

ENVIRONMENTAL HEALTH

HUMAN WASTE DISPOSAL

Man discharges into the environment waste substances grouped as:-

- a. Human excreta (urine & faeces) – Sewage (night soil).
- b. Solid waste and industrial wastes

This is spelled out in the Kenya's Public Health Act Cap 242, Sect 126, which deals with drainage and latrines. Each of these wastes exert negative impact upon specific environmental resources, namely, soil, water, food, etc.

NATURE OF EXCRETA & SEWAGE

Volume of excreta and sewage produced differ from race to race and community to community. The difference depends on factors such as diet, climate and state of health. Individual wet faecal weight vary from 20g/day per person – 1.5 kg per day. North America & Europeans produce 100 – 200 g/day, while people in developing countries average 130 – 520 g/day. Vegetarians generally have higher faecal weights than other groups and rural communities have considerably higher weights per person than the town communities. Children, adolescents and the elderly have lower faecal output than the others.

Table showing wet faecal Weights in the World

average wet faecal

<u>Subject</u>	<u>No.</u>	<u>Wt-g/day/person - range</u>	
<u>U.K</u>		<u>μ</u>	<u>range</u>
Naval rating & wives	15	104	39-223
Teenage-boarding – sch.Pupils	9	110	71 – 142
Vegeterians	24	225	71 – 488
Hospital Patients č added fibre	6	175	128 -248
Laboratory staff	4	162	123 – 224
Medical Students	33	132	

Medical Personnel	11	107
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U.S.A

Cincinnati	5	115	76 - 148
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Philadelphia-Black	10	148
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-White	10	192
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San Francisco - medical personnel	5	91
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- Norwalk, volunteers	6	103
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SOUTH AMERICA

Villagers Shipibo Indian, Peru	16	520 highest
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UGANDA

Senior boarding school pupils	27	185	48 - 348
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Rural villages	15	470	178 - 980
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INDIA

Nurses	13	155
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Healthy Indians	< 15 yrs	36	374	50	106
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Nutrition Unit-New Delhi	< 15 yrs	514	311	19 - 1505
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MALASYIA

Chinese - urban	1	227	180 - 270
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Chinese - rural	10	489	386 - 582
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**SOCIAL & BIOLOGICAL PUBLIC HEALTH PROBLEMS ASSOCIATED WITH
MANAGEMENT OF HUMA EXCRETA**

SOCIAL	BIOLOGICAL
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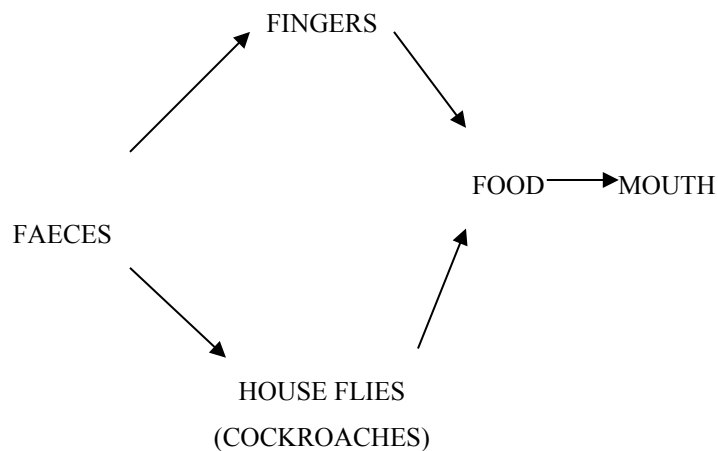
1. Surrounded by many taboos e.g.	malodorous – having ill smell
a) Bucket emptiers are considered outcasts	
b) Use of latrine by all members of the family may not be accepted	Contains disease pathogens
c) Witch craft – Enemy who gets your faeces may harm you	Vehicle for disease transmission
d) Bad spirits live in the pit i.e. cannot use the pit because bad spirits could kill him	Many support disease carriers, flies & mosquitoes

TRANSMISSION OF PATHOGENS FROM EXCRETA

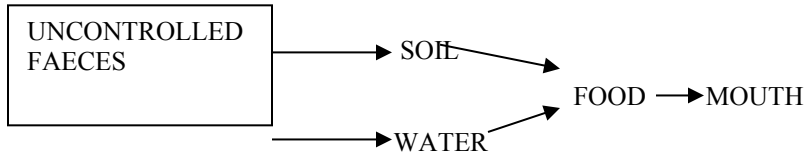
Human excreta is the major source of diarrhea diseases called gastro intestinal diseases;

A. DIRECT TRANSMISSION

This form of transmission is referred to as the Four “FS”



B. INDIRECT TRANSMISSION

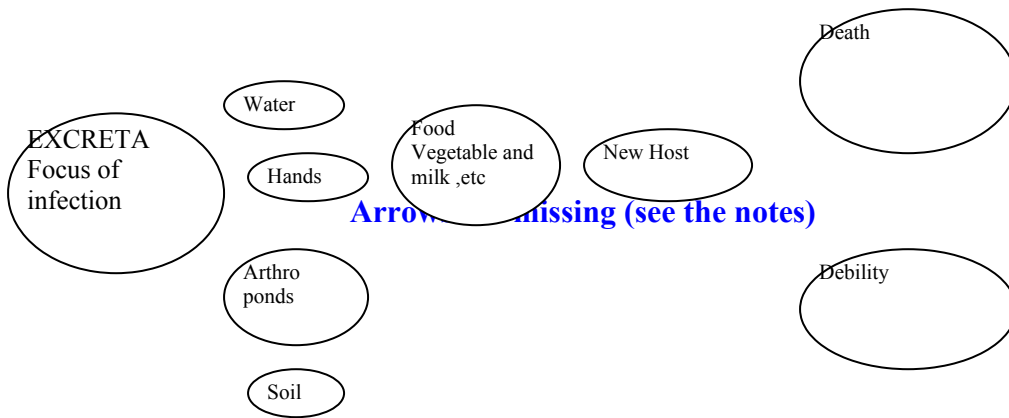


NOTE:

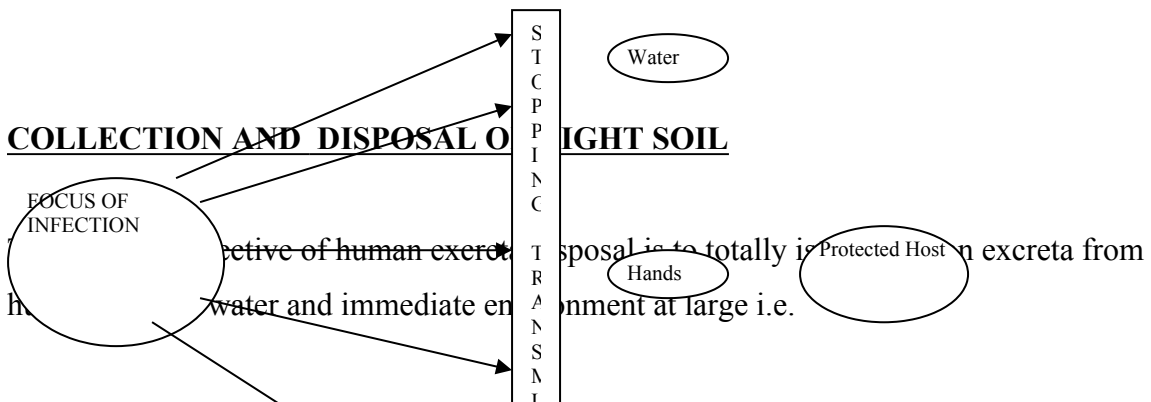
Excreta and sewage permit the breeding of certain disease vectors:-

- a) Certain fly vectors → musca domestica – trans diarrhoeas
- b) Culex mosquitoes → C. pipiens – breeding in Pits/Latrines – Filariasis (Elephantiasis)

Channels of Transmission:



Stopping transmission by means of Sanitation



1. To prevent contamination of surface & ground water.
2. To prevent contamination of surface soil.
3. To prevent accessibility of flies and animals to human waste.
4. To avoid a minimize direct handling of fresh excreta.
5. To provide privacy and convenience while relieving ourselves.
6. To eliminate bad odour, which attract flies and the unpleasant sight of areas defiled by human excreta.

Note: Choice of particular disposal system must satisfy the above objectives.

Points considered prior to selecting a particular system

1. Climate & nature of soil formation in a given area.
2. Type of construction material availability and the cost.
3. Financial capacity of the community to support a specific excreta system disposal.
4. The prevailing habits and customs of the community i.e. awareness of the dangers of human excreta as an imminent source of disease.
5. The aptness of a particular system; to install, to use and to replace when need arises.

Basically human waste disposal systems are divided into two types:

- a) Non-water carriage system
- b) The water carriage system

TRANSPORT SYSTEMS	NON TRANSPORT SYSTEMS
(WATER CARRIED)	(NON -WATER CARRIED)
<ol style="list-style-type: none"> 1. Flush toilet – Connected to sewer line 2. Flush toilet – Connected to septic tank 	<ol style="list-style-type: none"> 1. Bucket latrine 2. Pit latrine (V I P L)

<p>3. Aqua Privy</p> <p><u>Note:</u> i) Flush toilets are more expensive ii) 80% of the cost goes to reticulation, i.e. collection pipes network</p>	<p>3. Compost Latrine</p>
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RURAL SYSTEMS

1. PIT LATRINE

Commonly used in many parts of the developed and developing countries.

(a) Shape & dimensions:

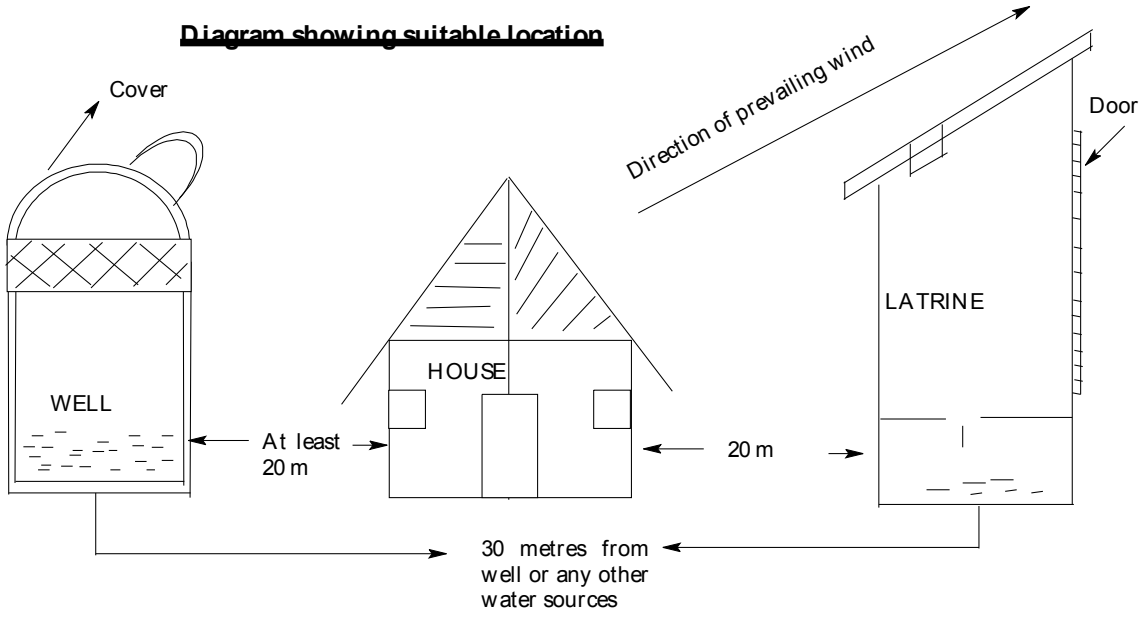
Vary from place to place. Generally circular in shape, 80 – 120 cm in diameter with depth varying from 2.5 – 5 or more metres. Not less than 2.5 m; otherwise would promote breeding of houseflies (*Musca domestica*).

(b) Sitting of the pit latrine:

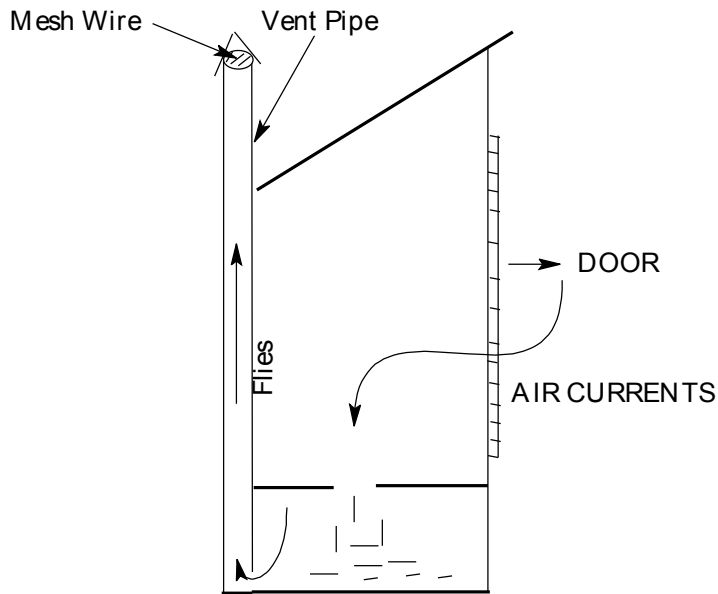
Proper location depends on several factors:-

- (i) For greater convenience near the home minimum 20m & maximum 50m. If too near the house it would create fly and smell nuisance. If too far it is not used regularly (regular use is reduced).
- (ii) From sanitary point of view (which is the most important factor), the pit should be located below the level of any well or water source, minimum distance of 20 – 30m and on the upward or leeward side and 1.5 metres above the ground water table only if the soil is uniform or free of cracks.

Diagram showing suitable location



VIPL



How the system works

Flies enter via the squatting hole, lay eggs and hatch. Adults escape but are prevented by wire mesh. They escape upward the vent because it is the only place they see the light. They bounce back & forth until they die. Air-smelly air is suctioned by the outside air moving over the vent.

Advantages

1. Contains the fly – hence reduces incidences of diarrhea diseases. They can be located near the house.
2. Controls the odour – hence can be located as close to the house as possible.

Advantages of having a Pit latrine

- a) If constructed according to the specifications used and maintained properly it satisfies the basic objectives of correct excreta disposal.
- b) It is relatively easy and cheap to construct.

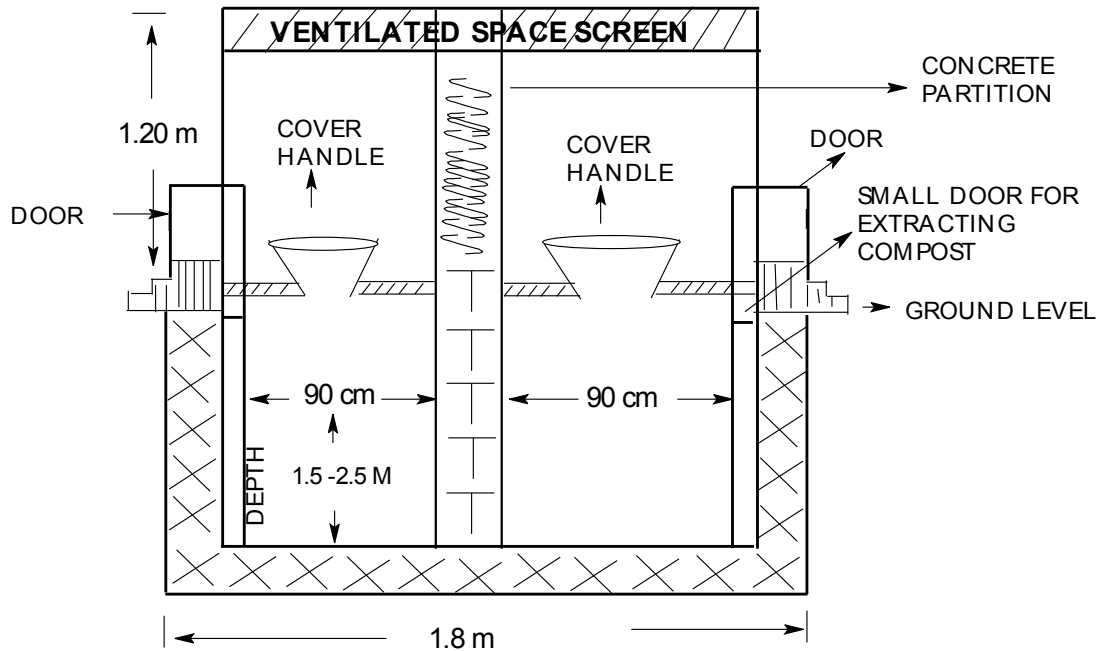
Disadvantages of a Pit latrine

- a) Not suitable for crowded town areas but appropriate for rural areas because there is space.
- b) Cannot be constructed in – rocky areas
- areas with high H₂O table.
- c) Sometimes act as breeding place for mosquitos particularly culex-piapiens.

2. COMPOST LATRINE OR DOUBLE-VAULT LATRINE

The term compost refers to decomposition of organic waste such as garbage, human excreta into suitable fertilizer. Hence it is a biological process brought about by aerobic and anaerobic bacteria.

This is practiced in Far East
China
Vietnam

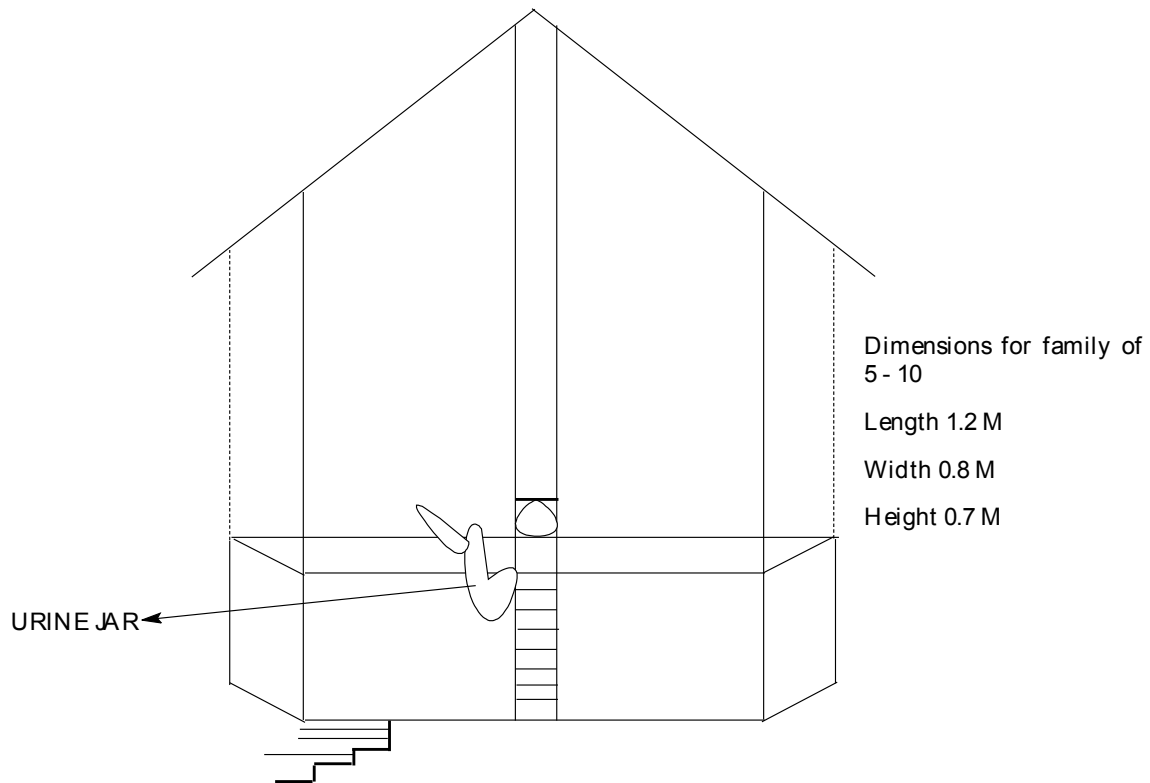


This method if properly practiced, it has two advantages;

- (a) It prevents spread of excreta borne diseases.
- (b) It provides compost i.e. soil fertilizer

One compartment is used and after it is filled, the other is used. The filled one is sealed with heavy unremovable material and left undisturbed for 6 – 9 months and then the compost is shavelled out. If correctly operated the temperature generally reaches 60° c -

70° c and the heat destroys all the pathogens in the excreta. A small door 30 cm by 30 cm for extracting compost is installed and sealed off until removal of compost.



Before use, the floor is sprinkled with ashes or soil and after use a scoop of ashes is added. This serves the following purposes;

- a) Absorbs moisture and prevents sticking.
- b) Facilitates decomposition aerobic and anaerobic.

The filled compartment is left undisturbed for 2 – 3 months and the second compartment is put into use.

According to Vietnamese experience, after 45 days, all the larvae of intestinal parasites are destroyed and the compost is ready to use as fertilizer.

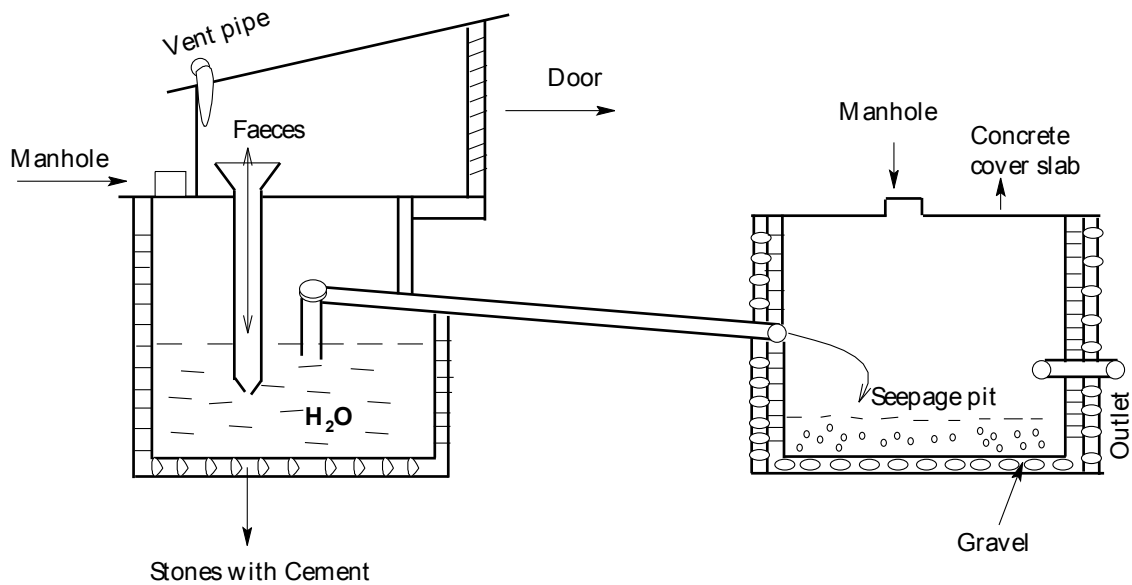
Currently there is a mass campaign to use as many as the number of homes.

SUB-URBAN DISPOSAL SYTEMS

These systems include few of the following;

- a. Aqua-privy or qua latrine
 - b. Pour – flush toilet - a water-seal latrine
 - c. Chemical toilet
 - d. Bucket latrine
- } Serve density of 100/
hectare
1 hect = 2.47 acres

a. Aqua-privy



The tank is 1.20 M long
90 cm wid
1.50 m dept

1. Ideal for 10 family members
2. Desludging 4 – 6 yrs

After each use a bucket of H₂O or 4 litres used for flushing.

Aqua-Privy literally means “Water Latrine”. The excreta is deposited into a tank containing a fixed level of water as shown.

- a) The funnel prevents flies from coming into contact with excreta.
- b) It also minimizes the smell (nuisance odour)

The drop pipe funnel is normally 10 cm – diameter and descends 10 cm below the water level. As aerobic digestion takes place in the tank, sludge settles and the liquid effluent is discharged into seepage pit. Aqua-Privy is more common in communities where water is available.

Advantages of Aqua Privy

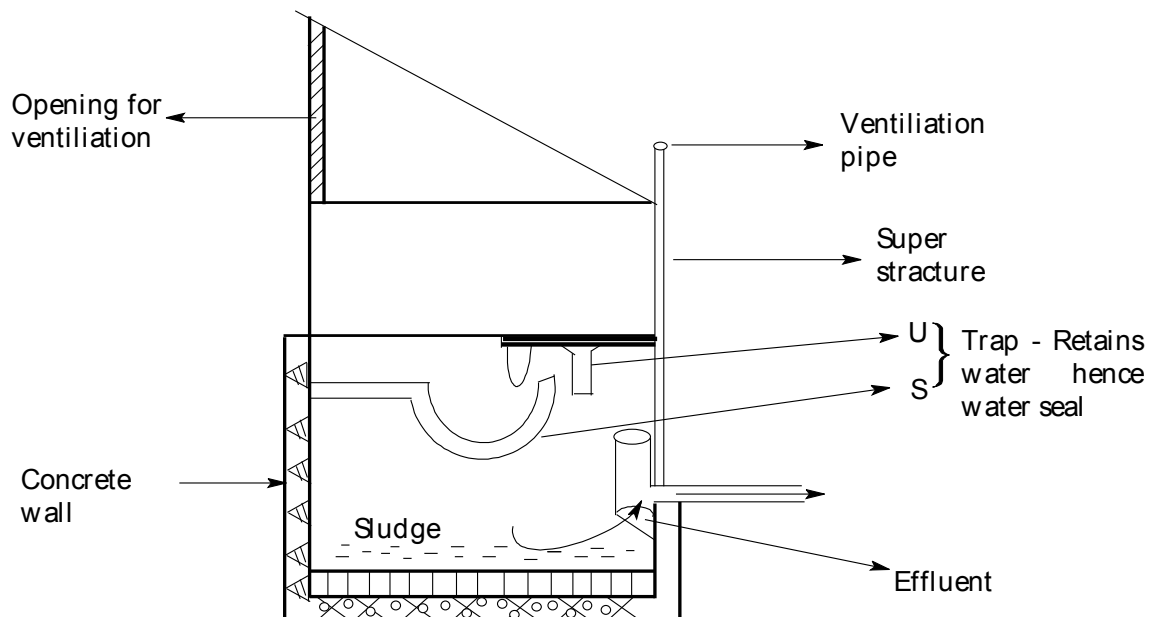
- a) If properly constructed, operated and utilized, satisfies the criteria for proper excreta disposal.
- b) Convenience – can be located as near the dwellings as possible and can be used by all ages at night & day.
- c) Saves water use, without installing flush system.

DISADVANTAGES OF AQUA-PRIVY

- a) The initial installation cost is relatively high.
- b) The system constantly needs water, though minimal.
- c) Entails effluent & sludge removal problem.

d) Requires supervision & maintenance e.g. daily flushing, periodic desludging etc.

POUR FLUSH TOILET (WATER SEAL)

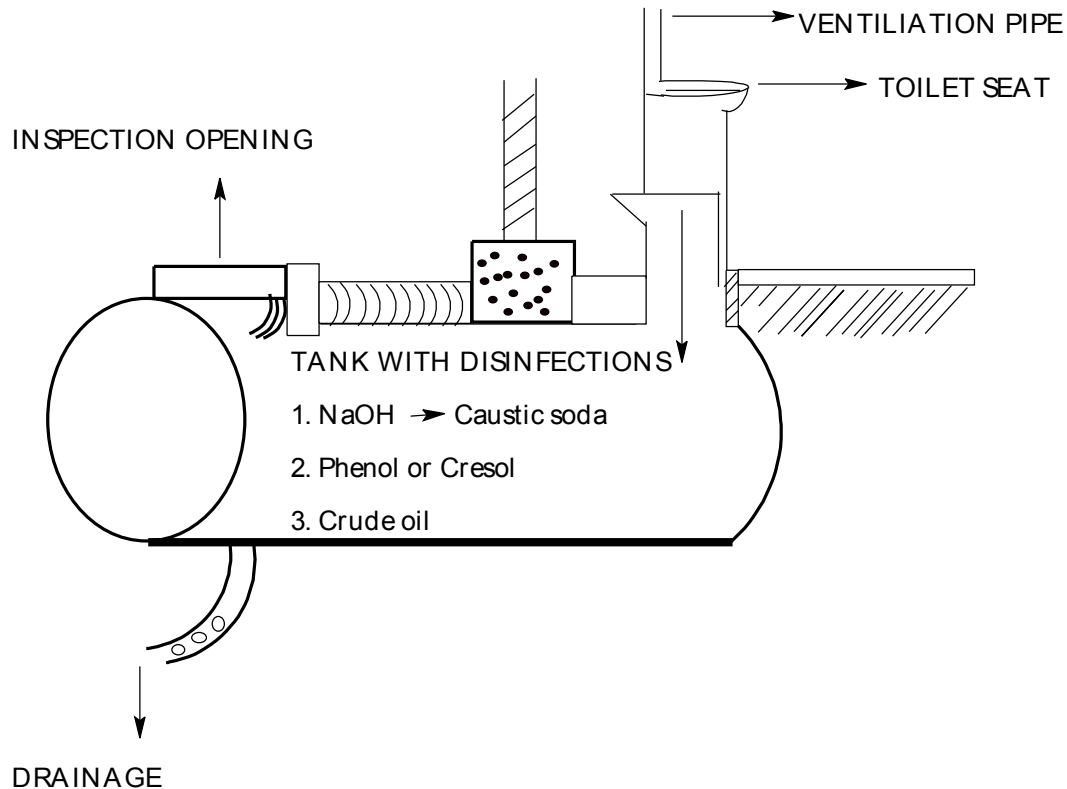


“Functions of Water Seal”

1. Controls flies and other insect vectors from coming into contact with faeces.
2. Controls/stops smell of H_2S , CH_4 , CO_2 gases from coming into the house, hence forced to escape to escape via vent-pipe.

After each use 3 litres of water is poured via the trap and moves excreta to the tank. The effluent moves via outlet “T” to an absorption seepage pit. Although the water is used, it is not a water carriage system.

CHEMICAL TOILET



The waste is deposited in the tank containing NaOH, Cresol or Phenol and bits of crude oil solutions.

1. **NaOH. Caustic Soda**: Break ups and sterilizers excreta.
2. **Phenol**: Disinfects and prevents foul smell.
3. **Crude oil**: Minimises splashing during use.

Once the tank is full, it is emptied via the drainage pipe and more of the chemicals are added. Chemical toilets can be of movable and non-movable types. Non-movables have capacities of 500 litres and contain 10 – 15 kg – soda + 50 litres of H₂O. Movable have capacities of 40 litres.

They are used in :-

- (a) Aeroplanes
- (b) Boats
- (c) Trains, motor caravans
- (d) Trailers

They are also used in isolated homes, construction sites etc.

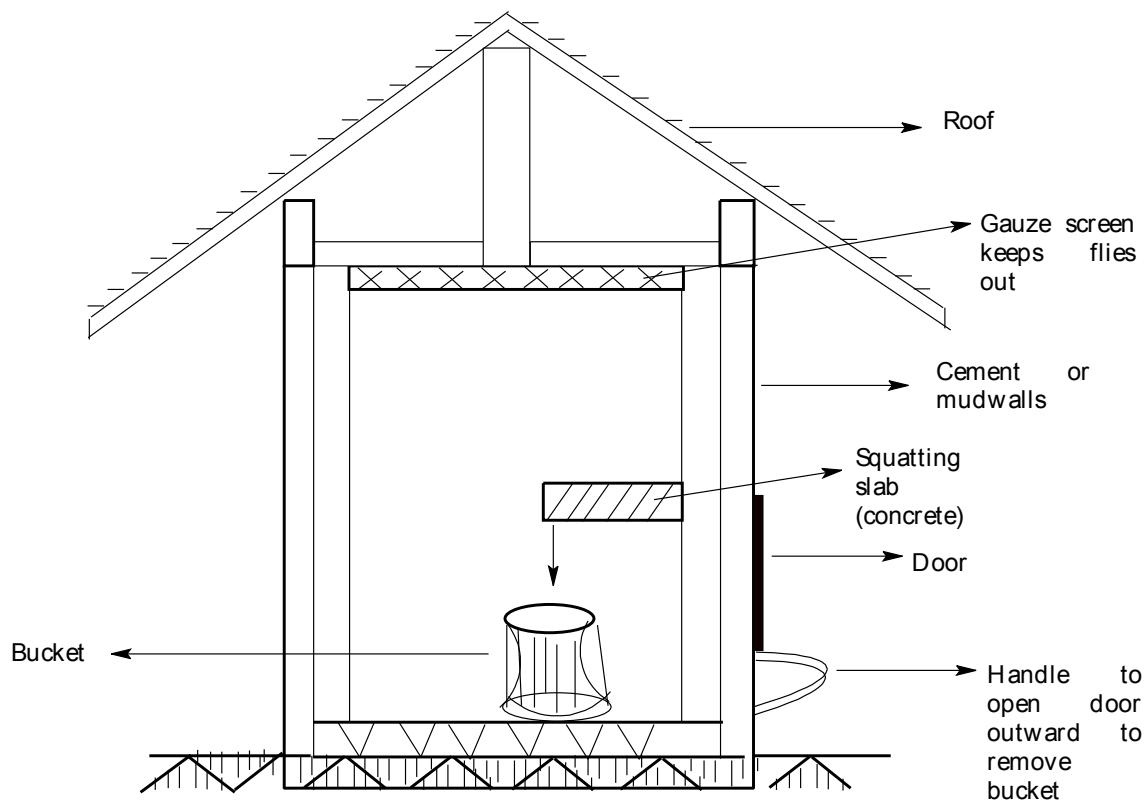
Advantages

1. If properly suited, satisfies the criteria set for proper human excreta disposal.

Disadvantages

1. Initial installation & operational expenses.
2. Corrosion – resistant tank material are expensive and difficult to find.
3. The cost of disinfectant is beyond reach by average man.

THE BUCKET OR PAIL LATRINE



They are the oldest in history and generally less hygienic. This method is regarded temporary suitable for refugee camps, army camps and small growing towns while permanent (sewer systems) solutions are underway. This type of work is an occupational health hazard, hence the workers should be protected.

Protective Clothing → Hand gloves
→ Gumboots

- Overall
- Helmet
- Musk or Respirators

Once the bucket is removed and emptied, it should be replaced by a disinfected one.

Sanitary workers load them into carts/lorries and take them to disposal site where:-

- a) Compositing is done
- b) Burial of excreta (night soil) takes place in pits or trenches
- c) Dumping into sewerline

In order to contain disease outbreaks, strict supervision is mandatory plus dedicated staff for this unpleasant work.

Health Problems associated with this system

1. It is mostly likely that it would contaminate workers and may result into disease transmission.
2. Offensive odours.
3. If buckets are not cleaned/washed under water pressure and disinfected, flies become a menace.

URBAN DISPOSAL SYSTEMS (WATER CARRIAGE)

The term as it implies, means water under pressure is used to remove the excreta from the building. Normally water carriage systems depends on the following:-

1. The installation of a piped water supply in homes.
2. The installation of sanitary fittings to receive excreta and waste water. (W. C. – Water Closet)
3. The construction of a network of pipes (reticulation) house drains, sewers etc, to collect sewage from individual houses and convey it to the final disposal site.

There are three major methods for disposing of human excreta.

- a) Septic tank system/s
- b) Conventional sewage disposal systems
- c) Natural (biological) oxidation porid systems.

These systems are the most expensive because:-

- a) They serve larger populations

- b) Sewer lines require 10 – 20 litres of clean water per flush.
- c) Require mechanical & non-mechanical treatment plant with a laboratory.
- d) Technical and non skilled workers.

The sewage is made up of 99% liquid and 1% solids. It contains thousands and thousands of both pathogenic and non pathogenic micro organisms.

As one flushes, the excreta goes through the “P” or “S” trap and finally to the treatment plant. At the plant the sewage undergoes biological decomposition processes; by the following types of micro organisms.

- (i) aerobic organisms – need O₂
- (ii) anaerobic organisms – thrive without O₂
- (iii) Facultative organisms – live in presence or absence of O₂

FLOW DIAGRAM OF CONVENTIONAL TREATMENT PLANT

PRE-TREATMENT STAGE

↓ ^{No}A proportion of Pathogens settle in the sludge ^{No}
 Large matter, rugs, babies etc. No pathogens removal.

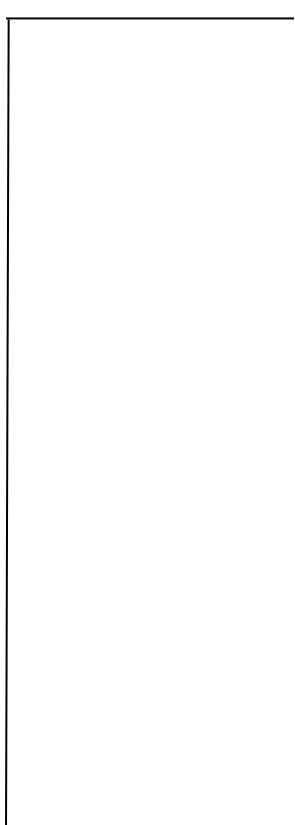
PRIMARY SEDIMENTATION

↓ 20 – 30 % of viruses are removed
 90% of bacteria in 3 – 6 hrs are removed
 50 % of cysts are removed
 ↓ 50 – 70% of helminths are removed
 30 – 50 of BOD is removed

ACTIVATED SLUDGE AND TRICKLING FILTERS

↓ This filter is like a bed small & large gravels
 Where micro-organisms attach themselves
 Hence ACTIVATED SLUDGE –meaning aerobic micro organisms
 Removes:- 90 – 99 % Virus pop
 80 - 99 % Cysts pop
 81 - 99.9 % Indicator pop
 60 – 99 % Pathogenic pop
 80 – 100 % Ova pop

SECONDARY SEDIMENTATION (HUMUS TANKS)



↓ This process is expected to achieve 94 – 100 %,BOD and Pathogen removal. Most of the effluent is water.

TERTIARY TREATMENT

↓ Deals with removal of everything and some times pre-treatment before being discharged into a stream, river or any water bodies.

EFFLEUNT DISCHARGE

SLUDGE DIGESTION



BOD – means the O_2 required to oxidize various organic chemicals in raw sewage e.g. Raw sewage O_2 demand of 300 mg/ requires 300 mg of oxygen

SLUDGE DRYING

SLUDGE DISPOSAL

SLUDGE DISPOSAL (DIGESTION, DRYING & DISPOSAL)

All the sludge from the tanks is pumped to the heated digesters. The heat facilitates the sludge digestion. Gases produced and released include Methane (CH_4) which primarily is used to heat the digesters or in the incinerator or in the laboratory. Finally it is spread out to dry and sold to the farmers as fertilizers. Therefore before the effluent is discharged off, sewage undergoes:-

(a) Physical Separation – removes large constituents

(b) Biological oxidation – decomposes giving off NH_3 , H_2S , CO_2 & CH_4 and organic acids.

DISADVANTAGES OF THIS SYSTEM

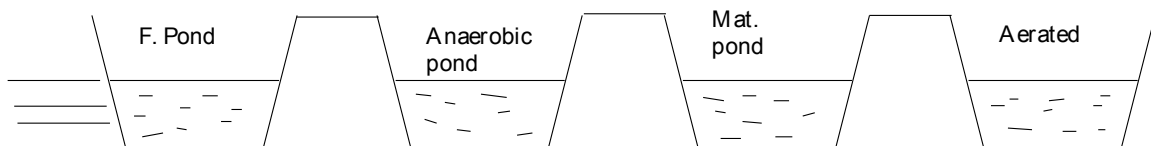
1. Initial installation relatively high.
2. Requires mechanically operated equipment.
3. Foreign exchange is relatively high since all equipments are imported.
4. Maintenance problems are prone.
5. Requires qualified personnel Engineers.
6. Requires energy in form of Electricity.
7. Does not remove as much as 90% of BOD.

SEWAGE WASTE STABILAZATION PONDS

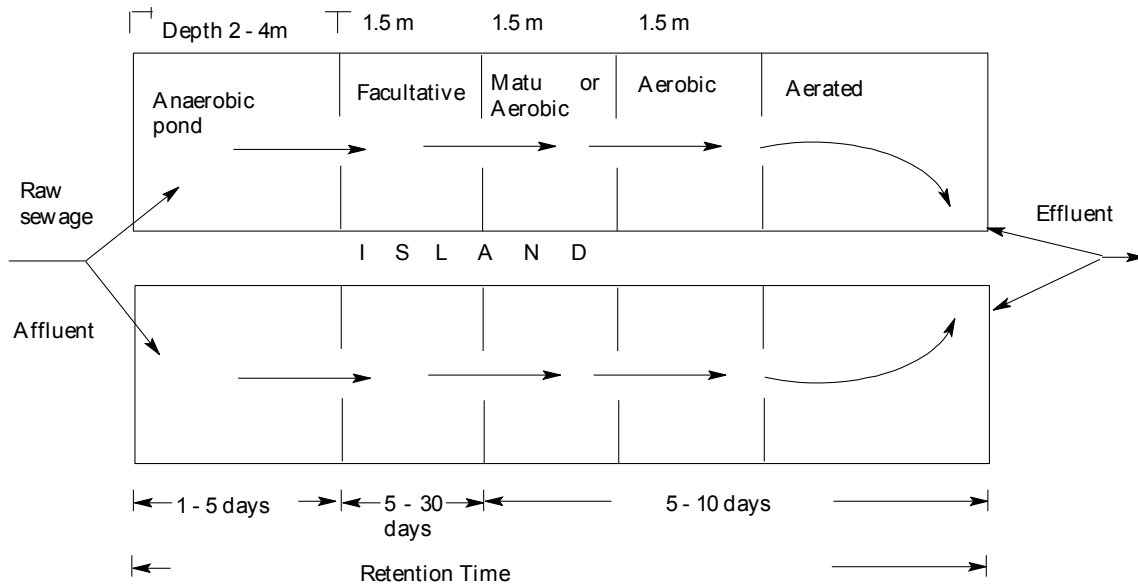
In some literature, they are referred as Natural oxidation ponds or Sewage oxidation ponds. They are the most widely applicable, appropriate and advantageous method of waste treatment in hot climates. They comprise of series of shallow lakes through with the sewage flows.

They are further divided into;

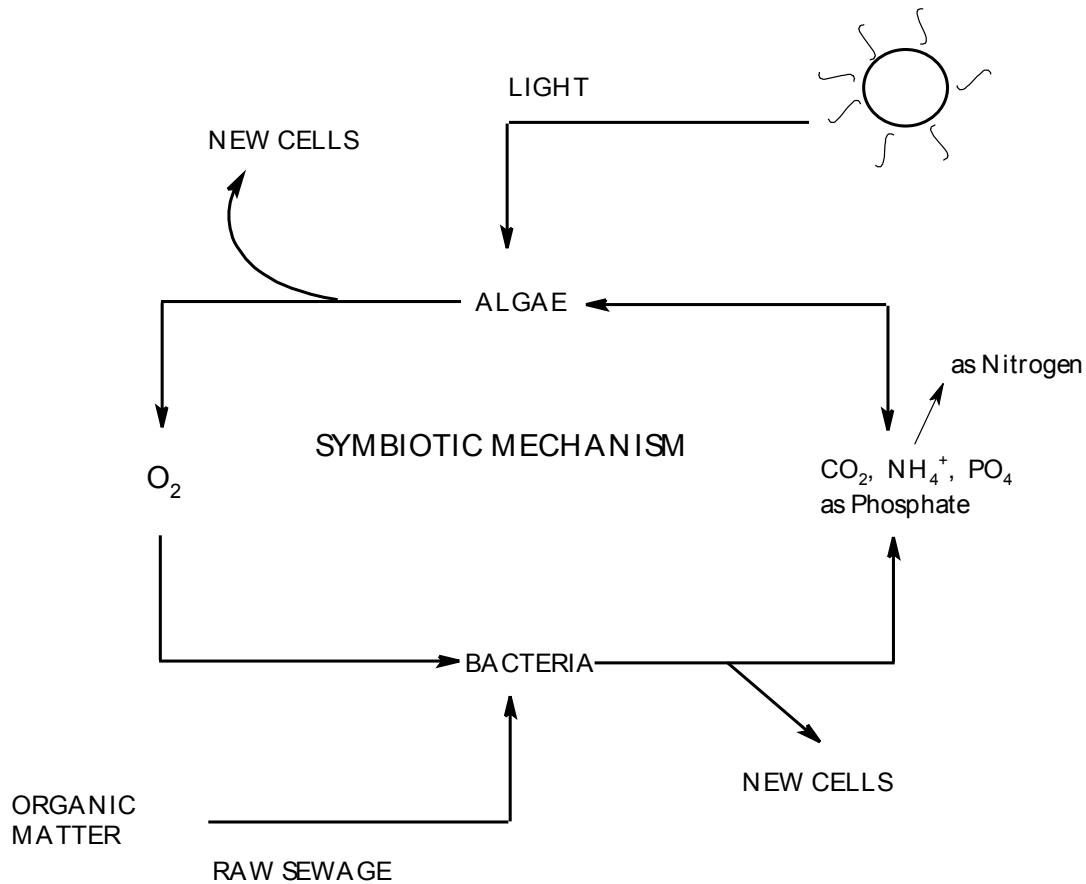
- a) Facultative ponds – Shallow pond O_2 or no O_2 by Micro.
- b) Anaerobic ponds – micro organism need no O_2 the pond is deeper than (a) one.
- c) Maturation ponds – Both aerobic and anaerobic processes take place shallow.
- d) Aerated ponds – Slanting (steep) and deep, aerobic



FLOW DIAGRAM IN SERIES



BIOLOGICAL PROCESSES IN THE PONDS



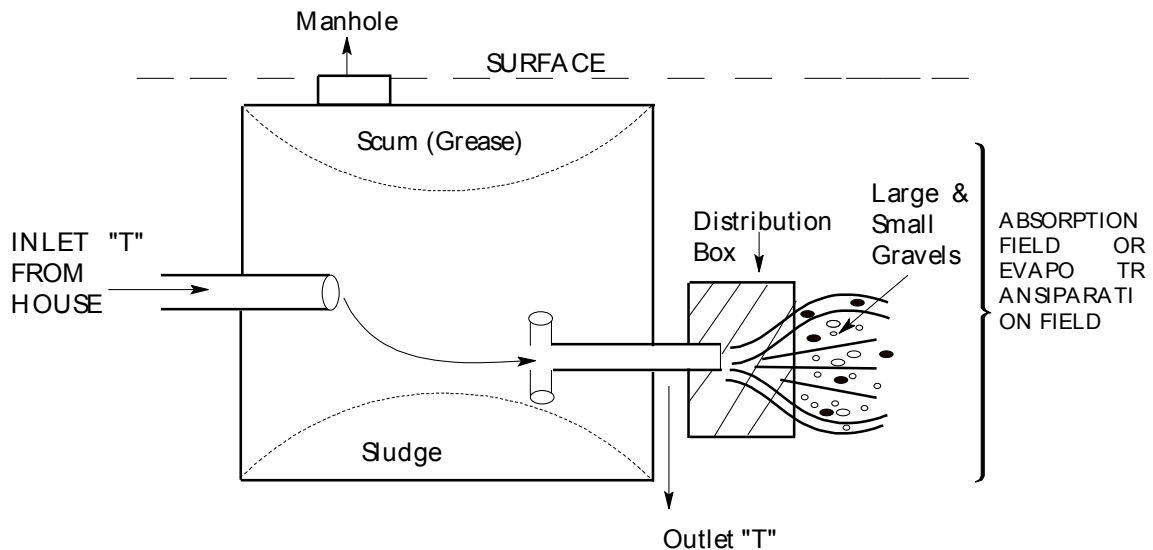
ADVANTAGES OF THIS SYSTEM

1. Cheapest, provides physical, chemical and biological process with no machinery, no energy than or except the sunlight energy.
2. Efficiency – has capability of removing 99.99% of pathogens.
 - Capability of removing 90% of BoD.
 - Hence gives effluent the WHO standard 40 mg/l of BoD.
The new WHO effluent standard is 20mg/l of BOD.
3. The ponds require no routine operation and can be expanded at minimal cost.
4. Saves foreign exchange, since no machinery is required and problems of spare parts are solved or avoided.

DISADVANTAGES

1. The greatest disadvantage is that they require and take up a lot of land. Thus a town of 50,000 requires a pond area of 15 – 20 ha's.

ASEPTIC TANK (WATER CARRIED)



A septic tank is a water tight settling system.

1. It is suitable for suburban residential areas, institutions – schools, health centres etc.
2. It is appropriate for low density areas, ~100 persons per hectare.
3. Most have capacity of 500 gallons (2000 litres), hence ideal for a family of 5 and needs de-sludging after every 3 years.

FUNCTIONS OF A SEPTIC TANK

1. Serves as a biological (aerobic) stabilization chamber.
2. A settling chamber for both solids (sludge) and grease (scum).

Advantages of the system

1. Releases effluent with few faecal solids.
2. Pathogens are reduced to minimal levels.

Problem/disadvantage:

1. If de-sludging is not done in time, it back flows to the house.

Caution :

Efficiency of anaerobes is altered if toxic chemicals are flushed in. Also temperature and P^H fluctuation kill the anaerobes. `