Issue sheet

Technology

WaterAid/Marco Betti

WaterAid helps poor communities in Africa, Asia and the Pacific region to set up safe water supplies, build their own latrines and learn about safe hygiene practices.

The technologies we use for water and sanitation are low cost, appropriate to the local financial and geographical conditions and within the technical capacity of the benefiting community to operate and maintain themselves. We aim to use technologies that include locally sourced materials and spare parts which can be purchased and transported easily.

So that communities feel a sense of ownership of their projects they must be involved in all stages of the work. They participate in planning and designing projects, assist in their construction and undertake training in how to operate and maintain the systems. This ensures that communities can sustain their projects after WaterAid ends its support, with possibilities to extend or replicate their projects in the future.

Water supply


WaterAid/Caroline Penn

Construction of a hand-dug well in Ghana.

WaterAid helps communities to set up and manage water supplies for domestic use. In rural areas where there is little or no existing water infrastructure, water projects are set up using uncontaminated water sources such as groundwater, rainwater or surface springs. It is much more sustainable to prevent the pollution of sources rather than treat polluted water as treatment chemicals and equipment are too expensive for poor communities. In urban areas we either use uncontaminated sources, or negotiate connections to existing municipal piped water supplies.

Groundwater sources

Groundwater is the prevalent source of safe, untreated water. It is usually safe to drink because permeable layers of earth act as fine filters removing bacteria and other impurities as water seeps through them.

Wells

A traditional method of obtaining groundwater in rural areas of the developing world, and still the most common, is by means of **hand–dug wells**. However, because they are dug by hand their use is restricted to suitable types of ground, such as clays, sands, gravels and mixed soils with no large boulders. Some communities use the skill and knowledge of local well–diggers, but often the excavation can be carried out, under supervision, by the communities themselves. The wells should be lined to prevent pollution and make them more stable – this is particularly important for those built in the dry season as they are liable to collapse in the wet season. The safest method of construction is to excavate within pre-cast concrete rings which later become the permanent lining to the sides of the well.

Below the level of the water table, linings have porous walls and the pre-cast rings are left unpointed to allow water to seep into the well. The volume of the water below the water table acts as a reservoir, which can meet demands on it during the day and should replenish itself during periods when the pump is not being used.

Above ground level the well lining is raised with a concrete upstand and cover slab to prevent polluted surface water seeping back in. Drainage channels and soakaways are also formed to prevent the formation of puddles of wastewater.

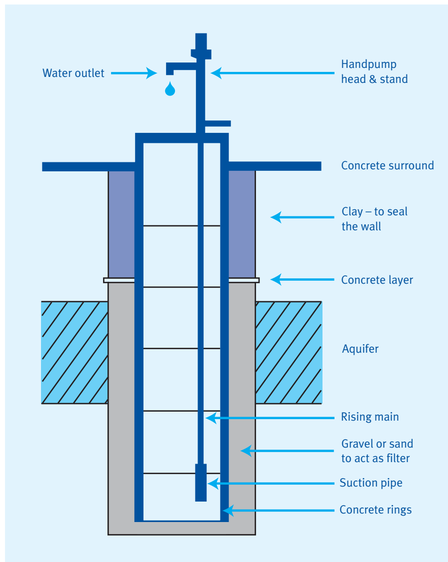
Rather than digging new wells, some programmes rehabilitate traditional unlined, uncovered and/or shallow hand-dug wells. The wells are deepened and widened, lined, sealed and protected to prevent contamination.

Tubewells are small diameter holes drilled by the hand-powered methods of augering or sludging. While they usually yield less water than hand-dug wells their advantages are that they can abstract water from a greater depth, are usually quicker and cheaper to sink, need no dewatering during sinking, require less lining material, are safer in construction and use, and usually involve less maintenance. They are suitable for construction where the ground or rock is soft, particularly in the water-logged silts and fine sands found in the flat river plains and deltas in the Indian subcontinent.


WaterAid/Abir Abdullah

A tubewell being constructed using the sludging method in Erendabari Char, Bangladesh.

Where there are harder rocks and/or the water table is very low, engine-driven augers and rock drills are necessary to cut through the earth to depths of 100m or more. These **boreholes** are only used when absolutely necessary as finding water takes time, money and effort, often involving thorough



Cross section of a hand-dug well and handpump.

Water supply – *continued*

hydrogeological surveys. They are also expensive to construct and run, particularly when deep.

Pumps

While water was traditionally collected from wells using ropes and buckets, this prevented wells from being sealed and meant the water could be contaminated by items falling in the well, or by mud and dirt from the rope and buckets themselves. The preferable option is to seal wells with a concrete cover slab and fit them with a pump.

Handpumps (as pictured on the front cover) come in a large variety of designs. However, most of them are positive displacement pumps and have reciprocating pistons or plungers. Handpumps should be selected according to the Village Level Operation and Maintenance (VLOM) principles which involve ensuring the pumps are:

- Easy to maintain by a village caretaker, requiring minimal skills and few tools
- Manufactured in-country, primarily to ensure the availability of spare parts
- Robust and reliable under field conditions
- Cost effective

Rope pumps are increasingly being used in WaterAid programmes in remote areas where the spare parts for handpumps are difficult to obtain. This simple pump involves a continuous rope fitted with discs or washers or simply knotted being looped around a wheel, often a bicycle wheel, to lift water to a discharge outlet by drawing the rope through a pipe. In newer, improved designs the rope is totally covered to reduce the possibility of contaminating the water.

WaterAid/Andrew Cook

A rope pump in Mozambique.

Diesel or electric pumps are used in wells where there is a high demand for water and/or where the water table is very deep. The water is usually stored in tanks before being piped to tapstands. Their main disadvantages are the costs of fuel and energy involved and the specialist and expensive maintenance required.

Surface water supplies

Springs occur where groundwater emerges at the surface because an impervious layer of ground prevents it seeping further down. **Protected springs** can be used either to supply a storage tank, or just to provide a single outlet that runs continuously. They can also supply **gravity flow schemes** that pipe water downhill to storage tanks and tapstands in communities that can be several kilometres from the source.

The protection of springs includes measures such as ensuring the spring is not really a stream which has gone underground and is re-emerging; ensuring the source and the collecting area are not likely to be polluted by surface runoff; checking any latrines are at least 30 metres upstream of the spring and fencing the catchment area around the spring to prevent pollution by children, animals or farming activities.

WaterAid/Marco Betti

A tapstand supplied by a gravity flow scheme in the mountains of Nepal.

Rainwater harvesting

Rain can provide some of the cleanest naturally occurring water and where it falls regularly there is scope to collect it, before evaporation takes place and before it becomes contaminated. Water is generally collected from pre-cleaned roofs, where it runs via guttering into a storage tank. Rainwater harvesting is a useful technology where there is no surface water, where groundwater is deep or inaccessible due to hard ground conditions, or where it is too silty, acidic or otherwise unpleasant or unfit to drink. It can also be used as a backup supply where piped water services are intermittent or where the yield of wells fluctuate seasonally.

WaterAid/Caroline Irby

A roof rainwater catchment system and storage tank at a school in Ethiopia.

Urban solutions

Because of the higher population densities in urban areas different technologies are often needed. While wells are appropriate in some circumstances, where possible it is usually preferable to negotiate with the local government or water authority to connect slum communities to the city's piped supplies. WaterAid and its partners help communities to construct waterpoints they can manage and maintain themselves and arrive at agreements with the municipal suppliers on how contributions are collected to pay for water bills.

WaterAid/Marco Betti

A municipal water supply in the Indian city of Gwalior.

Blocking the faecal oral route

All the technologies that WaterAid uses are designed to prevent the pathogens carried in faecal matter being ingested. Pathogens can enter people's mouths via a number of routes including water, soil, flies and fingers. This is called the faecal oral route. When used in conjunction with improved hygiene behaviour WaterAid technologies block this route and so reduce the likelihood of diseases being transmitted.

Sanitation

Given sensitive guidelines and a little technical help, families can build latrines for themselves at very low cost.

However, demand for sanitation services is generally lower than for water, as many people do not associate improved sanitation with improved health. Hygiene education is therefore essential to create awareness of the need for latrines, and to ensure they are used safely.

Pit latrines

The most common type of latrine is the **dry pit latrine.** The main criteria are that the pit should be at least three metres deep and completely above the water table. The squat slab covering the pit should be strong and easy to clean, with a keyhole shaped drop hole and foot pads. A shelter built of local materials provides privacy.

Ventilated improved pit (VIP) latrines also have ventpipes to take smells away. Flies are also reduced as they are attracted to the source of light at the top of the ventpipe, where they get trapped by a fly screen.

Where people use water to clean themselves after they have visited the latrine, **pour-flush latrines** are favoured instead. In these the latrine and pan is placed a few metres away from the pit and a pipe with a u-bend connects the two. A small amount of water is used to flush the pan and seal the u-bend to stop flies and smells escaping from the pit back into the latrine.

Composting latrines

WaterAid is increasingly reviving the old principle of **ecological sanitation**, which uses composting latrines to create a safe, renewable source of fertile compost from human waste, which is covered with soil and ash after each use of the latrine. Designs vary in complexity. The simple **arbor-loo** involves planting a tree in the latrine pit once it is full. The more permanent **fossa alterna** has two pits which are used in rotation. When the first pit is full its contents are left to decompose while the second pit is used. By the time the second pit is full the compost from the first pit is ready to be dug out and used, so that the first pit can come back into use.

Urban solutions

The sanitation challenge in urban areas is arguably more complex. In many slums and informal settlements most residents do not have land rights for their dwellings and in any case space for building latrines and bathing blocks is at a premium. In crowded areas communal pit latrines would fill too quickly and a high concentration of pit latrines could risk pollution of the water table.

WaterAid tends to promote the construction of communal sanitation blocks with the latrines either connected to cesspits that can be emptied by 'sludge-sucking' machines or connected to existing sewers if agreement is reached with the municipal authorities.

Some urban communities are able to construct **small scale community sewerage schemes,** some of which feed into the municipal sewers.

Building pit latrines in Tamale, Ghana

Curved concrete blocks are moulded from river sand and cement.

The blocks are built up to form the latrine lining of two latrine pits, within a rectangular pit dug by the householders.

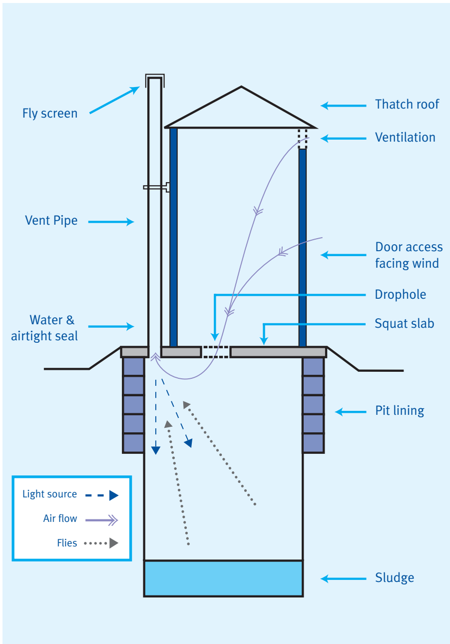
The concrete latrine squat-slab is cast within a mould, using steel rods for reinforcement.

The remainder of the rectangular pits around the latrine pits are filled back in and the latrine slabs are fitted on top of the pits.

The latrine huts are built, varying from simple thatch enclosures to more elaborate designs such as this.

Families learn about the importance of washing their hands after using the latrines.

Pics: WaterAid/Jon Spaull



Cross section of a VIP latrine

Water resource management

Water tables are falling dramatically in many parts of the world due to over-abstraction of water by agriculture and industry, a problem that will be exacerbated by climate change. Pollution is also increasingly threatening the safety of groundwater due to increasing population density and industrialisation. In recognition of this WaterAid is committed to a policy of ensuring that all its future water supply and sanitation projects address the issues of water depletion and contamination through appropriate water resource management.

WaterAid/Somesh

A rainwater catchment reservoir in India that provides water for irrigation.

This involves investigating the likely **sustainability of water sources** before project work is started. Wherever necessary, projects should aim to conserve water by alternating the use of water sources, or by using different sources for different purposes. While it is necessary on health grounds to use safe water sources for drinking, traditional sources such as rivers could be used for water to wash clothes, clean houses or give to livestock.

Projects can also be set up to recharge an aquifer, for example by collecting rainwater and channelling it into an open well. Communities should be made aware of the need to conserve water, with waste discouraged, possibly by tariff-setting (while still ensuring universal affordable access to safe water). Pollution should also be discouraged.

Communities are trained how to monitor the depth of water in open wells and how to keep a record of seasonal fluctuations and long term trends, so that they know if further action is required.

Projects will address **water quality maintenance** by testing the quality of water in neighbouring sources prior to development of a new source wherever there is any doubt. This is particularly important in areas prone to natural arsenic or fluoride contamination of the aquifers.

To prevent contamination of the aquifers WaterAid will continue to ensure that there is an adequate distance between water sources and latrines and adequate surface water drainage to prevent the buildup of stagnant wastewater at handpumps and tapstands.

Maintenance of projects

It is important that communities feel ownership of their water and sanitation projects and are given help in setting up the necessary operation and maintenance systems so that projects do not fall into disrepair.

The first step in most WaterAid projects is to set up a water and sanitation committee drawn from the community, with designated roles such as chair, treasurer, caretakers and hygiene educators. The treasurer is usually responsible for collecting financial contributions from each household to cover maintenance, replacement parts and, in urban situations, water and sewerage bills. The caretaker will be given training in basic maintenance such as how to check a handpump and carry out simple repairs as necessary.

In some projects community members are trained as mechanics who are able to fix more complex problems, while in others they contribute to a maintenance fund to buy the services of a mechanic as required.

In some cases, particularly in urban contexts, it is decided that community members will pay per container of water fetched. In this case the post of handpump caretaker can be a full-time job, and wages must be factored into the equation. In rural projects the committee members more often perform their roles on a voluntary basis.

WaterAid/Somesh

A spare parts store for WaterAid projects in India.

WaterAid/Jon Spaull

The water and sanitation committee in the village of Chipongwe in the Kafue District of Zambia.

Parkinson Nkhomo (first from left) is the chairman of the water and sanitation committee. "As Chairman I check and ensure that the pump is working well. If there are any problems then I will find ways of fixing the pump. Apart from this I also train people about hygiene – especially around the pump. I explain to people not to play around here and make sure that the area is kept clean."

Alan Malambo (third from left) is the pump mechanic. "I help to maintain this pump, 53 households use it, and because it is used so much it breaks down frequently. I received training when the committee was formed so I know how to repair the pump. The pipes wear out quite quickly so we use money we have collected for spares."

Benson Jango (fourth from left) is the treasurer. "Every household pays 500 kwacha [about six British pence] a month. So far we have 20,000 to 30,000 kwacha which we will be able to use if the pump breaks down. We will then be able to buy spares and the committee will be able to mend the pump."

£5 pays for a bag of cement for latrine slab in Ghana

£15 pays for the tools needed to construct a hand-dug well in Malawi

£46 pays for the construction of a pour flush latrine in Madagascar

£200 pays for a locally manufactured rope pump in Mozambique

£1,150 pays for training 200 handpump caretakers in India

Technical advice from WaterAid

More detailed information on the technologies used in WaterAid's fieldwork and points to consider before designing water and sanitation projects are available in our guide *Technology notes*, compiled by WaterAid's technical advisors. Printed copies are available on request or you can download a pdf version at **www.wateraid.org/technology**

Our technical advisors also offer an information service for technical enquiries. They are available on Tuesdays and Wednesdays on **020 7793 4546** or **technicalenquiryservice@wateraid.org**

Front cover image: A WaterAid funded well in the Singida region of Tanzania.

WaterAid

WaterAid – water for life
The UK's only major charity dedicated exclusively to the provision of safe domestic water, sanitation and hygiene education to the world's poorest people.

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WaterAid/Caroline Penn

Construction of a 21 feet deep hand-dug well in Uganda.

Yoram Lembris is the pump attendant for the borehole in Ndedo village in Tanzania's Kiteto District.


WaterAid/Alex Macro

Water is very scarce in this Masai settlement of scattered households. A borehole has been drilled which now supplies water for 800 of the 2500 residents, and alternative sources such as rainwater harvesting, dams and shallow wells are being investigated for the remaining people.

Yoram Lembris is responsible for looking after the diesel engine that pumps water from the borehole to the surface. "I operate the engine and keep it clean and safe and run it for the hours as instructed by the community. In the past we used to get our water from the same holes as the cattle, but now it's all separate it's much cleaner.

"The traditional wells were also very dangerous with women falling in and injuring themselves. The pits would also often collapse, killing anyone inside. Now we have clean clothes and people are building permanent houses here instead of travelling all over the region in search for water for the cows.

"Personally this project has given me responsibility so that my status has been raised. The community pays my wages so I get an income now. Also, by operating the pump I have been trained so I have a new skill."

Abdul Rezark helps manage the sewers constructed by his community in Faisalabad, Pakistan.


WaterAid/Martin Punaks

WaterAid and its partner Anjuman Samaji Behbood (ASB), are helping the communities here, who live in cramped, low-income settlements, to install underground piping to channel sewage to the main municipal sewage line. WaterAid and ASB are providing the technical know-how but the communities themselves are financing both the initial construction and maintenance, and providing the necessary labour.

The new community sewer project in the Hasan Pur slum has been so successful the community has been able to persuade the local government to pipe water to their area too.

Abdul Rezark, a lane manager in Hasan Pura, explains how the project works. "I was nominated as a lane manager by the residents on the street. I was then given training and technical assistance by ASB. As a lane manager I collect the maintenance money from the local residents and I also manage the labour. My main job is to look after the credit system and ensure it is benefiting everyone. The local residents all agree to pay a small amount for the project. If residents cannot afford it, ASB can loan them money which they pay back over several months. This is a self help project; we do not want anything for free."