24 Water supply in disasters and emergencies

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24.1 Introduction

This chapter focuses on the provision of drinking water supplies in emergency situations. It suggests both immediate and longer-term inputs that can be implemented by external agencies or by communities themselves.

To distinguish between a disaster and an emergency, we use these common definitions:

A **disaster** is a natural or manmade event that causes physical loss or damage, social and/or economic disruption and threatens people's lives either directly or indirectly.

A community[1] confronted with a disaster will need to react in order to save the lives of its members and prevent suffering as much as possible. However, the disaster may stretch beyond the capacity of a community and cause an emergency.

An **emergency** is a situation of hardship and human suffering arising from a disaster, which develops if the organisational infrastructures in place cannot cope with the situation.

In an emergency the affected population will need external assistance to ease the hardship and suffering to a bearable level and to minimise mortality and morbidity levels.

Disaster and emergency response operations may be very different, depending on a wide range of aspects, such as:

- scope and duration of the response needed: ranging from only required immediately after the event for a small number of specific aspects, to broad interventions required for several years after the event;
- presence of local and national authorities;
- level of operational capacity and effectiveness of authorities;
- degree of effective response of local authorities and other local actors/leaders;
- high security risks in area (especially in conflict areas);
- logistical and resource problems for agencies and authorities involved;
- location of affected populations (i.e. displaced, partly displaced or not at all);
- availability of water sources and their quality and quantity.

From a technical point of view drinking water systems used in response to an emergency may not differ much from similar systems used in development situations.

1 In this chapter a community is regarded as a group of people with some kind of longer-term coherence, like a town, a village, a neighbourhood, or a group of refugees.

However, in emergencies the factors that affect the choice of the drinking water systems[2] usually differ considerably from the factors influencing such choices in development situations. This often leads to the choice of a different drinking water system in an emergency from that in a non-emergency. In emergencies the most important decisive factors for drinking water interventions often are:

- security situation regarding accessibility to the area for national/international organisations and peoples freedom of movement;
- access to the area in terms of roads and topography;
- socio-political, legal and cultural constraints;
- availability of water sources and their characteristics;
- time required to develop the water sources;
- time required to mobilise the required resources;
- characteristics of the affected population (number of people, displaced or not, extent to which coping mechanisms[3] are still in place, etc.).

The initial aim of the intervention will be to achieve a survival supply of drinking water quickly so as to keep drinking water-related morbidity and mortality rates among the affected population within acceptable limits. If this is not possible, the affected population has to be moved to another, more favourable location. Once the survival supply has been achieved, work can start on realising a *longer-term supply* to provide people with more sustainable (less costly) and better drinking water facilities for as long as they need assistance.

Sometimes survival and/or longer-term supply systems can form the basis for the development of more permanent supply systems. Examples are the repair of existing water systems or the construction of new systems suitable for providing drinking water to the existing local population after the emergency has passed. Planners need to take account of this potential in choosing appropriate emergency interventions in situations where this is applicable. Efforts made to bridge the "gap" between the emergency and the "normal" or "development" situation are often described as *rehabilitation*. Repair of existing systems is an important option, especially in emergencies where the population has not been displaced.

Participation of beneficiaries in planning emergency supplies should be enhanced where possible. Beneficiaries are often well able to identify the most suitable locations for drinking water points, have local knowledge about the drinking water situation,

2 A "water system" in the context of this chapter includes all facilities, services and management inputs required to obtain, transport and treat water, and deliver it to the affected population.

3 The term 'coping mechanisms' refers to both the physical structures and means to survive, and the social relations with relatives and others that give basis for using and/or developing water sources.

hydrological circumstances, and existing water points. They are usually ready and able to provide their labour in the construction/rehabilitation of drinking water systems, and may be very effective in quickly spreading important hygiene messages. Important advice and inputs often come from key informants, local persons in powerful positions and local drinking water institutions. On many occasions these groups may be largely able to implement the required inputs themselves, needing only some external assistance with, for instance, the provision of equipment. On the other hand, effective participation by beneficiaries and local institutions may sometimes be difficult and time consuming in emergency situations. Facilitating participation requires the kind of skills that not all aid workers possess. Consequently, in emergency work, there are success stories but also failures with regard to participation. The critical question is whether participation can be made to work properly in the limited time frame available. Sometimes this is the case, sometimes not, and it is often not easy to predict beforehand what the best solution is.

The following points may provide some guidance for those in charge of an emergency intervention:

1. It is vital to obtain as much information as possible about the existing situation and immediate needs right at the start. That means gathering information quickly from the expected beneficiaries (women are particularly important informants with regard to drinking water needs), and from local institutions, key resource persons, community representatives and the people in power. Based on these consultations and other information (e.g. personal observations), a quick decision should be made, involving all the parties insofar as it is possible to do so. If time is very pressing this stage may have to be finalised within a day, sometimes even hours.
2. Those in power have to agree to the proposals before action can start. Assess to what extent those in power demand to be involved and judge what decisions you can make yourself and what decisions you cannot.
3. Depending on the situation, labour contributed by beneficiaries may be paid or voluntary. In camps, often labour provided for construction works is paid, but looking after tap stands is a voluntary input. Those involved in the operation of the system are paid. In most cases salaries are lower than usual, with the argument that beneficiaries already obtain food and other services free in the camp. It is important to have salary scales similar to other NGOs active in the area.
4. Active involvement of existing local drinking water institutions in the interventions may be very effective, as such institutions are usually familiar with the existing systems, have knowledge about suitable water sources, have key staff, equipment, and access to a local network of decision makers, and so on. However, local institutions may be overwhelmed by the events and/or be so weak in their performance that they can also be more of a threat than an asset in the initial

disaster response. A key consideration is whether the institutions are likely to provide the required inputs within the available timeframe. This is often not the case because local institutions are in most cases not set up for rapid interventions. Often it is easier, quicker and better to hire a number of beneficiaries for the work and supervise them directly yourself, than to provide guidance to a slowly operating local institution.

5. Participation of beneficiaries in the construction of survival supplies is possible and advisable if it contributes to increased quality of the intervention and/or time gain. It may apply to the siting of the water service points and the control over their use. Consultations with women and children help to adjust the design and location of the facilities to match their needs. The involvement of representatives from the community and, if it is a displaced community, persons with specific knowledge and skills on water system construction and management, helps to achieve sustainable water services[4].
6. Managing community participation requires a high professional level of planners and implementers (including sometimes professionals from among the beneficiaries). Decisions are needed on whether participation will provide the expected results and how such participation should be organised within the given circumstances and time limits.

Minimum requirements for longer-term supply interventions in response to emergencies have been developed by the Sphere project (WHO, 1993), a collaborative initiative of a large number of international humanitarian organisations. Table 24.1 shows some of the most important minimum standards for both survival and longer-term emergency drinking water systems in comparison to guidelines often used in development situations.

In chapter 2 the importance of linking water supply with hygiene and sanitation was explained. The environmental sanitation conditions in emergency and refugee situations are usually very poor. The risks of transmission of water and sanitation related diseases are very high because human waste disposal containing human faecal borne pathogens are often indiscriminately spread around in the area. Therefore, apart from the provision of water supply – the focus of this publication and chapter – sanitation improvement and hygiene promotion are key actions to prevent the outbreaks of diseases in these conditions of despair, uncertainty, poverty and crowding.

4 Women need to be brought into the picture as well as men. Emergency workers are often men and local women who have been affected by the disaster will be largely occupied with care for their children. This creates a risk that only local men's knowledge about water supply will be included and not the quite different perspective of women.

Table 24.1 Important guidelines for survival supply, longer-term supply and development drinking water projects

Standard	Survival supply in response to an emergency	Longer term supply after an emergency	Development supply
Water availability per beneficiary[5]	3-5 l per person per day (for survival supply)	15 l per person per day	20-50 l per person per day
Number of water collection points	1 point per 500-750 persons	1 point per 250 - 500 persons	1 point per 200-300 persons
Distance from water collection points	1 km	500-700 m	100-400 m
Maximum waiting time at water collection points	2 hours	20 minutes	no guideline
Turbidity	< 20 NTU	< 10 NTU	< 5 NTU
Residual free chlorine at water collection point	0.3 -1.0 mg/l	0.2-0.5 mg/l	if water is chlorinated: 0.2 mg/l
Conductivity	< 3000 µS/cm	< 2000 µS/cm	< 1400 µS/cm
pH	No restriction	6-8 for coagulation with aluminium sulphate; < 8 for disinfection	Preferably < 8 for effective disinfection with chlorine
E. coli or thermotolerant coliforms	Always aim to disinfect supplies. If this is not possible then use the best available source and apply solar disinfection for the drinking water	Always aim to disinfect supplies. If this is not possible then: < 10 thermotolerant coliform (E. coli)/100 ml (and apply solar disinfection for the drinking water)	0 thermotolerant coliform/100 ml (also in this case: apply solar disinfection for the drinking water)
Household collection and storage capacity	1 container of 10-20 l for collection per family. The container has a narrow neck and/or a cover	2 containers of 10-20 l for collection and 0-1 storage container of 20 l per family. The containers have a narrow neck and/or a cover	no guideline

(these guidelines have an unofficial status and come from many sources)

5 There may be considerable water needs as well for livestock, anal washing, medical centres, feeding centres, or even irrigation.

The rest of this chapter deals with technical aspects of drinking water systems used in survival and/or longer-term supply interventions insofar as they differ from "regular water supply development". For a comprehensive methodology for the selection of drinking water systems for both survival and longer-term supply in response to emergencies reference is made to House and Reed (1997). De Veer (1999) suggests quality systems for the operation of a number of different drinking water systems in camps. Davis and Lambert (2002) provide a comprehensive overview of drinking water techniques used in emergency response operations.

24.2 Water tankers

The provision of drinking water by tankers is a solution for survival supply when time is very limited and other systems cannot be realised within the time limits. Water supply by tankers is only possible when certain requirements are fulfilled (see below). Usually these requirements can be met locally. Otherwise trucks, repair facilities, etc. have to be brought in by road or air from elsewhere. Water supply by tankers is almost always planned and managed by specialised external agencies because of the complexity of its management and the high costs. This is not, therefore, a solution for longer-term water supply, although examples exist where large water tanker operations have continued for many months. Water tankers are also often used to supplement other water services.

Water tanker requirements

- Water tankers are normal trucks or trailers with storage vessels mounted on them (Fig. 24.1). If hiring or purchasing water tankers or storage tanks locally, you must know what they have been used for. Before use, rigorous cleaning and disinfection (super chlorination) is needed. Regular cleaning/disinfection during operations is also a good practice.
- The water source must have adequate yield and water of sufficient quality (biological contamination is usually not a direct problem because the water will be chlorinated). The place should allow for pumping into the water tanker. Permission will need to be obtained from the owner and water rights from the authorities.
- Water pumps are needed at the source and perhaps at the delivery location; a pump to empty the tanker quickly can save a lot of time.
- Water storage capacity and some tap stands need to be provided at the delivery location.
- Fuel and lubricants need organising for the trucks.
- A sufficient supply of chlorine has to be available for chlorination of the water;
- There must be enough truck drivers.
- O&M facilities include mechanics and tools, equipment and spare parts.
- Road access has to be available between the source and the beneficiaries (check road conditions, bridges, permission to use the road from local authorities, owners or those in power in the area).

- It may be necessary to equip the trucks with communication equipment, especially where security can be a problem or where the situation can change very quickly.
- Managing the water tankering operation properly demands professional skills and experience.

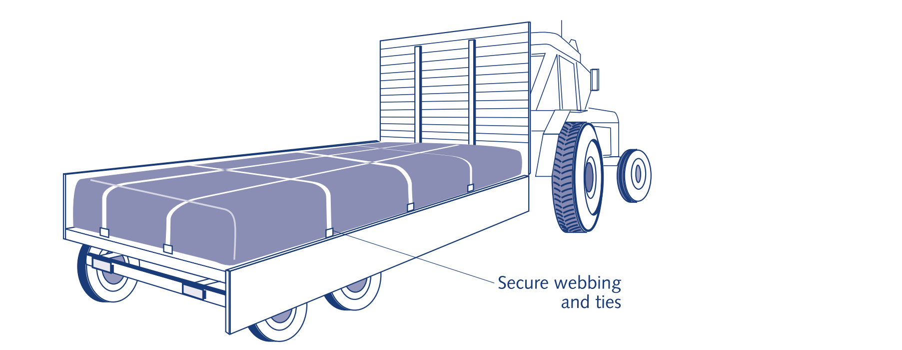

Fig. 24.1. Collapsible pillow tank mounted on a trailer
Source: Davis, J. and Lambert, R., 2002

Water tanker management

The effective operation of water supply by tankers requires good planning and management of staff, logistics and stocks. There are many pitfalls. Table 24.2 is an example of a water tanker schedule, illustrating the basic assumptions that need to be verified and the way that the required supply capacity is calculated.

Water should be chlorinated at the filling point if possible. A fixed amount of chlorine (usually sodium-hypochlorite) should be added to each tanker, according to the volume of water in the tanker. The journey will allow the chlorine to mix well with the water. The contact time should be at least 30 minutes. The chlorine dosing may vary depending on the turbidity and organic content, and therefore the dosing needs to be determined regularly. Monitoring of residual chlorine levels is recommended.

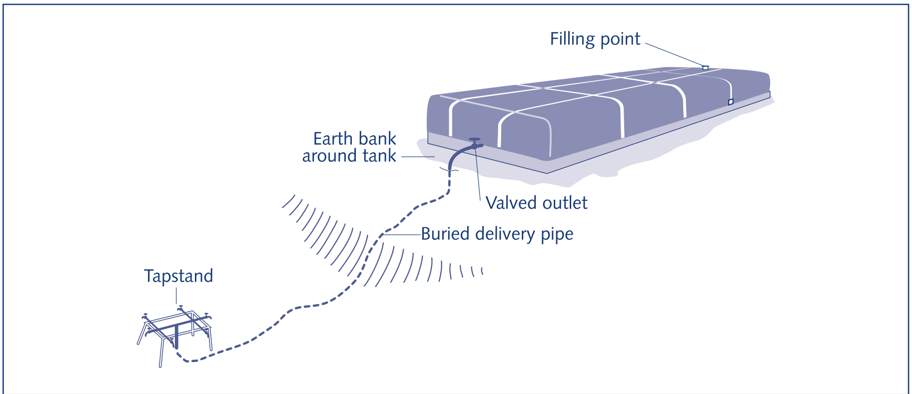

Fig. 24.2. Typical set-up of a distribution point in a tankering operation
Source: Davis, J. and Lambert, R. 2002

Water delivery points should be well organised with sufficient space for the trucks to off-load quickly in large enough water tanks. Crowding of people at the water distribution point needs to be prevented. A better solution is to have a storage tank with a number of tap stands situated at a sufficient distance from the tank, as in figure 24.2.

Table 24.2 Example of a water tanker supply schedule

Basic assumptions:		
Population:	10,000	persons
Minimum water requirement:	15	lcd
Distance filling station to distribution point:	15	km
Speed of water tanker:	20	km/h
Time required to fill the tanker at filling point:	20	minutes
Working hours per day:	12	hours
Water tanker capacity:	10,000	itres
Calculation of amount of water to be tankered:		
Daily water requirement:	150,000	litres
Allow 20% extra for wastage and for new arrivals:	30,000	litres
Water to be tankered:	180,000	l/day
Calculation of gross turnaround time:		
Time to fill the tanker:	20	minutes
Journey from filling station to distribution point: (assuming that all delivery points are at approximately the same distances, which is not always the case)	45	minutes
Time for emptying water tanker at distribution point:	8	minutes
Return journey to filling station:	45	minutes
Net turn around time:	118	minutes
Add 30% for contingencies:	35	minutes
Gross turnaround time:	153	minutes, say 2.6 hrs

Calculation of the number of water tankers required:

Number of deliveries per tanker per day = working hours in a day/gross turnaround time = 12/2.6 = 4.6

Amount of water delivered per water tanker per day = 4.6 x 10,000 = 46,000 litres

Numbers of water tankers required: 180,000/46,000 ≈ 4

24.3. Water intake, storage, treatment and distribution systems

Water transport and distribution systems constructed in response to a disaster/emergency situation follow the same principles as those constructed under normal conditions (see chapters 20 and 21). They may differ in certain details due to the factors described in section 24.1. Also the choice of a specific type of system may be dictated by the special circumstances prevailing in an emergency.

Construction of water transport and distribution systems in response to a disaster/emergency is usually done through paid labour, while in development situations much more use is made of voluntary labour from the beneficiary community. The common reasons are that, following a disaster, social coherence among the affected population is less than in "normal" communities, there is lack of a common feeling of responsibility, and people may believe that the facilities will not be beneficial to them for a long time. These factors can make it more difficult to mobilise beneficiaries on a voluntary basis. This is not a rule, though, and exceptions do exist.

Intake

If the water source is surface water then a temporary intake structure can be created by building a small weir made of bags filled with sand. The end of the inlet pipe needs to be covered with some kind of filter (netting) and positioned in the river directly upstream of the weir. The pumping equipment can be whatever is commonly available in the country; straightforward technology gives the best chances for reliable functioning. A source caretaker (a paid staff member) is required to make sure that the pump does not operate when the water level is too low.
Advantages of simple intake structures are that the materials required can be easily obtained locally or flown in quickly, construction requires little time and can be done without highly skilled technicians, management is easy, costs are low and the structures can be dismantled easily. Upgrading of the system may involve the use of floaters attached to the inlet, in case the water level rises, and small diversion structures to cope with flow variations in the river (Fig. 24.3).

Wherever possible, the water catchment area should be protected to minimise the risks of pollution. Human settlement, agricultural and livestock activities should be prevented as much as possible anywhere near or upstream of the intake. Part of the source assessment should be the identification of present or potential pollution sources upstream of the intake. If pollution threats are found, then the intake may have to be positioned further upstream (beyond the polluting source), or another reliable and safe water source needs to be found, or the people need to be settled elsewhere.

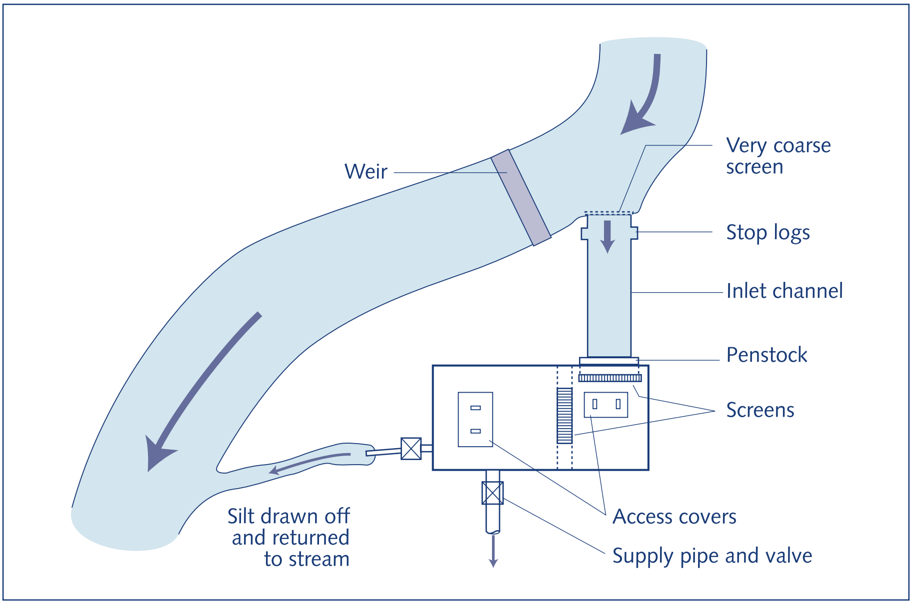

Figure 24.3. A diversion structure for a stream intake
Source: Davis, J. and Lambert, R. 2002

Pipes

The quickest response is achieved by using pipes that are locally available even if they are not an ideal solution.

Flexible hoses are suitable for survival supply. They usually have to be brought in from abroad but can be flown in and are easily transported over land, can be installed on site very quickly (rolled out) and connect easily to other types of pipe. However, flexible hoses are more expensive, more vulnerable and less durable than other pipes. Some flexible hoses, though, can resist quite large pressures. Two types are distinguished: lay-flat hose made of canvas or PVC material (collapsed when not in use, making it easy to handle and transport), and PVC suction and delivery hose made of flexible smooth bore PVC, reinforced with a semi-rigid PVC spiral.

Polyethylene (PE) pipes are suitable for survival supply due to the ease of jointing and the flexibility of the pipe. Jointing can be done through fusion welding or push-fit or mechanical couplings. All these jointing options are easy and quick and give very strong joints that can withstand end loading. They therefore do not need thrust blocks at points where the direction of the pipeline changes. Several couplings also allow connection to galvanised iron (GI) pipes and it is possible for low-pressure applications to screw PE pipe onto GI threaded pipe and fittings. The flexibility of PE makes it possible for smaller-diameter pipes to be delivered in long coils. This way only few joints are required and pipe can be laid very quickly. Even in freezing conditions PE remains flexible and can be laid easily. It also slows down freezing of the water in the pipes due to its thick wall and low thermal conductivity. Even if the water does freeze, the pipes will not break easily. Transport of the coils can sometimes be difficult because they require quite a bit of space. PE is often locally available. PE can initially be laid over land if necessary because it is quite robust and not very sensitive to sunlight (use the black pipes, not the blue ones). If laid over land, it is of course more vulnerable to damage by people walking over it and vandalism – and this danger should not be underestimated. Pipes should therefore be buried in trenches as soon as possible.

PVC materials may be used in survival supply situations when they are locally available and if there are no better alternatives. Large diameter and/or high-pressure class pipe often needs to be PVC. PVC is light and can be more easily transported to site than the heavier GI pipes. GI pipes are also much more expensive. However, during transport and storage, PVC is vulnerable to breakage and it becomes brittle at low temperatures or when exposed to sunlight. It should therefore not be laid over land or used in areas where it can freeze unless it is buried below the frost line. PVC pipes with push-fit joints are appro-pri-ate for survival supply because they can be laid quickly. They can also be easily dismantled compared with PVC pipes with solvent cement joints. This can be important for instance when refugees have returned to their home areas, leaving the infrastructure in the camp behind. However, push-fitted PVC pipes cannot sustain end loads; they must be anchored in position by backfilling the trench before pressurising the pipeline. Bends, blank ends and fittings must also be adequately anchored. If necessary it is possible to bend a PVC pipe by filling the pipe with sand and heating the area to be bent, although this will affect the strength of the pipe.

Water tanks

A typical water tank for disaster/emergency situations should be easily and quickly installed, should be suitable for quick transportation to the site (so light and easy to pack materials are needed) and should be easy and quick to dismantle at the end of the operation. Two types of tanks are specifically suitable for emergency response operations: OXFAM tanks and collapsible tanks.

OXFAM tanks

OXFAM tanks are made from corrugated steel sheets that can be bolted together to form the round casing for the tank. A synthetic rubber lining is hung inside and a plastic sheet can be put on top to form a roof (Fig. 24.4). The tank can easily be brought in parts and erected on site. An experienced team can erect an OXFAM tank within a day and it is fairly easy to learn the job (each tank comes with a self-instruction manual). There are OXFAM tanks with volumes ranging from 10.5-95 m^3. The tanks are very durable and can last for many years. They usually have to be brought in from abroad. Main uses are water storage and treatment in both survival (if the required materials are on site in time) and longer-term supply systems.

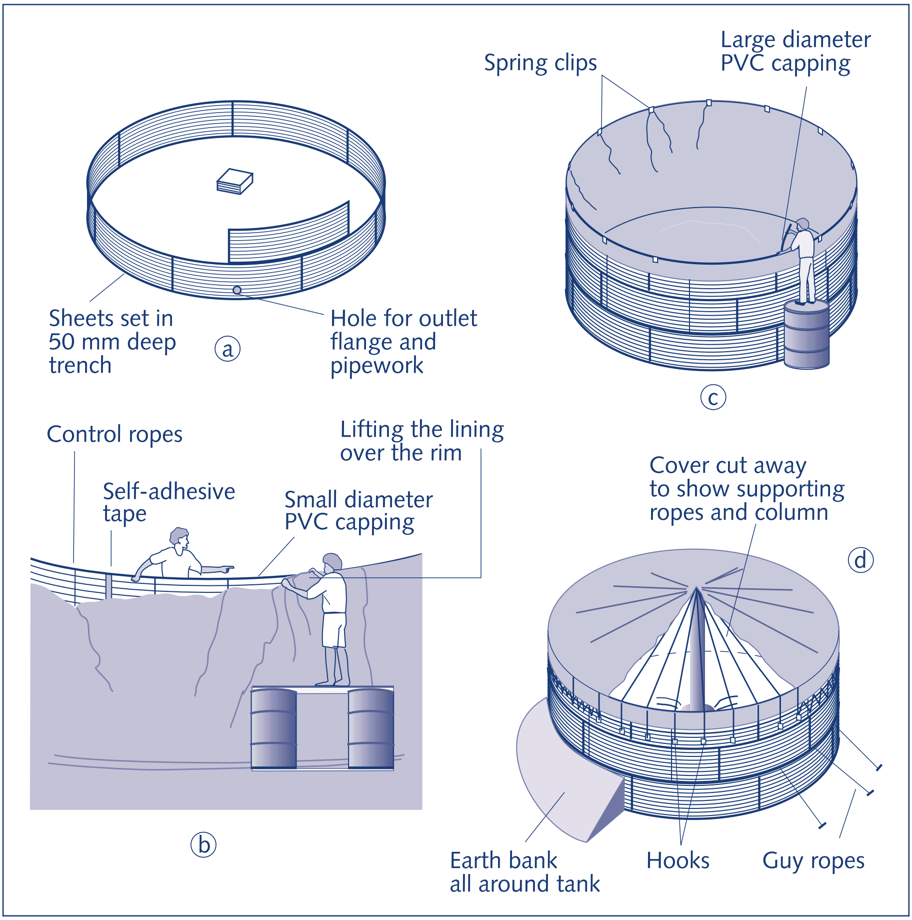

Fig. 24.4. Erection of an OXFAM tank
(Adapted from: Davis and Lambert, 2002)

Collapsible tanks

These tanks are made of collapsible fabric, without any supporting framework. They have a low packed volume and are easy to handle. An advantage is that they are very light and can thus be transported to site easily (over land or by air). However, they are usually not locally available and therefore have to be brought in from abroad. They are not very durable either and are vulnerable to vandalism (sticking a knife in causes major leakages, although the hole can be repaired relatively easily). Main uses are in situations where very quick action is required (within hours/days) and where no other tank materials are available. The tanks have an outlet that can be connected to a flexible hose leading to a tap stand at a slightly lower elevation than the tank (Fig. 24.2). In areas where the temperature can fall below zero, collapsible tanks should be placed inside buildings (e.g. in warehouses). There are two types of collapsible tanks:

a. Bladder tanks (also called "pillow tanks") are available in volumes of 2.5-20 m^3. The material is UV resistant high tensile EVA or PVC coated polyester. They should be positioned on a properly levelled piece of land from which all stones and sharp

obstacles have been removed (Fig. 24.2). It is advisable to place a groundsheet under the tank. Sometimes the tank can be fixed to the ground with pegs, otherwise it is advisable to form an earth bund around it to avoid any movement.
A disadvantage is that it is difficult to remove silt and sludge from the tank.

b. Flotation collar tanks (also called "onion tanks") are available in volumes of 1.8-90 m^3. The material used is synthetic rubber. The tank has a self-supporting buoyant foam-filled or inflatable rim and a loose cover. This tank can to a certain extent also be used on slopes.

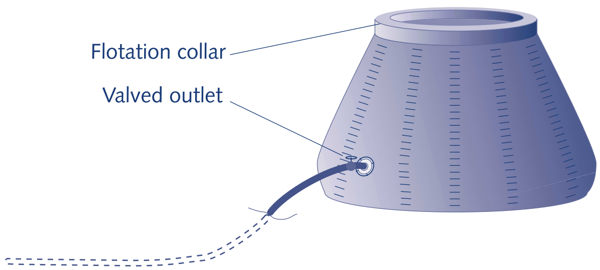

Figure 24.5. A flotation collar tank
(Adapted from: Davis and Lambert, 2002)

Water treatment

In disaster/emergency situations, water treatment complicates the water delivery process and should therefore be minimised and always be simple. It is better to look for a water source supplying water of safe quality wherever possible. When treatment is found to be necessary, deciding which treatment system is most suitable depends not only on the raw water quality but also on the availability of construction materials and chemicals.

Simple water treatment systems include the following:

1. **Sedimentation** using a large OXFAM or other type of tank.
2. **Coagulation/Flocculation.** Often used where no time is available to wait for the construction of filtration units and where the required chemicals (usually aluminium sulphate) can be made available. The system can be operated as a batch or continuous system. Staff should be well instructed and be monitored on their performance.
3. **Multi-stage filtration** (two coarse material filtration systems followed by slow sand filtration – see also chapter 16). These filters can be constructed fairly quickly (within a week) if use is made of OXFAM tanks and if the required coarse gravel and sand can be found nearby (figs. 24.6 and 24.7). If the turbidity of the water is not too high, large amounts of water can be effectively filtered. A well-trained and supervised crew is required. Also small multi-stage filtration units can be set up for specific applications (for instance for health and feeding centres) (Fig. 24.8). Other designs are given in chapter 16.

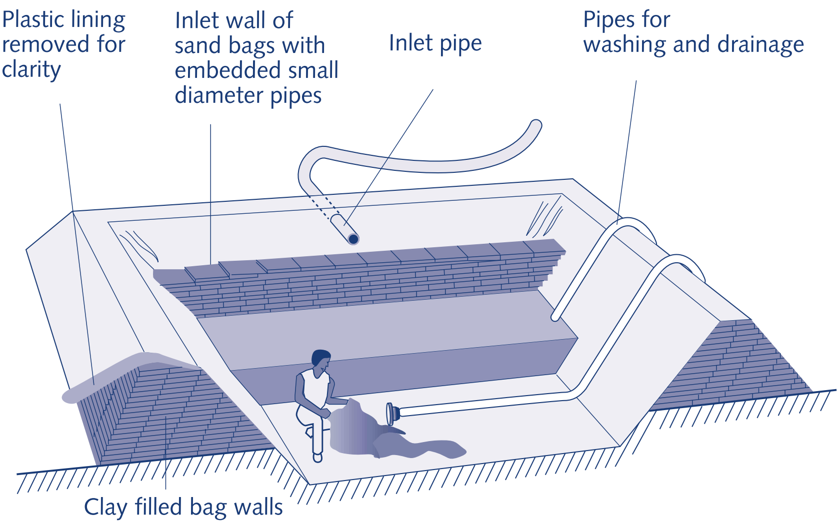

Figure 24.6. Cross-section of an excavated horizontal flow roughing filter (Adapted from: Davis and Lambert, 2002)

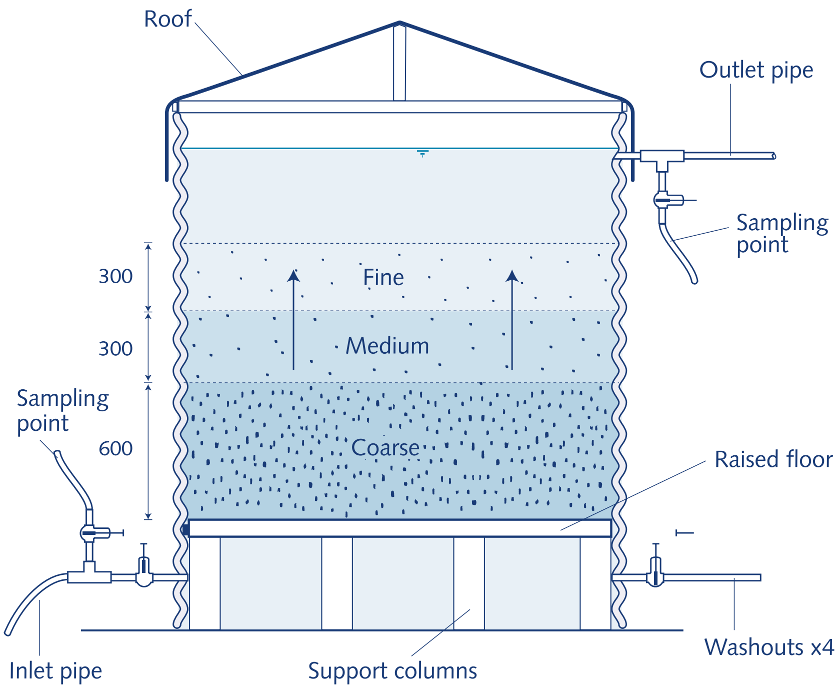

Figure 24.7. A vertical flow roughing filter (Source: Oxfam, 2000) (Adapted from: Davis and Lambert, 2002)

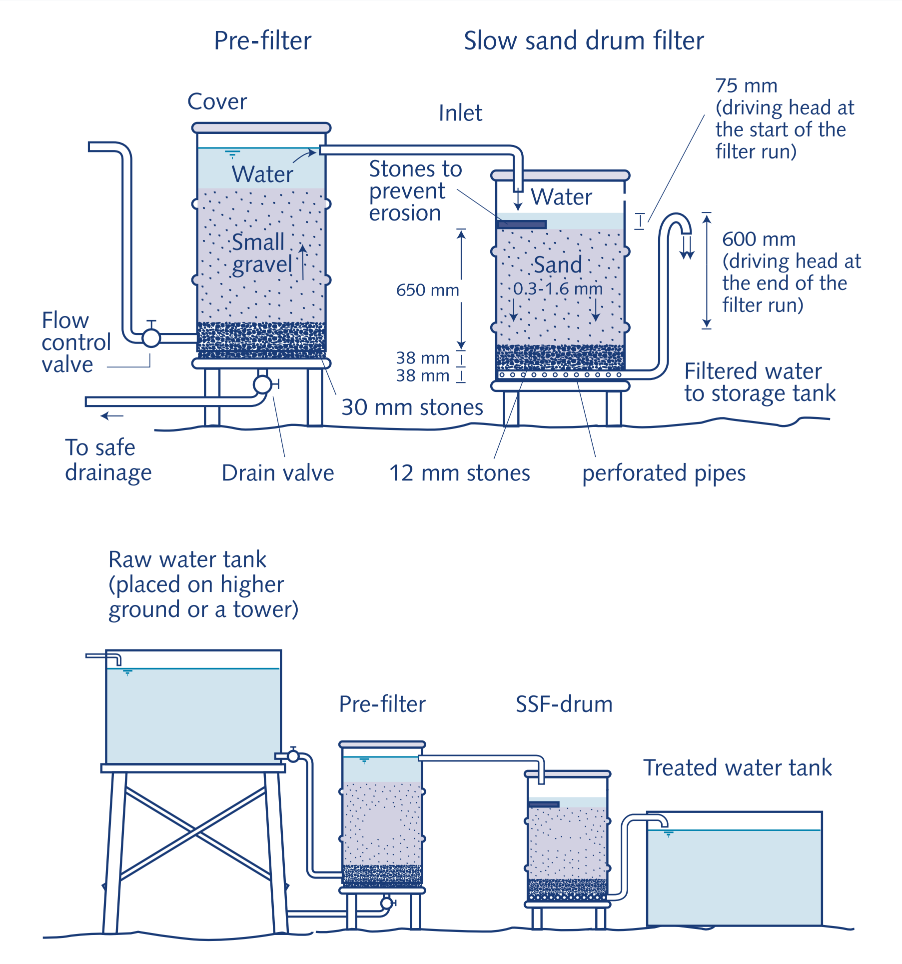

Figure 24.8. Small-scale multi-stage filtration units
Source: Davis, J. and Lambert, R. 2002

4. **Chlorination.** It is recommended always to chlorinate the water in disaster/emergency response operations. In a piped water supply system this is usually done as the last step of the treatment process. For survival water supply a batch system is the easiest: two small OXFAM tanks (of about 10 m^3 each) are filled with water and the required amount of chlorine is added. The chlorinated water should stand for 30 minutes before it is released into the distribution system. The most suitable chlorine solution is hypochlorite dissolved in water. A trained staff member should add the chlorine to the chlorine storage tank wearing protective clothes and goggles. Appropriate chlorine dosing equipment is shown in chapter 19.

The number of consumers and the changes in water quality determine the frequency of checking for residual chlorine at the tap point. It should be done at least once a month, but if there are thousands of people using the water supply, it should be checked at least daily. The required dose of chlorine may change over time due to changing characteristics of the water, for instance when the rainy seasons starts with more risk of contamination. If the residual chlorine is less than 0.3 mg/l then a trained staff member should determine how much chlorine is actually required and adjust the amount of chlorine to be added to the tanks. Free residual chlorine is an indicator that there is still disinfecting capacity in the water. The residual chlorine content will drop during transport between the point of adding the chlorine and the tap point as the chlorine kills micro-organisms. If the distribution pipes are not permanently under pressure, contaminated water may enter the system at points where leaks are present. That consumes more chlorine, and cause the residual chlorine level to drop.

Public standposts

In most disaster/emergency response operations water distribution is through public standposts. Private connections are not common unless existing systems are used. Special connections will be needed to public facilities such as field hospitals and health posts, feeding centres and market places. These facilities have their own water requirements, which should be included in the calculation of the total water demand and the design of the water supply.

For public standposts, usually push taps, also called self-closing taps, are used. These are robust taps that close automatically under their own weight after a user stops pushing the weight up. The taps help in this way to diminish water wastage, if users do not close the taps due to negligence. Sometimes people do keep the taps open on purpose by attaching a piece of rope between the weight and the pipe above. They may do so for instance if they want to use the water for irrigation, small industrial activities (beer brewing), etc. Particularly in situations where water of drinking water quality is scarce - which is usually the case in disaster/emergency situations – this practice should not be allowed and needs to be strongly controlled.

Each standpost should have a voluntary caretaker elected by the people using the water from it. The caretakers should be trained, monitored and guided by higher-level staff. Proper selection and training of caretakers can be quickly arranged, even in survival supply systems. It is, for instance, important to have the beneficiaries discussing the character and qualifications of the person they need as a caretaker. If this is done well, people often choose women to be caretakers. It is worthwhile to pay regular attention to and motivate the caretakers. This can be done by organising small workshops for them that may also provide good feedback to the programme, and by giving them small incentives (e.g. soap) once in a while. It is also important to give them a recognised status and acknowledge the work they do, for instance by inviting them to meetings and not taking their work for granted. But the main assurance that things will go well at the tap stand is regular supervision by higher-level staff.

Management

Larger piped water supply systems are used mostly for longer-term supply. Where these systems consist of repaired, rehabilitated and/or upgraded existing drinking water systems all efforts should be made to involve the local community and the responsible local water agency (which could be under the local government) from the beginning and throughout the project cycle. Always make sure that the different user groups are represented and inform and consult them. Depending on the size of the new system and the increase in the number of temporary consumers, the community and/or the water agency may be fully in charge or contribute to the management of the systems and service. In general management is carried out by external staff, to avoid learning time that may cost unnecessary lives.

Where large pipeline systems have been realised under other circumstances, such as in camps, management is often executed by external agencies. Sometimes this situation may last for many years. Only in a few cases has the management of such systems been handed over successfully to local beneficiary organisations.

An example of a successful handing-over of the management of a water supply system to beneficiaries is the camps for Afghan refugees near Peshawar in Pakistan. Here external organisations simply did not have the resources anymore to pay for the operation and maintenance of the pipeline systems. Another factor was that to a high degree the Afghan refugees were incorporated into the local economic system, which enabled them to pay for the water services and motivated them to get a grip on their own situation.

24.4 Spring protection

Where springs are a suitable source they can be quickly protected by installing a *mini-filter* (Fig. 24.8). If the amount of storage in the collection pit with the filter layers is small it is better to have an open outlet instead of a tap at the collection point to avoid possible build-up of back-pressure with the danger of the spring diverting to an alternative route. Instead of a tap that may break easily if used heavily, a simple wooden plug can be used. Drive a small bar horizontally into the ground to mark the level of the groundwater before disturbing the site. The bar will show the level below which the filter element with the outlet pipe has to be placed. The spring site should be cleaned and vegetation cleared. Care must be taken not to disturb the underlying impermeable layer; the spring could be lost by the diversion of groundwater away from the original eye. Ensure good drainage at the collection point. Fence the area 10 m around the spring to prevent contamination from beneficiaries and/or their livestock in the immediate surroundings of the spring. If the catchment area is in danger of contamination a larger area may have to be fenced (and/or guarded). A diversion ditch drains the rainfall runoff away from the spring. To avoid losing good quality water the outlet pipe can be connected to a water tank (for instance a collapsible tank (Fig. 24.2 and 24.5).

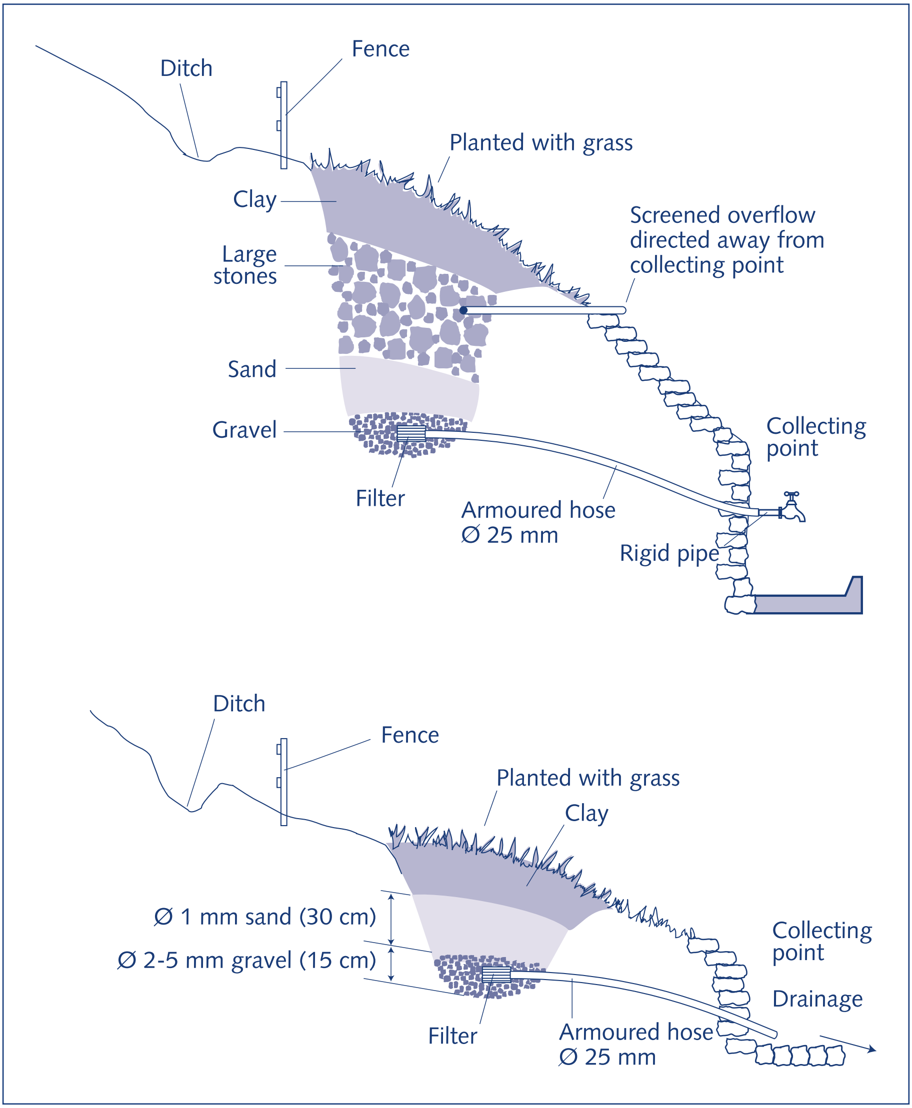

Fig. 24.9. Two "emergency" type spring protections
Adapted from: Davis and Lambert, 2002

Diffuse groundwater seepage can be collected through a "seepage spring protection" consisting of carefully placed infiltration trenches as shown in figure 24.10.

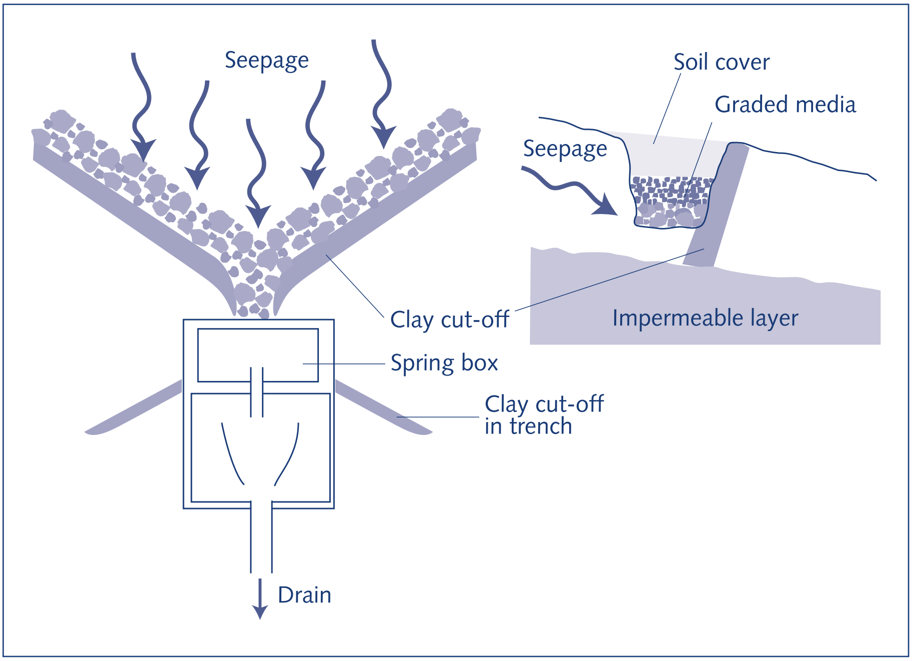

Fig. 24.10. Seepage spring protection
Source: Davis, J. and Lambert, R. 2002

24.5 Wells and boreholes

An important factor in the initial stages of an emergency response operation usually is whether wells or boreholes can be developed in time. From a technical point of view there is no difference between an emergency or a development situation with regard to wells and boreholes, although some methods for the development of wells or boreholes are quicker than others. Typical factors that play a role in the decision-making to consider wells/boreholes as an option are:

- availability of suitable companies for the drilling of boreholes; they may be there but already be hired by other organisations;
- the hydro-geological characteristics: do they allow for quick development of a well or borehole?
- available equipment and expertise.

In emergencies it may initially not be possible to develop a well/ borehole because of the time factor, but it may be a very good option for longer-term supply following on survival supply. For survival supply it is important to look at existing wells/boreholes. There may be existing wells/boreholes that are not in use; sometimes they only need to be cleaned and disinfected. Or existing wells/boreholes can produce much more water than they actually do; this extra production capacity may be temporary, for instance during the rainy season, but this will then at least provide a suitable source for some time, allowing time to develop other water sources. It may also be possible to increase the capacity of existing wells/boreholes, for instance by digging or boring deeper. Obviously these measures and uses have to be discussed with and approved by the local authorities and the owner.

In a non-emergency situation a point source such as a well or borehole usually provides up to a maximum of 300 people with water. For survival supply, a well or borehole can provide water to 900 people at a normal pumping rate because the collection of water will be more equally spread over the day and not with the high collection peaks of more normal situations. The amount of water required per person is also less. The production of a large diameter well can be increased by placing several handpumps on the same well, provided the aquifer allows for more abstraction. To avoid contamination of the groundwater the direct area of a well or borehole will need to be fenced and possibly guarded to keep away people and/or their livestock. Also protection against theft and vandalism is often required. If pumping is by motorised means, the standposts should be more than 10 m away (preferably more than 50-100 m), to prevent pollution of the direct well/borehole environment.

24.6 Rainwater catchment

Rainwater can be collected from roofs – these can also be tents or plastic sheeting - or ground surfaces. To avoid contamination plastic sheeting can be laid on the ground to catch the water. Rainwater can be an important source for survival supply, but the problem is that one cannot be sure that sufficient rain will fall just during the days it is required. Also, those who catch the water need to have sufficient storage capacity. See also chapter 7 on rainwater harvesting. Disinfection is usually needed to ensure good quality of drinking water. This can be done by using chlorine tablets, solar disinfection or boiling. Boiling is often not a feasible option because of lack of firewood and the flat taste of the water. See also chapter 19 on disinfection technologies.

24.7 Household facilities

In disaster/emergency situations affected households always need drinking water containers for fetching water and for storage in their house or shelter. Often people have lost these items during the disaster and they need to be made available. An important criterion is that the containers can be well closed and easily carried, by children as well as adults.

Typical containers are

1. Collapsible containers of 5-15 litres with a narrow neck and screw cap: easy to transport to site quickly and in large numbers, but often with a very short life time; they can break easily, sometimes even within days. These containers usually are not available locally and have to be brought in from abroad.

2. Jerry cans (usually plastic) of 15-25 litres with a narrow neck and screw cap. They have a long lifetime but are often difficult to transport to site in large numbers. Often these jerry cans can be purchased locally at low cost.
3. OXFAM bucket (Fig. 24.11). A bucket of 15 litres with a cover with a small hole plus attached push cap. Because the buckets can be stacked inside each other they can be more easily transported to site in large numbers quickly. While they are quite durable, they are expensive and not available locally. The form (round) makes them less easy to carry and the cover may get lost.

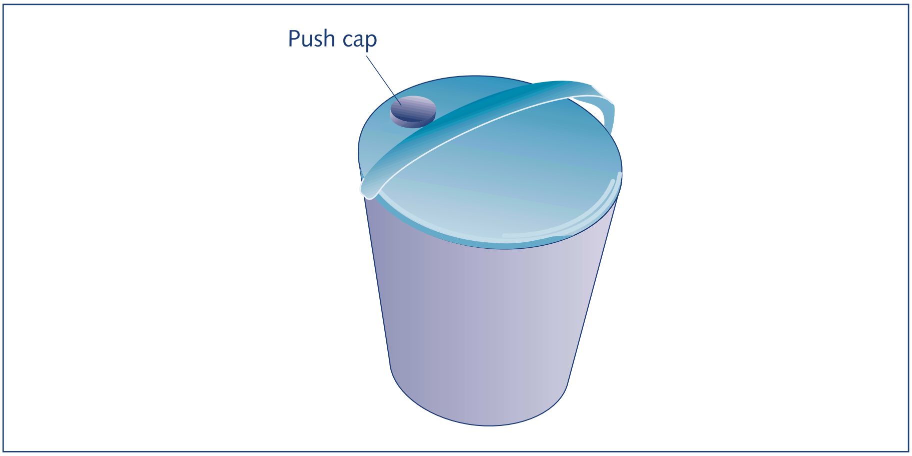

Fig. 24.11. OXFAM bucket.
Source: http://www.oxfam.org.uk

It may also be necessary to provide households with chlorine tablets, particularly when the water cannot be purified centrally and where water is contaminated to a dangerous level. Proper instructions and regular follow-up are of utmost importance to prevent people using too little or too much chlorine or even consuming the chlorine tablets thinking it is some kind of medicine. It is useful to try to size the tablets such that only one is needed for the size of water container that people have available. However, the amount of chlorine may change over time, the size of the containers people have may vary and the disinfecting capacity of the chlorine tablets may differ. If households are to boil their drinking water they should have access to sufficient amounts of fuel wood. This can have large environmental implications.

24.8 Emergency preparedness

To be prepared for emergencies actions are required at different levels:
- The international community should have the organisational infrastructure to provide assistance rapidly and effectively in case of disasters/emergencies, but should also assist poor countries to prepare themselves for coping with disasters and emergencies.

- From the national to the district level, authorities should work out disaster/emergency preparedness plans that indicate what assistance the national level should provide to local authorities and what assistance those levels should provide to the lower levels, etc., how to support NGOs, companies, etc. to cope and provide assistance when a disaster strikes.
- NGOs need to prepare themselves to provide assistance to communities struck by disasters/emergencies. They may also choose to play a role in facilitating authorities to prepare themselves, make them aware about the need for such preparations, and possibly help them with the resources required.
- Companies can prepare themselves for disasters by being ready to provide services and goods related to their business activities.
- Communities need to prepare themselves to be able to cope as well as possible with disasters themselves.

Persons with certain skills may want to assist in emergency work. People with specific useful skills can register with RedR[6]. This is an international organisation assisting in staff recruitment and training for disasters/emergencies. It is important for each of the parties involved in disaster preparedness that they work with scenarios for the disasters they may have to cope with and the specific roles they will have to, or want to, fulfil in such scenarios. An important principle in emergency work is to be as self-reliant as possible. If you rely on others for the execution of your tasks and the others don't perform well, you will also not be able to perform your tasks well. This is the reason why organisations choose to be independent from each other with, for instance, their logistical operations. It may cost more, but significantly reduces the risks. Especially for a community in a disaster prone area, it is important to assume that it will be alone when facing a disaster and it should use this assumption in the scenarios it defines when preparing for disasters.

Some specific measures that communities can take in order to be prepared for disasters that can potentially affect their drinking water systems:

1. **Ensure communication with the outer world.** Telephone lines and roads are often disrupted or not accessible after a disaster and the community could be cut off from the world, not even being able to request help. Therefore, it is helpful if there is radio equipment in or near the community. There should be a simple protocol agreed between the community and people who can be reached with the radio equipment on how to respond to and communicate in disaster situations. Both parties should have the protocol attached to the wall directly beside the radio equipment.

6 http://www.redr.org

2. **Ensure contingency supplies.** Sufficient supplies of spare parts, tools, equipment and chemicals, and construction materials for the drinking water system will enable continued operation and/or repair of the system even if supply lines are cut off for some time due to a disaster. The supplies can even be stored at different places if areas are prone to disasters that can affect restricted areas (e.g. where an area is prone to earthquakes, flooding or mud slides).
3. **Ensure sufficient skilled people.** When several people have knowledge about operational and maintenance tasks in the system, the chance is high that even if caretakers, bookkeepers, etc. become unavailable due to a disaster, other people are still available who can take over these tasks. Such 'spare' people should not only be trained initially, but should also be actively involved on a regular basis in executing the tasks they are supposed to be able to do.
4. **Place water tanks at safe locations.** Water tanks should not be placed where they could easily be affected by a natural disaster (for instance in locations prone to mud slides) or where water flushing out of breached tanks could cause great damage (for instance where water tanks are placed directly above inhabited areas).
5. **Have a contingency plan**. There should be a contingency plan that stipulates what needs to be done in case of a disaster and people in the community should have designated tasks for such occasions. A drinking water contingency plan should indicate who should do what. The involved key persons should discuss and go through the plan on a regular basis and adapt it to the circumstances whenever needed.

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http://www.sphereproject.org/handbook_index.htm

Web sites

REDR: http://www.redr.org

International Committee of the Red Cross: http://www.icrc.org/

Médecins sans Frontières: http://www.msf.org/

OXFAM International: http://www.oxfam.org/

Disaster Relief: http://www.disasterrelief.org/Links/

The Water Page: http://www.thewaterpage.com/response_and_relief.htm