WEDC

MOBILE NOTE 46

Domestic water containers

Introduction

This note examines the range of domestic water containers commonly found in low-income countries and explores the role that water containers have in ensuring that household water supplies are adequate and safe.

It also explains why planning for a water supply system should not end at the public tap or village well but extend to the place where the water is used. Here, the term water container includes pots, vessels, buckets, jerrycans or barrels used at household level.

Loughborough University

Contents

Understanding the ways in which people use water containers and designing the supply system to take account of this will help engineers to provide a better and safer service.

In this note, the term water container includes pots, vessels, buckets, jerrycans or barrels used at household level. Tanks on vehicles and carts are not discussed.

Engineers and other development workers may believe that their role in delivering water to people in low-income communities ends at the public tap, protected spring, handpump or well. However, water is usually collected from the water point, transported home and stored in a container. Even if there is a household piped supply, people may use water containers to treat and store water, or to carry it with them to work or school. Surveys of water treatment and

distribution networks show that this final stage of the water supply system can lead to the re-contamination of water and so is a weak link in the supply chain. Understanding the ways in which people use water containers and designing the supply system to take account of this will ensure that a better and safer service is provided.

Uses of water containers

Water containers are used to collect, transport, treat, store and consume water.

Collecting water

Whilst containers are often seen primarily as a means of transporting water, some containers are used specifically for collecting water. For example, a small scoop is used to transfer water into another container, especially where water is collected from shallow ponds that may not be deep enough for filling a large container.

With open wells, a designated bucket is sometimes used to lift water to the surface. This is for three reasons:

- It is hard work hauling a large bucket of water from the depth of a well: it is easier to use a small bucket several times and transfer the water to a larger container for transporting it home.
- If everybody uses his or her own bucket, the water in the well may become contaminated. People may stand their bucket on the ground, where it gets dirty. This dirt is washed into the well when water is collected. Having a single bucket tied to the haulage rope limits contamination, especially if the bucket can be hung off the ground when not in use.
- Plastic buckets may float, making collecting water from a well difficult. A bucket made from rubber will fall onto its side and fill more readily.

Sometimes containers are used to collect rainwater. These need a wide opening – or at least a funnel for directing rain into the container.

One of the key features of a good container is that it must be easy to fill. Small openings or awkward shapes may make filling difficult and time consuming, wasting time for the person collecting the water and for those waiting in the queue.

Figure 1. Drawing water from a well

Box 1. Collecting water

In Africa and Asia women are generally responsible for collecting water for their families.

On average, in rural Africa, women spend 26% of their time collecting water, which often means having to walk 8 kilometres or more to the nearest water source. In the dry season, when water becomes more scarce, this distance can double and it can take hours just to fill up one container as the water slowly filters through the ground.

Women often have to wait in turn to collect water, forcing many to leave home in the middle of the night to reach the source when there is no queue. Then, when they have collected enough water for their family, they will start the long journey back home carrying their heavy water containers.

Source: WaterAid (2009)

Figure 2. Carrying heavy loads

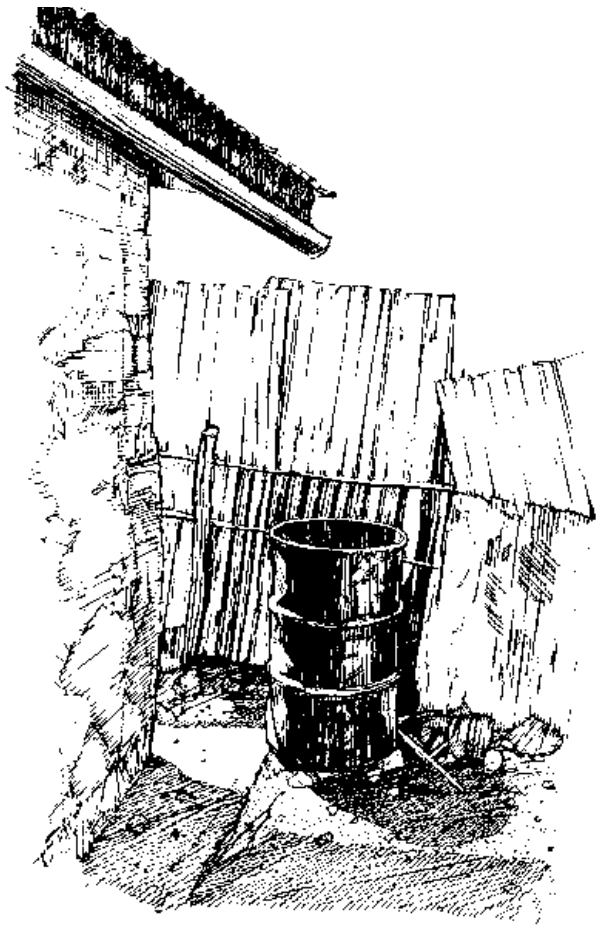


Figure 3. A simple rainwater container

Transporting water

Unless water is supplied directly into the home, it will need to be carried to where it is be used. This limits the size of the container, or it will be too heavy to lift.

The time taken to walk to the water source, fill the container and walk back home affects how much water is used (see Figure 4 from Cairncross and Feachem (1993)).

If the total time is over 30 minutes, water consumption can be seen to reduce considerably and reduced water consumption can lead to ill health.

Carrying water is hard work and is not only exhausting but can also lead to physical impacts on health.

The time taken to fetch water can displace other activities, such as productive work, education or rest.

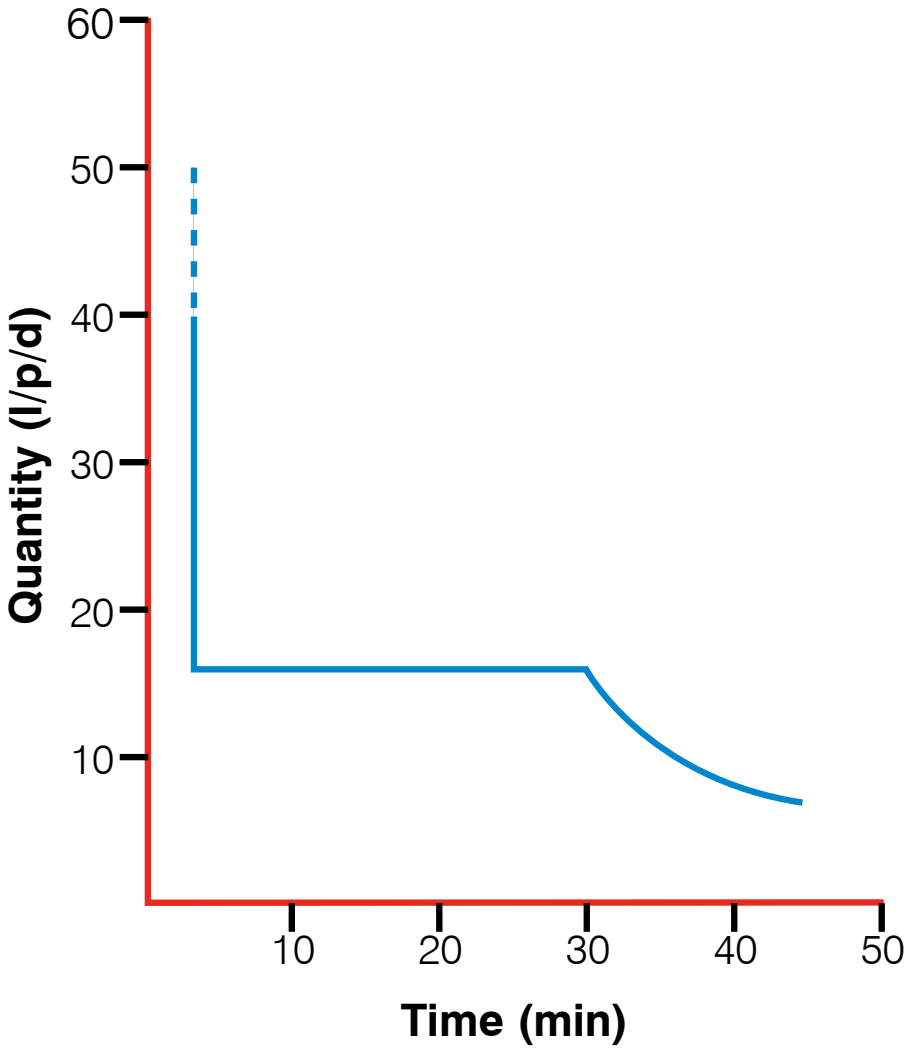


Figure 4. Relationship between water collection time and consumption

Storing water

Having to collect water from a water point away from the home is inconvenient. At busy times, when meals are being prepared, for example,

water may run out or have to be used sparingly. This may limit the amount of water available for handwashing. Having several containers means that the containers can be filled up at a convenient time, not just when they are empty and water is urgently required.

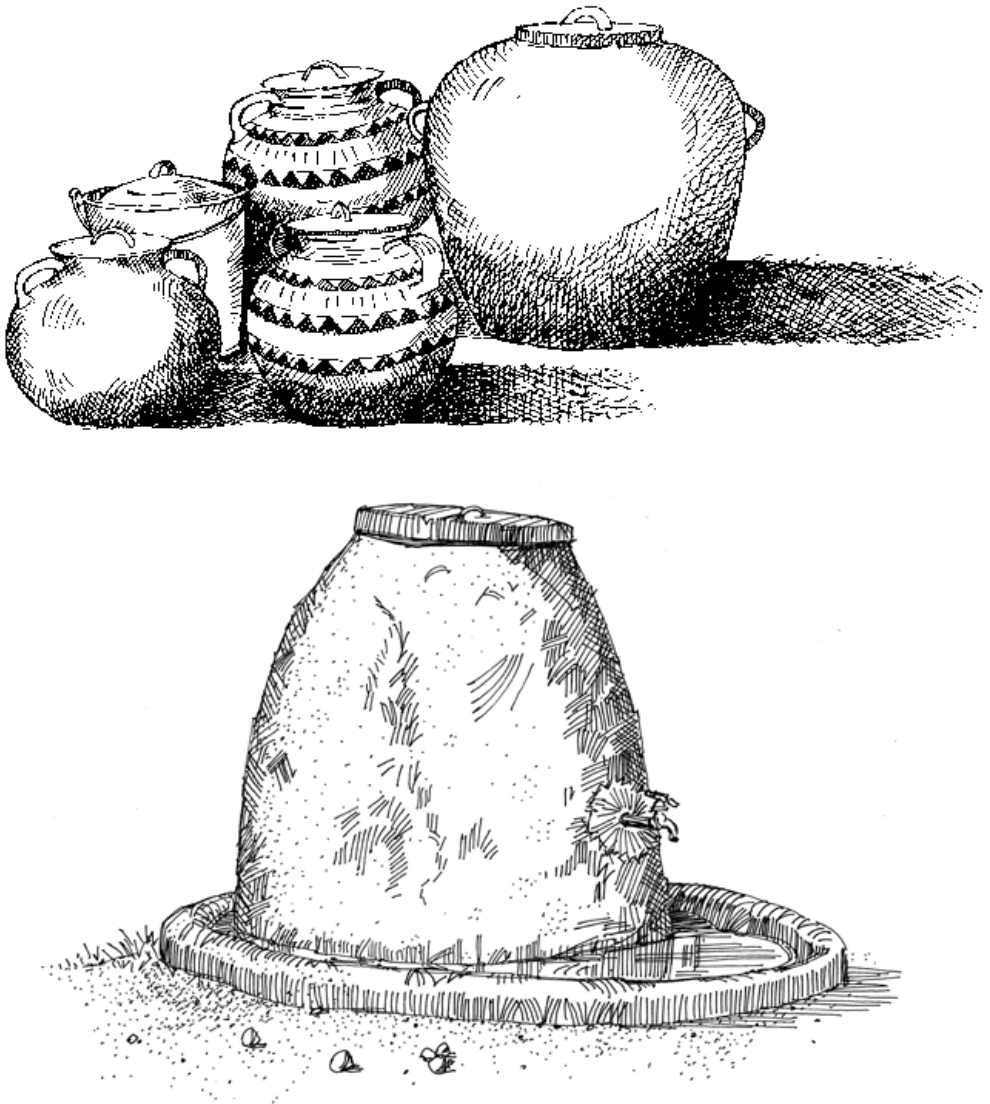


Figure 5. Storing water

Box 2. Storage capacity

A study of water collection and storage in 270 households [in Zambia] found that 40% felt that they would have liked to be able to store water for longer, but it was used quickly because storage capacity was inadequate. There was a significant correlation between storage capacity and the amount of water used per household, suggesting that discussions on promotion of more storage containers could lead to greater water use. There was no correlation with distance to water, but less than 5% of households used water sources which were more than a kilometre away.

Source: Sutton (2001)

If water supplies are unreliable or intermittent, then household storage can improve availability. Having spare containers increases the amount of water used, especially for hygiene.

Box 3. Household consumption

In a study in 1966-68, container size was the most influential factor in determining household water consumption. When the study was repeated in 1997, relative wealth of the household was the most influential factor.

Source: Thompson (2001)

Water containers can be used for different purposes, allowing drinking water to be kept separately (and therefore more safely) than water for washing or other purposes.

Treating water

Containers have an impact on the quality of the water. Dirty containers or containers without covers increase the risk of clean water becoming contaminated during collection, transport and storage. Containers can

be designed not only to maintain the quality of the water, but even to improve it through storage.

Handwashing

Handwashing has a significant impact on hygiene and some containers have been adapted specifically to help people wash their hands easily. Key design features include 'hands-free' operation and ways to minimize wastage.

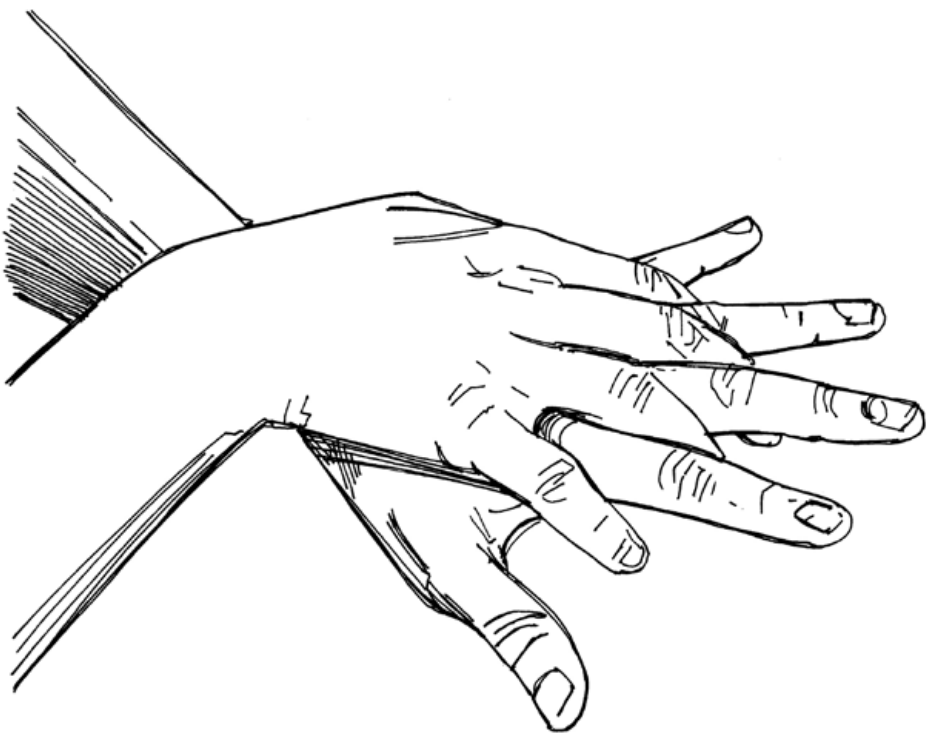


Figure 6. Handwashing

Drinking

Some containers are used for drinking. These are often small and easy to carry. Water sold in plastic bottles or plastic bags is usually drunk straight from the container.

Figure 7. Bottles of drinking water

Other uses

Water containers are commonly used for activities such as washing clothes and bathing. They may also be used for general storage of other household items and become dirty as a result. For example, if potatoes or yams are kept in a bucket that is also used for collecting water, there is a risk that it will not be properly washed between its two uses. However, a container (such as a jerrycan) with a small spout cannot be used for general storage, preventing contamination from this source, so this may be a preferred option. A tap fitted to a bucket helps identify the bucket as one reserved for water storage.

Some containers have been adapted for specific uses, such as watering plants.

Design of containers

Shapes and styles of water container have evolved to suit local preferences, conditions, uses and users.

Box 4. Place of manufacture

Locally-made containers do not need transporting very far and can be tailored to the needs of the local population. This can limit the type of containers produced however, with clay, beaten metal, canvas or recycled rubber being easier to manufacture than cast metal or moulded plastic.

Making and selling water containers can be a good way for local people to generate an income.

Figure 8. Locally-made clay pots

Size

If a water source is far away, the amount collected per trip will have to be maximized, to limit the number of journeys people will have to make. Using a larger container will reduce the time spent travelling. Smaller containers that are lighter and easier to carry can be used if the water source is close by. Larger containers that are difficult to lift are often used for water storage in the house.

Figure 9. A bucket fitted with a tap, reserved for drinking water

Children and people who are disabled or infirm will need smaller containers if they are not able to lift larger ones.

Shape

Containers are made in a variety of shapes due to the constraints of the way they are made, the materials and their intended use. Circular pots spread the water load equally around the wall of the container, whilst rectangular sections have high loads concentrated on the corners, with the weight of the water pushing outwards. Some containers have ribs or ridges to strengthen the vessel.

Bulk delivery of containers

Water containers have to be transported from where they are manufactured to where they are sold and then to where they are used. Fragile containers, such as those made of clay, need to be made locally. Metal and plastic are more robust, but take up a lot of space when transported. In order to overcome

excessive transport costs and to ensure efficient warehousing, especially for emergency supplies, three alternative designs have evolved.

Figure 10. Large containers are difficult to carry long distances

Stackable buckets are tapered slightly, so one can fit inside another. However, this means that the container has to have a large mouth, which is not so good for water quality control. Lids can be made to secure the water and these can be assembled once the buckets and lids have arrived near their point of use. However, they can also become dirty if they are stacked and stored.

Collapsible containers can be used immediately. They are made of flexible plastic that can fold down when not in use. They can be transported flat and inflated on delivery.

Box 5. Providing for people with disabilities

Containers can be adapted to meet the specific needs of people with disabilities.

Making handles longer or improving their grip may make them easy to use; lids help reduce spillage and reduced size can make them light enough to lift.

It is important that the user is enabled to select and adapt the container for their own needs rather than an 'expert' deciding this for them.

Good advice on this is available from Jones and Reed (2005).

Figure 11. A disabled woman carries a smaller container on her head

Rectangular containers require thicker plastic or metal than a circular container as the forces on the corners are greater, but they can be packed closely together and take up less space than cylindrical containers.

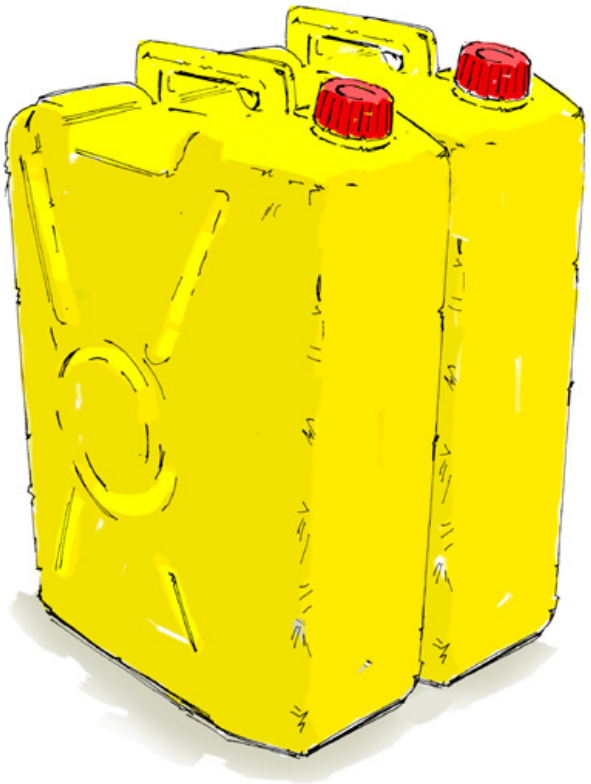


Figure 12. Rectangular containers can be packed closely together

Carrying

People carry containers in different ways and the design of containers has evolved to suit the carrying method.

On the back: Some people, in Ethiopia for example, strap the water container to their back. This may be supported by a strap around their shoulders or their forehead.

Figure 13. Carrying water on the back

A basket may be used to carry the container. A variation is to use a yoke, where two containers are hung from a pole carried across the shoulders.

On the head: This is popular in many areas. It may be more common for women than men, depending on the local culture and customs. A piece of cloth or a handful of grass fashioned into a ring is sometimes used to make this more comfortable.

By hand: Some people prefer to carry a water container by their side; this requires a strong handle with a comfortable wide grip. The container has to be fairly narrow so it hangs vertically and does not knock against the legs of the carrier too much.

Figure 14. Using a yoke

An alternative is to carry the pot tucked under the arm with the weight supported

by the hip. The pot requires a round base and is only suitable for medium-sized containers.

Animals: There are two ways of using donkeys or other domesticated animals to carry water. One is to strap conventional containers to a harness. The other is to use specially-made water bags, although this means decanting the water into another container for storage and use.

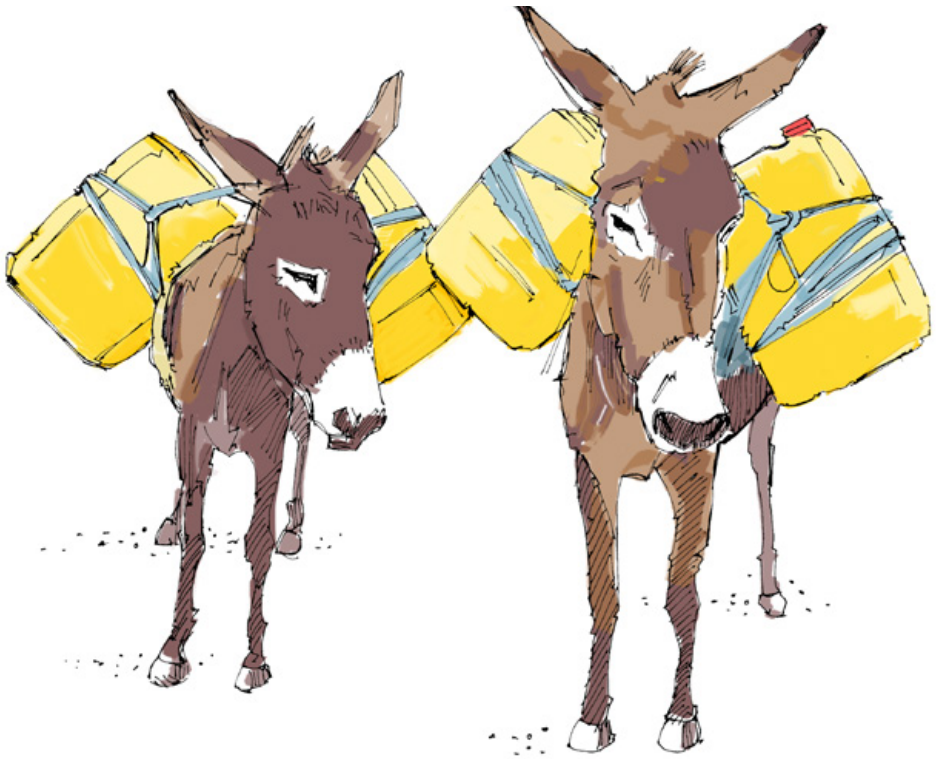


Figure 15. Using donkeys to carry jerrycans

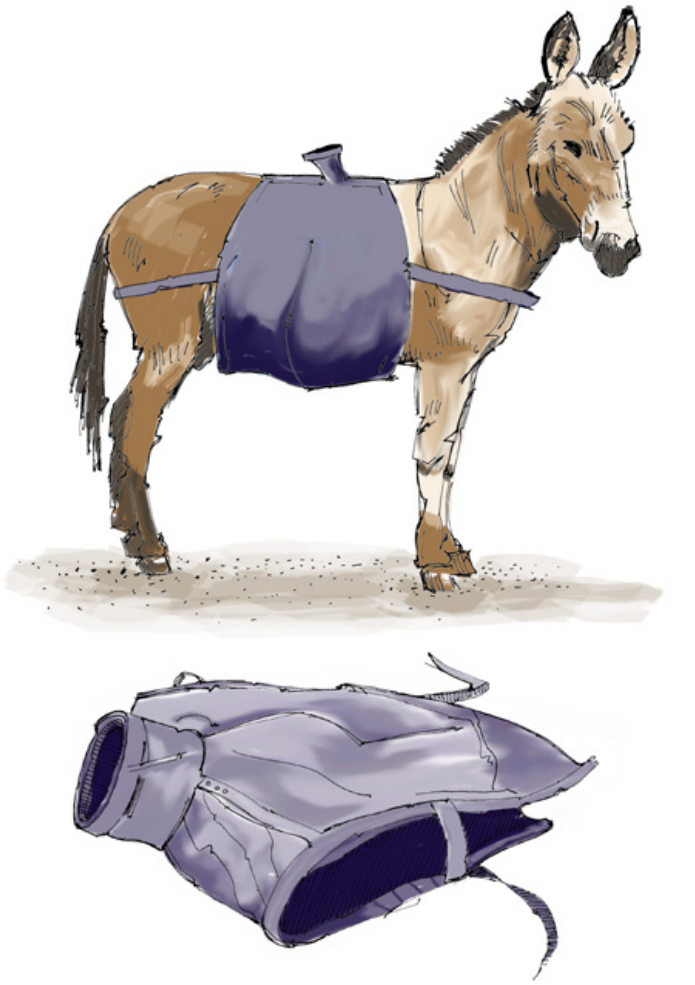


Figure 16. A donkey with a water carrier (Below: The carrier when not in use)

Bicycles and wheelbarrows:

If containers are strapped to an animal, to a bicycle or placed in a wheelbarrow, they need to have secure lids and handles so they can be tied on. If they are rectangular, they can be packed closely together.

Rolling: Larger volumes of water can be rolled along the ground in cylindrical containers. Oil drums can be strengthened at the edges and along the ribs with iron rims to make them more durable. Specially-made rolling containers are also available in some countries (South Africa, for example). These have a long handle so they can be pushed or pulled from a walking position reducing the physical effort required to manoeuvre the container.

Figure 17. Using a rolling container

Box 6. Re-use and recycled materials

Many water pots are made from recycled materials: old vegetable oil containers being a common source. Many rubber water buckets are made from old car tyres. If former chemical containers are recycled, they must be thoroughly cleaned before being used to store water.

Figure 18. Problems with small openings

Opening size and shape

The size of the opening and neck has to balance the ease of filling the container with the risk of contamination – i.e. whilst containers with larger openings are easier to fill, they increase the risk of contamination. Many handpumps, protected springs and taps do not release a narrow stream of water so water splashes around the opening of the container as it is filled. This wastes water and extends the filling time.

Containers with large openings may be easy to fill and scoop water out of without lifting the whole container, but they are more likely to spill during transport.

Pouring water from a container with a large opening can be awkward, causing spillage and wastage.

Cutting a 25mm slot along the top edge of a plastic jerrycan makes it easier to fill

in a pond or well as the slot still allows air to leave the container encouraging it to float on its side. The size of the of the slot still restricts access to the container and the handle can still be used for carrying.

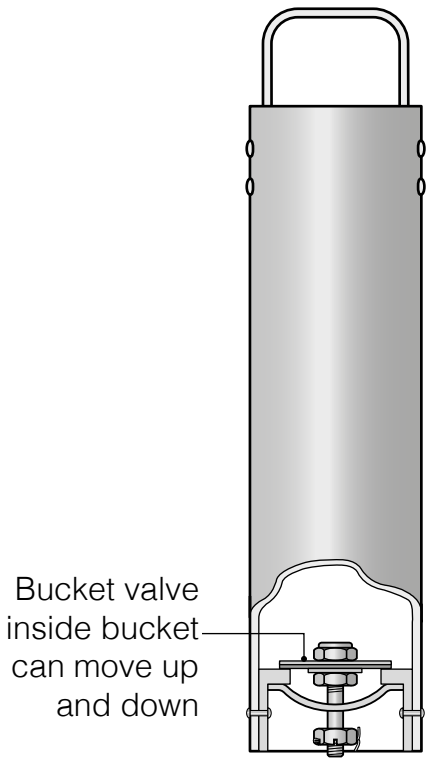


Figure 19. A bucket for narrow wells

One type of bucket specifically designed to collect water from narrow wells and boreholes was developed in Zimbabwe at the Blair Research Institute. This has a hole in the base of a narrow bucket, so it fills from the bottom. At this point

a simple valve shuts to keep the water in as the bucket is raised and the water poured into another container for transportation.

Box 7. Decoration

Water pots can be decorated. For people who have few possessions, a beautiful water container may be an affordable item to brighten the home. Choices of colour and pattern can be appreciated by the user. Basins and jugs for handwashing can be very ornate, as a way of welcoming guests.

Figure 20. A decorated bucket

Box 8. Handles

Some containers have a small handle, used to steady the vessel as it is lifted on to the head and carried home.

Other containers have no handle at all. People put their hands over the lip of the container to lift and steady it, which can pollute the water.

Figure 21. Pots without handles

Materials

There is a wide range of materials used to make water containers, all with costs and benefits.

Plastic and fibreglass can be moulded into various shapes and are light and durable, making them a popular choice at an industrial scale of manufacture. Cheap plastic buckets may not be strong enough to be used in wells, so they can be protected with a wire cage; the rope can be attached to the cage rather than a flimsy handle. Plastic bags filled with water are becoming a popular way of vending drinking water in cities. A corner of the bag is torn off, the water drunk directly and the bag thrown away. They cause litter, however.

Figure 22. Water bags

Metal water containers can be cast to form a pot, or can be assembled from sheets of beaten metal to form a simple cylindrical bucket. These can be heavy.

Figure 23. Metal containers

Clay pots are fragile but can be made locally from natural materials. The water from a clay pot is reported to taste good because it is cool. Some are made slightly porous, so water soaks into the pot and then evaporates from the surface. This evaporation cools down the pot and the water inside.

Figure 24. Clay pots

Natural water containers can be made from dried gourds and sections of bamboo. They tend to be limited in volume. Cutting them in half can make two useful scoops.

Cloth such as canvas and materials such as rubber can be made into buckets, forming a bag rather than a rigid vessel. These often leak so are not useful for storage. They have to be suspended from a hook as they are not stable when placed on the ground.

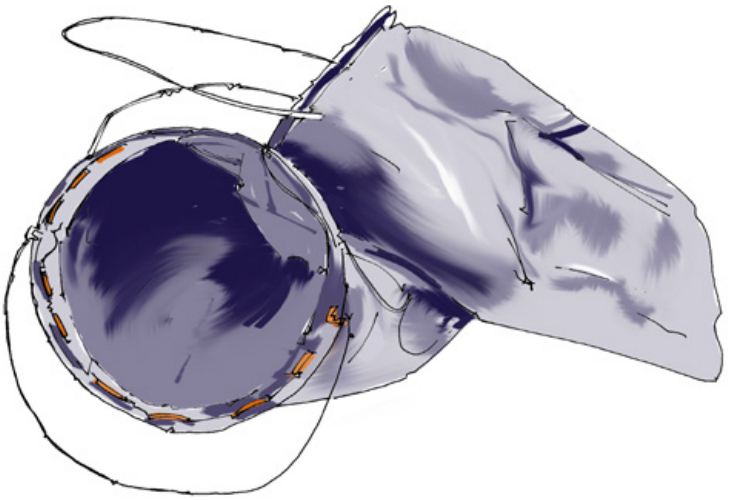


Figure 25. Rubber water containers

Wooden barrels and mortar jars tend to be larger and used for household storage rather than collection and transport.

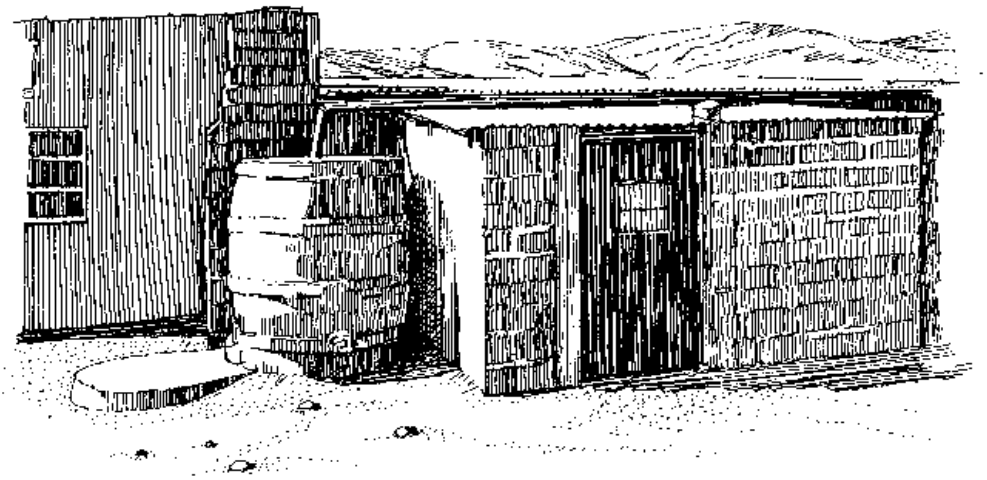


Figure 26. A wooden barrel for rainwater

Other features

Handles. The handle of a container should be strong enough to withstand repeated lifting and needs to be wide enough to provide a comfortable grip. Re-used vegetable oil containers often have thin wire handles that can cut into the hand. Rope can be used to make handles longer if needed and a wire cage can be placed around a plastic bucket to provide a firmer connection.

Buckets used to draw water from a well need to be designed to lift vertically, without spilling water. To keep them clean, these buckets should be suspended from the ground by their handle when not in use.

Taps and dippers. Drawing water from the container can be done in three ways:

- By pouring water out of the vessel. This requires the whole pot to be lifted and can be difficult with full or large containers.

- By using a dipper or cup. A single dedicated dipper or cup should be used that is hung up when not needed. Users should not dip their own cup into the water to get a drink as this can contaminate the water in the container.

- Simple taps help avoid contact with the water, maintaining its quality. These do add cost to the container but help identify it clearly as a water pot and not a bucket for laundry or for carrying other items. The connection where the tap enters the container needs to have a good seal to prevent leakage.

Caps and covers. Covering the container can reduce contamination and spillage during collection, transport and storage. Covers include screw-on caps, fitted lids or loose cloths. In some places, large leaves are placed on the surface of the water in a bucket to stop it slopping about when carried, but this can also

pollute the water. Caps for containers are easily lost, so plastic bags or large bananas are sometimes stuffed into the opening.

Large storage jars can become breeding sites for mosquitoes, so should be tightly covered.

Stands. Having a special stand at home for a water container can keep it clean, make it easier to use without bending down and stop it being knocked over. This can keep it out of the way of small children and animals. Round pots need a stand to keep them upright.

Funnels are used to make filling a narrow-necked container easier and reduce spillage. These can be made from a plastic bottle with the base cut off.

If these are kept at the water source, they need to be kept clean and not left on the ground.

Containers for anal cleansing

In many countries, water is used for anal cleansing after defecation. It is essential that dedicated water containers are used and that all members of the community understand that they should not be used for other purposes.

Figure 27. A variety of containers used for anal cleansing

Water containers for handwashing

A recent research project identified certain design parameters that any handwashing item should meet (Harries, 2005). The item should:

- be replicable using local materials and skills;
- use less than 300mls of water per handwashing procedure;
- be child, cross-gender and cross-generation friendly;
- be affordable;
- be robust, having strength and durability;
- be theft resistant;
- have fitness and function for purpose – it must work well enough to meet the needs of the users;
- be time efficient – handwashing should be completed in less than 40 seconds;

- have a one-touch-action – the device stems the flow of water negating the need for the user to touch the item after handwashing (so they do not re-contaminate their hands).

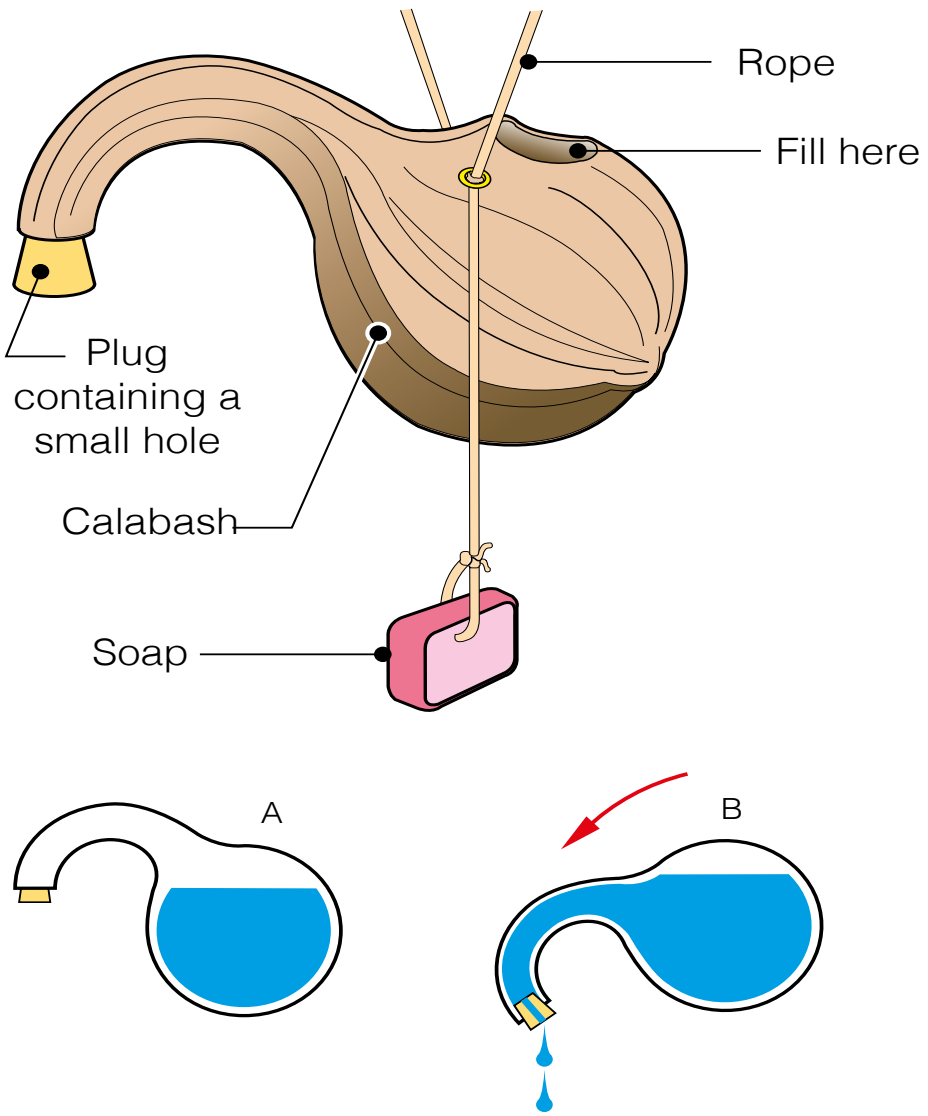


Figure 28. The mukombe

Various designs have been produced, including the 'Tippy tap', where a 5L plastic container has a hole made in the hollow handle. It is suspended on a pole or on a piece of rope and the user can tilt it to allow a measured quantity of water to flow slowly through the hole onto their hands.

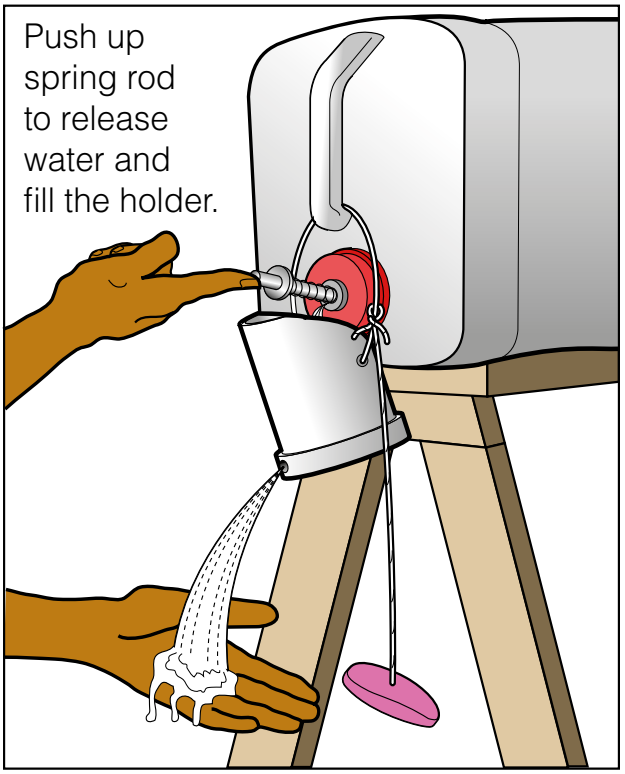
Other designs use simple push operated taps to dispense small amounts of water. (Some are just just screwed onto a large bottle which is then inverted.) 'Leaky ladles' can be used to scoop water out of a bucket for dribbling over the hands.

Treatment systems

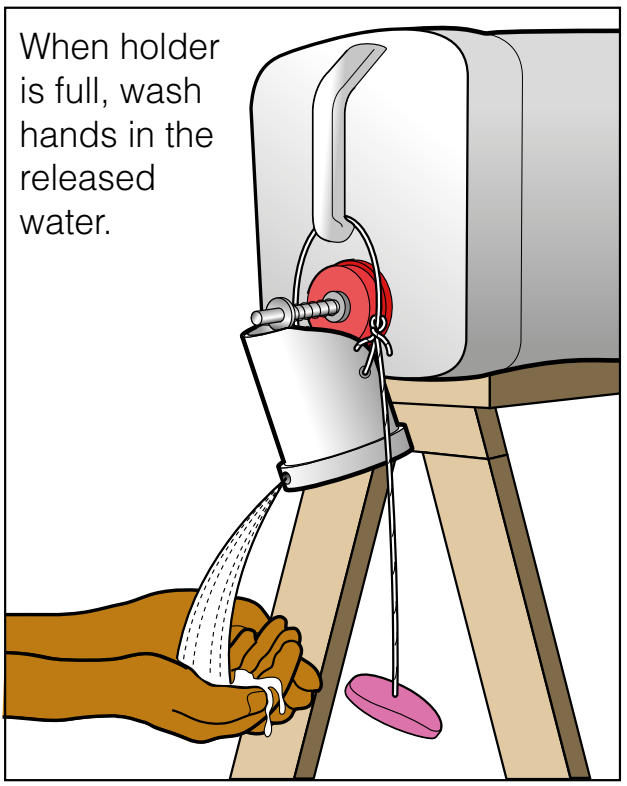
Pots can also enhance the quality of the water through various means:

Storage

If water is stored before use, any particles in the water will settle to the bottom of the container and pathogens die off. So storage in itself is a means of improving the quality of the water.



Stage 1



Stage 2

Figure 29. The Captap

Aeration

If water is stored for a period of time, it loses the oxygen that is dissolved in the water. This makes it taste 'flat' or 'stale'. Shaking the container aerates the water and improves the taste.

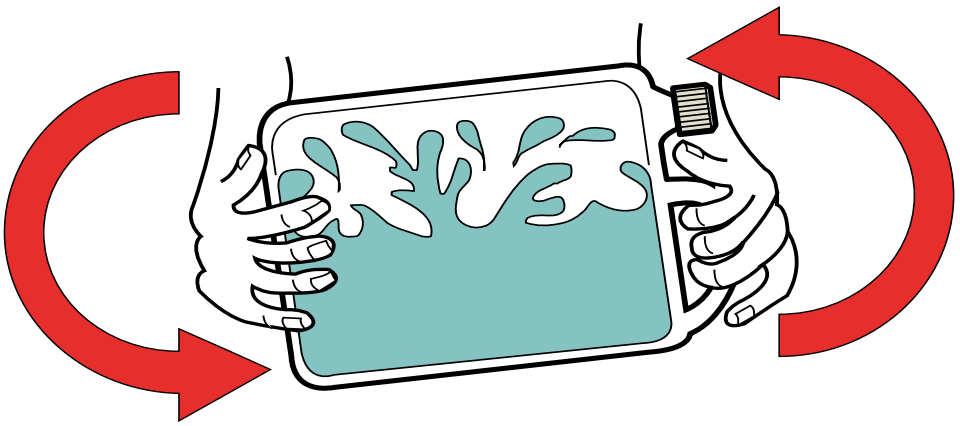


Figure 30. Aerating the water

Disinfection

Solar

Even if the water looks clean, it still may contain bacteria. If the water is placed in a clear plastic bottle in direct sunlight for a few hours, the ultraviolet light will reduce the number of pathogens in the water. This system is often called SODIS.

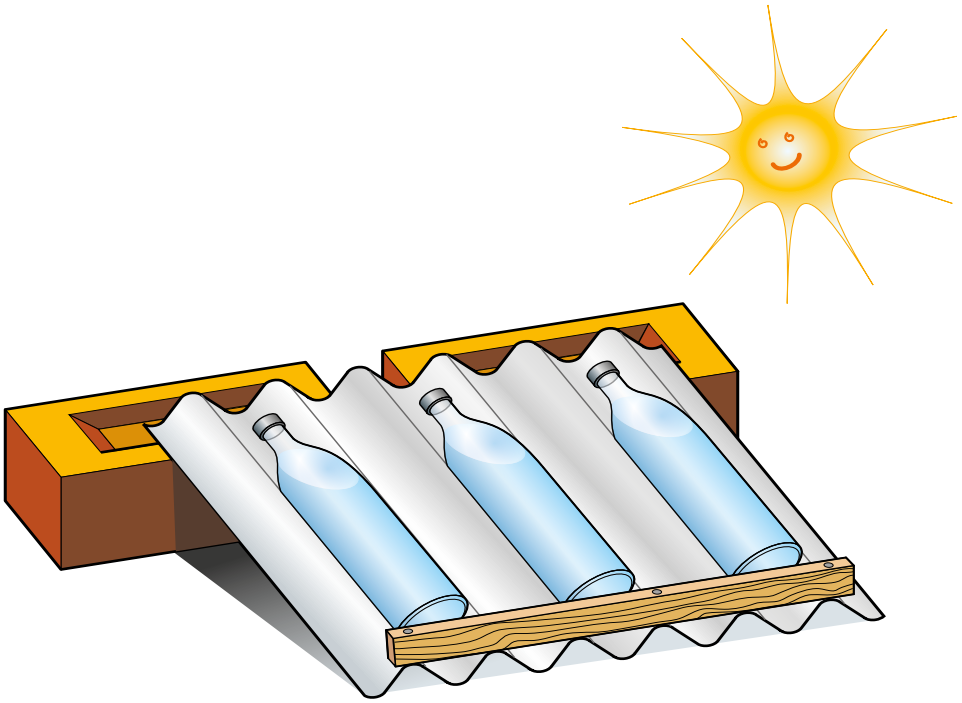


Figure 31. The SODIS system

Bucket chlorination

Chemicals (particularly chlorine compounds) can be added to the collection container to kill any bacteria. If the water is dirty, combinations of chemicals can be used to first settle the sediment and then sterilize the water. The water has to be left for at least 30 minutes before it can be used.

Cowboys in the 'Wild West' of the United States of America are reported to have

placed silver dollars in their water canteens (drinking bottles) as silver ions help reduce bacteria.

Filtration

Water containers can be used to filter water. The simplest form of this is to use a few layers of cloth stretched over the mouth of the container which can strain out the carriers of Guinea worm and even reduce the risk of cholera, as straining removes aquatic organisms such as diatoms that can host pathogens.

More complex filtration can be achieved by a water container that is in two parts.

Water is poured into an upper chamber and this drips slowly through a porous material or a ceramic ‘candle’ that can strain out varying levels of pathogens, even down to the size of bacteria. Water is then stored for use in the lower chamber.

Figure 32. Straining water through a fine mesh cloth

Boiling

If people sterilize their water by boiling it, the container needs to be able to withstand the heat and then provide safe storage for the water whilst it cools down and used. Pouring the boiled water into another container can lead to re-contamination if the storage vessel is not sterilized as well.

Maintenance

In order to maintain water quality, containers should be cleaned periodically. This can involve rinsing out the containers every time water is collected, especially if there is settled sediment in storage containers. Translucent containers may need cleaning to remove algae.

Occasionally the container needs a more thorough clean; buckets can be scrubbed but, whilst they reduce the risk of contamination, containers with narrow necks are more difficult to clean.

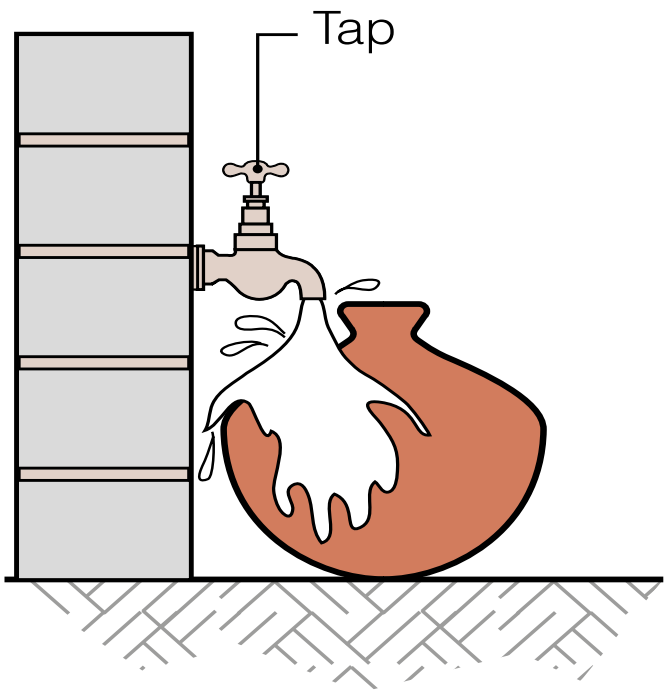
One method of cleaning containers with narrow openings is to place a handful of sand into the container, add water and then shake it to scour the insides before rinsing it out with fresh water. Bleach or other chlorine solution may be used, especially if a cholera outbreak is suspected. The container will need to be rinsed thoroughly after cleaning.

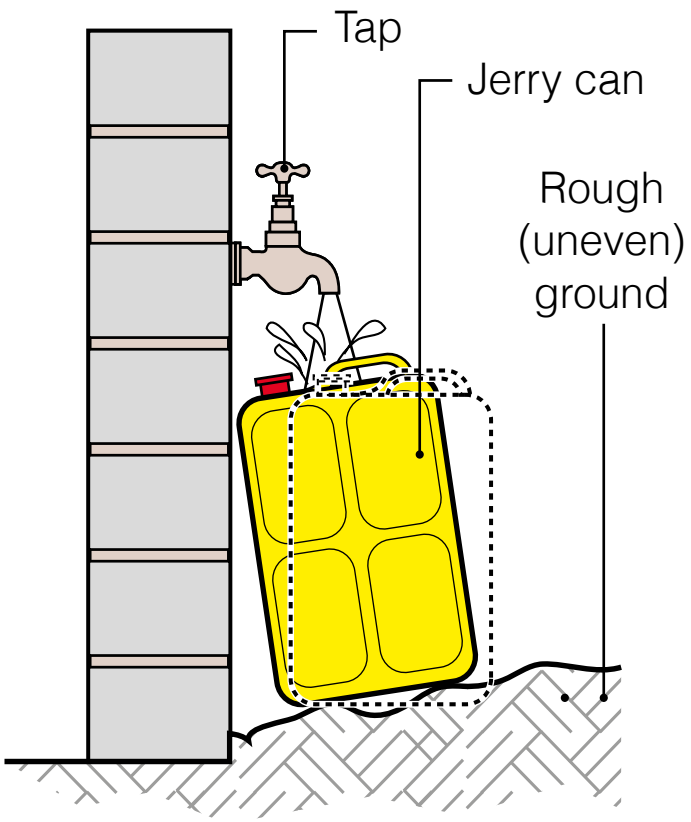
Water point design

Understanding the variety and importance of water containers helps engineers to design water supply points to meet the needs of users. The size and shape of the vessel should determine the position of the tap or water spout, ensuring that water passes into the container without spillage or the need for transferring it from a small container to a larger one for transport.

If water from the water point is regularly collected in containers that are carried on the back or head, providing a platform where the filled container can be lifted before it is raised onto the head or strapped to the back makes collecting water easier. Raising the tap or spout to head height is also an option.

Handpumps can have a small platform built next to the apron to allow the container to be lifted off the ground, so it can be lifted on to the head in two stages.


Tap


Tap
Jerry can
Rough
(uneven)
ground

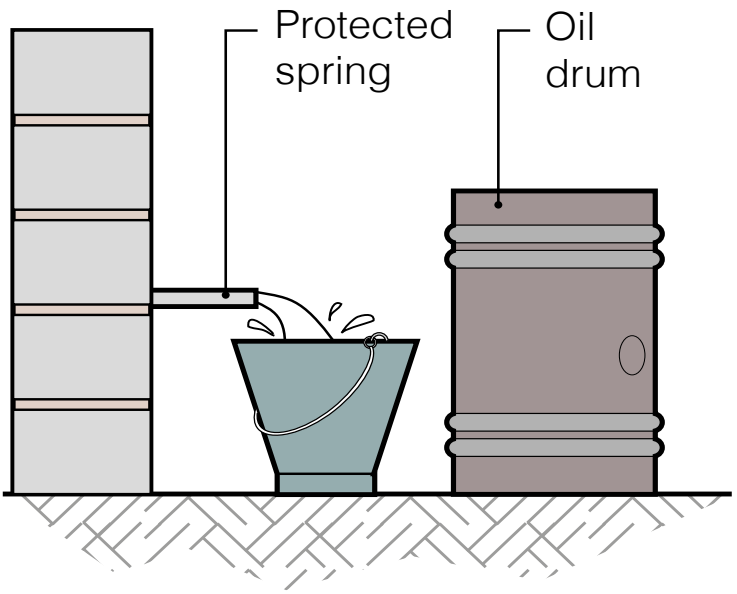


Figure 33. The types of containers communities use should inform the design of the water point

Summary

There is a wide range of different types of water container that have evolved to suit different local conditions. These play an important part in the supply of water to homes in low-income communities and after humanitarian crises.

Water containers can help preserve and even enhance the quality of the water supplied. They also have in influence on how much water is used in the home.

Water supply providers need to investigate what containers people have and how they are used. Consultation and dialogue with the users can improve both the quantity and quality of water being used in the household as well as reducing the burden on people. The water supply and the container need to be considered together as parts of the same system with adjustments and adaptations to improve water provision.

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Further information:

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Designed and produced by WEDC

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