Water Services Trust Fund

Public Sanitation

Excreta Disposal

Toilet at the Kitengela Glass Factory near Nairobi

Francis Oiro Ochieng

Toolkit for Urban Sanitation Projects
Excreta Disposal

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Toolkit for Urban Sanitation Projects
Excreta Disposal

1. Introduction

A basic fact of life is that human beings, old and young, rich and poor, need to get rid of their excreta every day. Excreta include both faeces and urine from the human body. The methods used for excreta disposal vary and depend on community habits and practices (such as wiping or washing the anal area), socio-economic status of the individual, availability of water and the method of water supply.

National coverage of the excreta disposal systems in rural East Africa stands at about 40 per cent. This, however, varies from district to district. Urban centres have more excreta disposal facilities. This is with the exception of informal settlement areas where latrine facilities are very few and those available are in such condition that they can no longer be used without risk of infection. In such slum areas, “flying toilet syndrome” is common whereby residents defecate into plastic bags in their rooms then throw the contents on to an existing toilet floor, compound or open drain channel.

2. Role of Excreta in the Spread of Diseases

Hygienic disposal of excreta is important because the infective because the infective organisms may enter diseases leave the human body in faeces and urine. The infective organisms may enter the human body directly or sometimes after an intermediate stage which may be free living or in an intermediate host.

The following infections mainly occur through consumption of foods contaminated with the disease organisms. They may be classified as follows:

- Viral diseases: poliomyelitis, infectious hepatitis and gastro-enteritis.
- Bacterial diseases: cholera, typhoid and paratyphoid, bacillary dysentery
- Protozal diseases: amoebic dysentery
- Parasitism: ascariasis (roundworm), trichuariasis (whipworm), pinworm, tapeworm.

Almost all the above viral, bacterial and protozal infections may be transmitted through drinking water contaminated with infected faecal matter. In addition, the other infection of faecal origin is schistosomiasis, both urinary (schist soma haematobium) and intestinal (schist stoma mansoni).

Likewise, all the above bacterial diseases may be spread through flies and other insects like cockroaches. The mode of spread may be mechanical, through insects’ hairs and feet, or by regurgitation of organisms on to food. The domestic housefly can also spread conjunctivitis.

Most bacterial infections may be spread through contamination of uncovered food or by soil and dust blown by wind. Other forms of infection from soil are ankylostomiasis

(hookworm) where the infective form of the worm in the soil penetrates the skin and enters the body.

Proper excreta disposal methods provide safe disposal of excreta to stop it from contaminating the environment. Any method selected for disposal of excreta should be:

- Simple, cheap and easy to use.
- Constructed of locally available materials.
- Easy to maintain.
- Fly-proof.
- Acceptable to users.
- As odourless as possible.
- Private.
- Non-polluting.

Various methods for excreta disposal are discussed below (see Figure 1).

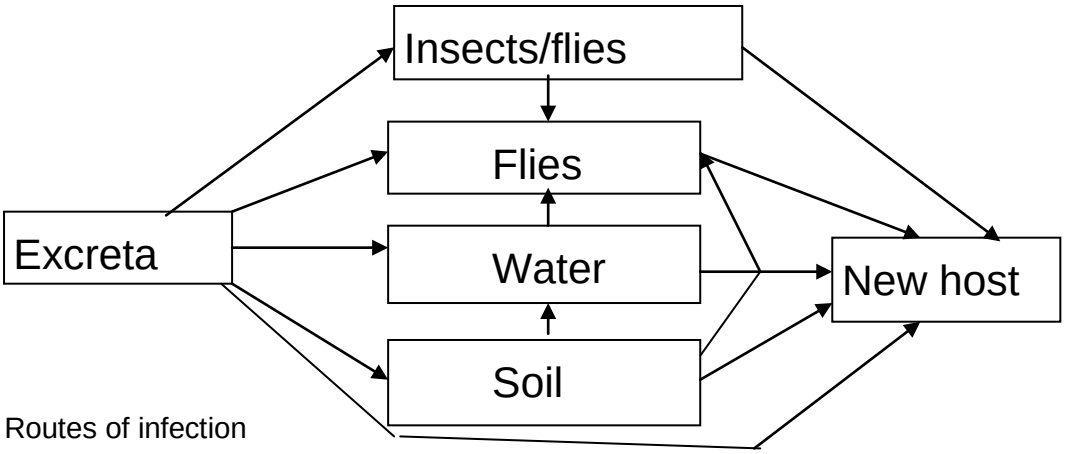

Figure 1: Routes of infection

3. Conservancy Systems

Excreta may be disposed of either with or without the use of water. Most rural areas in developing countries do not have piped water, and where it exists, the quantities may not be adequate. This situation necessities the use of non-water systems, commonly referred to as *conservancy systems,* rather than the more superior, hygienic water carriage system. Conservancy systems are those types of sanitation which excreta are returned directly to earth or are temporarily stored pending removal. It is any system where water is not used as a conveyance of excreta.

Common conservancy systems used in rural areas in Africa are traditional pit larine, ventilated improved pit latrine, trench latrine, bucket latrine, pour flush latrine, chemical closet and long drop latrine.

Conservancy systems have a number of limitations and rarely meet expected health criteria due to various reasons. Often there are unsuitable soil conditions which determine the depth and/or life of the pit. The situation of underground water may cause contamination of well or spring water as well as flooding or overflowing of the pit latrine. Unplanned human settlements do not always provide space for latrines, and the population density may be so high that there is no adequate space for toilets. At the same time, the economic status of the community may dictate the type of toilets to construct. There may be adverse attitudes by the users due to low literacy level, customs or unbecoming habits.

When selecting an appropriate latrine for a particular situation, the following points should be considered:

- Availability of resources to be used.
- Affordability and social acceptability of the latrine.
- Availability of adequate land and space for future expansion.
- Repair and maintenance costs.

4. Pit Latrine

Latrines are used to break the transmission of diseases associated with human waste disposal. When constructing latrines, you must consider and understand the community in terms of local beliefs, attitudes and practices may act as barriers or may be supportive. Religion plays a significant role in the provision of latrines. Some communities provide latrines merely for status without necessarily using them. The public health officer (PHO) and public health technician (PHT) and should understand the factors that determine the provision and use of affordable and appropriate technology.

The pit latrine is the most common and convenient of all the conservancy systems if properly maintained. It is compromised of three components: pit, slab and superstructure (see the Appendix, Figure 5.2).

4.1 The Pit

The purpose of the pit is to receive excreta deposits which are decomposed by anaerobic bacteria and rendered harmless. The pit should be dug to a minimum depth of 5 m, depending on the nature of the soil and the level of ground water. At that depth there is very little light, and fly breeding is reduced to a minimum. Determination can be made on the minimum depth required to cater for a family for several years. This calculation is based on the per capita excreta output of between 0.02 cubic metres for a slightly wet pit contains a mixture of excreta and water. The calculation is as follows:

No. of users *per capita output *No. of years expected to last

Cross- sectional area of pit

Half of the pit depth is added for biodegradable cleaning materials and other refuse. The pit is circular, square or rectangular depending on type of soil or preference.

Circular pits are often stronger than rectangular ones. The width of rectangular pit should be 0.9 m while a circular pit should be 1.2 m in diameter.

The site for digging the pit should be properly selected. The PHO or PHT can advise the impossible. Also, black cotton soil may collapse and reduce the life of the pit (during the rains, this soil retains high water content). Sandy soil may present problems when digging as it cannot the actual digging and after. The pit may be protected using concrete culverts slotted in while digging. Timber formwork may be slotted in during black cotton during dry weather. Reinforced concrete may be provided after digging to prevent future collapse. Also during digging, 200-litre drums may be used. Bricks, stones r concrete blocks can be built along the side of the pit after digging.

It may be advisable to provide leaching holes at the sides of pits protected with culverts, reinforced concrete, stone or drums to allow water to escape from the pit after flooding. The bottom part of the pit is left in a natural state to allow leaching away of liquids like urine. When bricks, blocks or stone lining are used, subsoil goes only halfway down the pit, protection is provided only to that point. The pit may be as long as desired. Care should be taken not to make the pit too expensive to construct. Width should be confined to between 0.6 and 1 m.

4.2 Slab

A slab is provided above the pit. It forms the floor of the latrine and supports the user. Usually the slab is made of reinforced concrete. However, it can also be made of timber supported by logs of wood or daub supported by timber formwork. A concrete slab lasts longer and is easily kept clean. To facilitate deposition of excreta into the pit, a squat hole or aperture is provided at the centre. The aperture is made such that it is not too large for children to fall through or too narrow end and 225 to 450 mm at the wider side. The widest part of the aperture should always be at the back.

The slab may also be provided with a foot rest. Care must be taken to avoid making it difficult to clean the toilet. To maintain cleanliness, the floor should slope towards the aperture. This enable the urine and wash to flow into the pit. The concrete slab should be reinforced or metal bars embedded in a concrete mix of 1:3:6 (cement, sand and ballast). It should be properly cured for a period of 7 to 14 days. The minimum depth of the reinforced concrete slab is 50 mm for a single pit. It should overlap the sides of the pit by a minimum 225 mm wide and 150 mm thick underneath it. Where lining is provided, the collar should overlap the whole lining and be fixed with concrete mortar. The slab should have a smooth finish for easy cleaning (see the Appendix, Figure 5.3: shapes of superstructure of apertures-measurements in millimetres).

4.3 Superstructure

Superstructures can be of different designs: circular, rectangular, square or spiral in shape. In each case, the superstructure has a roof, door and walls. The roof is runoff and t he same time protect the pit and the user from rain and sun. The walls should have an internal measurement of 0.8 m wide, 1.5 m long and a height of 2 m at the shortest part. They are usually made of stones, blocks, burnt bricks, timber, GCI sheets, mud or hessian cloth or bamboo. The spiral design latrine is sometimes

constructed without a door. The superstructure should have insufficient ventilation and lighting for the inside of the latrine. It must be adequate fly-proofed. The most ideal site for a pit latrine should be 30m or more from a well or water source. It should be more than 10m from a dwelling. The site should be unlikely to flood during rains and should be situated on the leeward side of the living quarters. The compound should be kept clean and tidy, free from long grass and bushes and not infested with rats. Surface water can be drained by provision of an earth mound around the latrine and a drain to absorb storm water. When pit latrines are properly sited and used, they can last for over 10 years. The bulk of the faecal matter will be reduced by anaerobic action while the liquid matter will soaks into the surrounding soil. Pit latrines have various advantages. There is enough land in the rural areas to be used for pit latrines, and they can be easily constructed by the local people. Materials are locally available, and water is not required. When properly used and maintained, pit latrines are clean and reduce faecal contamination around homes. Pit latrines can be used for quite a long time because decomposition takes place continually in the pits. Disadvantages are that latrines frequently have unpleasant odours. Also, when they are almost full, they provide a good place for insects to breed. The superstructure may collapse if poorly maintained. If they are fouled, latrines became unhygienic for users. Children may be reluctant to use the latrines because they are afraid of falling into the pit.

5. Ventilated Improved Pit Latrines

5.1 Introduction

The traditional pit latrine has two major problems; bad odour and flies. To minimise these problems, the latrine is ventilated by mean of a vent pipe. The vent pipe is fixed through the latrines slab and extends vertically to over 150mm above the highest part of the roof. At the top of the pipe, a fly screen is fixed. This is known as the ventilated improved pit (VIP) latrines; because of the reduced odour and flies, it can be located near a dwelling. Factors to consider when sitting VIP latrines are the same as those for an ordinary pit latrine. The VIP latrines has similar components-pit, slab and superstructure –except for the pipe (see the Appendix, Figure 5.4: VIP latrine).

5.2 Vent Pipe

A key component of the VIP latrines is the vent pipe. The vent pipe should preferably be diameter 75-225mm, depending on the material used. A wider vent pipe will cause a downward draught of air that will increase rather than reduce the odour in the superstructure. Material for the pipe will depend on what is available locally. The commonest and most suitable material in use is polyvinyl chloride (PVC).Others are asbestos, cement or galvanised iron pipes. The most suitable diameter for this pipe is 100mm. Wider pipes may be used but will be uneconomical. If split bamboo or other sticks are used, they can be held together by cement mortar, cooking fat tins or other similar tins fixed on top of each other materials may be papyrus reeds plastered together, bricks, blocks or dressed stone that will provide a square flue. The pipe can be placed either inside or outside the superstructure. The vent pipe has two functions; to reduce unpleasant odour and reduce flies. The vent pipe acts as a chimney for warm pit gases to rise to the top of the

superstructure and escape into the atmosphere. As the foul gases inside the pit escape through the pipe, fresh air flows in through the squat hole. The wind that blows over the top of the pipe causes a suction effect and so pulls the gases from the pipe into the atmosphere. The action involves a constant current of air from the door, through the squat hole, up the vent pipe and into the atmosphere, thus reducing the bad odour in latrines. For this action to be effective, the latrines should be constructed in a clear area not surrounded by tall building or trees. The vent pipe should extend more than 150mm above the highest part of the roof so as to catch maximum wind. The vent pipe and the slab should be completely sealed except for the aperture or vent pipe opening. If there are leaks, the air will be pulled through the leak and therefore interfere with odour control. The door of the superstructure should be self-closing and preferably raised (50mm) from the floor to allow in air. Where the atmosphere is hot and raises the temperature of the vent pipe, air movement upwards tends to increase. Thus, the pipe should be painted black of maximum heat absorption.

5.3 Fly Screen

Houseflies are attracted by the source of bad odours. When the odour is reduced inside the latrine and concentrated at the top of the vent pipe, flies converge at the point. However, they are prevented from going into the pipe by the fly-proof wire gauze fixed at the top. The few flies inside the pit are attracted to the vent pipe that serves as a source of light since the latrine is dark inside. The vent pipe, which is vertical, allows some sunlight into the pit and so attracts the flies. The flies move up the vent pipes and die at the top where they are prevented from escaping into the atmosphere by the fly screen. They therefore drop back into the pit. A squat whole cover, if provided, also reduces the amount of light entering the pit. This leaves the vent pipe as the only source of light. The fly screen is very important as it prevents flies, mosquitoes and other insects from going into the latrine. It also prevents flies from escaping from the pit to the atmosphere. The cheapest and most suitable screen is the PVC-covered glass fibre with a mesh of not than 1.5mm square. A standard metal fly screen may be used, but it tends to rust very fast and this reduces its life (see the Appendix, Figure 5.5: vent piper with fly screen).

5.4 Other Types of VIP Latrines

There are three main types of VIP latrines:

- single pit,
- double pit and
- multiple pits.

The single pit latrine is suitable for single families and rural areas where the pit can be dug as deep as required. A double pit latrine is used where pit cannot be dug deep enough due to rock or because of the high water table underground. An alternating double pit latrine may also be adopted where two adjacent pit are used alternately so that while one pit is in use, the other is resting. In this arrangement, when one pit is full, the squat hole is blocked and the other pit opening. The filled latrine is allowed to rest for a minimum of one year while the pit contents are breaking

down through anaerobic oxidation, after which the pit contents may be used as manure. The double pit must be completely separate from each other and each pit provided with its own vent pipe. Since pit contents are removed after settling, the latrine is very suitable for urban and densely – populated areas where digging of new latrines may not be possible. The multiple pit is a suitable technology in situations where there are many users (schools, market places, etc.) and where single pits are too expensive. The facility is made of a trench dug as long as necessary and on top of which are placed the required latrine compartments. The compartments must be partitioned from top to bottom so that there will be complete separately so as not interfere with pit ventilation (See the Appendix, Figure 5.6: Alternative double pit latrine).

6. Trench Latrine

The trench latrine comprises of a trench dug about 600mm deep and 400mm wide. Dug up earth is heaped on one side so that the other side of the trench will be for the access. Stepping boards or timbers are laid across the trench. Alternatively, wood planks supported by logs may make a temporary floor. Instead of a permanent superstructure, screens are provided of hessian sacks, cartons or timber. If the weather is rainy, a simple roof may be provided.

Trench latrines may be used where a settlement or camp is dug to stay for a short time (less than one year) and where provision of a pit latrine would be very expensive. They are used in military camps, construction camps, school outing camps, etc.

Each person using the latrine is expected to scoop a bit of the earth heaped at the side and cover the excrement. The earth then breaks down the excreta using numerous organisms. Soil also serves as a deodorant to mask the odour of the excreta. To ensure that excreta are covered all the time, a night soil operator may be employed by the management to undertake the task. After the camp is pulled down, the superstructure is dismantled for use somewhere else, and the trench is covered with the remaining soil.

The advantage of a trench latrine is that it is cheap to build, especially for temporary settlements or camps. However, there are several disadvantages. A trench latrine grossly pollutes surrounding ground and is likely to pollute water, especially during the rains. It attracts flies and other vermin and is a nuisance because of odour. There is unsightliness due to improper covering of excreta or from excreta left uncovered for a long time.

7. Bucket Latrine

7.1 Introduction

Bucket latrines are still used in Africa, south-east Asia and western pacific countries, whereas in other parts of the world, they are becoming obsolete in favour of more modern and hygienic types. In this system, excreta are deposited into a bucket which is emptied once a day and cleansed for use again. In Kenya, collection usually takes place during the night to avoid the odours and other health nuisances that may arise

from this operation. For this reason, it is usual to refer to the contents of the bucket as “night soil”.

7.2 Design

The bucket is normally made of seamless galvanised iron. It is commonly about 375 mm diameter at the top, 300 mm at the bottom and about 300 mm deep. It is provided with handles on both sides to facilitate lifting and empting. It is placed in a collection chamber below a squatting plate or seat. The chamber is normally built of brick, concrete or even timber. Most chambers open to the rear of the latrine, into the service lane behind (commonly referred to as the “sanitary lane”). In some cases, there is no collection chamber but instead only a seat provided above the bucket. Under normal circumstances, two buckets are provided so that during cleaning, the full one is replaced with the clean one.

The superstructure is built in the same manner as that for an ordinary pit latrine. It is, however, provided with an opening at the back of the chamber through which the full bucket is removed. The floor should be made such that a channel is provided to drain urine and wash to the back where a soak pit is provided.

One advantage of the bucket latrine is that it offers means of collecting night soil which may be used as manure. It also serves as an alternative excreta disposal system in areas with unsuitable soils. The initial construction cost is low, it can be constructed of local materials and it requires modest labour to construct.

There are many disadvantages to using bucket latrines. They are very expensive to operate and maintain. It is extremely difficult to obtain labour due to the social stigma attached to the job, and operators are always at risk of contracting infecting. The collecting chamber is rarely fly-tight, and the access door at the back is not always fly-proof due to rapid rusting at the hinges and edges. It is usually difficult to locate a suitable site for disposal due to spillage, lack of sufficient water, fly breeding, odour and rodent infestation (See the Appendix, Figure 5.7: bucket for a bucket latrine; Figure 5.8: superstructure for bucket).

8. Chemical Closet

Excreta can be deposited into a tank containing water and a chemical such as caustic soda. This chemical disinfects and liquefies the excreta. It also kills egg of various worms. The chemical closet system in use these days is more like a water carriage system than a conservancy system excreta are flushed through a closet pan into a tank fixed below it. In the old system, the seat was provided and excreta were deposited straight into a tank of water. This type of latrine (toilet) is commonly used in aircraft, ocean liners, long-haul buses, caravans, camps, etc. and even be used in individual houses. When the tank is full, or if the craft, vessel or vehicle reaches its destination, the contents of the tank are discharged into an existing sewerage system.

With proper operation, this toilet can be very satisfactory and can even be used inside a house. It is the most suitable system in planes, ships, etc. However, there are some disadvantages. It cannot withstand abuse; only absorbent tissue may be used. It is expensive to construct and maintain. If poorly maintained, there can be serious odour nuisance. Discharge into public sewers may cause flooding and shock

loading. The tank used is usually too small for communal use such as in markets or schools (see the Appendix, Figure 5.9: chemical closet (portable)).

9. Pour Flush Latrine

9.1 Introduction

A pour flush latrine uses water to transport excreta from the receptacle to the disposal pit. There is water seal which makes it hygienic. The pit is provided either at lower side of the latrine or under the receptacle. It is therefore more like the water carriage system, but instead of using the flushing apparatus, water is poured into the receptacle to push excreta into the pit. This is a system that is very convenient where there is no adequate piped water. It is also convenient for those persons who use water for anal cleaning.

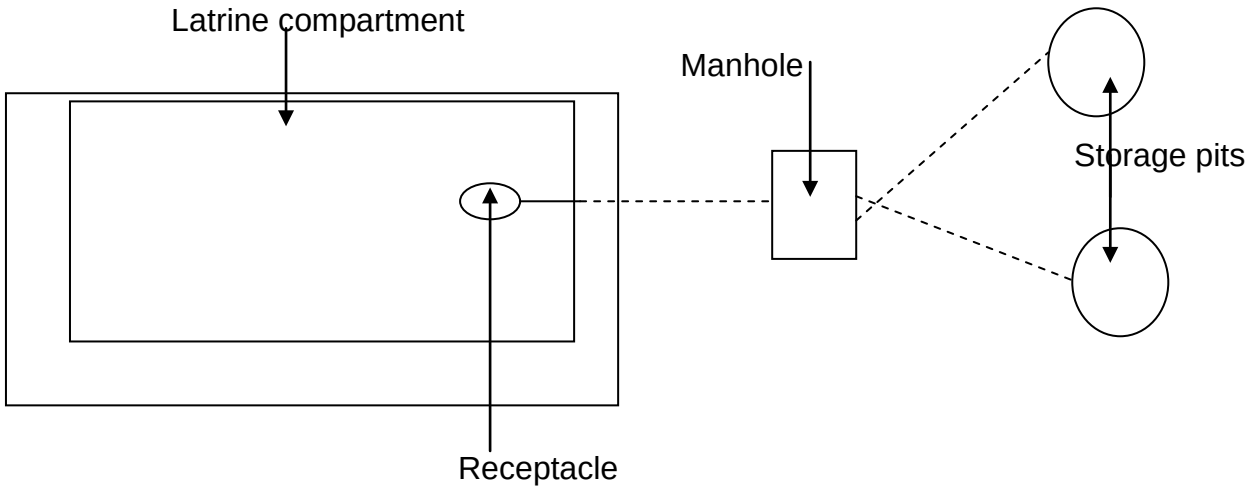

Figure 5.10 Pour flush latrine

The system components comprise of a flush bowl or receptacle, a pit and a superstructure. A pour flush bowl or receptacle may or may not be of pedestal type. Water forms a seal in the trap below the bowl and is an integral part of the bowl. The receiving pit may be directly below the bowl or a few metres from the latrine. Two pits may be used alternatively. Where pits are located away from the toilet, a discharge pipe is provided. The superstructure should have all the requirements of a pit latrine.

The seal underneath the bowl traps water and prevents foul gases from escaping through the bowl to the latrine. After defecation, a litre of water is poured into the bowl. This water pushes the excreta into the pit leaving a little behind to form the seal in the trap. Two pits are used alternatively, so that while one is in use, the other is resting. When the pit fills up with sludge, it is then closed and the other pit opened.

The excreta in the pit are broken down an aerobically while the liquid part of the waste percolates into the ground. To prevent water logging, there should be plenty of space between the two pits.

9.2 The Pit

Two pits should be provided to be used alternatively. It takes about 2 years before a pit needs emptying. The pit may be provided directly under the bowl or bowl or a few metres away. It must be located away from any underground source of drinking water. The volume of the pit is determined by number of people using it, accumulation rate (0.02-0.06 cubic m per person per year) and the numbers of years the pits are to be used before filling up. The distance between pits should be as far as possible and never less than their full depth with bricks, stone or concrete. Open joints or leaching holes must be provided to allow water seepage into the ground. Where the water table is high, over-the-ground pits or tanks may be provided.

9.3 Cover

The pit is usually with a reinforced concrete slab with a bowl placed at the centre of the slab.

9.4 Bowl, Pan or Receptacle

The bowl is usually 450 mm long and about 200 mm wide and oval or pear-shaped. The outlet is located at the rear, and the bottom slopes at any angle of 25 degrees to 30 degrees towards the back. Materials for the bowl may be cement mortar, glass fibre, glazed ceramic or moulded plastic. Where people prefer to sit, a pedestal unit may be provided. The trap should have the depth of seal of a minimum of 20 mm and an outlet of a minimum 70 mm diameter.

9.5 Discharge Pipe

The pipe should be a minimum 75 mm diameter and have a slope of 1:30 to be self-cleaning. It should be as straight as possible. Materials may be PVC, asbestos cement, cast iron or any other corrosion-resistant material. Where the pipe enters the pit, it should protrude a distance of not less than 100 mm to prevent excreta from running down the wall.

9.6 Superstructure

The superstructure should be a minimum of 0.8 wide and 1.0 m long. It should be made of locally available materials: bricks, blocks, stone, mud brick, timber, etc. The roof should be a minimum of 2 m high.

This is low-cost sanitation technology. It can be placed inside the house, as there is a water-sealed trap under the bowl. This is a very adaptable system in that it can suit many situations. It can be placed in the upper floors of multi-storey buildings; pits can be placed under footpaths or roads, etc. There is no nuisance from odour or flies. It can easily be upgraded to a water carriage system when the supply of water improves.

One disadvantage is that the system requires a constant supply of water. Bulky anal cleaning materials may cause blockages. It may not be successful in adverse areas with rocky ground, a high water table or very impermeable soils; it is likely to pollute ground water. Though it can be built in densely-populated areas, the pits must be accessible for emptying by vehicles.

10. Ecological Sanitation (ECOSAN)

There are two types of modern systems of waste disposal where both urine and faecal matters are put into economic use, e.g. Dried or composed faces are used as fertilisers in the farms, and production of biogas, etc.

Urine diverting toilets (UDDT) is a method where urine is collected in the tanks and stored, then later sprinkles in the farms. This is the new modern system of disposal adopted and being implemented by both Water Services Trust Fund & GTZ in conjunction with Ministry of Water and Irrigation and other stakeholders.

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Water Services Trust Fund

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Appendix

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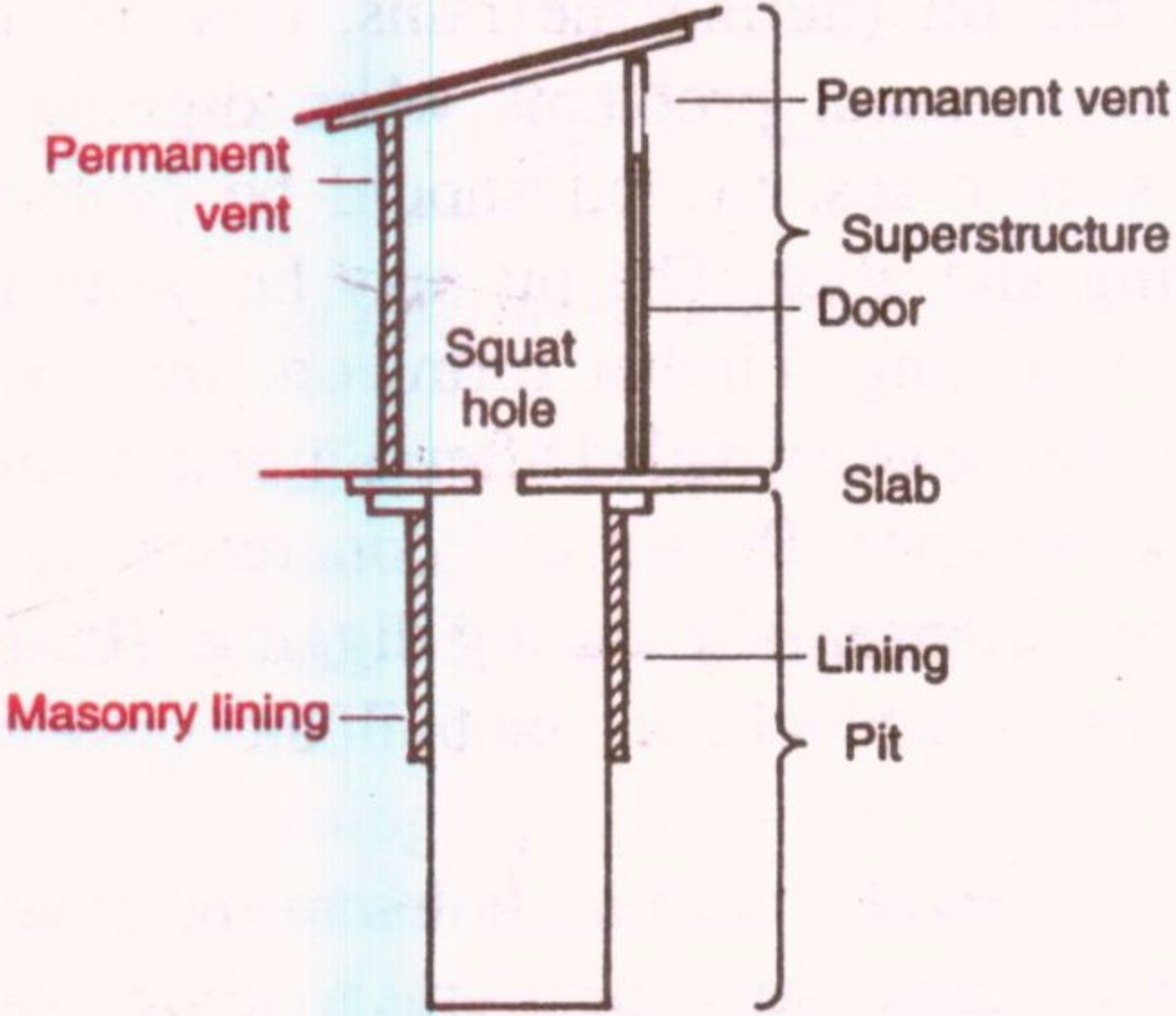

Figure 5.2 Pit latrine

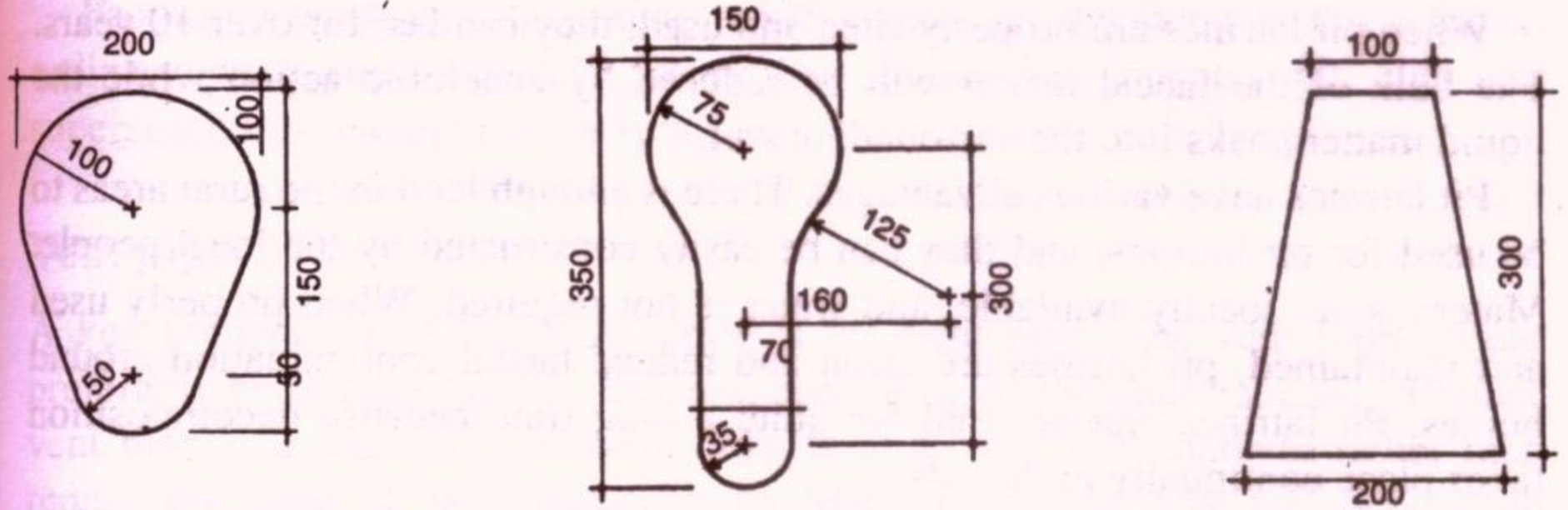

Figure 5.3 Shapes of apertures (measurements in millemetres)

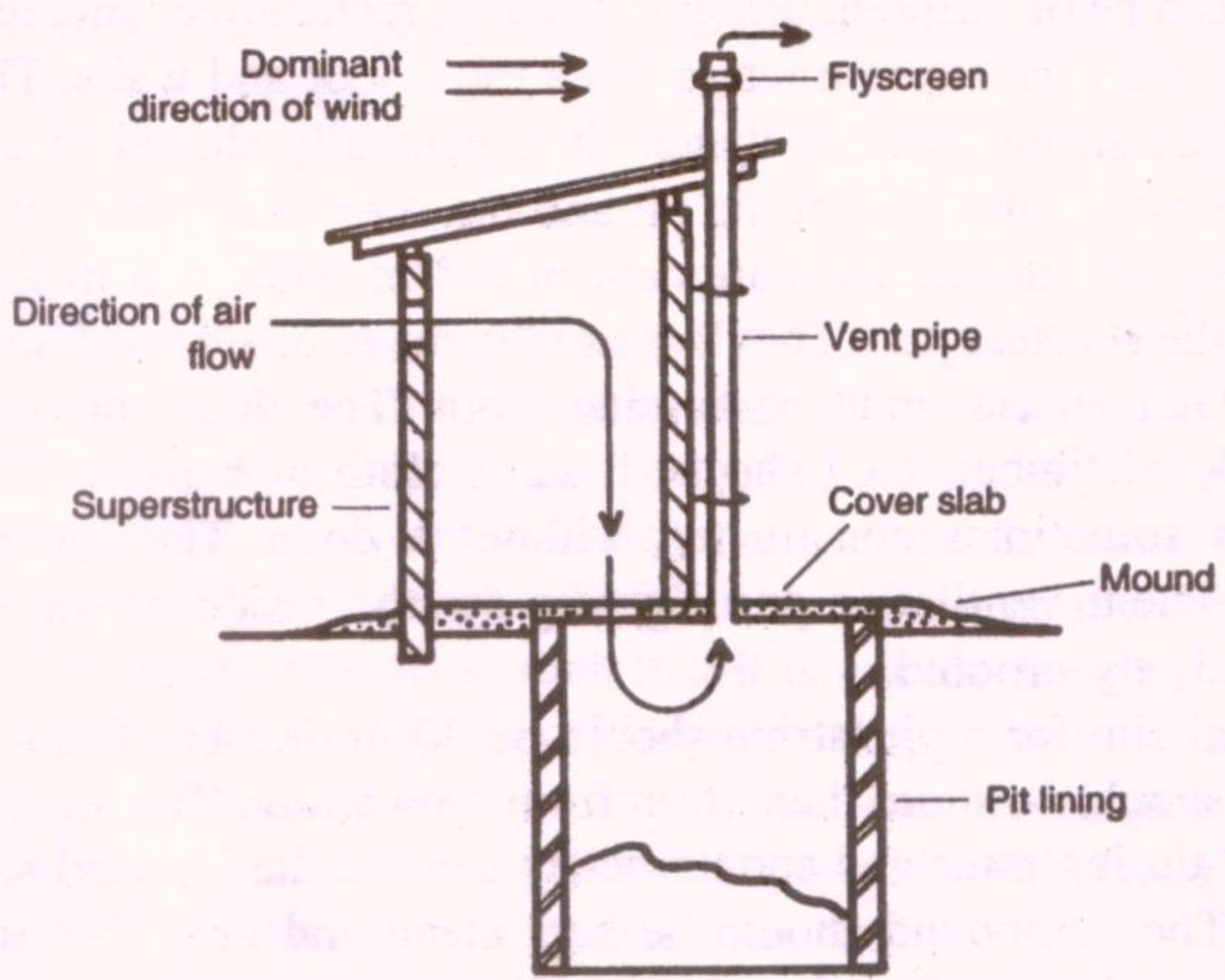

Figure 5.4 VIP latrine

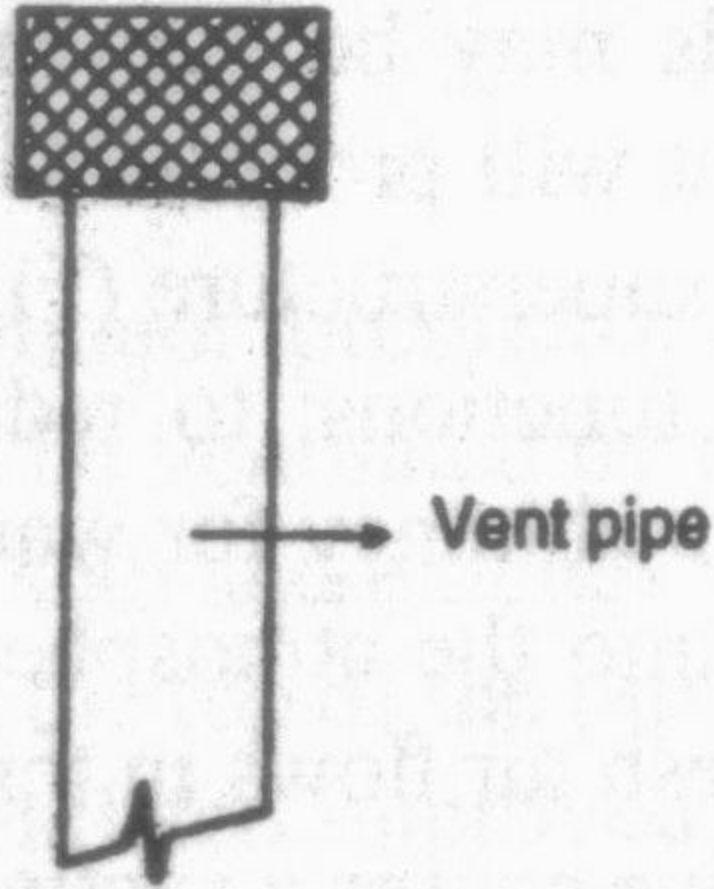

Figure 5.5 Vent pipe with fly screen

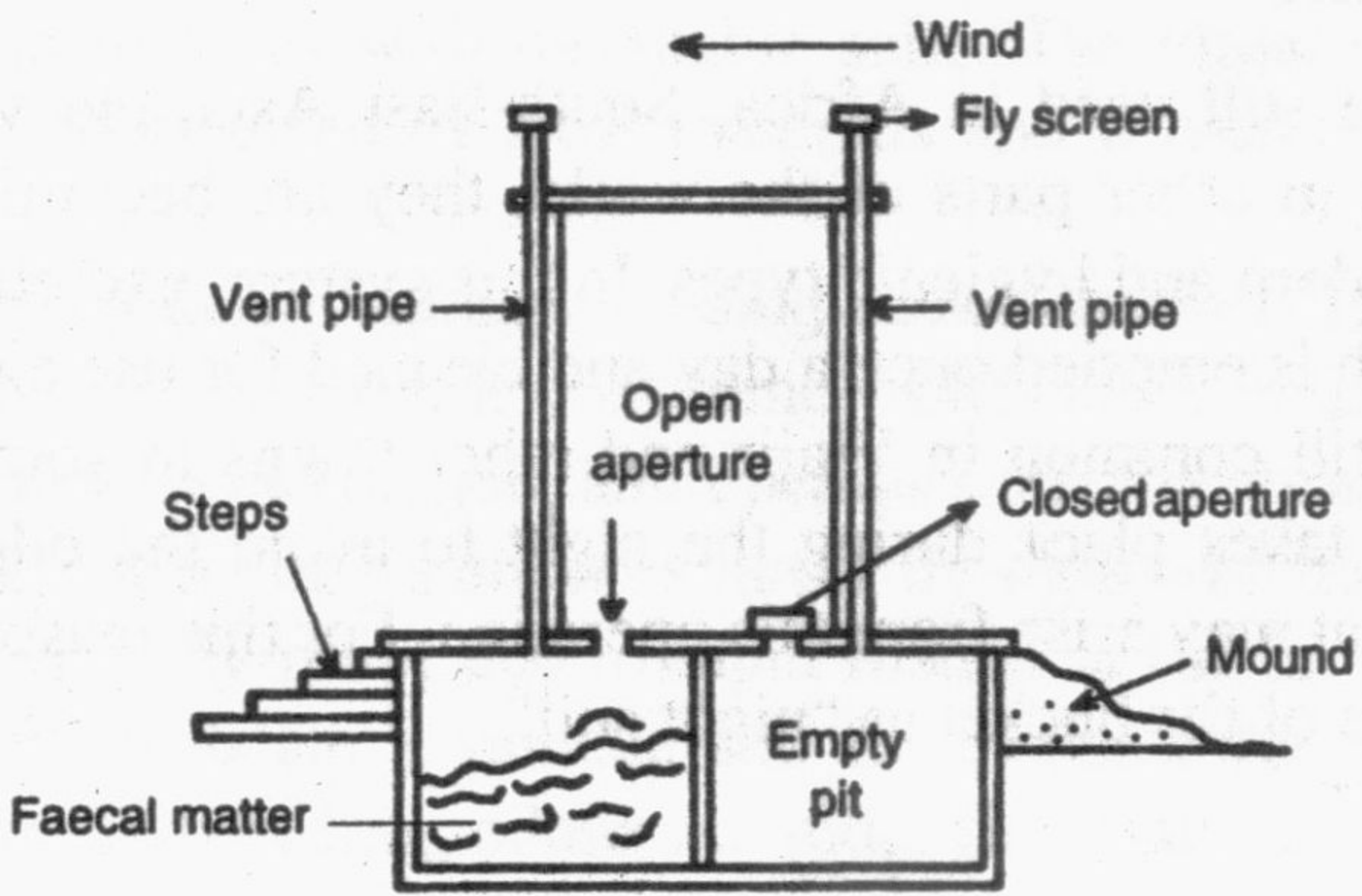

Figure 5.6 Alternating double pit latrine

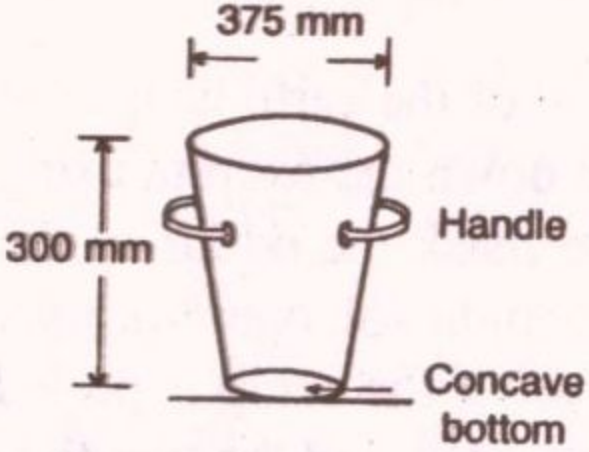

Figure 5.7 Bucket for bucket latrine

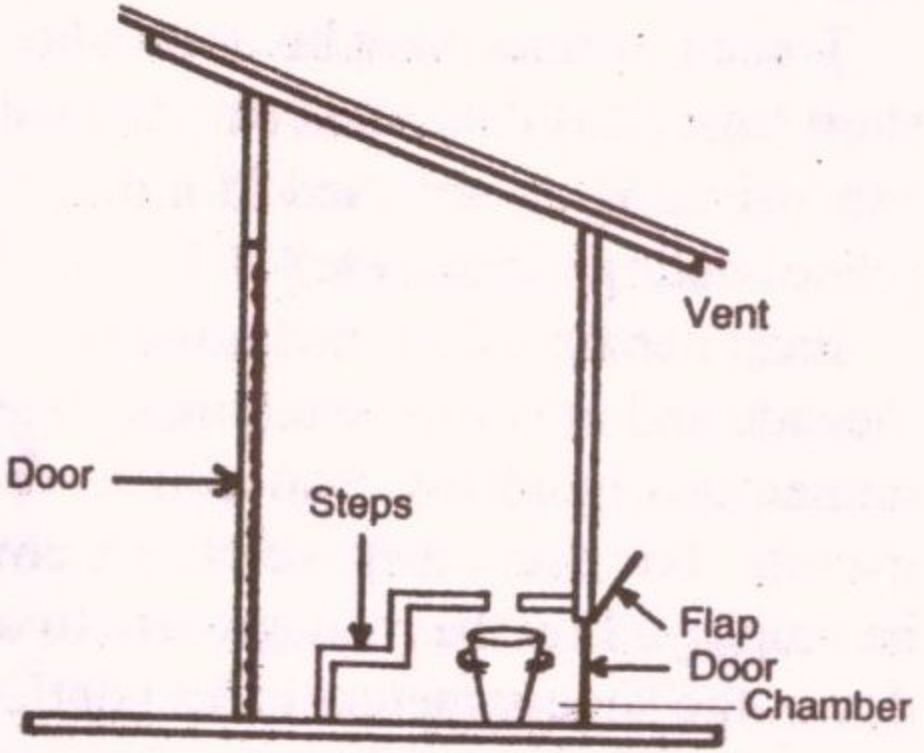

Figure 5.8 Superstructure for bucket latrine

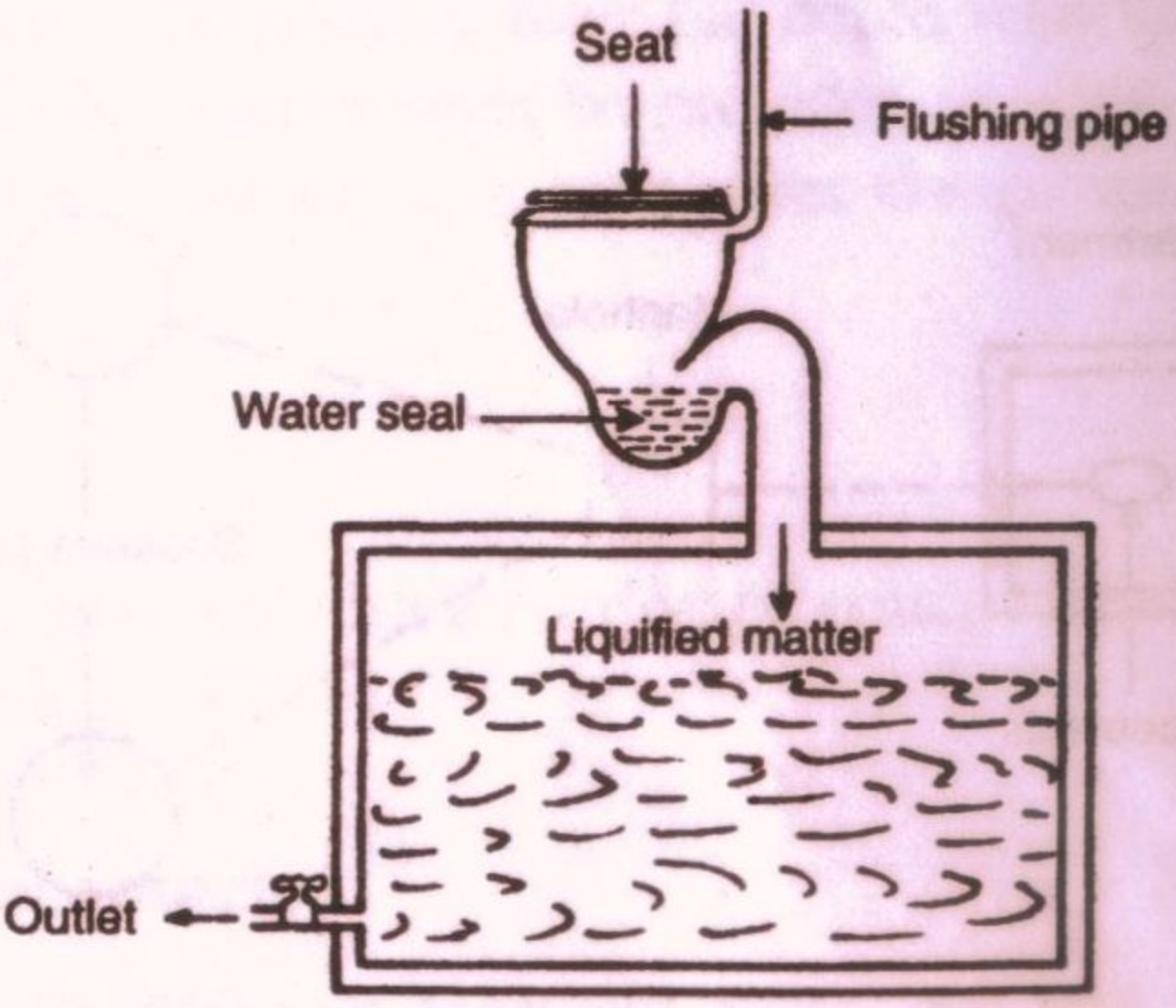

Figure 5.9 Chemical closet (portable)

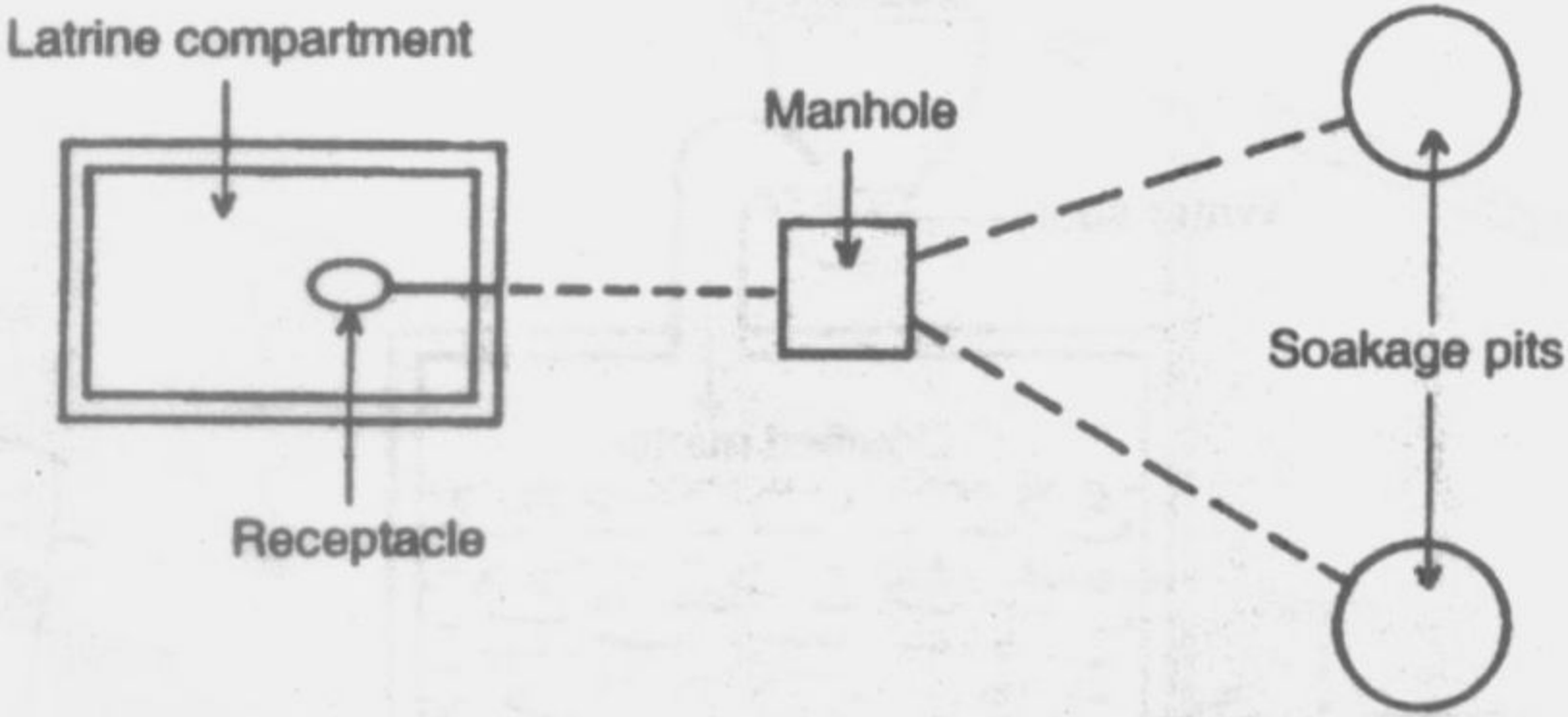

Figure 5.10 Pour flush latrine