



## Springwater quality improvement in slums

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LACK OF REASONABLE access to adequate supplies of safe drinking water is a big problem in sub-urban and rural communities in developing countries. Most of the water-related problems are compounded when methods and techniques used for abstraction do not take into consideration the unique local conditions.

Springs are a chief source of domestic water in Kampala and are known to supply up to 50 per cent of the population (Kampala Urban Study, 1992). Most of the springwater dependants are low-income earners and reside in sub-urban areas commonly known as slums. Many of the slums are located on low-lying land with a water table close to the surface. A special research project carried out in Katanga, one of these slums, indicated that over 70 per cent of the inhabitants obtain their domestic water from springs (Naturinda, 1997). This is due both to economic reasons and the haphazard settlement patterns that make it difficult for a piped water network to be constructed.

There is extensive use of pit-latrines in Kampala slums, but some residents do not use latrines at all. This puts groundwater at a risk of contamination, which is aggravated during the rainy season. Table 1 shows results of the bacteriological water quality tests carried out on water from three representative springs in Katanga denoted **SP1**, **SP2** and **SP3**. It can be seen that the groundwater is contaminated with faecal material. The recent dysentery and cholera outbreaks in these areas may be associated with this contaminated springwater.

### Spring protection

An adequately protected spring can provide safe water for human consumption. However, the local conditions in the slums cannot permit such protection because usually the catchment area is inhabited, and there is human activity including cultivation and waste disposal even up to within ten metres upstream of the abstraction point. This may

explain the poor bacteriological quality of the springwater in Katanga. Hence, an appropriate technique to improve the springwater quality in slums is imperative.

### Simulated on-site storage

Storage improves the microbiological and physical qualities of water (Hofkes, 1987). However, storage is not usually used as a separate independent water purification method, since more rapid sedimentation and removal of colloidal matter can be achieved with chemical coagulation and filtration (Steel & McGhee, 1985). Chemical treatment for springwater in slums is practically inapplicable on a significant and sustainable scale. Hence, storage can be an appropriate springwater quality improvement technique.

During the research carried out on springwater in Katanga (Naturinda, 1997), an on-site storage situation was simulated in the laboratory to predict the effectiveness of storage in improvement of the bacteriological quality. The experimental set-up was designed so as to allow for two anticipated situations:

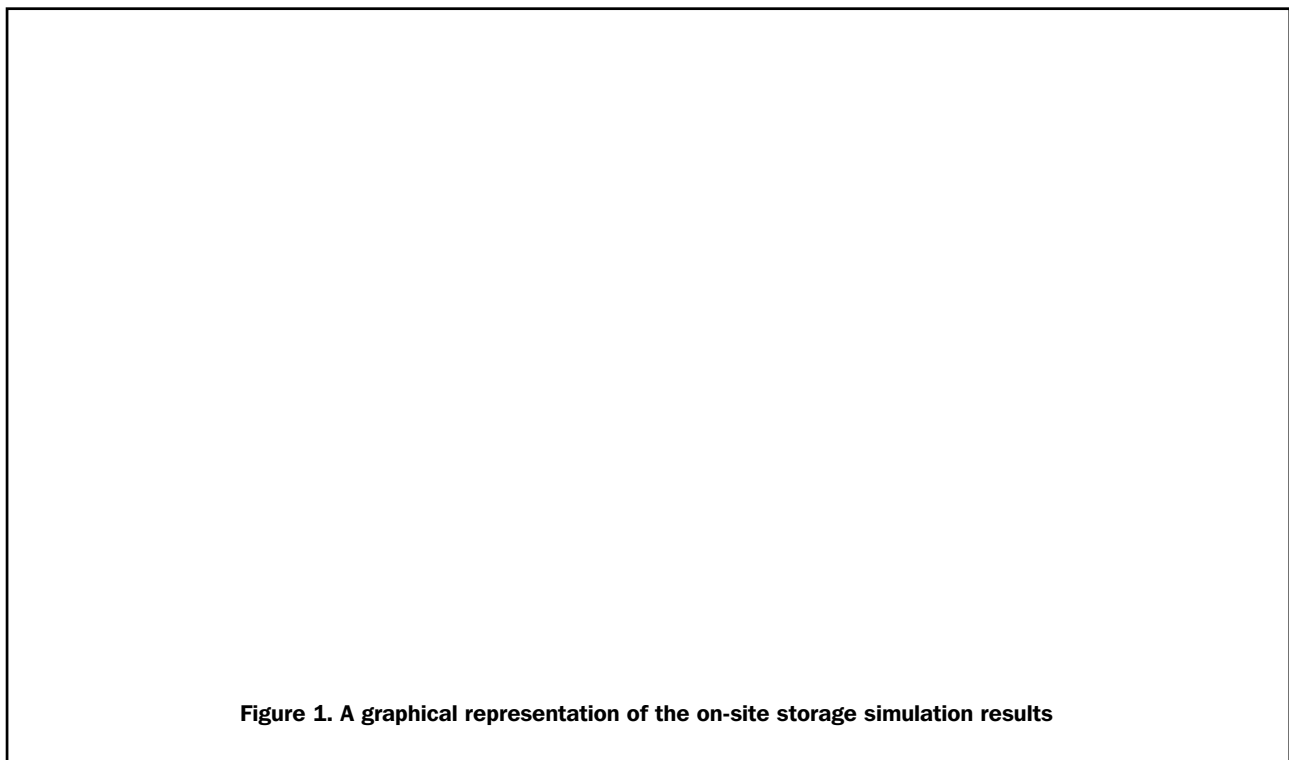
- Phase I - A phase with little or no interruption of the water undergoing natural purification in storage. This situation portrayed the conditions at night when the storage is full and raw water is not allowed to mix with the water in storage, and was named 'plug flow' phase.
- Phase II - A phase that allows mixing of raw water with water in storage. The rate of mixing was determined from the maximum hourly demand as the extreme case of abstraction. This situation catered for the conditions during the day, when water is abstracted from storage, while raw water is allowed into the storage.

The duration of each of the phases was determined from the maximum number of hours of the day over which water is abstracted from the spring (obtained from actual field observations). The bacteriological quality variation of the water in storage was monitored at hourly intervals over the two phases.

### Results of the simulation

A general reduction in the faecal coliform counts was observed during the 'plug flow' phase. This reduction was later upset with the inflow of raw water during the 'mixing' phase (see Figure 1 below). However, at the end of one complete cycle of the 'plug flow' phase and the 'mixing' phase, an average faecal coliform reduction efficiency of about 20 per cent was achieved.

\*Table 1. Faecal coliform counts (in MPN/100mL) for three representative springs in Katanga



### Conclusions and recommendations

A 20 per cent reduction efficiency implies that only 80 per cent of the microbes present at the beginning of a cycle will be present at the beginning of the succeeding cycle. This reduction is cumulative, and it is anticipated that when the system is operated for a long time, substantial microbe reductions may be achieved to declare the water safe for human consumption.

To avoid algal growths and contamination from the surroundings, it is proposed that a covered and ventilated storage concrete box (as illustrated in Figure 2) can be used. The controllable outlet and an overflow pipe allow for the 'plug flow' phase, when there is no abstraction.

The pH of the springwater in Katanga was found to be fairly low (see Table 2), hence, a well constructed concrete storage facility may be a better option than a steel reservoir which may be susceptible to corrosion.

**Table 2. pH values for a range of tests on water from three representative springs in Katanga**

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The average cost of conventional spring protection in Uganda is about US\$2,800. The inclusion of say, a five cubic metre concrete reservoir (which costs about US\$300) to a protected spring to boost its purifying capacity would only increase the total cost by 10 per cent. This is a clear indication of the economic appropriateness of this technique to the low-income communities in slums, for as long as the required quality can be achieved then the risk of water-borne diseases can be reduced.

On-site experiments with a prototype during various seasons may be necessary to determine the actual efficiency of the technique in a real situation. This is because mixing in the lab was done intermittently and regularly, unlike in the field where draw-off can occur at any time of the day. This is likely to influence the bacteriological counts and give different results.

### References

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**Figure 2. Illustration of a protected spring with a provision for on-site storage**

\* NB: The maximum allowable level of faecal coliform counts for untreated water sources is 50No./100mL, according to the Uganda Draft National Guidelines.

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