Why pit latrines fail: some environmental factors

by Robert Reed

Although pit latrines are cheap, simple to operate, and easy to manage, in certain circumstances they can be inappropriate. What planners need is a suitable, objective mechanism for choosing the right sanitation system at the outset.

MIGRATION FROM RURAL areas and large family-size has resulted in the dramatic growth of urban centres in developing countries over recent decades. Many of these new urban dwellers live in poor, cramped accommodation on marginal land. Such communities are frequently very poor, and are unable to afford even the basic services that they need. At the same time, local municipalities are frequently under-funded and under-staffed and are, therefore, unable to provide these services. Solutions have to be found which are appropriate to the particular situation and are largely affordable by the recipient community.

One of the most basic services is sanitation, particularly the disposal of human excreta (sanitation is usually considered to include the disposal of excreta, sullage — the mud and silt deposited by flowing waters — and solid waste). There are various options for the disposal of human excreta, but the most common are pit latrines (of differing types), septic tanks, and sewerage systems. There are other options, such as composting and bucket latrines, which are likely to be appropriate in only a minority of situations.

In general, the first choice for excreta disposal will be the pit latrine. Pit latrines — properly designed, located, and constructed — are relatively cheap, easy to operate and maintain, can be improved regularly, produce minimal health and environmental hazards, and can be managed by local communities with minimal input from external agencies.[1] The alternative is usually a sewerage system which is considerably more expensive to construct and maintain. It is important, therefore, that the use of scarce resources is optimized, and that sewerage systems are constructed only when necessary. This article discusses the environmental circumstances when pit latrines may not be appropriate, and suggests a mechanism for objective decision-making.

Failure

Pit-latrine failure occurs under two broad groups of circumstances: poor design, construction, operation or maintenance of the latrine; and inappropriate environmental conditions. Experience proves that the reasons listed in the first group are by far the most common. A recent study of pit latrine failures in Mauritius, for example, showed that most had failed because of inadequate maintenance.[2] A programme of pit-emptying and renovation was all that was necessary to make the latrines satisfactory, an option that was much cheaper than replacing the pit latrines with a sewerage system. When planning a new programme, however, failure due to environmental factors becomes a more important consideration. In a new scheme, the design and construction can be controlled, but environmental conditions — either at the beginning or later in the scheme's life — may indicate that pit latrines could fail.

There are a number of environmental factors that may contribute to pit latrine failure. Not all will be present at a particular site, and there may be special local factors, such as the impact of tourism, affecting appropriateness. Many of the factors are interrelated and closely connected to water consumption. These interrelationships can be seen clearly in Figure 1 (below) which shows the most common environmental factors likely to affect the viability of pit latrines; it may require amendments, however, to take account of local conditions.

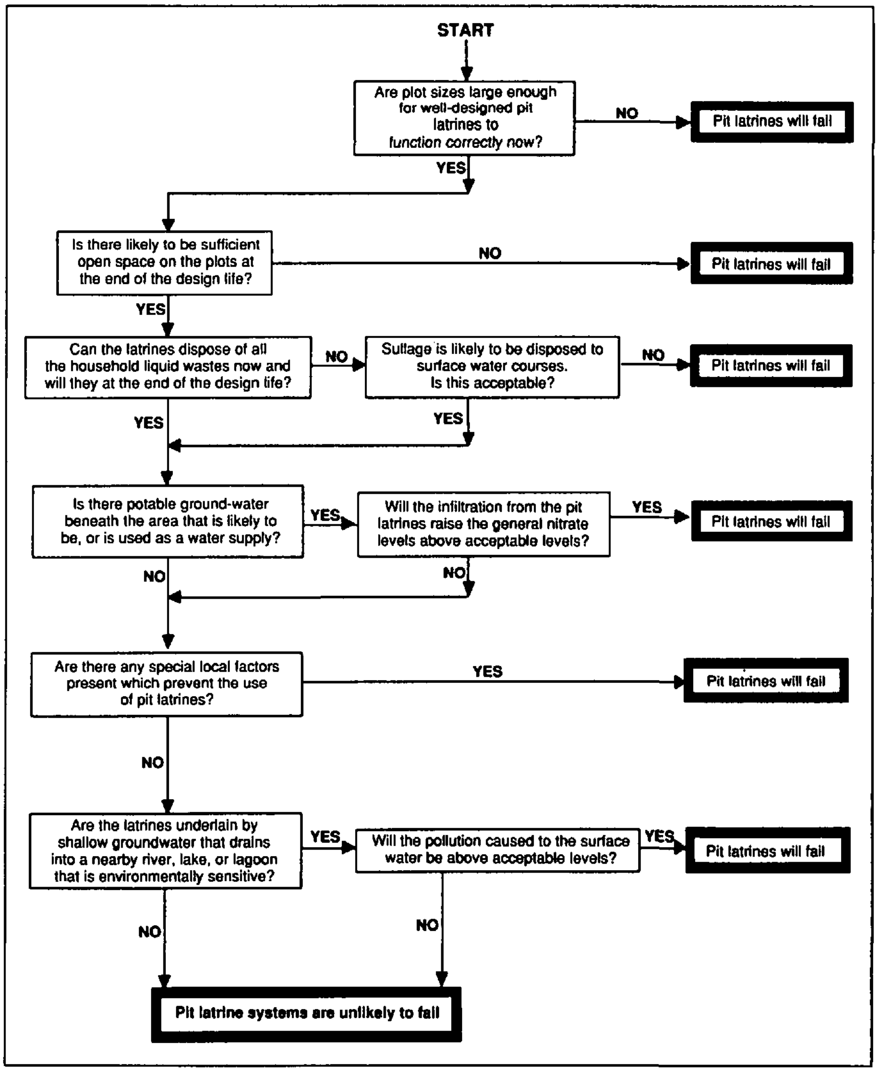

Figure 1. Predicting the likelihood of pit-latrine sanitation failure.


UNICEF/Sean Sprague

Reports of groundwater pollution caused by pit-latrine infiltration have been greatly exaggerated.

Pit latrines dispose of wastes into the ground. Since the disposal system is commonly constructed on the plot, but outside the building, it follows that there must be sufficient open land available on the plot to accommodate it. The amount of land required depends on the type of pit latrine to be constructed. Simple pit latrines require little more than 1 to 2m^2 of land, whereas twin-pit, offset pour-flush latrines may need more than 12m^2 (excluding access space). In general, finding the space for pit latrines will only be a problem in very high-density housing areas, particularly where there is multi-storey occupancy.

Ground-infiltration failure

Pit latrines function by infiltrating liquid wastes into the surrounding soil. The pit walls, therefore, must be capable of absorbing the volume of liquid. A soil's capacity to absorb liquids with a high organic content, such as that found in human wastes, varies according to its composition and texture. Poorly absorbent soils will infiltrate lower volumes of effluent than porous soils for the same unit of soil area. Most soils will dispose of human wastes safely when water consumption levels are low. As water-use rises, however, infiltration rates increase and many soils, particularly those with a high clay and silt content, will block up. Table 1 gives suggested safe infiltration rates for liquid wastes in pit latrines.

Blockages are commonly prevented by first separating the sullage from the excreta. The excreta is disposed of in the pit latrine, and the sullage is discharged to a surface drainage system. Small communities, living on well-drained land receiving frequent rainfall, are unlikely to be adversely affected by sullage disposed to open drains. Larger communities, however, particularly if located on flat and poorly drained land, may be exposed to significant health and environmental hazards such as fly and mosquito breeding, vermin infestation, and offensive odours; a community in Brazil gave the removal of offensive odours and unsightly polluted drains as one of the main benefits of installing sewerage.[3] The disposal of sullage to surface-water drains is common in many cities; in others it would be considered unacceptable. Local circumstances alone will decide whether it can be considered a cause of the failure of the sanitation system.

Table 1. Infiltration rates for waste-water into different soil types.

Soil type	*Description*	*Infiltration rate (litres/m²/day)*
Gravel, coarse and medium sand	Moist soil will not stick together	50
Fine and loamy sand	Moist soil sticks together but will not form a ball	33
Sandy loam and loam	Moist soil will form a ball, but still feels gritty when rubbed between the fingers	24
Loam, porous silt loam	Moist soil forms a ball which deforms easily and feels smooth when rubbed between the fingers	18
Silty clay loam and clay loam	Moist soil forms a strong ball which smears when rubbed, but which does not become shiny	8
Clay	Moist soil moulds like plasticine and feels very sticky when wettened	Unsuitable for soak pits

Source: Franceys, R., Pickford, J., and Reed, R., *A Guide to the Development of On-site Sanitation*, World Health Organization, Geneva, 1992.

Groundwater pollution

All pit latrines will pollute the surrounding soil. This is only significant, however, if the pollution enters a potable and usable groundwater source in sufficient concentrations to make the water dangerous to drink without being (expensively) treated. Details of the circumstances in which such conditions are likely to occur are given in the WHO guide listed at the end of this article.

Pollution from latrines takes two forms: bacterial and chemical. Bacterial pollution, although a direct health hazard, is usually quickly rendered harmless by natural processes in the soil. Indeed, provided the bottom of the pit is more than two metres above the water-table, bacterial pollution of the groundwater is highly unlikely. Chemical pollution is predominately nitrogenous, and can increase the level of nitrates in the groundwater. It is more potentially harmful than bacterial pollution from latrines because it lasts longer, travels further, and is more difficult to remove.

The pollution from a single domestic pit latrine is minimal, and only a hazard if there is a groundwater abstraction point within 15 metres of the latrine. Of greater significance is the cumulative pollution produced by a large number of latrines in a small area. Shallow groundwater abstracted within that area will almost certainly be contaminated by bacteria and chemicals. Deep groundwater within the area, and shallow groundwater may be contaminated by chemicals.

The problem presented by groundwater pollution is often over-emphasized, however; depending on local conditions, even fairly large communities using on-site sanitation systems will have little effect on the quality of underlying groundwater. A good example of this is illustrated by Figure 2, which shows the change in the level of nitrate contamination in an aquifer, as it flows under a town (Vacoas in Mauritius) with a population of 56 500. Virtually all the properties in the town have septic tanks or pit latrines. The aquifer and ground above are formed from a highly fissured volcanic lava with minimal topsoil. The water-table is approximately 20 metres below ground but, because the aquifer has a high velocity, pollution levels are minimized.

The point at which the pollution becomes unacceptable will normally be reached when the concentration of chemical indicators, such as nitrate, within the general body of the aquifer, exceeds national guidelines. The size of community that produces unacceptable groundwater pollution will be affected by many factors, particularly the number and size of infiltration systems, the depth to the water-table, soil and rock conditions within and above the aquifer, aquifer depth, and groundwater-flow rate. It is worth remembering, however, that when a water source is polluted by sanitation systems, it is usually cheaper to relocate the source of the water supply, than to remove the sources of pollution. Developing new water sources, and connecting them to an existing reticulation system, usually costs less than sewering a community.

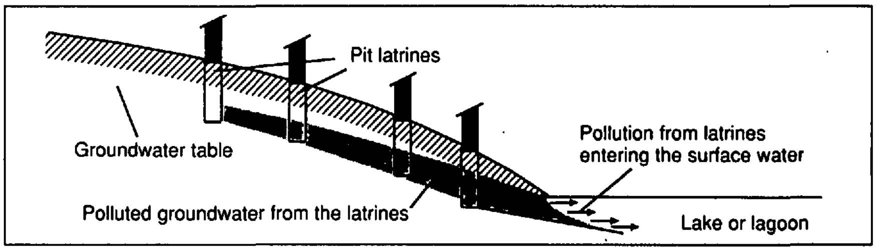

Figure 3. Pollution from pit latrines polluting surface waters via the groundwater.

Surface-water pollution

As described above, the sullage from homes using pit latrines will often end up in surface-water drainage networks. Even in smaller communities, such overflows will quickly destroy the natural flora and fauna of natural water courses, causing unsightly polluted rivers and streams. Whether or not surface-water pollution is a sufficient reason for condemning a latrine system will depend on the local socio-economic conditions and the significance of the water course polluted.

Surface waters can also be polluted via polluted groundwater. Latrines constructed close to surface water in ground with a high water-table may pollute that surface water if the groundwater flows into it. This has been identified as a problem in areas where communities situated close to lakes and lagoons have polluted these water sources via the groundwater (see Figure 3 above).

Conclusions

As urban centres continue to grow, the need for appropriate excreta-disposal facilities has never been greater. Consumer poverty and municipal underfunding makes it imperative that, as much as possible, the pit latrine is used for family sanitation, as it is the cheapest, safe excreta-disposal system available. Unfortunately, many pit latrines fail, so it is essential, when planning a new sanitation programme, to decide whether they really are the most appropriate form of sanitation. Pit latrines fail for many reasons, notably poor design, construction or maintenance. Still more fail, however, because local factors render them inappropriate: plot size, soil-infiltration rates, groundwater pollution, and surface-water pollution. There may also be other local factors. Most will not be 'absolutes', but will depend on the community's socio-economic conditions. All these factors should be considered when the provision of services to a number of communities are being compared, as a way of deciding where investment should be focused. ●

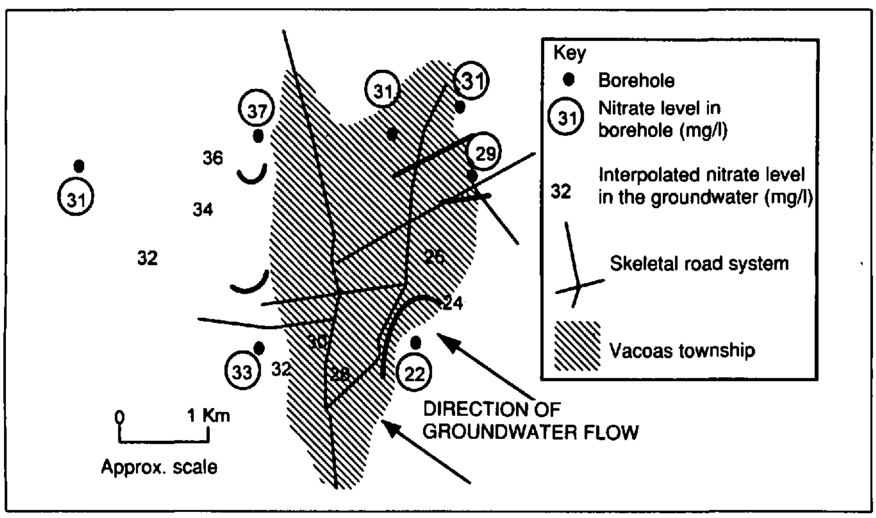

Figure 2. Changes in the nitrate concentration of groundwater as it flows under a community of 56 500 people.

References

1. Franceys, R., Pickford, J., and Reed, R., *A Guide to the Development of On-site Sanitation*, World Health Organization, Geneva, 1992.
2. Severn Trent Water International, 'The sewerage master-plan for the islands of Mauritius and Rodrigues Development Programme, Rural Areas'. Prepared for the Ministry of Energy, Water Resources, and Postal Service, Government of Mauritius, 1993.
3. Reed, R., and Vines, M., 'Condominial Sewerage in Petrolina and other towns in Pernambuco State, Brazil', WEDC, Loughborough, 1992.

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