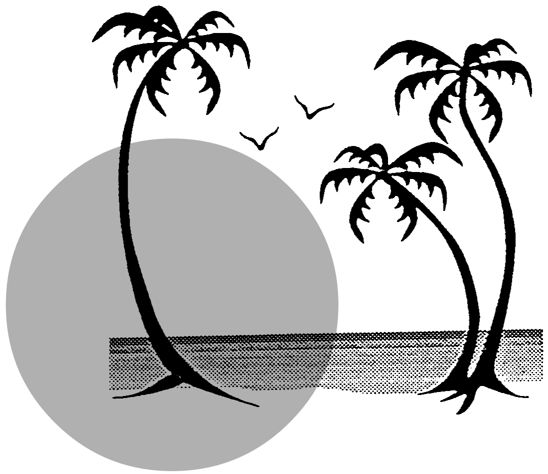
SANITATION

for small islands



Guidelines for Selection and Development

Derrick Depledge

Compiler

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Compiled by

Derrick Depledge

Published by the

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in conjunction with the United Nations Development Programme
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SOPAC A PROFILE

SOUTH PACIFIC APPLIED GEOSCIENCE COMMISSION

SOPAC is a Pacific, regional, intergovernmental organisation with 17 member countries. SOPAC assists its island member countries with the sustainable development of their physical environment and non-living resources through the application of geoscience, giving members access to modern equipment, an extensive database and experienced marine scientists.

Activities: SOPAC's annual work program is dependent on members' requests, funding and the expertise available to the Secretariat at the time. The range of activities includes: studies of geological processes and hazards; resource studies for environmental management and coastal development; assessment of indigenous energy and mineral potential; coastal and seabed mapping; water resource and sanitation and training in geosciences. These are incorporated under SOPAC's four major programs: Resource Development, Environmental Geoscience, National Capacity Development and Corporate Services.

Publications: SOPAC News (newsletter); range of technical reports for member countries; proceedings of the annual meeting, SOPAC Projects (non technical summaries of work), and others. For more information contact

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TABLE OF CONTENTS

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1. INTRODUCTION

Although this paper was prepared for use in small islands, it provides a useful introduction to issues and options applicable in many other situations.

One of the basic facts of life is that all people need to get rid of waste matter every day. The technical term for this waste is excreta, which consists of faeces, (solid matter), and urine, (liquid matter). See page xx for other technical terms used in this booklet.

This booklet has been prepared to give some background and provide some guidelines on sanitary ways of dealing with excreta in the small islands of the Pacific. It is aimed at helping both those considering providing and those considering upgrading their sanitation facilities.

1.1 WHAT IS SANITATION?

Dictionaries regard sanitation as a general word for the protection and improvement of health.

For example:

Protection of health by maintenance of sanitary conditions (**Webster**).

The improving of public health especially by efficient drainage and disposal of sewage (**Nelson Contemporary English Dictionary**).

Improvement of conditions aimed at helping, (or not impeding) the protection of health against dirt and infection (**Oxford Pocket Dictionary**).

In more practical terms sanitation has been defined as:-

The means of collecting and disposing of excreta and community liquid waste in a hygienic way so as not to endanger the health of individuals or the community as a whole (Franceys et al, 1992).

1.2 WHY DO WE NEED SANITATION?

Health Aspects

As the dictionaries point out sanitation and health are closely intertwined.

A lack of good sanitation and hygienic behaviour puts all people at risk of diseases and epidemics , and is a cost to all society, both rich and poor. Sanitation is the first barrier against diseases associated with human waste. A sanitary environment is a human right and necessary for human dignity.

Good sanitation must, therefore provide a barrier to the transmission of disease, either by destroying pathogens, or effectively isolating them from human contact.

If the disposal of human faeces and urine in a community is insanitary and inadequate to protect health, then the sanitation facilities need to be improved.

If the sanitation facilities are inadequate:-

- humans, rodents and other animals can spread disease by spreading faeces
- flies can breed freely on the faeces and transmit diseases, and
- the ground and water supplies will be contaminated.

Pathogens

Most diseases are caused by a PATHOGEN, a biological agent. There are four types of pathogen:-

1. eggs of helminths (worms)

Examples of worm infections	*organisms*
ascariasis, (roundworm)	Ascaris lumbricoides
trichuriasis, (whipworm)	Trichuris trichiura

2. protozoa

Examples of protozoal diseases	*organisms*
amoebic dysentery	Entamoeba histolytica
giardiasis	Giardia lamblia

3. bacteria

Examples of bacterial diseases	*organisms*
Cholera	Vibrio cholerae
Typhoid fever	Salmonella typhi
Paratyphoid fever	Salmonella paratyphi
Bacillary dysentery	Shigella
Diarrhoeal disease	E coli, Salmonella, Campylobacter spp

The median infectious dose for bacteria is typically 10 000 or more. Bacteria are able to multiply outside their host.

Faecal material can contain as many as 1 000 000 000 bacteria/gram in the excreta of an infected individual.

4. viruses

Examples of Viral Diseases	*organism*
Infectious hepatitis	hepatitis A
Poliomyelitis	poliovirus
Diarrhoeal diseases	rotavirus and others

Viruses are transmitted as inert particles that are unable to replicate outside a living host. These particles, or virons, have the ability to cause disease in people who ingest them with drinking water or contaminated food. Over 100 types of viruses have been isolated from faecal material. Viral particles lose their infectivity with time. The length of time varies with viral types. Routes of viruses include through the ground into the water table, and via contaminated food, fingers and flies. Excreted viruses have low infectious doses (<100).

Faecal material can contain 1,000,000 viruses/gram in the excreta of an infected individual.

Shigellosis, Hepatitis A and Typhoid are more likely to outbreak in untreated groundwater systems than surface water systems. Whereas giardiasis, viral gastroenteritis, salmonellosis and chemical poisoning are more likely to occur in surface water systems, (Canter et al, 1988).

Many of the climatic and lithological features of tropical sand and coral islands, create conditions which favour the extended survival and subsurface transport of enteric bacteria and viruses. An exception is the prevalence of high temperatures which accelerate the attenuation of these microorganisms in the subsurface, (Dillon, 1996).

Nitrogen

In addition to pathogens, excreta produces a number of chemical substances which can find their way into the natural environment. From a health point of view the most serious of these is Nitrogen, N, which may cause a condition known as blue baby syndrome, if water with high Nitrate-content is ingested by young bottle fed babies.

It has been estimated that each person produces about 8 kg of nitrogen each year in excreta, which can contribute significantly to high levels in natural water systems. The limit recommended by the World Health Organisation, (WHO), is 10 mg/l nitrate-nitrogen for water used for drinking.

Environmental Aspects

Coastal Water Resources

Globally, land-based pollutants contribute 75% or more of all pollutants entering the oceans.

Sewage is one of the most significant source of marine pollution in the Pacific region. On the smaller islands, the source is raw or partially treated sewerage flowing from latrines and privies, and water seal toilets.

For the larger population areas the conventional approach to sanitation is to install a “proper disposal system”, that is to use water to carry excreta out of sight. Even if the effluent is treated this simply results in the problem shifting from one place to another, often to the ocean or lagoon.

Critical environmental problems which can occur are the development of algal blooms, eutrophication in lagoons and dying reefs.

Freshwater Resources

On coral and other small islands, and in coastal areas of larger islands contamination by sewage can impair the beneficial uses of freshwater resources, including the ecosystems which are supported by such surface or ground water.

In particular, where population densities are high there is a risk to the natural water systems of microbiological and nitrate and other nutrient contamination, which can have a serious and recurrent effect on local communities.

The Resource Value of Human Excreta

The idea of excreta as a resource rather than a waste needs to be promoted in the Pacific region. Human excreta contains nutrients, and is therefore potentially a product of value. Composting toilets, which are described later in this booklet, provide a technology which converts human excreta into a useful product, and at the same time eliminates any discharge into the natural water system as well as the need of water to carry excreta away.

1.3 WHAT ARE THE PARTICULAR PROBLEMS OF SMALL ISLANDS?

Atolls and small island nations have unique needs in terms of sanitation. Some of the specific problems relate to:-

- small land area
- fragile ground water systems
- increasing population density
- lack of income to pay for improvements

It is necessary first of all to define “small” as applied to an island. Some very small islands, or cays, can be less than 200 m in diameter or width, with little vegetation, probably no ground water, and generally without a population.

Small islands up to 2000 km^2 may be of low elevation, with shallow ground water and population densities varying from very low to very high.

Where the population is small there may be no need for any upgrading of sanitary arrangements. Traditional defecation practices such as using identified areas of bush or beach may be sufficient to ensure reasonable protection of health from communicable diseases. But populations are generally increasing in the Pacific and with this increase, the risk to health from inadequate sanitation is also increasing. This is particularly noticeable in the small atoll nations where urban drift has led to high population concentrations in such places as Funafuti in Tuvalu, South Tarawa in Kiribati, and Majuro and Ebeye in the Marshall Islands.

Where the groundwater table is shallow, bacteriological and chemical quality quickly deteriorates as a result of poor excreta disposal in areas of population concentration such as villages. Lifuka in the Ha'apai Group of Tonga is an example of this contamination of ground water resources, (Furness,1996).

On higher islands, perhaps raised atolls such as Niue, the ground water is at less risk because of the filtration capacity of the soil through which effluent from sanitary facilities has to pass.

Many small islands have enclosed or partly enclosed lagoons in which the residence time of the water is quite long. These lagoons receive effluent via runoff or from groundwater seepage and can deteriorate in quality rapidly.

Another major problem, particularly for the more remote islands, is that many people exist at the subsistence level and can contribute little to financing sanitation.

2. THE NEED TO COMMUNICATE

A successful, sustainable sanitation system needs to be :-

- acceptable to the users,
- affordable for most people, and
- technically adequate.

It requires an open ***dialogue*** between those wanting or needing the sanitation facility and those who are able to advise on and assist with the provision of such facilities.

To get the right balance between what is affordable, acceptable and adequate will need a lot of two-way communication. The better this co-operative approach progresses the better the result will be in terms of a sustainable sanitation development.

2.1 INVOLVING THE COMMUNITY

If improved sanitation is to be acceptable, it is essential to involve the community.

The community should be involved in the choice, construction, operation and maintenance of any sanitation facility. People must be consulted about their preferences.

They might need to be persuaded that sanitation improvements are needed, (see section 2.2 Health, Hygiene and Sanitation Promotion).

Assistance in strengthening local capabilities for financial control and project management may be required.

Training of health workers and community health education sessions is best carried out in the village or town setting of the project where there are opportunities to relate to real life local situations.

Health education workers, preferably selected from the local community, should be carefully chosen for their humility, commitment, sensitivity and self confidence. They will need appropriate training, not only the technical aspects of health and sanitation, but also in the various methods of communication.

Community leaders have an important role to ensure successful community participation by encouraging people to come to meetings, arranging meeting places and interpreting information.

A Project Management Committee needs to be established. It should be representative of all groups within the community, particularly women but also including youth, church, village elders, local council, and teachers etc.,

Information should be obtained from the community on their priority wants and needs.

Participatory learning processes using simple language and practical demonstrations is necessary for people to understand the need for change.

Communities should be informed of the various sanitation options and given the opportunity to choose for themselves.

Monitoring and evaluation of the project, including the effectiveness of health education training is essential. Monitoring and evaluation should be done jointly with the community, the Project Management Committee and the agency promoting the programme. It may be desirable to establish indicators to measure effectiveness as the project progresses.

Appropriate compensation or remuneration for community health workers and others involved in the project should be arranged where possible.

If improved sanitation is to be introduced it must be affordable. Affordability should result in the best option for the money available. The agreed sanitation option must be affordable to the majority of the local population, to those who are the target beneficiaries, and should be based on the income of the poorer section of a community. Payments should not exceed 1-3% of the annual household income.

All financial resources should be looked at - local, government and external.

Things to consider

The ideal sanitary facility for a small island may be too expensive, therefore there will be a need to compromise.

Financial input, however small, by the house-owners or villagers, is essential if the facility is to be maintained in good condition. The chosen design must improve the present position, and must be reproducible on a large scale.

The chosen design should be able to be upgraded when more finance becomes available.

A range of options may be necessary for people with varying needs and financial resources.

Promotional costs, educational costs should be incorporated in the total project costs.

Projects should be flexible enough to allow households to invest in on-site sanitation when they feel motivated and when they have the financial resources.

2.2 HEALTH, HYGIENE AND SANITATION PROMOTION

When people start living close together in villages or urban areas the need for sanitation increases if health problems are to be avoided.

People will need to be made aware of the potential danger of improper excreta disposal.

There will be a need for stimulation of demand for sanitation from individual householders.

Education is fundamental to the sustainability of programmes. Begin with mothers, extend to the school curriculum and continue into the community.

Community elders and church leaders are crucial to community education. Programmes should be cohesive and comprehensive

Health education is a combination of activities undertaken to achieve voluntary behavioural change with respect to the use and benefits of water and sanitation facilities.

Public health, general health and hygiene education are major factors in the changing of people’s attitude towards sanitation.

It is not simply a question of transmitting educational messages, but a more complicated effort at modifying human behaviour.

Changes can be brought about by threat, incentive or as the consequence of an epidemic.

Some custom beliefs restrict people from adopting good sanitary alternatives.

Public awareness and effective health education programmes are needed.

The motivation of communities and individuals is required.

The issues of health and status should be addressed through the various media.

The written or spoken local language should be used wherever possible.

Illustrations should always depict local people rather than foreign figures.

The ideal form of education is person to person, one to one oral communication. Most learning in small communities is from family members, nurses and teachers.

Village based workshops are a good strategy for most projects.

Develop teaching methods and materials which can be taken into the field, such as flip charts.

Keep messages and drawings as simple as possible, one message at a time.

Prototype promotional material should be thoroughly pilot tested before being made widely available.

Money and time are needed to transmit the message regarding health and hygiene to the entire population.

3. DESIGN OPTIONS

If sanitation is to be introduced choose the right technology. It must be adequate for the local situation and needs.

Get the design right.

Low cost sanitary waste disposal on small islands requires sensitive and creative adaptations of existing designs.

Available Technology

The facility must be easy to build and maintain, and should require a minimum of off-island expertise or equipment.

Some questions which must be addressed at an early stage are given below. The answers will affect cost, the effect on the environment and the effectiveness of the facility in bringing about health improvements.

Questions

- Squat or sit?
- Water sealed or open, (visible)?
- Water for flushing or no water, pour flush or cistern flush?
- Single or double chambers, pit, bucket, vault, aqua privy or septic tank?
- Effluent seeps into the ground or to an outflow pipe?
- Outflow to ground, or to soakaway trenches or to septic tanks or to ET trenches or to a piped sewage system?
- Local or imported housing material? Superstructure can be designed to suit local preferences and locally available materials. Not of major concern in the design, although it must be acceptable to recipients.

A list of the basic designs is given in the table at the end of Section 3, page 17, which gives an indication of the level of technology, the health risks, pathogen removal or containment, resource reclamation, relative costs and constraints and advantages of each.

These designs are described in more detail below.

3.1 OPEN DEFECATION – BEACH OR BUSH

In some Pacific islands there are no sanitation facilities. From a health and hygiene point of view the worst case is where defecation is indiscriminate. Uncovered faeces can result in transmission of disease by flies, animals and people.

Defecation in designated areas is more acceptable, particularly where population density is low. If open defecation occurs in the bush, the faeces should be covered. Designated areas of mangrove or beach can be used as long as there is a strong tide or current to flush the waste. It should be noted that most mangrove swamps have little current movement.

Where people live closely together in compact villages or small urban areas open defecation can be a danger to health and the environment, and alternative sanitation should be considered.

Open Defecation

Source: Tearo, 1997

Where there are no latrines people resort to defecation in the open. This may be indiscriminate or in special places for defecation generally accepted by the community, such as defecation fields, rubbish and manure heaps, or under trees. Open defecation encourages flies, which spread faeces-related diseases.In moist ground the larvae of intestinal worms develop, and faeces and larvae may be carried by people and animals. Surface water run-off from places where people have defecated results in water pollution. In view of the health hazards created and the degradation of the environment, open defecation should not be tolerated in villages and other built-up areas. There are better options available that confine excreta in such a way that the cycle of re-infection from excreta-related diseases is broken.

3.2 OVERHUNG LATRINES

Where people live near the sea, a river or other body of water excreta may be dispersed into the water by constructing a raised superstructure with a squat hole in the floor. A walkway is provided to reach this 'over-hung' latrine. These sanitation facilities are adequate if:-

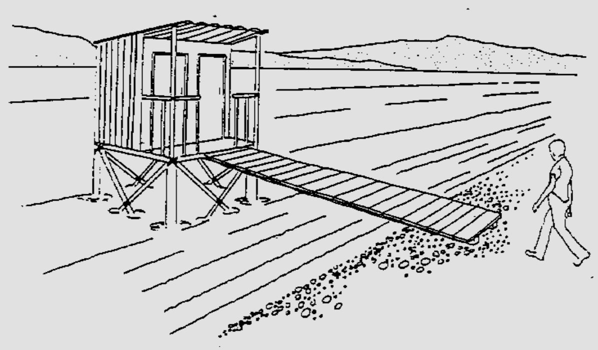
- the water is sufficiently deep
- the water is not still and currents carry away solids
- the water is not used for recreation or fishing
- the walkways are structurally safe

They are a common feature in some countries of the Pacific. In the islands of Tokelau, for example, there are many public over-water latrines, which fulfil a social function as a meeting place where local news and views are exchanged.

In Papua New Guinea, the overhung or 'drop' latrine remains popular for villages sited on rivers, inlets or the ocean front. They are particularly common in the stilt villages around Port Moresby, where they are described as odourless and breezy.

In Micronesia in the 1970's the over-water "benjo" represented the state of the art sanitary facility. These were conspicuous and often desecrated an otherwise pristine beach. They were also found over rivers and in man-groves. Today, they no longer exist, replaced largely by water-seal toilets.

Overhung Latrine



Source: WHO, (1991)

A latrine is hung over the sea, a river or other body of water into which excreta drop directly, is known as an overhung latrine. If there is a strong current in the water the excreta are carried away. Local communities should be warned of the danger to health resulting from contact with or use of water into which excreta have been discharged.

Advantages are that it my be the only feasible system for communities living over water and it is cheap. The disadvantage is that there are serious health risks associated with it.

"DRY" LATRINES

Many latrines do not use water to flush away excreta. Waste material is allowed to drop directly through an open hole.

It should be noted that whilst this is good for conserving water resources, some water is always needed for hand washing. If there is sufficient rainfall the roof of a latrine can be used for collecting water for this purpose.

3.3 BUCKET LATRINES - "NIGHT SOIL"

The simplest form of latrine consists of a structure in which excreta are collected in a bucket or container, which is periodically removed for disposal or treatment.

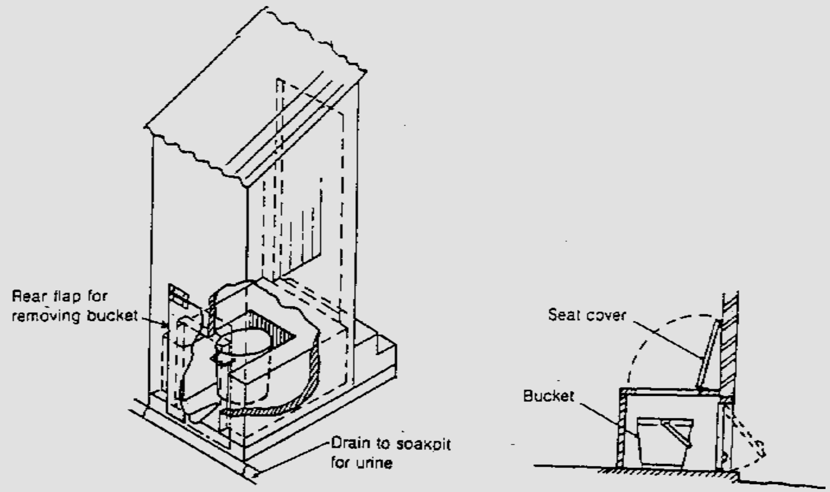
Reusing human waste from these containers has been common in many parts of Asia, where the product is treated as a valuable resource and is sold at a price.

The technology is low cost, but is unhygienic in that spillages can easily occur in the transfer of the 'night soil' into large containers and transported to the disposal or treatment site.

The excreta may be used directly in the fields, it may be composted, buried or used to fertilise fish ponds.*

In the Pacific some small towns and urban areas of PNG still use a 'night soil' or sanitary pan system, with the excreta emptied untreated into the environment.

* *N.B. Where the excreta is used directly onto fields or into ponds, there is a serious health risk due to the possible transmission of pathogenic organisms which might be present in human waste.*



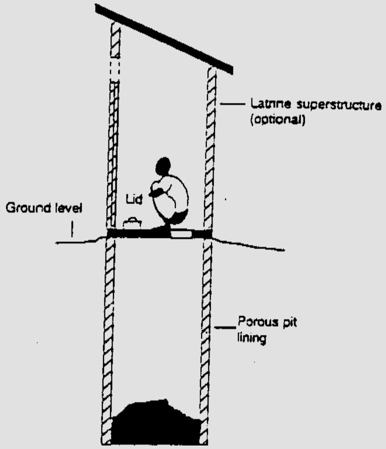
Source: WHO, (1991)

3.4 SIMPLE PIT LATRINES WITH ONE OR TWO PITS

A simple pit latrine can be constructed by digging a pit and placing a slab with a squat hole over it. The latrine may have a superstructure for privacy.

Single pits have a limited life depending on their size and on the number of people who use the latrine. Some pits can last as long as 15 to 20 years. Double pits, requiring two cover slabs have the advantage of allowing each pit to be emptied after two years of anaerobic digestion, which is usually sufficient to kill off all pathogens. There is however no controlled process taking place in the pit. This also allows rotation of the pits, giving the latrine an indefinite life span. With a single pit the superstructure has to be relocated once the pit is full.

Simple Pit Latrine



Source: Intermediate Technology, 1991

This consists of a slab over a pit which may be 2 metres or more in depth. The slab should be firmly supported on all sides and raised above the surrounding ground so that surface water cannot enter the pit. If the sides of the pit are liable to collapse they should be lined. A squat hole in the slab or a seat is provided so that the excreta fall directly into the pit. **Its advantages are its low cost, that it can be built by the householder and that it needs no water for operation. Disadvantages are the considerable fly nuisance (and mosquito if the pit is wet) unless there is a cover over the squat hole when the latrine is not in use. They can also be quite smelly.**

Dry pits can also be formed by drilling 200 mm to 500 mm diameter holes to depths of about 10 metres.

These sanitation facilities isolate excreta from human or animal contact, but are not always effective in isolating insects, particularly flies. They often have an unpleasant odour and attract flies.

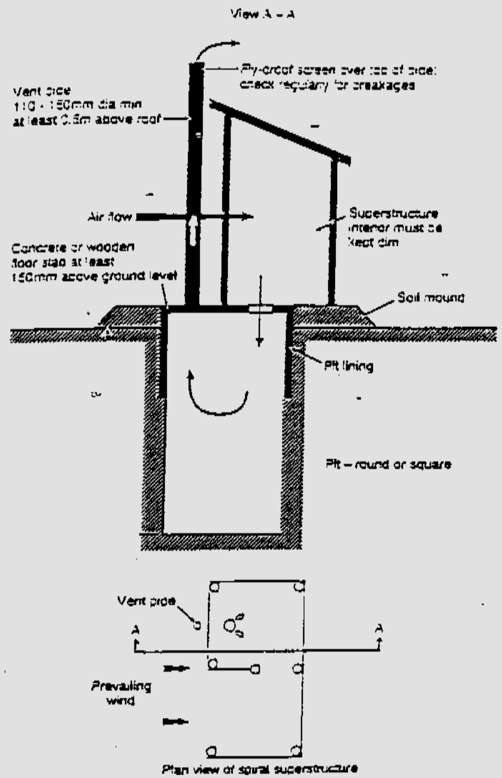
Children fear the darkness of the hole in the ground and are often dissuaded from using this type of latrine.

The simple dry pit also can pollute underlying ground water resources by the seepage of liquid effluent. However, this risk is minimal if the groundwater level stays always at least one metre below the bottom of the pit.

3.5 VENTILATED IMPROVED PIT, (VIP), LATRINES

With the addition of a vertical ventilation pipe, extending from the pit to at least 0.5 metres above the superstructure, and capped with fly-proof netting, the simple pit latrine can be made odourless, and can reduce the problem of flies.

Ventilated Improved Pit Latrine



Source: ??????

Fly and odour nuisance may be substantially reduced if the pit is ventilated by a pipe extending above the latrine roof, with fly-proof netting across the top. The inside of the superstructure is kept dark. Such latrines are known as ventilated improved put (VIP) latrines. **Advantages are low cost, can be built by householder, needs no water for operation, easily understood, control of flies and the absence of smell in the latrines. Disadvantages are that it does not control mosquitoes, the extra cost of providing vent pipe and the need to keep the interior dark.**

To create the air flow the defecation hole must be left open, the pipe painted matt black to induce convective flow up the pipe, and the top of the pipe located in clear air, away from shelter by buildings and trees.

An inlet to the toilet should be provided in the form of a vent at least three times the size of the vent pipe. Wind speeds of 2m/s around the structure should lead to air flows in the ventilation pipe of about 1 m/s.

Double pits allow the rotation of the pits and the use of the contents as a soil conditioner when dug out after decomposition.

Pits can be sealed to protect any ground water resources, or can be unlined allowing drainage of liquid effluent to the surrounding soil, where no environmental problems are anticipated.

PIT LATRINES - WET

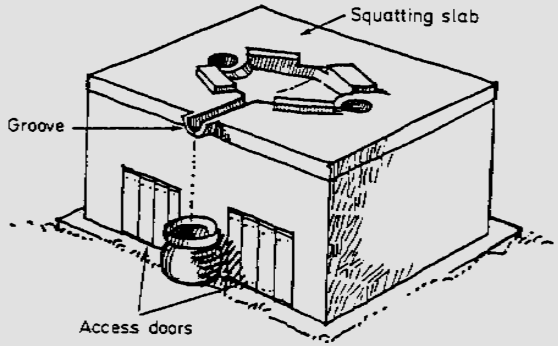
A simple way to eliminate access by flies and to prevent odours is to use a water seal. This, of course, requires a supply of water and leads to the need to dispose of liquid effluent in varying quantities.

3.6 COMPOSTING TOILETS

The ancient practice of using human excreta as a fertiliser has been used for many centuries, particularly in Asia. The excreta is taken from the bins or containers and applied either directly to the soil or decomposed in specially made pits or heaps. This removal and use of raw sewage represents a health hazard. To overcome the problem and to retain the value of human excreta, designs have been made of latrines which store and compost the material in-situ.

Dry pit latrines described in previous sections can produce a safe composted material providing the excreta pile is kept untouched for up to two years to allow complete decomposition and die-off of pathogens.

Vietnamese double – vault latrine.



Source: Rybczynski et al. 1982

Composting Latrine

In this latrine, excreta falls into a watertight tank to which ash or vegetable matter is added. If the moisture content and chemical balance are controlled, the mixture will decompose to form a good soil condition in about four months. Pathogens are killed in the dry alkaline compost, which can be removed for application to the land as a fertiliser. There are two types of composting latrine; in one, compost is produced continuously, and in the other, two containers are used to produce it in batches. ***The advantages are that a valuable humus is produced, water is conserved and groundwater is protected from pollution. Disadvantages are that careful operation is essential, urine has to be collected separately in the batch system, and ash and vegetable matter nust be added regularly.***

Composting toilets aim primarily at aerobic decomposition, which can be achieved in a shorter period of time. It has been called the dry conservancy method because no water is used in the toilets and the material is not disposed of to waste, as in other methods.

For on-site aerobic treatment the requirements are :-

- one or more containers
- provision of a bulking agent, (vegetation) and/or separation of urine, to maintain a suitable carbon to nitrogen ratio for the microorganisms

- ventilation to provide the necessary oxygen for oxidation and heating of the pile

The solid material is broken down by aerobic bacteria and other organisms and the small amount of liquid waste drained to horizontal sealed trenches, where it is disposed of by evapotranspiration. Alternatively the urine can be separated from the solids before entering the pit diluted and used as a nitrogenous fertiliser, or disposed of.

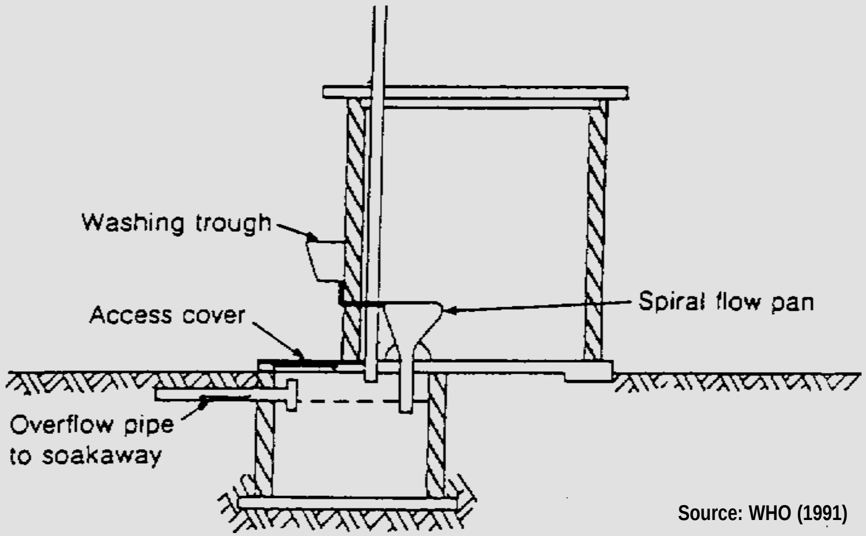
The solid material can be broken down rapidly into a soil like or leafy material which has a pleasant earthy odour, if composted correctly.

Composting toilets need a supply of vegetation material handy to add to the container regularly and a ventilation system which maintains a through flow through the compost pile. A range of designs are available from pre-fabricated units to home made latrines aimed at reducing costs. A detailed description of designs and options is given in SOPAC Miscellaneous Report 249.

3.7 AQUA PRIVIES

Where water is in short supply the aqua privy design can be used. This consists of a 100-150mm diameter chute or drop pipe placed below the squat plate or latrine seat. Excreta drops through this chute directly into a water-filled, sealed container. Excess fluid is dealt with via an overflow pipe to a soak pit, a drainage trench or a sewer. The bottom of the drop pipe extends to 75mm below the liquid level. This provides a seal against escaping gasses, and limits access by flies and mosquitoes.

A bucketful of water is needed daily to clean the chute and maintain the fluid level. Regular removal of the sludge is required, which can be a health hazard if not done carefully.



Source: WHO (1991)

Aqua Privies

An aqua privy has a water-tight tank immediately under the latrine floor. Excreta drop directly into the tank through a pipe. The bottom of the pipe is submerged in the liquid in the tank, forming a water seal to prevent escape of flies, mosquitoes and smell. The tank functions like a septic tank. Effluent usually infiltrates into the ground through a soakpit. Accumulated solids (sludge) must be removed regularly. Enough water must be added to compensate for evaporation and leakage losses.
The advantages does not need piped water on site and is less expensive than a septic tank. The disadvantages are that water must be available nearby, that it is more expensive than the VIP or the pour-flush latrine and the fly, mosquito and smell nuisance is very real if the seal is lost because there is insufficient water added. Also, regular desludging is required - the sludge requiring careful handling and permeable soil is required to dispose of effluent.

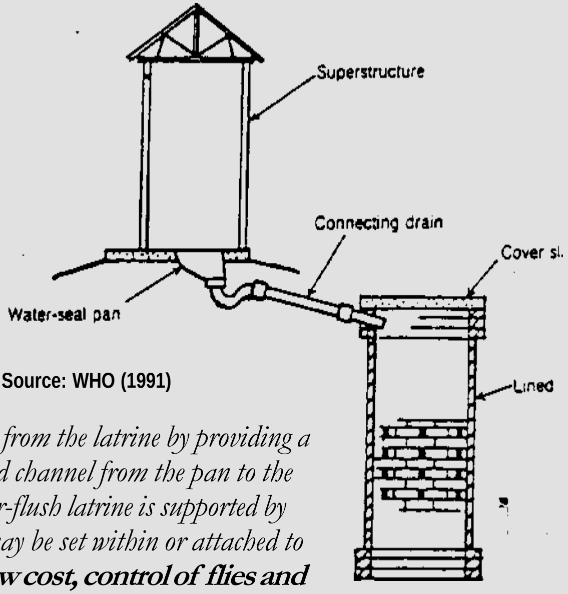
3.8 POUR FLUSH LATRINES

Another way of creating a barrier with water is to install a water seal, or trap, in the disposal chute beneath the squat plate or latrine seat. These traps can have various configurations but require a bend in the pipework in which water is permanently located. Faeces are cleared after each use by flushing with a sufficient quantity of water to wash the solids through into the pit or vault. A minimum of one litre is needed for each use and the water does not need to be of high quality. There may be one or two pits which may be below the latrine or off-set.

These water-seal toilets are effective in preventing access by insects and in eliminating odours. They are, however, likely to block, especially if solid materials are used for anal cleaning. They can be installed inside a house if the pit is off-set. Care should be taken with the discharge pipes and pits should be located at a distance from the house not less than the depth of the pit to avoid any effect on the house foundations.

The volume of effluent produced from these latrines can pollute shallow ground water resources, and on a small island may ultimately affect near-shore, particularly lagoonal waters.

Pour Flush Latrine



Source: WHO (1991)

A latrine may be fitted with a trap providing a water seal, which is cleared of faeces by pouring in sufficient quantities of water to wash the solids into the pit and replenish the water seal. A water seal prevents flies, mosquitoes and odours reaching the latrine from the pit. The pit may be offset from the latrine by providing a short length of pipe or covered channel from the pan to the pit. The pan of an offset pour-flush latrine is supported by the ground and the latrine may be set within or attached to a house. ***Advantages are low cost, control of flies and mosquitoes, absence of smell, contents of pit not visible, gives the users the convenience of a WC and can be upgraded by connection to sewer when sewerage system becomes available. Also, for the offset type of pour-flush latrines, the pan is supported by the ground and the latrine can be inside the house. The disadvantages are that a reliable (even if limited) water supply must be available and that it is unsuitable where solid anal cleaning material is used.***

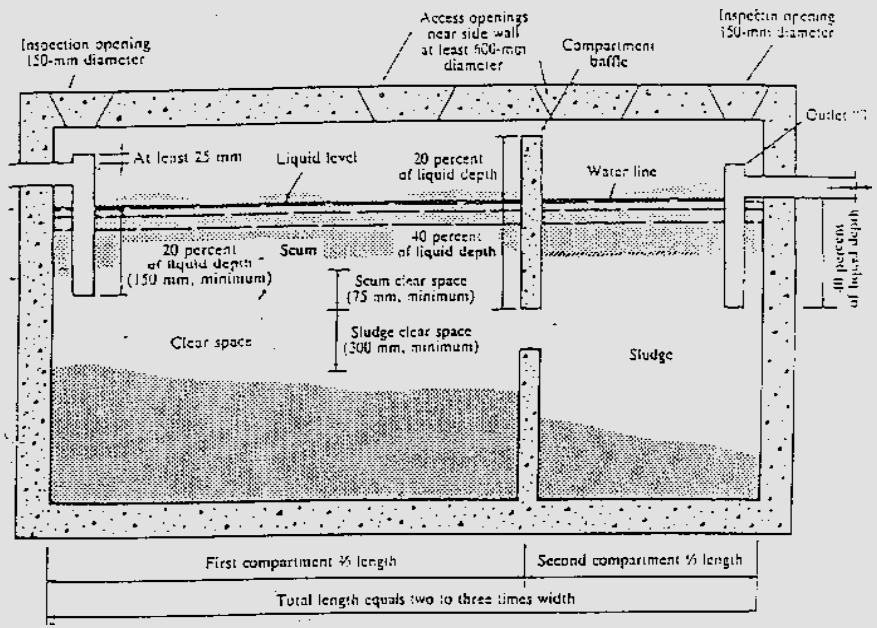
3.9 SEPTIC TANKS

If a higher amount of wastewater is being produced through flushing, washing, cooking etc., a septic tank can be used to treat the waste water from a wet latrine to improve the quality of effluent which is discharged into the environment

Septic tanks are essentially an enclosed tank constructed of concrete, polyethylene or fibreglass, in which suspended solids settle and scum floats on the top, as shown in the diagram at the top of the page across. The waste water is partially treated in the 1-3 days it remains in the tank. 60-70% of the suspended solids (SS) and about 30% of the BOD are removed.

A continuous piped water supply is necessary to flush the solids through the system. Effluent from the septic tanks is disposed of to the surrounding ground via soakpits or tile drains laid out in trenches, or can be tied into a piped sewer system.

The disposal to ground depends on available land area, the permeability of the ground and the depth to water table. In Tonga soakpits are used, 2 metres in diameter and 2 metres deep, where the water table is below 4 metres below ground level. Septic tanks there are designed on a one day hydraulic retention time with an allowance of 55 litres of sludge per capita



Source: Gunn, 1989

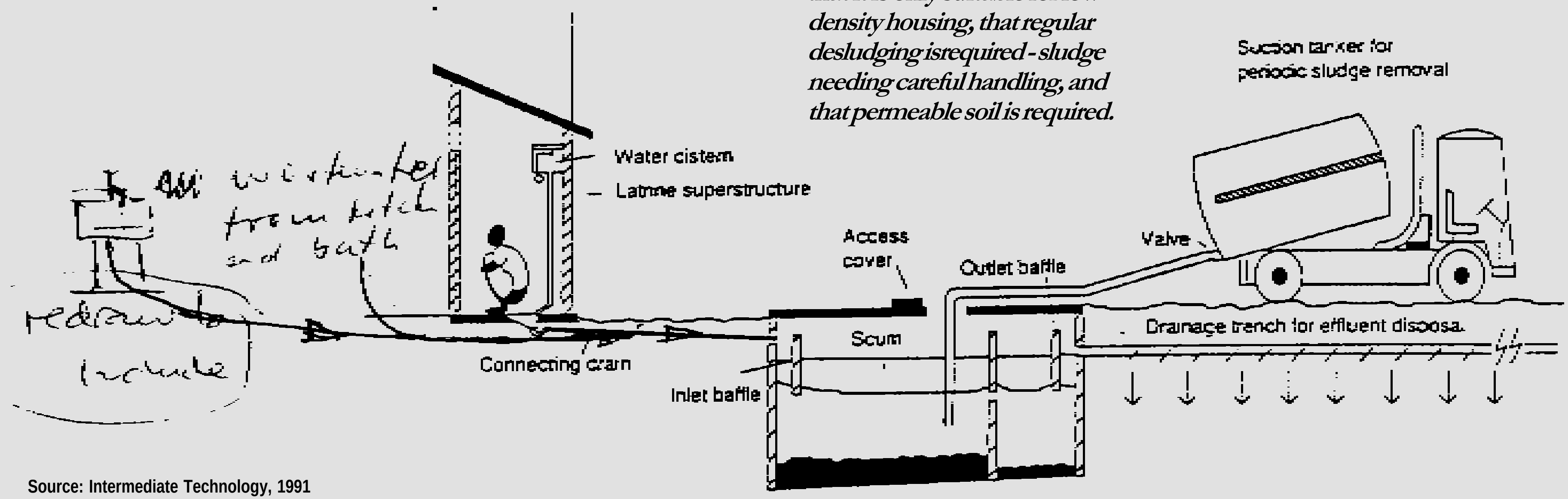
per year, (l/c/y). Desludging is assumed to be needed every seven years with wastewater throughput of 80-100 l/c/day.

Desludging, that is the removal of the solids when they occupy half to two thirds of the total depth between the liquid and the bottom of the tank, is required on a regular basis. Depending on the size of the tanks and the number of users this may be needed every 2 to 7 years.

Septic tanks are more expensive than the simpler forms of pit latrines but can be used on small islands in low density urban areas, where incomes may be high enough to allow a higher water consumption and to purchase and operate these systems and where environmental and ground water pollution problems are not likely to occur.

Septic Tank

Main advantage is that it gives the users the convenience of a WC, and the disadvantages are its high cost, the dependence on a relaible and ample piped water required, that it is only suitable for low-density housing, that regular desludging isrequired - sludge needing careful handling, and that permeable soil is required.



Source: Intermediate Technology, 1991

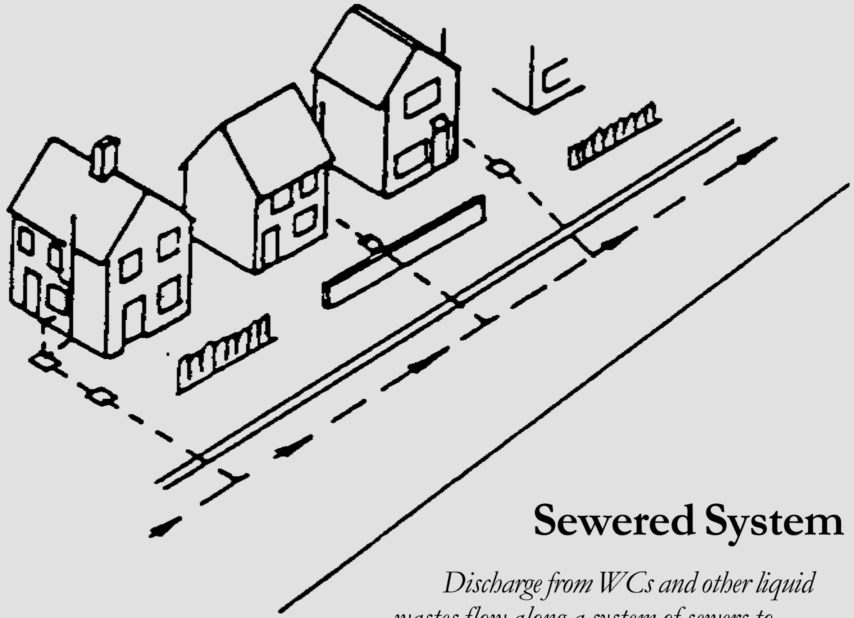
3.10 SEWERED SYSTEMS

In urban areas where it is possible to impose some form of charge for waste water disposal a piped sewer system , taking the effluent to a treatment plant or to a natural water body such as the sea or a river can be used.

They are expensive to construct and need efficient operation and maintenance to ensure blockages do not occur and that the outfall are kept in good working condition.

Sewers of smaller diameter than usual (small-bore sewerage), sewers built nearer to the surface than usual, and sewers with flatter gradient than usual have been tried. Many of these systems require a chamber at each house to retain solids, which have to be removed and disposed of from time to time. Some of these systems have been found to be suitable for providing sanitation simultaneously for a large number of high-density dwellings (Mora, 199x)????

In some high density areas of Pacific Island countries, such as Tarawa in Kiribati and Majuro in the Marshall Islands, there are sewer systems flushed by a saltwater source. These require careful attention to operation and maintenance because of the corrosive nature of sea water, and can be expensive because of the need for non-corrosive pumps, pipes and fittings.



Sewered System

Discharge from WCs and other liquid wastes flow along a system of sewers to treatment works or directly into the sea or a river..

The advantage is that the user has no concern with what happens after the WC is flushed. Disadvantages are high construction costs, that it requires an efficient infrastructure is required for construction, operation and maintenance, and that an ample and reliable piped water supply is required for operation. A minimum of 70 litres per person per day is recommended if discharge is to a water-course. Adequate treatment is also required for excreta to avoid pollution.

AVAILABLE TECHNOLOGIES

CHOICE	RELATIVE COST	TECHNOLOGY	RISKS	RESOURCE RECLAMATION	PATHOGEN CONTAINMENT	PATHOGEN REMOVAL	CONSTRAINTS	ADVANTAGES
beach/bush	zero	zero	direct F/O transmission	no/yes	no	?	low population good tidal flush (beach) designated defecation site (bush)	easy
night soil	low	very low	F/O transmission at spills social odium vectors/vermin at disposal site	yes	yes	no	requires designated safe disposal good access to houses	easy, private
pit latrines	low-moderate	low	vector breeding	yes/maybe	yes	yes	requires land	private
general	low-moderate	low	pollution potential	yes/maybe	yes	yes	deep soil/water table	low O and M contains pathogens
wet pit	low-moderate	low	groundwater pollution	yes/maybe	yes	yes	requires permeable soils	slow to fill
dry pit	low-moderate	low		yes/maybe	yes	yes		
ventilated	low-moderate	low		yes/maybe	yes	yes	requires exposed site for sunlight and wind	odourless traps vectors
septic tanks general-tank	moderate-high	medium	vector breeding poor construction	yes/maybe	yes	yes	requires water supply requires desludging facility	proven technology
absorption	moderate	low	groundwater pollution	yes/maybe	yes	yes	requires depth of soil/water table	simple
ET	moderate	low	plants may not tolerate	yes/maybe	yes	yes	requires land area	simple
wetlands	moderate-high	medium	overflow, vector breeding	yes/maybe	yes	yes	requires land area	minimal discharge
filters/aeration	high	high	breakdown problems	yes/maybe	yes	yes	expensive	high quality effluent
mix'n match water-borne small sewers	high	medium	pipe-damage pollution households may not connect	maybe	yes	yes	requires pipeline routes requires safe disposal areas	removes wastes
municipal sewers	very high	high	breakdowns	maybe	yes	yes	requires pipeline routes and pumps requires treatment/disposal areas high O and M costs	clean, modern
composting toilet	moderate	medium	very few	yes	yes	yes	requires dry organics requires high set structure	very clean

4. MAKING THE CHOICE

After the important stage of communication and consultation, and assuming that all the facts and information on needs, health and technology have been made available, comes the time to choose a design.

The following criteria must all be considered in making the selection. It should be noted that the initial choice is one for a trial installation to demonstrate the suitability and effectiveness of a particular design. Changes can be made if problems occur in this initial trial period, including small and large design modifications.

What are the priorities?

Often the basic need is for improved sanitary conditions for health reasons. The chosen technology must be able to provide the improvement in sanitation required. For this a programme of health and hygiene education associated with the use of the sanitation facility is essential. The importance of handwashing, for example, is vital if transmission of enteric pathogens is to be totally eliminated.

Associated with the provision of a barrier from direct or indirect contact with excreta is the need to protect any water sources which can be an additional health hazard if waste water from the latrines reaches these sources.

How important is the environment?

If effluent from latrines is produced in sufficient quantity the general environment can deteriorate with the addition of nutrients and pathogens to coastal, ground and inland water bodies. Economic activities such as fishing and tourism can be adversely affected by degradation of the environment.

Are local materials and labour available?

The cost of constructing a new sanitation facility can be greatly decreased if local materials are used and if local labour can be employed to build the latrines. Organisation of the work can assist the speed and efficiency with which the improvements can be made. Personnel for technical supervision, if available, will also ensure good construction and later operation and maintenance of the structures.

Are there any social, religious or cultural constraints to the choice?

Some existing conditions or constraints may be compatible with good health and environmental needs. Others may have to be discussed as being detrimental to the well being of the particular society. The choice, however, must always be with the recipients of the sanitation.

Can the community afford the chosen design?

To be affordable does not necessarily mean ready cash is needed. Credit facilities may be available to the users which they can arrange themselves. Wherever possible private sector local builders should be used with local assistance.

There should always be some financial input from the recipients to ensure there is a feeling of ownership. As a general rule, the users should always pay fully for the operation and maintenance of the system. Wherever possible latrines should belong to individual households. Community toilets seldom are maintained adequately.

Will the users like the toilets?

If the design is to be widely accepted it must be liked. This means that it should be attractive, odourless, comfortable, easy to use, simple to clean, suitable for adults and children, and not offend any social or cultural norms.

Even with all the above information and considerations it will not be possible to provide or afford the ideal sanitation. Some compromise is always necessary. A suggested approach might be community based risk management. For this the community sets objectives for their needs/wants in terms of improved sanitation facilities. Depending on finances, limits may have to be set on the health and environment needs required at the stage of development. Technology is then chosen to match the requirements. It should be noted that the facilities can be further upgraded at a later stage, particularly if appropriate designs are chosen to allow this.

Wet or Dry?

If: water for flushing is available all the year round,

water is used for anal cleaning,

the water table is more than 3-4 metres below ground level, and

the soil is relatively permeable

consider using one of the wet latrine technologies: 3.7 to 3.10.

If any of the above conditions are not met consider using one of the dry latrine technologies: 3.2 to 3.5.

Where dry latrine methods are chosen:

If: it is not possible to dig a pit;

the water table is shallow, (<3metres); and

people do not object strongly to handling human excrement as a soil conditioner consider usind a composting toilet: 3.6.

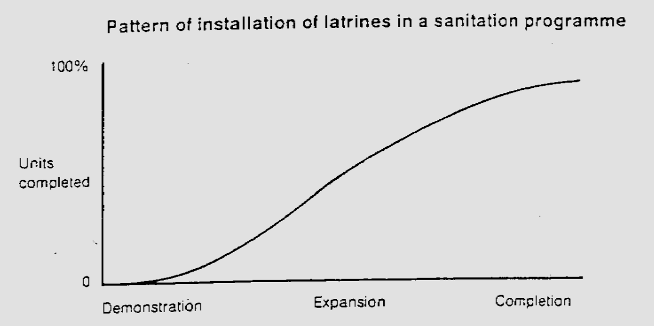
5. TRIALS AND DEVELOPMENT

To try out a particular type of sanitation takes time. There are no short cuts in a pilot project. Planners of improved sanitation must conduct the economic and social research outlined in previous sections of this booklet, build and demonstrate the chosen units, monitor and evaluate reactions before a truly appropriate and acceptable latrine can be found. In Lesotho in Africa, for example, a sanitation project stretched from the 1970s to the 1990s. The actual time scale will depend on the size of the population to be served, the receptivity of the users and the financial resources available. Such projects will cover years. Sanitation development cannot be done in a hurry.

After the initial feasibility studies, surveys and community consultation, comes the demonstration or experimental phase. This is a practical test of the feasibility of the recommended or chosen options. This acts as a kind of shop window to stimulate demand. It also acts to prove that the basic technology is feasible before widespread implementation of the design.

This is followed by a period of consolidation to organise the institutional aspects of the project. In this period householders and institutions are encouraged and enabled to acquire satisfactory and adequate sanitation within a certain period of time.

Finally comes a mobilisation or expansion phase when most of the facilities are constructed. This should be accompanied by monitoring and evaluation to determine how effective the improvements are.



Source: WHO, (1991)

6. FINAL THOUGHTS

Control Measures

There is much that can be done to avoid the need for expensive forms of sanitation on small islands. For example planning regulations can be introduced to limit population densities becoming too high, generally requiring sewered systems. Well-head protection zones can be introduced to maintain a minimum separation distance between drinking water wells and sanitation facilities. Monitoring procedures can be introduced to ensure water supplies are not being affected by existing sanitation facilities.

If there is a health or environmental problem in a small island situation it is necessary first to ask what the options are and how each will improve the existing situation. A dialogue must form the first part of the investigation of sanitation development. Wants and needs must be clearly identified both by those receiving the sanitation and those able to provide the guidance and assistance.

After this initial discussion, in which all information must be made available, a choice has to be made. This may not always be the ideal sanitation facility, but it still must be acceptable to those asking for the improvements, it must be affordable to the majority of the community and it must be adequate to bring about the improvements to health and environment which have been identified as needed.

But it does not stop there. Latrine construction is only the beginning of the real sanitation programme. Continuing health and hygiene education are necessary if the recipients are to realise the benefits of their investment. Technical assistance is needed to ensure the new systems function properly. A great deal of time may be needed to try out and encourage the use of new means of sanitation. It may take several years to stimulate demand in a community. There will follow a consolidation phase in which the institutional arrangements will be worked out, that is who will organise repayments, who will be responsible for maintenance, etc. Ultimately there will be an expansion phase when all households may see the need to obtain equal status with their neighbours in terms of available sanitation. A mix of assistance, motivation and legislation may be necessary to produce the desired results of improved health and environment through sanitation.

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N.B. Most of these publications are available at the SOPAC Library in Suva.

Further literature can be obtained from:

SOPAC Secretariat, Private Mail Bag, GPO, Suva

and the

World Health Organisation

8. TECHNICAL TERMS

aerobic
living or taking place in the presence of air or free oxygen

anaerobic
living or taking place in the absence of air or free oxygen

biochemical oxygen demand
(BOD), the mass of oxygen consumed by organic matter during aerobic decomposition

composting
the controlled decomposition of organic solid waste in moist conditions to produce a humus

desludging
removal of settled solids from pits, vaults and tanks

effluent
liquid flowing out of a pit, tank or sewage works

helminth
a worm, which may be parasitic or free living

humus
decomposed organic matter

pathogen
organism that causes disease

scum
layer of suspended solids less dense than water and floating on top of liquid waste

soakpit
hole dug in the ground serving to disperse liquid waste

squat hole
hole in the floor of a latrine through which excreta falls directly to a pit below

superstructure
screen or building of a latrine above floor level for privacy of users.

vent pipe
pipe provided to facilitate the escape of gases from a latrine or tank

water closet
W C pan from which excreta is flushed by water into a drain

NOTES