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REACHING THE UNREACHED: CHALLENGES FOR THE 21ST CENTURY

STED systems in South Africa

L.M. Austin, South Africa

AN ESTIMATED 21 million South Africans do not have access to adequate sanitation facilities. This situation is similar to that which exists in many other developing countries, in that it is usually the poorest section of the population which bears the brunt of a nonexistent, or at best unsatisfactory, sanitation infrastructure, whether for financial or political reasons. Sanitation provision in South Africa has generally been characterised by extreme solutions, with the "privileged" enjoying well-maintained waterborne sewerage while the majority had either buckets or other equally unacceptable systems. Even bucket systems require a high level of organisation and funding in order to function properly; however, both were often lacking in many areas. In an attempt to provide a more cost-effective service, efforts were made to introduce other sanitation systems in developing communities, usually without consulting the intended users. The result was all too often a legacy of poorly planned and inadequately maintained systems provided by well-intentioned but short-sighted authorities, who gave very little attention to factors such as environmental impact, social issues, water supply service levels, reliability, upgradeability, settlement patterns or institutional needs.

To redress existing inequalities the new government has taken responsibility for developing a national sanitation policy, whereby it is made clear that sanitation is not simply a matter of providing toilets, but rather an integrated approach which encompasses institutional and organisational frameworks as well as financial, technical, environmental, social and educational considerations. It is recognized that the country cannot afford to provide waterborne sanitation for all its citizens, nor, for that matter, should it necessarily aspire to do so. The emphasis has shifted to promoting other "intermediate" technologies, for example septic tank effluent drainage (STED) systems, that can offer perfectly acceptable, healthy and environmentally friendly solutions if properly engineered and implemented, and should not be perceived as being inferior or second-class systems. It has become clear that not only could economic disadvantages be imposed by providing high levels of service to low income households who cannot afford the running costs of these systems, but also that environmental pollution becomes a lesser risk when the sanitation system is inherently more robust and able to tolerate more abuse than conventional sewerage networks.

Development of STED technology in South Africa and lessons learned

While septic tank effluent drainage is not a new technology, having been in use for many decades in various countries, the installation of these systems in South Africa is still a relatively new experience, with the first projects only being commissioned during 1989. This late start should, theoretically, have had the advantage that the collective experience with these systems in countries such as the USA and Australia, for example, would be available as a reference; good points from successful projects could then be fruitfully utilised and, equally importantly, factors causing problems could be critically examined and the necessary modifications made. As is frequently the case, however, the valuable lessons which should be learned are in many cases merely consigned to the archives and mankind continues to re-invent the wheel again. Engineers are, to their shame, often no different from the rest of mankind where this problem is concerned.

A number of salutary lessons have been learned from the introduction of STED sanitation in South Africa. Many of the problems could have been avoided if proper attention had been given to matters such as education (both of the users and the local authorities), social and economic factors, as well as such seemingly obvious things as quality control during construction. The latter aspect has been responsible for a number of negative experiences which have unnecessarily tarnished the image of STED technology. Some design engineers have also not given enough thought to future maintenance activities in the systems, whether out of pure ignorance or possibly in the belief that none would be required.

In some instances it appears that, because there is not the same need for the rigid design and construction specifications which characterise waterborne systems, there may now be a complete relaxation of all standards, including construction supervision and training of maintenance personnel. This mindset has created the unfortunate situation where some local authorities are now reconsidering their previous commitment to STED and are publicly stating their disillusionment with the technology. The author believes that this is nothing short of a tragedy, as STED, *properly designed and operated*, is not only a sound sanitation system but also a technology which should be encouraged with much more vigour in South Africa, and indeed in many other countries, due to easier

construction, lower maintenance requirements, easier treatment of effluent and generally lower overall cost.

Design and installation problems

Interceptor tanks

Many of the STED systems installed in South Africa were conversions from other types of sanitation schemes, e.g. individual conservancy tanks or ordinary septic tanks with soakaways, where the inlet and outlet configurations of the tanks were (sometimes) modified and connected to the new systems. Some of the latrine units were previously nothing more than a dry pedestal above a vault and, although connected to a soakaway, the only liquids entering the system were excreted body fluids. Where these units were in place the only sensible option was to utilise as much of the existing structures as possible in order to save costs. The size and configuration of the existing septic or conservancy tanks were in most cases adequate to serve as interceptor tanks in the new STED systems: the only factor that needed attention was the correct installation of inlet and outlet fittings.

Where completely new systems were installed, i.e. in areas where no readily modifiable structures existed, the decision was sometimes taken to opt for commercially available prefabricated digester tanks, usually made from moulded polyethylene in various shapes and sizes. Although easy to install, the different types of polyethylene tanks have varying operating characteristics in terms of hydraulic efficiency and retention period, with the result that they do not all work as well as one would have liked. In some other areas plastered masonry tanks were constructed, usually with the purpose of providing employment opportunities or to optimise the use of local materials. In these cases also, the size and configuration of the tanks was generally adequate in terms of existing knowledge of sludge and scum accumulation rates. As will be seen later, however, the situation in many parts of South Africa in terms of utilisation of sanitation facilities was not always taken into account, with the result that in some cases the design criteria applied were hopelessly inadequate. In mitigation of the engineers' role in these failures though, it should be made clear that unforeseen social factors, such as densification, were largely to blame in most instances.

Pipes and fittings

Pipe diameters employed were usually between 50 and 100 mm, with few accessible structures such as manholes, cleaning eyes and so forth. In terms of pure hydraulic requirements, this would normally be adequate, considering that the reticulation systems are supposed to be solids-free. What became obvious later, however, was that the criteria used in more developed countries cannot simply be applied in all areas of South Africa without consideration of the social factors that accompany the varying levels of income and sophistication of the population. What works in the higher income areas where the people are generally better informed about septic tank systems and able to afford proper tissue paper for anal cleansing, for example, will in all probability not be a viable solution in areas where poverty is rife or community education programmes are nonexistent. The abuse of sanitation systems which takes place in the latter areas precludes the successful application of first world design criteria, and the difference in maintenance requirements between STED systems installed in middle to upper income areas and those in poor communities has proved to be remarkable.

A problem encountered with the design and installation of the reticulation networks was, and still is, the lack of customised pipes and fittings for use in STED systems. The result was that in most cases uPVC water pipes and specials were specified (which are not manufactured to standardized South African sewer configurations) and used in conjunction with conventional sewer fittings where possible. The result has been a haphazard assortment of materials which, although hydraulically adequate, probably resulted in the networks costing more than would normally have been the case with readily available, standardized materials. An interesting innovation in some projects, however, has been the use of these water pipes in a white colour, rather than the normal blue, so that maintenance staff can easily distinguish the different services.

There have been instances where cast iron fittings have been used in networks. Because the South African National Building Regulations stipulate the use of cast iron pipes under buildings for conventional sewer systems, engineers and contractors unfamiliar with the difference between septic and conventional systems have unwittingly carried on with this practice, with unfortunate results: severely corroded cast iron fittings have had to be excavated and replaced by local authorities within a few years of their installation.

Lifting stations and treatment facilities

It appears that in most cases conventional ponds have been chosen for effluent treatment, and where properly designed and maintained, these operate perfectly with very little odour problems. However, there are some cases where bucket sanitation systems and STED still exist in the same municipal area and the local authority has sited the bucket washing facility at the ponds, which are often not far removed from the residential suburbs. The unfortunate consequence is that residents then associate the bad odour with their new STED sanitation system. There are also cases where solid matter has found its way into the STED effluent, with the result that the conventional water pumps in the lifting stations have had to be replaced with sludge pumps. The economic advantages of the STED systems have in this way been largely negated.

Utilization problems

Some of the more interesting (and educational) examples of good and bad practice concerning STED systems in South Africa are given below. They are, in fact, applicable to any STED system anywhere in the world, and for this reason should be noted by all practitioners.

Grease traps

There are always problems at places such as hotels, restaurants, butcheries, etc. where grease traps are either nonexistent or not cleaned regularly. The fats and greases, which are usually in the form of a hot liquid when they enter the tank, cool down rapidly and solidify, and in time clog the tank outlet. Where the tank configuration is such that the inlet and outlet are very close to one another, these substances can also pass into the reticulation system before they solidify.

Cleaning eyes

Very few access places were made available for maintenance personnel to flush out blockages in the pipe networks. Not only the fats described in the previous paragraph, but also certain particulate matter very often enters the system. Where the pipes are laid on a shallow gradient, as is usually the norm for STED reticulation, any irregularities in this gradient (such as a slight hump, for example) become focal points for deposition of sediment, and there is often not enough hydraulic pressure to overcome this. This often happens where there has been insufficient construction supervision, and poses a major headache for maintenance personnel who cannot get access to the line. Some local authorities have eventually resorted to installing cleaning eyes themselves. These fittings, while adding to the project cost, are a sound investment and a good rule is to install one in every street block, preferably close to a fire hydrant.

Manholes

One of the advantages of STED systems is that conventional sewer manholes are not generally required, thus considerably reducing the cost of the reticulation networks. However, engineers and maintenance supervisors are inherently conservative (and curious) people and a number of town engineers have expressed their frustration at not being able to "see what's going on inside". A few manholes at strategic places will not add much to the total cost of the system and will also be an advantage where lines need to be flushed out.

Position of cleaning eyes

Where cleaning eyes have been provided, they have sometimes been installed in places susceptible to damage, for instance gravel sidewalks and verges. As the protecting structure is usually installed either flush with or proud of the ground surface, any grader carrying out maintenance work is almost certain to slice it off. The pipeline is then immediately exposed to entry of dirt and rubbish, as well as vandalism. This type of problem occurs when not enough thought is given to design details and construction supervision.

Inlet and outlet fittings

It is important to ensure that the inlet to the interceptor tank is at least 200mm higher than the outlet in order to accommodate peak flows satisfactorily. Further, it has been found that conventional T-pieces do not always work satisfactorily as an outlet mechanism without some sort of modification to act as a "strainer", such as drilling 10 mm diameter holes in the vertical leg of the T, or adapting this leg by cutting slots into it and then heating and bending the strips to reduce the size of the bottom opening. Some local authorities have also resorted to drilling holes in the cap at the top of the T to cater for occasions when the lower portion is blocked and the water level rises. Blockages of the outlet occur mostly where foreign objects such as plastic bags are introduced into the tank; these float on the surface and clog the outlets very easily. It was observed that this occurs frequently in places where the latrine unit is separated from the house; residents are reluctant to use the latrine at night due to cold weather or sometimes even out of fear, and frequently resort to using plastic shopping bags as "potties" and then disposing of these in the toilet the following morning.

Adaption of existing systems

A major problem has been encountered in places where the tanks of previously dry systems have been adapted and connected to STED reticulation. Because these tanks have never worked as digesters, having only excreted body fluids entering them, the faeces remain as solid matter, much the same as in pit latrines. When the tanks are converted and expected to act as the interceptor tanks in a STED system, the old excreta simply forms a crust which floats on top. Eventually small pieces begin to break off and enter the reticulation network, with predictable results. The lesson here is that before old tanks or vaults are incorporated into a STED system, they must be thoroughly cleaned out, otherwise the local authority will be left with a maintenance problem which will continue for a long time as it battles to find the source of the problem.

Anal cleansing materials

As is the case in poor communities throughout the world, most available money is spent on buying food, and toilet tissue paper does not even feature on their list of priorities. Instead newspaper, brown paper, cement sacks, orange bags, rags and any other materials which will do the job are used. These substances degrade very slowly, if at all, and always float on top of the liquid in the tank; they absorb other faecal material and in time form a massive floating "plug" up to 300mm thick in some cases which eventually interferes with the proper operation of the

system. Where use of soft tissue paper is the norm, however, no problems in the tanks were recorded. Site investigations invariably proved that the tanks were operating perfectly, with the usual thin scum layer on top and no evidence of any foreign matter.

User education

It is difficult to believe that after so many years of emphasising the fact that user education is a vital part of any sanitation programme, this aspect still remains almost totally neglected in South Africa. Funding agencies and local authorities continue to provide STED sanitation without making any concerted effort to protect their investments by launching information programmes on the operation of the systems. A classic example even in middle to higher income communities, where a conservancy tank system has been upgraded to STED, for example, is the repeated calls to the local authority by residents who report that their tanks are full and requesting that a tanker be despatched to empty them. A simple explanation in the local municipal newsletter would go a long way towards remedying this situation. In less literate societies, the problem could be addressed by community workshops. Also, the abuse of STED systems by depositing non-degradable anal cleansing materials will continue as long as the users cannot afford tissue paper; time and again, within a relatively short space of time, the whole investment slowly but surely begins to degenerate as the system breaks down, maintenance personnel struggle to sort out the problems and users revert to using the bush and vandalise the structures.

The author contends that sanitation providers should think carefully about other technologies, such as VIP latrines, in situations where it is obvious that a STED service will not be a sustainable investment, instead of blindly pushing ahead with an inappropriate solution. Of course, this would need to be done in consultation with the communities concerned. The Government has already acknowledged that, as far as public health is concerned, there is absolutely no difference between a well-constructed VIP latrine and a higher level of sanitation service, as long as basic hygiene principles are adhered to. It has been established that there are very clear differences in maintenance requirements between STED systems in higher earning communities and those in poorer areas. Where well engineered systems have been installed in middle to upper income neighbourhoods, the local authorities have almost invariably endorsed the technology and expressed their satisfaction with the reduction in operating costs which have been experienced.

Local authority education

It is surprising that so many local authorities have installed STED systems for their communities without ensuring that maintenance personnel know and understand the concept. Discussions with municipal staff in various towns and villages have brought to light a number of misconceptions about the technology, and it is clear that success with the systems in these areas will not be achieved unless this situation is speedily rectified.

Socio-economic factors

A number of low-income communities have had problems with their STED systems due to high latrine user ratios. Cases have been recorded where, due to overcrowded living conditions, up to 30 people make use of one toilet where the tank size is such that it is only adequate for a household of about 6 people. The systems simply cannot handle this type of abuse and a thick layer of undigested faeces forms on top of the liquid due to insufficient available digestion time in the tank. Problems with blocked and overflowing tanks occur frequently in such cases, which is a continual source of annoyance to neighbouring residents. Strong social upliftment programmes are required to counter this phenomenon, and engineers should also bear in mind that tanks should, if at all possible, be sized in the knowledge that a higher than expected user ratio may well occur.

Conclusions

It is unfortunate that a potentially good sanitation system such as STED has not met with greater acceptance in South Africa. Some of the problems can be laid at the door of the professionals, as inadequate engineering (both design and construction) has in many instances contributed to the poor image of the technology. In many other cases pure socio-economic factors have been the cause of failures. Whatever the reasons for the negative perceptions of STED, it is clear that something needs to be done to rectify the situation, for the good not only of the recipient communities but of the engineering profession's reputation as well. The Division of Building Technology of the CSIR is currently involved in a number of related research projects with this purpose in mind. Outputs of these projects will be guidelines for various aspects of STED technology, covering engineering matters such as design and construction, local authority concerns like operation and maintenance, as well as nontechnical information for users, community leaders and sanitation committees. It is expected that these endeavours will lead to improved acceptability of STED systems among all communities in South Africa.