Technology Options

Basic choices

Sanitation choices are available in relation to:

- On-site sanitation facilities
- Disposal of household wastewater on or off the plot.
- Wastewater transport options
- Wastewater treatment options
- Wastewater reuse/disposal options

Choices or preferences at one stage in the wastewater management process will influence the viability/desirability of options at other stages in the process. In particular:

- The sanitation technology adopted will influence the quantity and quality of wastewater produced, which in turn will influence the possibility of on-site disposal, and transport, treatment and reuse options.
- The preferred wastewater reuse/disposal option will influence the type and degree of treatment required.

This note takes account of these points while providing a brief introduction to sanitation technology options. The main focus is on wastewater transport, treatment and reuse options but the main toilet options are also described, with particular reference to their impact upon the type wastewater produced. The note is divided into the following sections:

1. Toilet options (covering pit latrines, ecological toilets and water-flushed toilets)
2. Wastewater disposal and transport options
3. Wastewater treatment options
4. Options for reducing health risks associated with wastewater reuse.

TOILET OPTIONS

Toilet technologies can be classed as either "dry" or "*wet".* Dry systems do not use water to flush or transport excreta and thus do not produce wastewater. Wet systems, on the other hand, rely on water and usually produce wastewater.

The other basic sanitation choice is between those that retain wastes on-site and those that transport them off-site in some way.

Table 1 brings these options together in as simple matrix.

Table 1 - Basic matrix of sanitation options

	DRY SYSTEMS	WET SYSTEMS
ON-SITE	Various forms of pit latrine including ecosan options	WCs/pour-flush toilets connected to leach pits and via septic tanks to soakaways
PARTIALLY ON –SITE (Hybrid systems)		WCs/pour-flush toilets connected via interceptor tanks to drains and sewers.
OFF-SITE	Bucket latrines (Generally considered unacceptable on health grounds). Vaults and cartage systems. (Not currently feasible in developing countries).	WCs/pour-flush toilets connected to sewers. Cess pits and tanks (from which liquid and solid wastes are removed at regular intervals)

The key points to note from a wastewater management perspective are as follows:

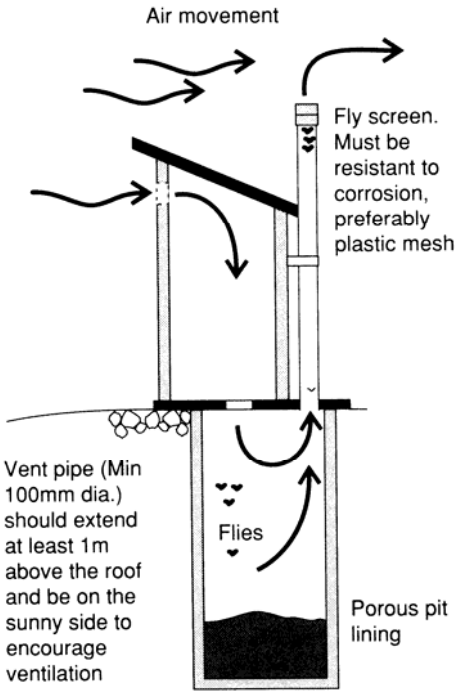
- Dry systems produce no wastewater and so off-site wastewater management is concerned only with grey or sullage.
- On-site wet systems produce black water but retain it in a pit or soakaway on site so that off-site wastewater management is concerned only with grey water.
- Off-site and partially on-site wet systems (sewers, cess-pit systems and interceptor tanks connected to drains and sewers) produce sewage, which has a high oxygen demand and pathogen content and must be managed effectively to prevent harm to health and the environment.
- On-site and partially on-site systems retain faecal solids in a pit or tank. For all but the largest pits, these solids must be periodically removed and treated.

Where there is no water connection on or close to the plot, a dry system is likely to be the only option. Pour-flush toilets are possible once per-capita water use reaches about 25 litres per person per day, which is likely to require a well or standpost located close to (say within 30 metres) of the plot. At this level of water use, on-site disposal of black water will normally be possible. Partially on-site systems can be used at water use levels not much higher than this but full sewerage, designed to transport faecal solids, requires levels of water use that only become possible with an in-house water supply.

Further information on specific toilet options is given in the pages that follow.

DRY ON-SITE SYSTEMS: PIT LATRINES

What is it? Pit latrine designs range from simple unimproved pit latrines, through ventilated improved pit latrines or VIPs (illustrated) to twin pit systems, which are designed to allow the pit contents to remove the need to handle fresh excreta and so reduce the health risks to those who have to empty pits. The basic components of a pit latrine are the pit, ideally 4-5 metres deep, a cover slab with a hole through which users defecate into the pit and a superstructure, sufficient to ensure privacy and provide protection from the weather. It must be possible to clean the slab. Partly for this reasons, most slabs are made of concrete but it is possible to use a smaller concrete 'sanplat' laid on top of a latrine cover made from wood and other 'natural' materials. VIPs develop the basic concept by incorporating a vent pipe, designed to draw in flies and smells. The flies are trapped by a screen located at the top of the vent pipe and eventually die. Twin pit latrines



When to use it? Pit latrines are the best conventional sanitation option when there is no source of water on or close to the plot so that water use is low (typically less than 25 litres per person per day). They may also be used when water consumption is higher, provided that separate provision is made for sullage water disposal. However, they ma be less attractive to users that pour-flush toilets in such situations.

Advantages: Simple pit latrines are cheap. VIPs and twin pit designs are more expensive but still cheaper than other sanitation options in low-density areas.

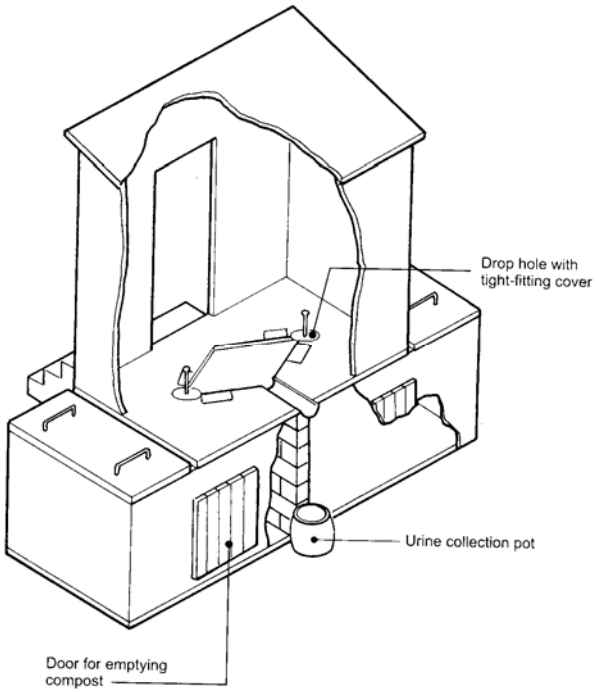
Disadvantages: Simple unimproved pit latrines may smell. VIPs should be better but users may not appreciate the need for a dark interior and may modify the superstructure to provide more light, thus undermining the basic rationale behind the design. The VIP design is very dependent on a durable fly screen and health and may give rise to insect problems if the screen fails for any reason.

Technical requirements The slab must be structurally sound. The vent pipe should extend well above the roof of the latrine superstructure, as this will ensure a good draft of air up the pipe. The screen must be made of a material that is resistant to corrosion. Access to the pit to remove the contents may be gained via removal slabs located outside the superstructure. Alternatively, a hole can be provided in the superstructure wall through which a tanker suction pipe can be introduced. See Figure 6.2). This arrangement is more likely to be effective if the pit contents are wet.

More information. The Blair Research Laboratory in Zimbabwe has developed a range of VIP designs suitable for different conditions (Morgan 1990). Information on pit latrines can be found at http://info.lut.ac.uk/departments/cv/wedc/garnet/tncpitl.html and http://www.sanicon.net/titles/topicintro.php3?topicId=22.

DRY ON-PLOT SYSTEMS – ECOLOGICAL TOILETS

What is it? Ecological toilets are dry toilets that are designed to separate faeces and urine and dispose of them separately. Most of the nitrogen contained in excreta is in the urine which, transmits few of the diseases associated with human waste. (Schistosomiasis is an exception but is only a problem in some areas). So, once separated, urine can be used as a fertilizer without treatment. A key aspect of the ecological approach is its focus on resource recovery. Rather than 'flush away' or 'drop and store' wastes, it stresses the desirability of using wastes as a resource so as to complete the ecological cycle. Some commentators advocate the addition of straw and vegetable waste to faecal wastes in order to optimize the carbon to nitrogen ratio in the waste and thus speed up the decomposition process.



When to use it? Advocates of the technology argue that ecological toilets should be used wherever possible and should eventually largely replace other forms of sanitation. In practice, consider their use when (a) there is interest in using digested faecal material, urine or both to fertilize land (b) people understand and accept the technology (c) There are few existing sanitation facilities

Advantages: An obvious advantage of ecological toilets is their potential to produce valuable resources from wastes.

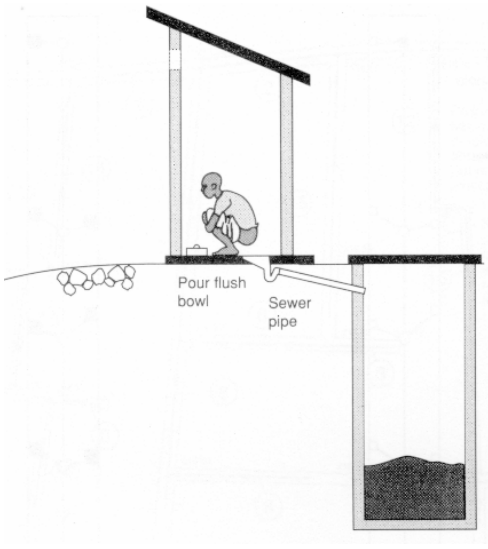
Disadvantages: Ecological toilets must be operated as designed and this places greater responsibilities on users than conventional sanitation options. They should only be considered systems to inform users and monitor their subsequent use of the latrines can be put into place. (This should become less necessary if and when they become the norm and so are generally known). People are less likely to adopt the approach when they already have a latrine, pour flush toilet or WC.

Technical requirements Most ecological latrines in developing countries have two chambers that are used alternately as in double pit VIPs. The diagram shows one such design, the Vietnamese double vault system. Many ecological toilets are or can be built entirely above ground level. This makes the design suitable for places with a high groundwater table or hard sub-surface rock. Some designs include a panel, designed to catch and transmit solar radiation and hence heat up the contents of the vault or chamber and hence their water content.

More information A newsletter, containing information on recent experience with ecological sanitation, is available in English at www.gtz.de/ecosan/docs/nl6eng.pdf.

WATER-FLUSHED TOILETS

What is it ? A water-flushed toilet depends on water to flush urine and faecal material from a pan either directly into a pit or more normally through a pipe to a pit, septic tank or sewer. All conventional designs include a trap which forms a water seal. The water may be provided from a cistern or poured from a bucket or other hand-held receptacle. Such 'pour-flush' systems are common although some commentators reserve the term pour-flush for latrines designed to operate with a small volume of flush water (around 1.5 litres as opposed to the 9 litres or more discharged from a standard cistern).



When to use it? When water is available on or close to the plot so that per-capita water use is at least 25 litres per person per day.

Advantages The most important advantages of water-flushed toilets are that they are easy to use and keep clean and that they remove faecal material from the household environment. The water seal prevents flies from entering the house through the waste pipe. From the point of view of household members, they represent a case of 'out of sight, out of mind'.

Disadvantages Water-flushed toilets produce black water, which has a high oxygen demand and a potentially very high pathogen content. The first can create severe environmental problems if wastewater is disposed of to a watercourse. The second can pose dangers to health if there is a possibility that the outflow from leachpits may pollute the groundwater table or, even more critically, may be used without treatment for irrigating crops. So, water-flushed toilets often bring private benefits but create hazards for the wider public.

Technical requirements Water flushed toilets require a bowl or pan , into which excreta are deposited and a water seal, created by placing a 'U' bend beneath the bowl. The bowl and 'U' bend can be integral or can be manufactured separately. The bowl may be designed to allow the user to squat or to sit, according to local custom. Most 'commercial' toilets are manufactured from ceramic or strong plastic materials. Some low-cost designs use cement mortar faeces will tend to hang to the sides of cement mortar bowls unless it is possible to achieve a very smooth 'mosaic' finish. Conventional toilets use a 50mm deep water seal. To reduce the amount of flush water required, some designs reduce this to around 25mm.

More information Information on conventional water-flushed toilets may be obtained from manufacturers. Little specific information is available on the design of low-volume pour-flush toilets. Country-specific information may be available from international agencies and NGOs with an interest in improved sanitation. UNICEF is often a particularly good source of information.

Options for wastewater disposal Wastewater from water-flushed toilets may be discharged either locally to a leach pit, a septic tank and soakaway or to a sewer or drain which carries it away from the plot. Local disposal and wastewater transport options are considered in the next section.