical University of Denmark, in Institute of British Civil Engineers Conference Papers, Session 12, No. 40, London, 1977.

b/ Source: FAO Soils Bulletin No. 40, 1970.

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Medellin, Colombia: a/ Some 550 tons of solid waste are dumped daily at Medellin's landfill. Empresses Varias, a semi-public company, is responsible for collecting and disposing of this waste which is composed of the following materials:

Organic matter	56 %
Metal	1
Glass	2
Paper	22
Plastic	5
Textiles	4
Miscellaneous	10

The relatively low quantity of non-organic matter which finds its way to the landfill is explained by ubiquitous recycling in the city. For the past 25 years scavengers have had the right to separate materials from wastes delivered to the landfill. The workers and their families, basuriegos, live in two shanty towns next to the landfill. There are four levels of recycling:

(a) Households and businesses accumulate such items as newspapers, bottles, cans, boxes and cloth, for sale to brokers or processors.

(b) Some 3,500 door-to-door buyers, carretelleros, scavenge waste from households and businesses. Materials are sorted, graded and delivered to purchasers by handcart. An average daily sorting of 200 kilograms of refuse might earn 195 pesos.

(c) Empresses Varias' employees earn up to 90 pesos a day by selling pre-sorted refuse to purchasers en route to the dump. This is against the company's regulations but goes unseen and unpunished.

(d) Basuriegos work at the landfill. There are sub-levels of activity, where compradores, small middlemen, purchase sorted materials. Aggregated materials are then resold to buyers in town.

Cairo, UAR: One part of a proposed World Bank project is aimed at introducing low-cost intermediate waste disposal systems, and improving waste collection, particularly in low-income areas, by expanding the role of small private contractors. b/

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a/ (Report to the World Bank), Solid Waste Collection and Disposal Project for the Metropolitan Area of Medellin, Colombia, Neil Seldman and Francisco Ospina, June 1979. Institute for Local Self-Reliance, Washington, D.C.

b/ In Urban Examples, No. UE-1, February 1979, UNICEF, New York.

APPENDIX A

The International Drinking Water Supply and Sanitation Decade: 1981-1990

Estimates of the number of urban families lacking adequate and safe water supplies are widely varied. The WHO figures show that 25 per cent of those living in Latin America and the Caribbean lack access to safe water, whereas the Pan American Health Organization suggests that 63 per cent are without safe water (Table G). Another set of figures suggests that 80 per cent of the population of that region are served either by house connexions or standpipes (Table H).

One reason for the discrepancies between estimates may be differences in the criteria on which these figures are based. If having "access to a safe water supply" includes everyone who has water available to them at some time during the day --whether the supply is intermittent or continuous-- a greater number of people will be included in the overall percentages than if only those who have water available to them for more than three hours a day, or more than six hours a day are counted. Additionally, figures may be based on different estimates of quality, depending on how "safe" water is defined.

A third problem arises when attempts are made to compare percentages of population served with tables showing increases in the number of house connexions or public standpipes in an area. The effect of a dramatic increase in the number of piped water connexions is quickly reduced by an even greater increase in population over the same period. Similarly, the number of services which are breaking down each year is in constant competition with the number of new services under construction. The need both for new services and maintenance and upgrading of existing services is not confined to the poorest peoples of the world; they are simply the least likely to obtain it.

The World Bank estimates that about 50 per cent of urban water is consumed by large industrial consumers, some 30 per cent goes to middle and upper-income customers, and the remaining 20 per cent to the low-income groups, with the poorest using least of all from the public system. More meaningful indications are given in specific slum and shanty areas. In three unplanned areas in Khartoum, separate communities of 39,500, 28,000 and 65,000 people are without direct access to water. a/

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a/ "Although the urban poor do have some access to water through organized vendors, this service is considered inadequate (e.g., high cost of water, exclusive reliance on commercial vendors, irregular distribution, unhygienic method of transport, etc.)." Jim Antoniou, Sudan-Water Supply Project. Urban Poverty Review, Khartoum and El Obeid, Consultant's Report to Urban Projects Department, East Africa Water Supply Dept., October 1979.

ESTIMATES OF URBAN POOR TARGET POPULATIONS AND THOSE LACKING ACCESS TO BASIC REQUIREMENTS IN 1975

Region 1/	Total Urban Population (million) 2/	Below Country-Specific Urban Poor Target Income 3/ (million)	(%)	Safe Water 4/ (million)	(%)	Public or Private Sewerage Systems 4/ (million)	(%)
Eastern Africa	20.7	5.3	(25)	7.8	(39)	11.6	(57)
Western Africa	24.4	6.7	(27)	8.6	(34)	12.8	(53)
EMENA	78.8 5/	15.7 5/	(20)	-	-	-	-
	110.0	-	-	16.2	(15)	19.2	(17)
Latin America	(184.3) 6/	-	-	(118.7) 6/		(108.2) 6/	
and Caribbean	186.5	46.8	(25)	47.0	(25)	68.5	(37)
East Asia and Pacific	69.1	21.4	(31)	30.9	(45)	24.5	(35)
South Asia	167.8	85.6	(51)	78.9	(47)	45.7	(27)
TOTALS	547.3 5/	181.5 5/	(33)	-	-	-	-
	578.0	-	-	189.5	(33)	182.3	(32)

1/ World Bank operating regions.
2/ From U.N. population statistics, and staff estimates.
3/ From staff estimates (see Bank Memorandum of May 17, 1977, Updated Poverty Income Levels).
4/ WHO estimates.
5/ Not including Europe.
6/ Alternate estimates from P.A.H.O., Director's Annual Report, 1975.

ESTIMATED URBAN WATER SUPPLY SERVICES IN SELECTED COUNTRIES
1962-1970-1975

Estimated Urban Population in Millions

	1962 (75 countries)						1970 (91 countries)							1975 (71 countries)					
Region[1/]	Total	Served By House Connections		Served By Public Standpipes		% Total Served	Total	Served By House Connections		Served By Public Standpipes		% Total Served	% Intermittent	Served By House Connections		Served By Public Standpipes		% Total Served	% Change 70-75
		no.	%	no.	%			no.	%	no.	%			no.	%	no.	%		
Africa South of the Sahara	17	2	12	7	38	50	31	9	29	11	38	67	27	8	33	7	34	65	- 2
Latin America and the Caribbean	98	59	60	26	27	86	155	91	59	26	17	76	23	121	67	25	14	81	+ 5
West Asia and North-east Africa	40	17	44	11	28	71	65	37	60	16	26	86	34	30	52	16	28	80	+ 1
Algeria, Morocco, and Turkey	16	6	35	6	39	74	25	12	50	5	22	73	22	17	67	3	14	81	+13
Southeast Asia	108	13	12	20	19	31	158	56	36	26	17	53	91	88	47	39	21	68	+18
East Asia and Western Pacific	26	4	16	9	34	49	38	23	65	4	10	75	49	30	75	6	16	91	+15
TOTAL	305	101	33	79	26	59	472	220	50	88	19	69	54	294	57	96	18	75	+ 8

1/ WHO Administrative Regions.

Sources: C. S. Pineo & D. V. Subrahmanyam, Community Water Supply and Excreta Disposal Situation in the Developing Countries, Geneva: WHO, 1975, Annex 2, p. 36.

World Health Organization, World Health Statistics Report, Vol. 26, No. 11, 1973, Table 3.

World Health Organization, World Health Statistics Report: Water and Sanitation, Vol. 29, No. 10, 1976, Table on Comparison of Services, 1970 and 1975.

In March 1978, the United Nations Water Conference adopted a target resolution to provide clean water and sanitation for everyone by the year 1990. The number of people (in millions) who would need to be serviced by 1990 in order to meet the goals of the Water and Sanitation Decade have been estimated as follows: a/

	Water	Sanitation
Urban	640	650
Rural	1570	1570
Total	2210	2320

It is further estimated that there are approximately 250 million people who have access to services which are badly in need of rehabilitation.

In a two-year research study of appropriate technology for water supply and sanitation directed by the World Bank, a consultant comments that attainment of the Decade target would require "either heroic acceleration of current activities or the adoption of new strategies". b/

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a/ Ed. David Howell Jones, Water Supply and Waste Disposal, Poverty and Basic Needs Series, Sept. 1980 Transportation, Water and Telecommunications Dept., World Bank.

b/ Energy, Water and Telecommunication Department, World Bank, Appropriate Technology for Water Supply and Waste Disposal in Developing Countries, Washington, 1976-1978. The study investigates alternatives to water-borne sewage disposal and assesses the public health and social objectives of improved water supply and sanitation. It also reviews the technical, economic, environmental and institutional constraints of the various alternatives. Included in the seven-volume study is an annotated bibliography of low-cost sanitation options prepared from over 20,000 references and 1,200 documents by the International Development Research Centre (IDRC, Ottawa, Canada). This information will be updated by an International Rural Sanitation Centre at the Asian Institute of Technology, Bangkok. The IBRD study also includes a description of existing sanitation conditions and practices in the cities of eleven countries (Japan, Korea, Taiwan, Indonesia, Malaysia, Sudan, Nigeria, Ghana, Zambia, Colombia and Nicaragua), and a review of soico-cultural aspects of water supply and excreta disposal based on eight case studies in Latin America. The health aspects of excreta and wastewater management are covered in a detailed section of the study. Much of this research will be published in three volumes by the Johns Hopkins University Press in 1981. These and the ongoing series of reports resulting from the original research are listed in the Bibliography, below.

Since the declaration of the Decade, a Steering Committee for Co-operative Action has been established, which is chaired by UNDP. Members include UNICEF, UNESCO, WHO, FAO, ILO, the World Bank and the UN. Some of the co-operative ventures which have been initiated in pursuit of the goals of the Decade are:

WHO/World Bank Co-operative Programme: Sector studies, as well as rapid assessment studies have been prepared for water supply and sanitation, funded by the Bank and carried out through the offices of WHO.

WHO/UNDP (with bilateral assistance from the FDR and Sweden): Three interregional projects covering 36 developing countries are proposed to prepare plans for water supply and sanitation. Assistance is also being given in the identification of priorities within each country.

UNDP/World Bank Inter-regional Project on Low-Cost Water Supply and Sanitation: Assistance is being given to governments and other agencies in their efforts to develop low-cost water and sanitation projects.

UNDP GLO/78/006: Low Cost Water Supply and Sanitation Project: UNDP is attempting to assist developing countries in designing and implementing low-cost projects which are "responsible to communities' needs, affordable, and widely replicable." UNDP is also giving assistance to countries in the identification of potential financial sources for the implementation of water and sanitation projects. The project is being executed through the World Bank's Water and Wastes Department by a Technical Advisory Group (TAG). a/

The Sector digests, which have been prepared as part of the WHO-World Bank Co-operative Programme, provide a "review at a glance" of the actions needed to meet the goals of the Decade and the potential for external co-operation. A review of these digests suggests three categories of country:

(a) Those with a high absorptive capacity and programme capabilities but with a major constraint in funding: e.g. Western Pacific, South-East Asia and American regions of WHO.

(b) Countries with adequate financial resources but with deficiencies in programme capabilities: e.g. most of the oil-rich countries.

(c) Countries with low socio-economic development, which also lack resources for programme planning and implementation.

At a recent conference held to discuss strategies for the Decade, two points were noted with reference to the third category listed by WHO:

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a/ Sources of technical and Financial Assistance in the Field of Drinking Water Supply and Sanitation, WHO document prepared for the second consultative meeting for co-operative action for the International Drinking Water and Sanitation Decade.

.../

These conditions produce a relatively high per capita cost of coverage. The choice of "tailor made" projects for short-term implementation may be limited. The preparatory period 1979/80 may demand external co-operation for assistance in status studies (planning, programming and infrastructure) before projects can be processed for implementation. Manpower and management development would claim special attention.

It is imperative, therefore, that when external co-operation is provided to supplement national resources, the projects and studies for which it is sought must be seen to be necessary by the national authority, based on political decision and policy commitment. a/

Recognizing that one of the areas which needs further attention in all development projects is the capacity and capability of national governments to plan, implement, repay and maintain development, the World Bank, along with many other bilateral agencies, has emphasized the need for including these aspects in future projects. Specifically, the Bank lists three priorities of planning new water and sanitation programmes, institution building on a national level, training of qualified personnel on all levels, and dissemination of information on low-cost technologies to aid governments in making policy decisions.

In addition to the question of how well governments in the developing countries are prepared to absorb aid and implement water and sanitation projects is the question of where the money necessary to finance achievement of the Decade target will come from.

The amount of money devoted to water and sanitation projects by international agencies has increased dramatically in the last 20 years as the seriousness of the problem has become more and more apparent, but the problem itself has meanwhile grown so rapidly as to defy efforts to reduce it. World Bank figures show a jump from $24 million for water and sanitation projects for the period 1962-70 to $3000 million for 1970-79, with fully 75 per cent of that money being committed within the last five years. Similar figures are available for other agencies. b/ Table I shows a breakdown of the estimated $2.4 billion spent in 1979 on water and sanitation programmes in the developing countries. Even accounting for an unusually high allocation of $900 million committed by the World Bank for that year, the table makes clear where most of the money that can be expected over the next ten years is likely to come from.

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a/ WHO Inter-Regional Workshop on Strategies for the International Drinking Water Supply and Sanitation Decade - Nairobi, Kenya, 1979. EHE/WSD/WP/79.1.

b/ Sources of Technical and Financial Assistance in the Field of Drinking Water Supply and Sanitation, op. cit

	WATER			SANITATION		
United Nations Region	urban	rural	total	urban	rural	total
Asia and the Pacific (ESCAP: west to Iran)	203	925	1128	355	1136	1491
Latin America (ECLA: incl. Caribbean)	108	110	218	212	120	332
Africa (ECA: incl. N. Africa)	104	310	414	130	342	472
West Asia (ECWA: Arab world excl. Africa)	16	22	38	20	25	45
Europe (ECE: e.g. Cyprus, Portugal)	14	21	35	30	30	60
World Totals	445	1388	1833	747	1653	2400

Table Number of people in developing countries (in millions) to be reached with water and sanitation by 1990 if the Decade's 100% targets are to be achieved. (WHO figures based on data supplied by Governments)

United Agencies (mainly UNDP and UNICEF)		6%
World Bank		43%
Regional Banks (Asian, African and Inter-American)		17%
OPEC Agencies		7%
Bilateral Assistance (Western countries)		23%
Federal Republic of Germany	26%	
United States	25%	
Sweden, Canada, United Kingdom and Australia	24%	
Other donors (incl. Japan)	25%	
Voluntary Agencies		4%
TOTAL INTERNATIONAL ASSISTANCE		100%

Table Percentage breakdown of International Aid to Water and Sanitation for 1979 (Estimated at $2.4 billion and representing 35-40% of total aid to water and sanitation)

Source of both tables: World Water, Vol. 3, No. 11, London, November 1980

The cost of attaining adequate water and sanitation levels world-wide has been variously estimated at figures ranging from $200 to $500 billion, depending on levels of service envisioned and the feasibility of employing alternative technologies. This would represent on average an increase from the current $7-8 billion being spent in these areas to roughly $30 billion per year. With the World Bank expecting to increase <u>its</u> yearly average of $300 million (1974-78) to $700 million (1979-83) this leaves an incredible gap between projected costs and expected finance which is hardly likely to be made up by other institutions.

Indeed, revised expectations in the face of actual assessments by the WHO/World Bank Co-operative Programme of both global demand and implementation costs indicate that a doubling of current spending (which is the most optimistic level of commitment envisaged) and the combined efforts of international agencies and national government may just be able to hold the number of people <u>without</u> service to the 1975 levels of 1,500 million people.

Thus, the possibility of effecting real change in the number of people who have access to adequate services will have to come from a reassessment of the roles of Governments, professionals, the community, and a revision of policies, regulations and standards.

APPENDIX B

Historical Sketch of Bilateral and International Intervention in Urban Water and Sanitation Services Since 1900

Present water and sanitation conditions in any city can be thought of as an accumulation of decisions taken or avoided at different times in its history. Each of these decisions will have had an effect on the spatial distribution of services.

The part which western engineering techniques have played in establishing water and sanitation services in the developing world depends largely on the colonial history of each country and city and upon the demands made at different times by the expatriate community living in them. Until very recently, the poorer sections of cities have been inadequately served and shanty towns have been all but ignored.

The following is a generalized chronological sketch which suggests the changing direction of bilateral and multilateral intervention in the field of water and sanitation during this century:

c. 1900-1930 As the population and density of cities increased, western engineering techniques were used to improve water supplies and sanitation in an ad hoc manner, often in response to cholera and typhoid epidemics.

c. 1930-1950 Engineering consultants and contractors were employed on a bilateral basis to expand systems. Treated water supplies from central water authorities and conventional sewerage were provided in the central areas of some cities in some countries.

c. 1950-1975a/ United Nations WHO assistance was provided to extend and improve urban water-supply and sewerage systems. Established National agencies for the operation of water supply and sewerage were International consultants who were employed to prepare "Water and Sewerage Master Plans." Slums were typically excluded from these plans on the assumption that they would be removed, along with shanty towns.

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a/ C.S. Pineo and D.V. Subrahmanyan, Community Water Supply and Excreta Disposal Situation in the Developing Countries, Geneva, WHO, 1975.

An analysis of technical assistance in providing community water supply between 1966 and 1970 indicated that almost 50 per cent went to Latin American countries and only 2 per cent went to South-East Asia during the same period. It was noted that the majority of water-supply system managers in the Latin American region were construction-oriented engineers, who tended to attract investment funds for construction but who did not emphasize the fiscal or other management aspects of water supply.

1970-1980 Bilateral, WHO, and IBRD sectoral financing of urban water and sewerage projects continued during this period. IBRD Urban Projects began to include sites-and-service projects and later, squatter upgrading. a/ Bilateral assistance and regional bank financing followed suit.

1977 The UNDP "International Drinking Water Supply and Sanitation Decade" was proposed (See Appendix A, page). The IBRD produced a major report, "Appropriate Technology for Water Supply and Water Disposal in Developing Countries," following a research project of the Energy, Water and Telecommunications Department 76-78, and established the Technical Advisory Group with UNDP funding. b/ The WHO began to change its emphasis from urban to rural projects.

1960-1980 An apparent shift was made in the policy of some governments away from slum and shanty-town clearance, especially where individual areas were politically and physically difficult to move and where external funds were available for improvements, e.g., IBRD projects in Manila-Tondo; Calcutta; Jakarta. c/

The role of governments and international agencies in water and sanitation projects is treated in more detail in Chapter 2.

Before indicating some of the common characteristics of slums and shanty towns, a sketch of typical sections of cities, together with their likely levels of sanitation service, are given:

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a/ Prior to 1979, IBRD Urban Projects (sites-and-services) emphasized individual water supply and water-borne sewerage. (Sites-and-service projects had been successfully carried out by colonial governments in the 1920s, e.g., Casablanca, Morocco and Nairobi, Kenya.)

b/ Technical Advisory Group experts, including engineers and social scientists, have assisted in planning and executing water and sanitation projects.

c/ There are many examples of continued shanty-town clearance in cities where foreign-funded improvement projects are under way in different parts of the same cities.

.../

The likely levels of water and sanitation service in typical sections of a hypothetical city in a developing country might be as follows:

(a) Indigenous city cores, or small towns built of local materials where residential and commercial activities take place side by side at fairly high densities. Some such areas are often described as slums. They often employ the traditional methods of water supply and sanitation, e.g., wells, springs, underground reservoirs and channels; seepage pits, vaults, and nightsoil removal.

(b) Colonial settlements added to older centres, or built as new towns, to accomodate a small expatriate business and administrative community, and selected indigenous employees. They are usually served by modified versions of western water and sanitation systems.

(c) More recent authorized residential areas are usually built at higher densities in the city's centre than at the periphery. They may be connected to sewerage systems or have independent household sanitation systems (septic tanks) where density permits. Treated water is supplied from piped mains in most cases.

(d) Separate commercial and industrial sections which typically require extensive water supply and sanitation systems of cities are usually served by mains-water and sewerage. Shanty towns are frequently built nearby to make use of these services.

(e) Recent unauthorized shanty towns are normally built in a makeshift fashion on inaccessible or peripheral land, both in and around cities. Depending on subsequent development, shanty towns may have connexions to city water supplies; but at the outset water usually comes from springs, rivers or wells, and sanitation is rarely organized.

(f) Temporary resettlement camps, which may be authorized but are often unplanned, may be set up as a result of natural disasters, slum clearance, or large influxes of refugees. These temporary camps often become permanent but fail to qualify for normal municipal water and sanitation services.

WATER AND SANITATION IN SLUMS AND SHANTY TOWNS

Bibliography - Part A

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1. Listed above are books considered to be essential background reading. Many other documents and seminar papers are referred to in the report as footnotes.

2. Bibliography - Part B is attached as an Annexure since it is a printed bibliography by the World Bank of their publications on water supply and sanitation. These are also considered to be essential background reading.