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in Developing Countries

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Sanitation in Developing Countries

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Zambia's Experience with Aqua Privies

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Industrialization in Zambia in the 1950s resulted in a massive influx of migrant labour. It was mostly the indigenous population that moved from the rural areas into the recently established urban areas. As the urban population grew, however, the problems associated with overcrowding, such as water supply and excreta disposal, emerged. In order to prevent outbreaks of communicable diseases it became necessary to install cheap and well-organized excreta disposal systems in areas of low-cost housing.

Before the introduction of self-topping aqua privies, four systems of sanitation were used in the townships of Zambia (at that time, Northern Rhodesia). The systems included pit latrines; pail latrines; conventional aqua privies; and waterborne sanitation systems. Of the four systems, only aqua privies will be discussed in this paper.

There are three types of aqua privies: (1) conventional, with soakaways; (2) self-topping, with soakaways; and (3) self-topping, sewered. The second and third types are simple modifications of the conventional aqua privy. They are modified to dispose of household wastewater (sullage).

The Conventional Aqua Privy

Essentially, the conventional aqua privy consists of the superstructure (for privacy), the squatting slab or plate, a small (septic) tank situated immediately below the squatting slab, an overflow from the tank, and soakaways. A vent pipe is usually provided also. The squatting slab has a built-in drop pipe called the chute. The diameter of the chute varies from 100–150 mm. The water level in the tank is allowed to come within 100–150 mm above the bottom of the chute. In this way a water seal is maintained between the squatting slab and the tank contents. If the aqua privy is to function properly, the water seal must be maintained at all times. It requires the user to add sufficient water, 4 gallons (18 litres) per day, through the chute to replace any losses. The water is normally drawn from a nearby communal standpipe.

Human wastes are discharged directly through the chute into the tank. Here, the organic solids are acted upon by anaerobic bacteria to form gases and semiliquids. The overflow from the tank is disposed of in a soakaway. The inorganic matter settles to the bottom of the tank by sedimentation.

Desludging of the tank is required. The frequency of desludging depends upon the size of the tank and the rate of use. Normally, the tank is desludged when it is two-thirds full.

Problems with the Conventional Aqua Privy

With the exception of the waterborne sanitation system, all of the other sanitation systems installed failed to operate effectively. The conventional aqua privy failed for the following reasons:

(1) Failure on the part of the users to maintain the water seal. Users were either

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unaware of the importance of maintaining the seal or they disliked being seen carrying water into the toilet. Failure to maintain the water seal transformed the aqua privies into shallow pit latrines. Human wastes, therefore, became exposed to rodents and insects. Nuisances in the form of odours followed.

(2) Failure of the soakaways due to impervious soils; porous soils becoming clogged by organic matter; and seasonal high water tables.

(3) The system could not dispose of the household wastewater because it was not designed to cope with this form of waste.

Need for a Cheaper but More Effective Sanitation System

Although the waterborne sanitation system (WC type) was successful, it was not possible at the time to install it in areas of low-cost housing. The majority of people in low-cost housing areas had relatively undeveloped skills, which resulted in low productivity, small incomes, and, therefore, low rent-paying capacities. Communal sanitation facilities, even the conventional waterborne sanitation systems, are rarely acceptable. Extensive supervision and the employment of attendants must be resorted to if even a minimum standard of cleanliness is to be maintained.

Faced with the need to overcome these problems, it became necessary to investigate methods of developing a cheaper, but more effective, system of sanitation for low-cost high-density housing areas. In this regard, an analysis of the merits and faults of the existing systems was made by the then African Housing Board. From this survey, a system based on aqua privies that incorporate most of the advantages of waterborne sanitation systems evolved.

The Self-Topping Aqua Privy System

This system is designed to:

(1) Discharge all the wastewater from the household into the aqua privy and in this way retain the seal around the chute.

(2) Eliminate the use of soakaways by discharging the effluent from the aqua privy tank into sewers which take it to stabilization ponds. Where ground conditions permit the use of soakaways, the effluent from a number of tanks could be collected by a common sewer connected to a common septic tank with soakaways. Gradual change to a fully sewered system could then be undertaken at a later date.

(3) Use the aqua privy as a sedimentation tank for all the inorganic solids and to pretreat the organic solids so that they will be in a form suitable for transportation in the sewers.

A supply of piped water was to be made available to the ablution units.

Description

When the building serves two families it is usually placed across the common boundary; where it serves three or four families it is placed on the corner junction of the plots. The building is located away from the house for the following reasons: (1) the economic advantage gained by combining more than one unit and reducing the number of lengths of connections to the sewer; and (2) a natural reluctance of the people to have the latrines attached to the houses and their tradition of doing the household washing outside.

Ablution and Latrine Cubicles

In the plan under consideration, the ablution (washroom) and latrine cubicles have a common door and are placed at right angles to each other. This arrangement was selected to avoid passing under or squatting under a water drip if and when a shower was installed. The floors of the cubicles are sloped to provide good drainage toward the drainage pipe in the ablution cubicle and the squatting plate in the latrine cubicle. The wastewater from the ablution cubicle discharges into the aqua privy tank through a pipe terminating 10 cm below the surface of the tank (Fig. 1).

Household Washing Facilities

The washing facilities are under the cover of the roof. Each family has its own wash-

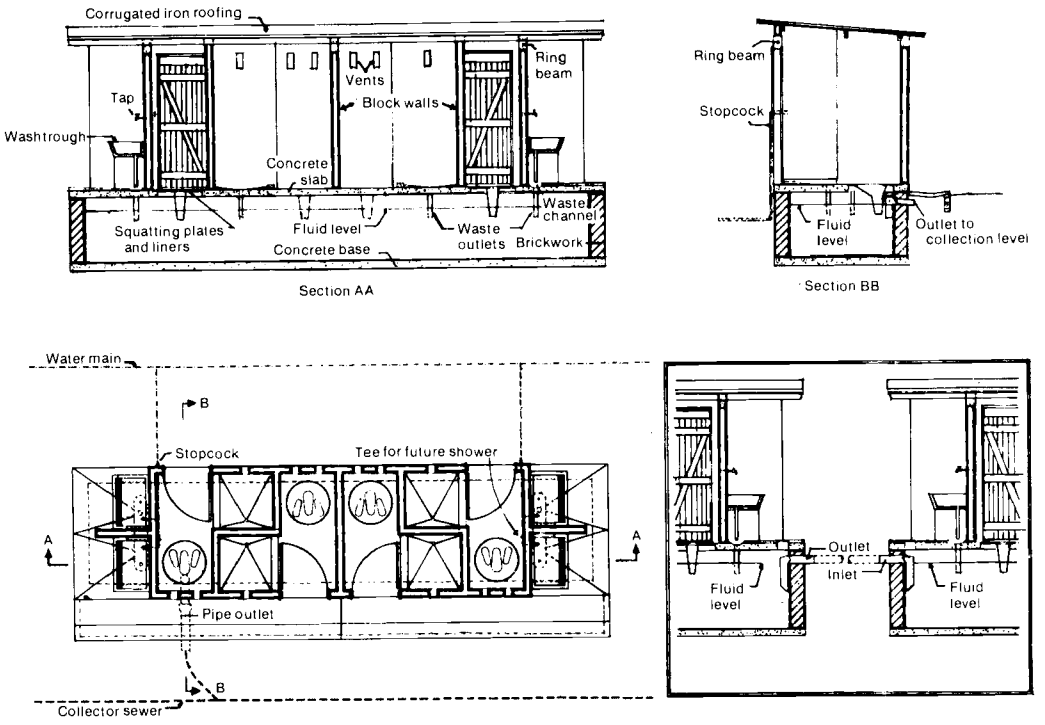

Fig. 1. Layout of sanitation block.

trough separated from that of its neighbours. The wastewater from the troughs discharges into the tank below through a vertical pipe. Blockages are infrequent and easily removed from a vertical pipe by rodding. In previous designs equipped with a trap in the pipe, blockages frequently occurred with debris or sand (commonly used for pot scouring). Consequently, trapped pipes were discontinued.

Squatting Plate and Chute

The top of the tank is covered with a concrete slab into which is set the requisite number of 24 in. (61 cm) diameter manhole frames in which are placed the squatting plates. The squatting plate has an opening with two suitably located footpads cast into it. The footpads are raised above the surface of the plate and to facilitate drainage the plate is graded down toward the opening. To the underside of the squatting plate a chute of stainless steel or other corrosion-resistant material is fixed by means of an airtight joint. Because odours are undesirable and attract flies, it is essential to ensure that there is no gas leakage from the tank. The outlet from the tank to the sewer is located below one of the squatting plates to facilitate clearing any blockage. This squatting plate is removable and serves as a manhole cover providing access to the tank. External tank manholes are not recommended unless fitted with relatively heavy covers because light covers are sometimes lifted and the tank used for garbage disposal.

The Tank

The tank is placed below the building and its width is the same as that of the building, the longitudinal walls of the building bear directly upon the walls of the tank. The tank extends beyond the end walls of the building so that wastewater from a washing trough can drain into it directly from above. The floor of the tank, which also forms a foundation for the whole superstructure, consists of concrete 4 in. (10 cm) thick. By making the

tank an integral part of the building, the foundations are simplified and differential settlement is reduced. In earlier designs, smaller tanks were used, but it has been found that the present design, with its larger tank, costs no more, gives a better quality effluent due to the longer retention time, and the tank has a longer life before desludging becomes necessary.

Stabilization Ponds

The aqua privy effluent is easily treated in stabilization ponds because the anaerobic decomposition in the aqua privy tank has already reduced the biological oxygen demand (BOD) concentration appreciably. The gain from this pretreatment is that the number of people per acre whose effluent can be treated in the ponds is very high. Moreover, because neither stones nor sand are present in the effluent, the inlet arrangements to the ponds treating aqua privy effluent are very simple.

Discussion of the System

Each family has its own water tap, latrine, ablution cubicle, and washtrough and each family has the responsibility of keeping its own unit clean. The system requires nothing beyond the normal household activities to keep it functioning properly and the simplest hygiene practice to keep it clean. The system disposes of all the liquid waste and excreta from the household.

Costs

Installation Costs

The cost of each sanitation unit comprising latrine, ablution, and washing facilities is approximately the same as that of a unit having a flush latrine and washbasins discharging directly into a sewer. There is, therefore, no saving here. There are, however, some savings on sewer lines and stabilization ponds. As velocities of flow and the size of sewer pipes are reduced, the cost of excavation is reduced also. There is no need to drain to a central disposal site because each drainage area can have its own small stabilization pond system. This will invariably reduce the length and the diameter of the main sewer. Also, the stabilization ponds can be sited very near the houses because a correctly designed series of ponds is odourless.

Maintenance Costs

Apart from periodically desludging the tanks when they are two-thirds full, the maintenance costs are minimal, requiring only regular inspection by unskilled personnel. At the ponds, almost no maintenance work is required. Should desludging be neglected, however, serious problems may arise.

Water Consumption

The aqua privy system, as compared with the flush system (WC), is economic in terms of water consumption because only wastewater is used to transport the waste products. Piped water may not be necessary for the proper functioning of the system. In this case, the aqua privies may be connected in series. Wastewater from a communal standpipe, which is located at the head of the series, is introduced into the first tank. The use of series-connected aqua privies reduces the cost of sewers and fittings, but this may be offset to a degree by the increased depth necessary for the tank to provide adequate coverage for the connecting sewers. Where water is plentiful and cheap, a flush system may be installed in each cubicle, draining into the tank underneath.

Recent Experience with Existing Installations

Self-topping aqua privies were installed in nine local townships plus several other small settlements in the late 1950s and early 1960s. The primary pond with the smallest surface area is at Kafue. It is 1/60th of an acre in extent, treating effluent from a school septic tank servicing 120 people. The largest primary pond is three acres in extent in the Matero suburb, Lusaka, treating aqua privy effluent from over 10 000 people. A recent survey into the performance of these self-

topping aqua privies, almost 20 years after installation, was conducted by the National Housing Authority with funds from the International Development Research Centre (IDRC). A summary of the findings and conclusions for two areas, Lusaka and Ndola, follows.

Lusaka

The main survey areas were Matero and Balovale.

Sewered Aqua Privies in Matero

Matero is a large municipal housing area with a population of about 34 000. There were 1156 self-topping sewered aqua privies installed in Matero in the early 1960s. The toilets are constructed in blocks of four, each with a washtrough and an external tap. The mean household size in Matero was found to be 6.34 and because each household has its own toilet it was assumed that the average number of users was not much higher than 7.0. Of the units selected for inspection, 2 were rated very clean; 22 clean; 23 fair; 1 dirty; and 1 very dirty. Because of individual responsibility a number of units were kept clean.

In terms of the performance of the system at the time, 7 had blocked tanks and 43 were in good working order. Thirty-nine of the users recalled a problem with their units during the previous year. In all cases interviewed, a blocked or full tank was reported to the Lusaka city council. Of the people who were able to remember how the council dealt with their situation, 15 reported that no action was taken; 3 that action was taken immediately; 3 that action was taken within 1 week; 3 that action was taken within 1 month; and 2 that action was taken after 3 months. Twenty-four people reported that the problem of blocked tanks had since recurred, which could be attributed to the claim of 15 respondents that only part of the contents of the tanks were emptied by the tanker. Fewer people had experienced problems with their units in the period from 5 years to 1 year prior to the survey (23 as opposed to 37 in the last year), suggesting that the sludge buildup had recently reached a critical state.

It was found that users did not react favourably to the system because: 3 were very satisfied; 8 satisfied; 9 had no particular reaction; and 23 were very dissatisfied. When asked to give opinions on other systems they knew of, 10 mentioned pit latrines as being worse and 39 discussed water closets, which all but 1 regarded as being better. Twenty suggested or were in favour of the toilet being part of the house; 2 people were against this idea. Sixteen people were prepared to say how much they would pay for their ideal toilet system, the mean sum being K3.00 (K1 = U.S. $1.3) per month. This is not enough, however, to cover the cost of upgrading.

Aqua Privies Leading to Soakaways in Balovale

Balovale is a small residential area consisting of 80 houses near old Kamwala in Lusaka. In 1954, toilet blocks, each containing 12 cubicles, were built to provide sanitation for the residents. The system consists of a series of self-topping aqua privies leading to soakaways. A communal standpipe is provided at the head of each series so that spillage from the standpipe is led into the first tank, thereby maintaining the water seal in all of the units.

The investigating team found that: (1) the majority of soakaways were not functioning; (2) sludge buildup as high as the aperture of the toilets had hardened in some cases; and (3) the sink and concrete washing slab were blocked and overflowing.

Although each household has its own toilet cubicle, there is no way of locking the door. As a result, passersby frequently use the units, exercising less care in the process than the residents would normally do. Of the 20 toilets inspected, 1 was very clean; 7 clean; 10 fair; and 2 very dirty. From these figures, the survey team concluded or assumed that the lamentable state of the toilets is due to negligence by the city council's Health Department.

All of the 20 respondents had suffered from blockages in their toilets during the previous year. Although 60% of them said that the council had acted upon their complaint within 1 month, no one recalled the

council acting immediately or even within 1 week. Furthermore, they claimed that the vacuum tanker pumped out only part of the contents of the tanks, with the result that 19 of the 20 suffered a recurrence of the problem.

Nineteen of the users were very dissatisfied with their toilets and no one could think of anything to be said in favour of the system. When asked about other types of toilets known to them, four people favoured pit latrines; two mentioned pail and pit latrines as being worse; two preferred the aqua privies in Matero; and the rest favoured WCs. The mean monthly sum which they were prepared to pay for a WC was K1.11.

Ndola

The main survey area was Kabushi, also a large municipal housing area.

Sewered Aqua Privies in Kabushi

There were 863 self-topping sewered aqua privies installed in Kabushi suburb in the late 1950s. The toilets are built either as individual units or in pairs. Double units have one washtrough shared by two households. A high-level water tap is installed additionally inside each toilet cubicle for cleaning purposes (some users have converted this into a shower). The effluent from each tank is sewered to a communal septic tank with soakaways. A gradual change to a fully sewered system is planned. The mean household size was 7.0 persons.

Again, units were selected at random for interview. It was found that 6 were very clean; 14 clean; 19 fair; 7 dirty; and 2 very dirty. When compared to the Matero units, it was found that the additional tap served no purpose.

With regard to the performance of the system at the time, 17 tanks were full and 23 were in good working order. Thirty-six users recalled a problem with their units during the previous year. The major complaints were blocked tanks and soakaways. The council dealt with individual complaints as follows: 3, action taken immediately; 3, action delayed 1 week; 15, action delayed 1 month; 3, action delayed 1–3 months; 4, action delayed 3 months; and 22, no action taken. Sixteen users reported that the problem of blocked tanks had since recurred. Twenty-seven users did not experience any problems in the period 1–5 years prior to the survey.

As with the Matero aqua privy systems, fewer users than might have been expected claimed to be satisfied with their toilets: 7 were very satisfied; 9 satisfied; 6 gave no reaction; 11 were dissatisfied; and 16 very dissatisfied. With regard to other toilet systems known, 39 users regarded pit latrines as being worse but preferred WCs. Eighty percent of those interviewed preferred the toilet to be part of the house. The mean monthly sum which they were prepared to pay for a WC was K1.73.

Conclusions

In theory, the sewered aqua privy systems are supposed to function properly. In practice, however, this is not the case. Two factors may be responsible for this:

(1) The design of the system requires modifications. Experience from Matero suggests that in the design stage, population and flow estimates should be extremely liberal. Within 5 years of installation, the Matero units caused problems because the average household size had been greatly underestimated so that predicted flows were inaccurate. In addition, push-on taps were replaced by turning taps, increasing the flow by 43%. As a result, the original 100 mm diameter sewers could not cope and they had to be replaced with 150 mm diameter pipes at extra expense.

(2) The second factor involved periodic desludging of tanks. When this is not done or when the sludge is allowed to exceed the set maximum, serious problems arise. The Balovale aqua privies are an example.

It was clear from the survey that the tenants were not happy with the units, although when maintained properly they function quite well. Self-topping aqua privies sewered to soakaways were found to be unsatisfactory because of the marked tendency of these soakaways to become blocked. Self-topping sewered aqua privies

are a better and more effective system when the design is done properly and desludging is carried out when necessary. When each unit is shared by two houses, there is a reduction of control over the cleanliness of the toilet by each household. It is recommended that such an arrangement be discontinued.

In recent designs of low-cost housing, by municipal councils and local authorities, aqua privies have been replaced by conventional water closets that discharge wastes into sewers (where they exist) or into shared septic tanks. One reason for this, among others, may be the problem associated with emptying the aqua privy tanks, which the municipalities have been faced with. In self-built low-cost houses, however, supervised self-built pit latrines are being encouraged.