Chapter 5

ENVIRONMENTAL HEALTH

Description

This chapter reviews the general principles of environmental health and the relationship between environmental conditions and the health of displaced populations in humanitarian emergencies. The critical factors for managing the water supply, sanitation, and vector-control programs are discussed, as well as the strategies for preventing and controlling environment-related diseases.

Learning Objectives

- To describe the underlying principles of environmental health management and the main problems of environmental control in emergencies.
- To discuss various sanitation concepts and the recommended options for excreta disposal and personal hygiene.
- To define the limitations of various water sources, and the standard levels of service for water quality and availability.
- To define the steps for setting up an environmental health program.
- To discuss the public health control measures for diarrhoeal diseases affecting displaced populations.
- To describe the methods by which water and sanitation programs can be monitored.

Key Competencies

- To recognise the environmental health risk factors and the main constraints of environmental health management in complex emergencies.
- To understand the basic function of a sanitation program, both at the individual and community level.
- To understand the value of various water sources and minimum standards for water quality and quantity.
- To design a simple environmental health program.
- To describe diarrhoeal outbreak control strategies.
- To identify key indicators for monitoring environmental health programs.

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Table 5-1: Definition of Key Terms

Key Term	Definition
Chemical Quality	Acceptable levels of arsenic, mercury, lead nitrates, fluorides, salts and other hazardous components in water.
Contamination	Becoming impure or unusable due to contact or mixture with certain pathogens that are transmitted through faeces or urine. Contamination with human faeces is of major concern, although animal faeces may also cause disease transmission.
Cross-contamination	Process by which contaminated liquids (usually sewage) are transferred into potable water pipes. Common causes include a break in the water pipe or changes in pressure inside the pipe.
Disinfection	Killing of infectious agents (bacteria, viruses, and protozoa) outside the body by direct exposure to physical or chemical agents.
Faecal Coliforms	A category of bacteria that match the characteristics of bacteria found in the stool of warm-blooded mammals. Finding these bacteria in water indicates faecal pollution and the water sample potentially dangerous. Other indicator bacteria are E. coli, faecal streptococci, or total coliforms.
Faecal-Oral Diseases	Diseases transmitted by ingesting faecal pathogens through water or food. Includes water-borne diseases.
Filtration	Passing water slowly through filters—usually specially constructed sand filters—to remove solid particles, protozoa, and most bacteria.
Flocculation	Gentle stirring of water to encourage the formation and settling of heavy colloidal particles called *flocs*.
Free residual chlorine	Hypochlorite ion form of chlorine that is lethal to most bacteria and viruses
Microbiological Quality	Based on normal levels of indicator bacteria such as coliforms or E. coli. Sometimes includes total viruses.
Pathogen	Anything that causes disease, especially micro-organisms.
Personal Hygiene	Tasks that are primarily carried out by an individual to promote or preserve his or her health, such as keeping hands and body clean by bathing, avoiding contaminated articles, clothing, etc.
Physical Quality	Acceptable taste, smell, and appearance of water.
Potable Water	Water that is of sufficient quality to be drunk and used for domestic and personal hygiene without causing significant health risk from short term use due to water-borne diseases or to chemical or radiological contamination.
Sedimentation	The removal of suspended particles in water by gravity.
Settling	Storing water undisturbed for 1-2 days to allow heavy matter to settle (sedimentation) and many viruses, protozoa, and bacteria to die off. Aluminium sulphate speeds up the sedimentation process but not the dying off of pathogens.
Spring	A location where groundwater flows naturally upwards to the earth's surface.
Water-Borne Diseases	Diseases acquired by drinking contaminated water (e.g., diarrhoea, cholera, amoebiasis, leptospirosis, infectious hepatitis).
Water-Washed Diseases	Diseases arising due to lack of water (e.g., scabies, skin infections, eye infections, lice (typhus), salmonellosis (food).
Well	A deep hole in the ground that is dug or drilled to obtain water.

General Principles of Sanitary Engineering

The field of environmental health is based on the concept that certain *hazards*, (disease-carrying organisms, chemicals, etc.) move through the environment and cause harm to humans. Control measures need to be focused on the following areas:

- preventing the *creation* of the hazard
- preventing the *transport* of the hazard
- preventing people from being *exposed* to the hazard once they encounter it

These three types of preventive approaches will apply whether the sanitation technician is trying to prevent diarrhoea or vector-borne diseases, or to control toxic waste. The principal hazard of water and sanitation programs in humanitarian emergencies is usually human **faeces**, which can transmit various types of pathogens. In vector control, the disease-carrying vector or rodent is the main hazard (refer to the *Vector Control* chapter for more details).

Because *creation* of faeces is unavoidable, a sanitation technician must ensure the following:

- minimise the *transport* and spread of faeces in the environment by setting up a sanitation system for proper disposal
- minimise the displaced population's *exposure* to faeces. For diseases that are transmitted by the faecal-oral route, this means minimising oral ingestion through personal hygiene measures, food hygiene and water treatment.

Examples of environmental health strategies to control malaria and cholera are shown below:

Table 5-2: Environmental Control Measures for Malaria and Cholera

Disease	How to Prevent Creation	How to Prevent Transport	How to Limit Exposure
Cholera	Cook shellfish in areas where cholera has an ecological niche	Chlorinate water Disinfect and sterilise contaminated material	Promote food hygiene and consumption of acidic foods Promote home water treatment
Malaria	Drain stagnant water to stop mosquitoes from breeding	Spray against mosquitoes	Use impregnated bed-nets Apply insect repellents

No environmental control measure functions perfectly 100% of the time. In wealthier countries, this shortcoming is dealt with by putting **multiple sanitary barriers** between the hazard and a population. How free a population is from an environmental hazard depends on how concerned the public health officials are about the consequences of the hazard, and how willing they are to invest in multiple barriers to keep the population's risk low.

In the case of surface water supplies, water sources can be *protected* from pollution by preventing individual consumers from having direct access to the source, e.g. by covering the surface or building a fence around the water source. This dramatically reduces the amount of pathogens in the water before it reaches the treatment plant. After this, solids and most of the pathogens are *settled* out. Then the water is *filtered* and *chlorinated* before being distributed to the public. If one of these four sanitary barriers is not working properly, the others will keep the risk of the hazard reaching the public relatively low. In developed countries, water-borne disease outbreaks often occur where most of the multiple sanitary barriers have failed.

Similarly, carrying out multiple control measures is often the most effective way to control outbreaks of vector-borne disease. For example, a malaria outbreak may be controlled by minimising mosquito breeding sites and, at the same time, spraying shelters, using mosquito nets and repellents, and giving appropriate anti-malarial treatment to all suspected cases.

Another sanitary principle is **distance.** The more dangerous a substance is and the more volume that exists, the greater the distance needed to separate the hazard from a population. This is because:

- The greater the distance between a hazard and a population, the more time will pass between any accidental release of a hazard and the time when the population is exposed.
- Distance provides more opportunity for the hazard to be detected, and time for the population to take measures to protect itself.
- Finally, distance allows most pollutants to degrade or become dispersed.

Therefore, increasing the distance between a population and hazardous materials helps to reduce the risk of the hazard. It may cut down on human exposure regardless of how the hazardous material is treated or contained. For example:

- The distance between a hazardous waste dump and the people living near it is usually greater than the distance between city dwellers and a city refuse dump.
- For vector control, moving camps of displaced populations away from vector-infested areas can significantly reduce the number of deaths and illness. In the early 1980s, moving the Cambodians on the Thai border away from the forested areas cut the malaria mortality rate by half and the incidence rate by two-thirds.

In summary, environmental control aims at interrupting the creation, transport and spread of diseases. The following table shows various sanitary engineering and personal measures that can help to achieve this aim:

Table 5-3: Summary of Sanitary Engineering and Personal Measures

Sanitary Engineering	Personal Measures
Provide treated water	Safely collect and drink potable water
Provide sufficient water	Wash and clean regularly
Provide latrines	Dispose excreta safely
Ensure adequate drainage	Dispose wastewater safely
Provide refuse disposal sites	Dispose refuse safely
Reduce vectors and rodents populations	Individual protection and home management
Provide domestic equipment and fuel	Handle and cook food properly

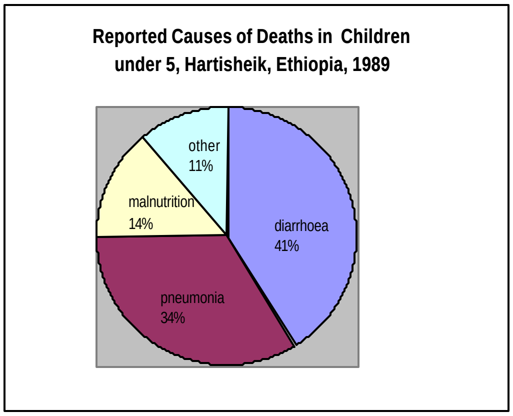
Problems of Environmental Health Control in Emergencies

Environmental control may be compromised when it is applied to refugee settings. In many humanitarian emergencies, large populations that have fled from their homes typically settle at the nearest place that they feel safe. Because time and resources are limited, water and sanitation systems are not usually set up before their arrival. Displaced people are normally shifted onto the only unclaimed land available where setting up multiple sanitary barriers may not be practical. It is impossible to get “extra” space to separate people from the nearest hazard if the land is only a few square kilometres. As the settlement area becomes overcrowded and the living conditions unhygienic, preventing the transport or exposure of people to environmental hazards may be difficult.

Large-scale outbreaks of diarrhoea and other environment-related diseases are frequently reported among displaced populations, particularly during the acute emergency phase (refer to exhibits below). These outbreaks may be a sign of insufficient efforts in controlling environmental hazards and the monitoring risk of disease outbreaks. Planners of emergency relief programs have to make environmental health control (sanitary engineering as well as personal measures) their top priority.

Control measures should be started immediately and improved gradually (based on urgency and resources) to achieve the Sphere Project's minimum standards of services by the end of the acute emergency phase.[i]

Figure 5-1: Reported Causes of Death in Children Under 5 Years



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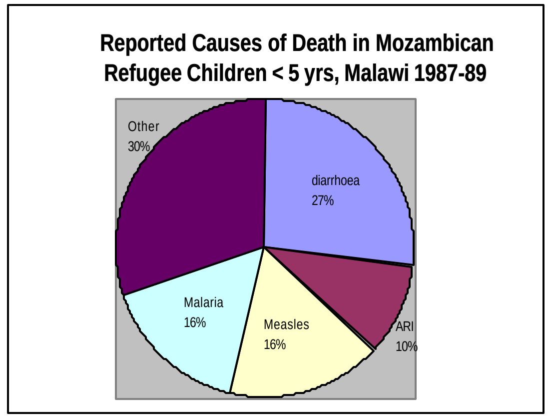


Source: MSF

SANITATION

Basic Concepts

In humanitarian emergencies, establishing a sanitation system for large, displaced populations should be among the first priorities. This is because epidemiological studies in developing countries have shown that use of latrines or other excreta containment facilities provides greater protection against diarrhoeal diseases than any other environmental health measure. Even though the type of facility varies between settings and cultures, several basic concepts always apply:

1) *The purpose of a sanitation system is to contain human excreta at the moment of defecation so that it is not free to spread throughout the environment.*

   Getting as many people to use excreta containment facilities as often as possible is the goal of all sanitation programs. Sanitation workers should clearly communicate to the affected population how it is essential for *everyone* to always defecate in the excreta containment facilities. Whatever the circumstances, an appropriate sanitation program must be developed that considers the following:

   - In some cultures, there is need to build separate latrines for men and women and special latrines for children.
   - In some settings, latrines may be needed at places of work or public gathering areas (market, health facility, etc.)

   Note: *Although animal faeces and urine may also transmit disease, the danger is much lower than from human faeces.*

2) *People's excreta poses little hazard to themselves.*

   Faeces from one's family members may be less hazardous than other people's faeces because families are more likely to have common immunological histories as a result of exchanging pathogens on an ongoing basis. Where possible, different households should not share latrines or toilets. Because latrine cleaning and maintenance is an unpleasant task in virtually all cultures, having a latrine for every household helps maintain clean facilities. However, the health benefits of having enough latrines for each family must be balanced against the time, effort, and expense of building them. Populations that are unstable or are expected to move within a short time are perhaps better served by a communal latrine system. The minimum standards of the Sphere Project recommend having a minimum coverage of 20 people per latrine. (This level of coverage is rarely achieved in transit and reception centres).

3) *Mortality and morbidity rates among displaced populations in the first days and weeks of a crisis are often many times higher than for the same population once it is settled.*

Providing some type of sanitation facilities during the first days of a crisis is critical for preventing outbreaks of diarrhoeal diseases. Either some latrines should be built before the population arrives at a site (which is rare) or defecation fields should be established immediately following their arrival. A proper site must be reserved for defecation fields at the outset of a crisis. These fields must be away from water sources but not too far from the dwellings to discourage people from using them. (For more details about defecation fields, refer to the section on Sanitation Options.)

4) *Young children pose a particular concern for excreta control programs.*

Children experience a disproportionate amount of diarrhoea compared to other members of the population, and they shed the most hazardous faeces. Their defecation habits are particularly difficult to control. The solution to this problem involves two steps:

- First, educate child-care providers about proper handling of children's faeces and the importance of washing their hands after cleaning children and/or handling children's faeces.
- Second, child-friendly latrines need to be available. Child-friendly latrines are not dark (perhaps even have no walls) and have a squat hole that is smaller than in an adult latrine.

5) *The habits and beliefs of the displaced people will determine what structures and materials are most appropriate.*

Most latrine/toilet options perform the primary task of containing excreta, whether they are **above-grade barrels**, **pit latrines**, or **solar-heated composting toilets**. It is best to let the displaced population match the proper hardware and educational inputs according to their own beliefs and habits. Letting displaced populations design and construct sanitation facilities, especially if each household can construct latrines for themselves, is perhaps the most effective way to assure that facilities will be used and maintained properly.

Sanitation Options

The following factors should be considered when selecting sanitation systems:

- *Acceptance* – cultural factors are considered in the design.
- *Access* – the population has access to latrines.
- *Use* – the population is educated on proper latrine use.
- *Maintenance* – proper maintenance of latrines is organised.
- *Drainage* – the latrines are protected from surface water drainage.

Defecation Fields

In arid and semi-arid climates, reserving specific areas for defecating can be an acceptable means for keeping people separate from their excreta. In all settings and climates, defecation fields may be a necessary choice in the first days of an acute emergency. To provide optimal health protection, defecation fields should have the following characteristics:

- They should not be near or uphill from water sources or living areas if there is a chance that rain will occur.
- They should be close enough to the population so that they will be used, even in the evening hours.
- Defecation areas should be clearly delineated.
- Because the need for privacy varies between cultures, local representatives should be consulted to determine if separate facilities for males and females are mandatory or if screens are adequate.

Defecation fields should be managed so that some areas are used for a day or two and then closed as unused areas are opened. If the defecation field is on a slope, it is wise to start using a strip at the bottom that runs across the slope (not up and down) and then move up. People can be guided to the open portions of the defecation zone either by ropes or tapes, by a screen (which can provide some privacy), or by gangplanks. Whatever mechanism is used to guide people, it should be moved periodically to prevent them from having to wade through areas with excessive faecal contamination.

Trench Latrines

A communal type of latrine is often used when sanitation facilities are needed quickly and defecation fields are inappropriate. The fastest and easiest type of communal latrine to construct may be a trench latrine. This latrine is simply a trench measuring about 0.5 to 1m in depth and width, and of varying length. Such a trench can be dug very quickly with a backhoe. A board or logs are placed across the trench so that people can squat over the void and defecate. Most often, the dirt from the trench is left in a pile beside the latrine and a thin layer of soil is shovelled on top of the excreta on a daily basis. This acts to reduce odours and control flies. It also causes the trench to fill quickly. Therefore, depending on the number of people served per trench and the size of the trenches, digging of new trenches may necessary every few days. Because a trench latrine can be dug fast and easily, it allows a large population to be served by many facilities quickly.

Barrel Latrines

A barrel latrine is an option in places where the water table is high, the soil is too hard to dig, or the weather is cold; thus, demanding indoor latrines. Typically, there are two designs:

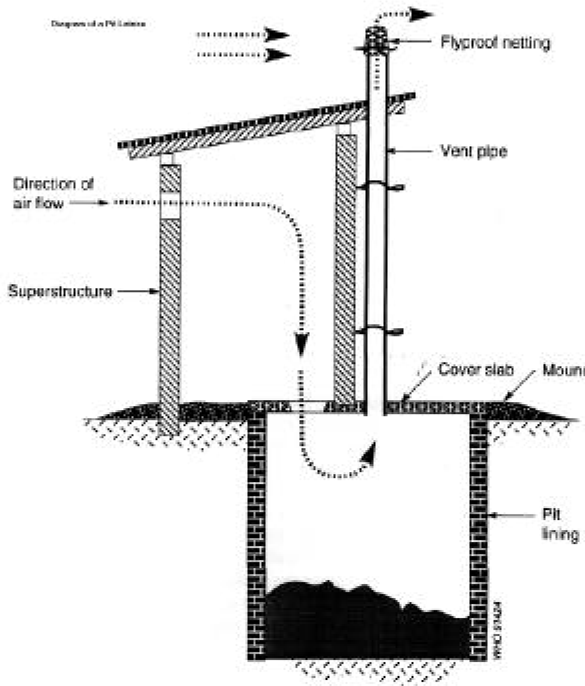
1. The first type uses the bottom half of a 200-liter metal barrel. A piece of plywood or other material (with a squat hole in the middle) is placed over the top of the barrel to serve as a platform. People step onto the platform to defecate into the barrel. When the barrel is approximately half filled, the platform is removed and the barrel is taken to a dumpsite and emptied, and then brought back for reuse. Some military manuals suggest pouring gasoline into the barrel and burning the contents. This is only recommended when sanitary disposal is not possible (e.g., where there is a very high water table) and should be used with great caution.
2. The second type of barrel latrine uses an entire 200-liter barrel as a collection vessel. But, because a 200-liter barrel is more than a meter high, a platform with steps must be built so that people can get above the barrel and defecate into it. The barrel is periodically emptied as with the half-barrel design.

Pit Latrines

The most commonly selected sanitation option for displaced populations is the pit latrine. A pit latrine is a wide hole in the ground that is covered by a platform with a squat hole to defecate through. Designs vary from a simple latrine made of a hole in the ground with two logs across it, to elaborate composting latrines that separate faeces and urine and have a vent to make them odour free. Most areas in the world have a local latrine design that usually has a superstructure with walls to provide privacy. Preferably each household or family, will usually build culturally appropriate latrines if they are given the proper construction materials and some guidance. As mentioned earlier, the key point is for everyone involved to understand that the goal is for as many people as possible to use a latrine with as little sharing as possible.

Note: *Pit latrines are not an option where the water table is high or the soil is shallow or hard.*

Figure 5-2: Ventilated Improved Pit (VIP) Latrine with Illustration of Air Flow (WHO)



Pour Flush Latrines or Flush Toilets

Toilets that are flushed with a bucket of water or those that flush on their own are the norm in many parts of the world, but they are rarely appropriate during a complex emergency. A pour flush toilet is a basin with a water trap at the bottom and a pipe to carry sewage to a soak-away pit or sewer. The water trap (a tube that curves up from the bottom of the basin a few centimetres above the bottom and then curves downward again) causes the basin to hold between 200ml and 2 litres of water. After defecating in the basin, 2 to 5 litres are poured onto the basin. This causes the waste to be flushed away. The advantage of this system is that it is relatively clean and odour free. However, the disadvantages of pour flush latrines are greater. Not only do such designs use large amounts of water, but they also require a sewage collection system that is expensive and time consuming to build. Where piped water or other plentiful water sources are available, water-flushing options may be suitable.

Personal Hygiene

Personal hygiene refers to those tasks that are the primary responsibility of the individual, such as keeping hands and body clean by hand washing, bathing, avoiding contaminated articles, clothing, etc. Personal hygiene promotes health and limits the spread of infectious diseases that are transmitted by direct contact.

No area of environmental intervention is more difficult than promoting personal hygiene. Not only do cultural practices vary between people, but some languages often do not easily translate words such as privacy or faeces. Therefore, as in sanitation, local professionals are the people who are best suited to develop and deliver hygiene education. Regardless of the setting, several basic premises seem universal including:

1. People need to be able to clean themselves after defecating. If anal cleansing is done with paper or sticks, these materials must be readily available in or near the latrine. If anal cleansing is done with water or with people's hands, water and soap must be made available at the latrines.

2. Hand washing, particularly after defecating and before preparing food, has been shown to be protective against faecal-oral illnesses. No studies examining the impact of personal hygiene found health benefits associated with education alone[1]. Therefore, any efforts to promote hand-washing should be monitored to ensure that increased hand-washing is actually occurring.
3. Soap provides protection from diarrhoeal illness independent of any educational program that may accompany it. Therefore, providing soap should be a priority in settings where diarrhoeal diseases and dysentery are likely to occur.
4. Educational messages should be short and focused. All messages and pictures included in an educational campaign should promote ways that are known to prevent the specific health threat at hand. They should also focus on behaviours that are not being practised by a significant fraction of the population.

   An educational campaign promoting six messages about hygiene was organised in Tajikistan, by ICRC, during a typhoid fever outbreak in 1997. An evaluation of the campaign found that people who received and understood the messages were as likely to develop typhoid fever as those who had not. In this case, only one of the six messages, "boil your drinking water," had any relationship with the way the disease was being transmitted.

   The following tables show examples of short and focused messages on hygiene and defecation:

Table 5-4: Example of Educational Messages on Hygiene

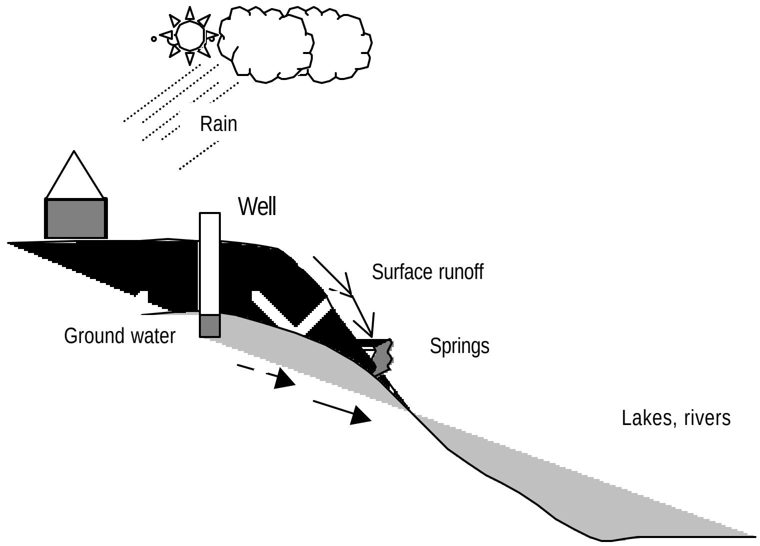
• Wash hands with soap after defecation. • Wash hands with soap after cleaning babies. • Wash hands with soap before preparing food. • Wash hands with soap before eating.

Table 5-5: Example of Educational Messages on Defecation

• Go to the defecation zone and help children to go to the defecation zone. • Use the shovel to dig a little hole in the ground. • Cover the excreta with soil after defecation.

[1] studies included in a recent review by Bull. WHO 1991; 65(5): 609-21

Figure 5-3: Sources of Water



Sources of Water

Water sources fall into three general categories (refer to the Figure above):

1. **Rainwater***:* In general, rainwater, though pure, is not reliable or a sufficient source to provide for a large displaced population and is rarely considered during complex emergencies.
2. **Surface water***:* Surface water from lakes, ponds, streams, and rivers have the advantage of being accessible (water easily collected) and are predictably reliable and plentiful. They have the disadvantage of generally being microbiologically unsafe, and therefore, requiring treatment.
3. **Groundwater**: Groundwater from wells, springs, etc. tends to be of higher microbiological quality (having undergone natural soil filtration underground). However, it is relatively difficult to extract. More technology and energy is needed (compared with other water sources) to bring water from within the earth up to the surface.

The following factors are important when selecting the type of water sources for displaced population:

1. the reliability of available water sources
2. the water needs in relation to population size
3. the intended length of intervention
4. the locally available skills and resources
5. the capacity of the implementing agency

Water Quantity

In developing countries, evidence shows that providing people with *increased amounts* of water is more effective in protecting against faecal-oral pathogens than providing them with *cleaner* water. The minimum standards of the Sphere Project states that at least 15 to 20 litres per person per day (l/p/d) is needed to maintain human health. While the availability of water is influenced by the situation, more water can almost always be obtained with more resources (more wells, trucks, or pipes). Because obtaining water in arid areas is expensive and the relationship between water quantity and health is not well understood, there is a tendency not to invest enough in water infrastructure when other demands seem more serious. This makes monitoring the availability of water during emergency situations an essential component of a public health program.

During the acute emergency phase, water consumption should be estimated weekly. Often, the utility company or relief organisation providing water to a displaced population has these estimates. It is important to realise that water consumption means *what people receive* not what the *water team produces*. Disagreements may arise between "production" and "consumption" estimates because:

- Water can be lost or wasted during pumping and transport.
- Lack of water containers can prevent people from collecting enough water.

Surveys or household interviews that document the amount of water collected at watering points or people's actual use of water are preferable to simply dividing the amount of water produced at a well or a plant by the number of people served. Cholera outbreak investigations have repeatedly shown that not owning a bucket puts families at increased risk of illness or death. Thus, not only should the average water consumption be 15 l/p/d or more, but there should not be anyone in the population with very low water consumption (<7 l/p/d). In addition, all families should be provided with suitable water containers for daily collection and storage of water. Special drainage pits should be constructed to manage runoff water at distribution points.

Water Quality

Water quality is usually measured by the presence of specific groups of micro-organisms. This indicates the possible presence of faeces. Because human faeces typically contain tens of millions of bacteria per gram, even the smallest trace of faeces in water is often detectable by bacterial monitoring. Faecal coliforms are a category of bacteria that match the characteristics of bacteria found in the stool of warm-blooded mammals. Other indicator bacteria, such as E. coli, faecal streptococci, or total coliforms, are maintained by the same premise — absence implies safe water.

The following table shows the recommended guidelines for assessing water quality.

Table 5-6: Guidelines for Water Quality (UNHCR)

Faecal Coliforms (per 100 mls of water)	Interpretation	Recommendation
0-10	Reasonable quality	Acceptable
10-100	Polluted	Better protection and simple treatment
100-1000	Very polluted	Treatable, but look for alternative source
Over 1,000	Grossly polluted	Source to be avoided

Note: *Water quality testing may be performed by a competent local laboratory (must be done within 6 hours of sampling), or by using field testing kits, e.g. the Oxfam/Del Agua Kit or Milliflex Kit from Millipore. However, these kits are expensive and require trained people to use them and interpret results.*

The above table shows that *no* faecal coliforms in water is a good indication that there are no faecal-oral bacterial pathogens present, whereas finding *low* levels of faecal coliforms in water does not mean that the water is dangerous.

Note: *Contaminated water sources should not be closed until equally more favourable sources become available.*

While water sources may differ in water quality, it is how water is handled and stored by consumers that will finally determine whether the water is safe for drinking. Studies have shown that dipping hands into household storage buckets causes considerable contamination and that water quality declines over time after the water is initially collected. The best way to keep water safe in the household is to add a chlorine residual to the water (refer to the next section on water treatment for details on chlorine residuals). This means that in unsanitary settings, or during times of outbreaks, it may be necessary to chlorinate otherwise safe groundwater.

Getting and Treating Surface Water

Water is not usually consumed directly from the surface water sources. It first needs to be transported, stored, and purified before it is distributed to the people who need potable water. All along this chain of delivery, potable water needs to be protected from contamination by human and animal faeces, urine, or any other hazardous material.

Bucket Collection

When people collect water directly from water sources in buckets, the only treatment that can be done easily is chlorination. Health workers can chlorinate water at the point of collection or in the home. Ideally, enough chlorine should be added to the bucket so that after 30 minutes there is still at least 1.0 mg/l of free chlorine in the water. Typically, an initial dose of 2.5 mg/l of chlorine will be sufficient to react with the organic material in the water and leave an adequate level of chlorine residual. (Free residual chlorine is the hypochlorite ion form of chlorine that is lethal to most bacteria and viruses). People should wait for 30 minutes after chlorination before consuming the treated water in order to allow disinfection to occur.

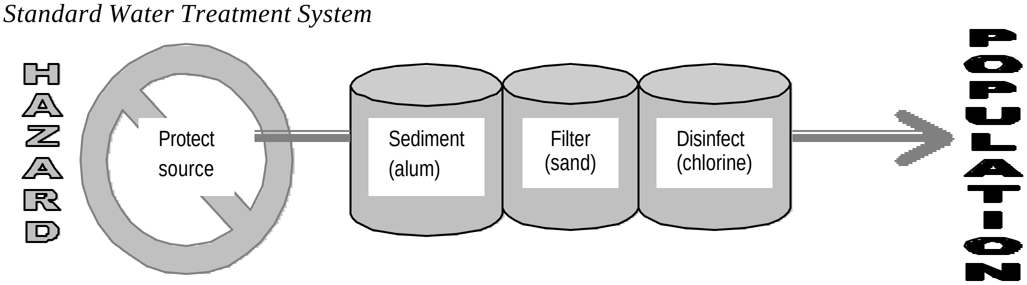
Pipe Distributions

When water is drawn from a surface water source and distributed through a piped system, there is the potential for dramatically improving the quality of the water. In general, three measures are taken to purify water at surface water plants and to ensure it remains safe until it reaches the consumer:

- *Settling* removes solids (through sedimentation) and protozoa, e.g. giardia (by causing them to die). It is often speeded up by adding coagulants such as aluminium sulphate (alum) and *flocculation* (gentle stirring to encourage the formation and settling of heavy colloidal particles called flocs).
- *Filtering* through sand removes particulate matter including microbes (e.g. bacteria, amoeba).
- *Disinfecting* with chlorine deactivates all major water-borne bacteria. Within a piped system, chlorine levels are typically adjusted to ensure that 0.2 to 0.5 mg/l of free chlorine is in the water at the tap level where it is consumed. For systems with many breaks along the distribution pipes or during times of diarrhoea outbreaks, it is appropriate to aim at having 0.5 to 1.0 mg/l of free chlorine. Water treatment plant attendants can be trained to perform a simple test for free chlorine levels by using a pocket size chloroscope (chlorine comparator kit).

  Note: Although *boiling of water is the surest method of water sterilization, it is not appropriate for large-scale water treatment because about 1 kg of wood is needed to boil 1 litre of water.*

Figure 5-4: Standard Water Treatment System



Removing solids by coagulation and filtration greatly improves the chlorine's effectiveness. Therefore, these three measures are not simply multiple barriers, but when combined produce a synergistic effect on water quality.

It is not enough to focus on water treatment methods because shortcomings in the distribution system have been the main cause of major waterborne outbreaks in the world during the 1990s. Sometimes, piped water systems break down. The resulting drop in pressure allows contaminants to get into pipes through cracks, which during times of constant pressure only allow water to seep out. The process of drawing contaminated water into potable water pipes is called **cross-contamination**.

During times of armed conflict, electrical outages, explosions, and the inability to conduct routine maintenance make the problem of cross-contamination particularly serious. Two things can be done to prevent this process:

1. *Increase the pressure in the water pipes* — pressure can be raised by increasing the rate of pumping into the system, by cutting down on water waste, or by closing off sections of the distribution system.
2. *Increase the level of residual chlorine* — because cross-contamination occurs sporadically along the distribution system, the level of chlorine residual must be kept high throughout the entire pipe network. Levels of residual chlorine should be increased until there is free chlorine virtually everywhere (at least 95% of locations).

Getting and Treating Groundwater

Water that has been collected from groundwater sources is usually considered safe for drinking. It only needs to be extracted and transported in a way that prevents contamination. The most serious threat to the safety of groundwater supply is human faeces.

Springs

A spring is a location where groundwater naturally flows upward to the earth's surface. Because the volume of water flowing from a spring is controlled by underground physical and hydrological factors, the amount of water produced by a spring is fixed. The only task required for a spring is to protect the water so it can be collected without being contaminated. This is usually done by building a spring box, which is a collection basin with an outflow pipe that is placed at or just below the point where the water comes to the surface.

Wells

A well can be constructed by digging or drilling to raise ground water through a pump or other device. The type of well (tube well, dug well, borehole) depends on the depth of the water table. The deeper it is, the more difficult and expensive it is to raise the groundwater. Again, the priority is to prevent the groundwater from being contaminated at the surface. This is usually done by lining the well or by sealing off the top of the well. To line a well, a skirt is built around the opening of the well. The following issues are important when constructing a well:

- A well may never be used if it is not located in a suitable place or was not constructed properly.
- Wells typically operate for a while and then fail because they are not maintained or repaired properly.

Agencies or groups planning to build wells need to choose the site carefully and budget from the start for funds to maintain the wells (spare parts and personnel) until the local wealth and economic activity can sustain the water system, otherwise the wells will be abandoned.

Chlorination

Groundwater from wells and springs is usually safe for drinking without chlorination. However, when household water contamination is high or when the groundwater is of poor quality, water disinfection may be necessary. As with surface water, buckets can also be chlorinated as the water is collected, or people can be equipped to treat their water at home. Many agencies have chlorinated wells as a public health measure. This is done by the following methods:

- **Shock Chlorination:** Shock chlorination is conducted by adding 5-10 mg/l of chlorine solution to water in a well and allowing it to sit unused for a number of hours. The first water drawn from the well after the disinfection period is discarded. Normal use of the well can then be resumed. Shock chlorination does not mean that the water given to people for their homes is chlorinated. After the first few hours of use post-treatment, there will be little or no residual chlorine in the drawn water.

  Shock chlorination can be performed to eliminate a temporary threat to water quality of a well, e.g. in newly dug wells, or for groundwater that has been contaminated by people or an unusual event (such as a major rainstorm).

- **Pot Chlorination**: The chlorination pot is usually a vessel, such as a 1-liter plastic bottle, with a few holes punched in it. This vessel is filled with a chlorine powder and gravel mixture and then placed in a larger vessel (such as a 4-liter milk jug or a clay pot) which also has a few holes punched in it. The chlorine disperses from the double layered pot slowly. The number and size of holes determines the dose of chlorine released into the well.

  The pot chlorination method protects against a continuous source of contamination in the groundwater. It also counteracts any new contamination in the well, and it provides a protective chlorine residual in the water people use. Unfortunately, to operate this type of system effectively, extensive monitoring is needed. The ideal target dose of free chlorine in water drawn from a well is 0.5 to 1.0 mg/l. The number and size of holes in the vessels have to be tailored to match a specific well volume and withdrawal rate. The first water drawn in the morning will have an offensively high level of chlorine. If a well has certain periods of very high use, the dose may become too low. Therefore, the pot chlorination method is not widely used. This method is particularly unsuitable during the acute phase of a crisis when lack of time and attention can prevent proper monitoring and adjustment of the chlorine levels.

PLANNING ENVIRONMENTAL HEALTH PROGRAMS FOR EMERGENCIES

To establish an effective environmental health program in humanitarian emergencies requires a good understanding of the relationship between the human and socio-economic parameters and the physical landscape. Therefore, the need for a proper assessment cannot be overemphasised. Environmental control measures that have a rapid impact but a long-term view should be selected. They should also achieve the minimum standards in emergency response within three to six months. Because maintaining a clean environment depends on the co-operation of the affected people, a representative group should take part in planning and implementing the environmental health program. To get the maximum impact from environmental control measures, there must be similar improvements in health services and other sectors.

Assessment

The Planning Cycle

Environmental health assessments should involve multiple sectors (water and sanitation, food, shelter, health services), the local authorities and representatives from the displaced population and other local NGOs. Appropriately qualified personnel (such as the environmental health technician or sanitation inspector) should lead it. Assessment checklists are useful for ensuring all the key questions have been examined, but they must be adapted to the particular disaster situation. The following checklist may be used to assess health needs, the local conditions and identifying local resources.

Table 5-7: Checklist for Environmental Health Assessment

1. General • How many people are affected and where are they? • What are the people's likely movements? What are the security factors for the population and relief interventions? • What are the current or threatened water and sanitation-related diseases? What is the distribution and expected evolution of problems? • Who are the key people to consult or contact? • Who are the vulnerable people in the population? What special security risks exist for women and girls? **2. Water Supply** • What is the current water source? Are alternative sources nearby? • Is the water source safe/protected? • How much water is available per person per day? • What is the daily/weekly frequency of the water supply? • Is the water available at the source enough for short term and longer term needs? • Are water collection points close enough to where people live? Are they safe? • Is the current water supply reliable? How long will it last? • Do people have enough containers or the right size or type? • Is the water source contaminated or at risk of contamination? • Is treatment necessary? Possible? What treatment is needed? • Is disinfection necessary, even if supply is not contaminated? • Are there alternative sources nearby? • Are there any obstacles to using available supplies? • Is it possible to move the population if water sources are inadequate? • Is it possible to tanker water if water sources are inadequate? • What are the key hygiene issues related to water supply? • Do people have the means to use the water hygienically in this situation? **3. Solid Waste Disposal** • Is solid waste a problem? • How do people dispose of their waste? • What type and quantity of solid waste is produced? • Can solid waste be disposed of one site, or does it need to be collected and disposed off site? • Are there medical facilities and activities producing waste? How is this being disposed of? Who is responsible?	**4. Excreta Disposal** • What is the current defecation practice? If it is open defecation, is there a designated area? Is the area safe? • Are there any existing facilities? If so, are they used/ sufficient/ operating w ell? Can they be extended or adapted? • Is the current defecation practice a threat to water supplies or living areas? • Is the current defecation practice a health threat to users? • Are people familiar with the construction and use of toilets? Which type of toilet are they familiar with? • Are people prepared to use latrines, defecation fields, trenches, etc.? • What are current beliefs/practices, including gender-specific practices, about excreta disposal? • Is there enough space for defecation fields, pit latrines, etc.? • What is the slope of the terrain? • What is the level of the groundwater table? • Are soil conditions suitable for one-site excreta disposal? • What local materials are available for constructing toilets? • Do current excreta disposal arrangements encourage vectors? • Do people have access to water to water and soap after defecation? • Are there materials or water available for anal cleansing? • How do women deal with menstruation? Are there materials or facilities they need for this? **5. Vector-Borne Diseases** • What are the vector-borne disease risks and how serious are they? • If vector-borne disease risks are high, do people at risk have access to individual protection? • Is it possible to make changes to the local environment to discourage vector breeding (drainage, refuse disposal, etc.) • Is it necessary to control vectors by chemical means? What programs, regulations and resources for vector control are there? • What information and safety precautions need to be provided to households? **6. Drainage** • Is there a drainage problem? • Do people have the means to protect their shelters and latrines from local flooding?

Source: Sphere Project, 2000

There are various techniques for gathering assessment information, and these should be carried out in a systematic way. Key people may be interviewed first followed by a review of existing records. Thereafter, existing water and sanitation systems should be inspected. A rapid survey may be organised to collect information from a sample of the displaced population. The goal is to ask as few questions as possible about the key topics.

The following Figure gives an example of a questionnaire for assessing water consumption and latrine coverage:

Figure 5-5: Example of a Survey Questionnaire

HOUSEHOLD WATER SURVEY

Date:__________________________________ Interviewer:__________________________________

Location:________________________________ Household number:_____________________________

1. *Introduce yourself and explain the purpose of the survey.*

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2. *Ask the person who collects water for the household*:
   How much water did you and other family members collect yesterday (for all purposes)? ____________
3. How many water vessels do you have? Number ____________; Estimate total volume ____________
4. a. How many members are there in your family? ____________
   b. How many of them consumed water yesterday? ____________
5. Does your family have a latrine? ____________
6. How many other families share the latrine? ____________
7. Do you own livestock? ____________
   If yes, what kind of livestock and how many? ____

After the assessment, all the information should be analysed and presented in a way that allows for transparent and consistent decision-making (refer to the *Disaster Epidemiology* chapter for details on Data Analysis and Presentation).

For example, average water consumption and latrine coverage may be calculated using data from the above questionnaire shown in the following Figure:

Figure 5-6: Calculations Drawn from Questionnaire

1. *Average Water Consumption =* $\dfrac{\text{Total amount of water collected}}{\text{Total number of family members present}}$

2. *Give the family credit for ½ or 1/3 of a latrine, depending on their sharing habits with other families.*

   Latrine Coverage = $\dfrac{\sum \text{Number of latrines}}{\text{Total number of families interviewed}}$

The assessment should help relief planners determine whether external resources are needed, depending on the national standards for water supply, sanitation and vector control of the host country. The following exhibit outlines the conclusion of an environmental health assessment report:

Figure 5-7: Conclusions of an Environmental Health Assessment

1. **Main hazard** affecting the disaster situation (human excreta, vectors) should be stated.
2. **Current measures** to control the hazard (note whether they are adequate).
3. **Immediate and future actions** if necessary should be outlined, using a phased approach. Actions may include the following environmental health interventions:
    - setting up temporary defecation areas until other solutions are available to improve the general hygiene
    - providing sufficient quantities of quality water and restoring damaged water system
    - reducing the vector and rodent populations to acceptable levels
4. **External resources required** (technical skills, chemicals, equipment or spare parts, staff to organise culturally and technically appropriate defecation facilities or areas).
5. **Further investigations** if necessary (e.g. by a road or water and sanitation engineer).

Problem Identification

The assessment information should identify the displaced population's health needs and risks related to water supply and sanitation, such as:

1. There is improper disposal of human faeces because:
    - sanitation facilities are too far or there aren't enough.
    - sanitation facilities are poorly maintained.
    - people are not motivated to use sanitation facilities.
2. There is not enough water for hygiene and domestic use because:
    - the demand for water and sanitation exceeds the local resources.
    - people do not have vessels for collecting and storing water.
    - the wells and springs have dried up or were damaged by the disaster.
    - lack of security prevents collection of water.
3. There are an increased number of cases with vector-borne diseases among displaced population because:
    - the number of breeding sites (wet, swampy areas, shade, etc.) have increased.
    - the population has higher health risks (non-immune, poor nutrition, crowded conditions) of disease.
    - there are unusual weather conditions that have given rise to the disaster (floods).

Setting Priorities

When identifying the priority problems and conditions related to water and sanitation programs, consider the question: Which of the defined conditions cause or can solve the identified problems? The table below list possible problems and conditions. It is important to involve local experts and to consider the views of the both the displaced and the local (host) populations.

Table 5-8: Identifying Priority Problems and Conditions

Define the Problems	Define the Conditions
• Mortality data, • Causes of death, • Public opinion, • Social factors (time spent in essential activities, violence patterns)	• Water consumption (litres/person/day), • Sanitation coverage, • Proportion with safe drinking water), • Proportion with access to soap, • Proportion with adequate water vessels.

Ranking is another method of identifying the priority environmental health problems or the most appropriate interventions. The following example shows how ranking can be used to prioritise mosquito control measures:

Table 5-9: Prioritising Mosquito Control Strategies

	Health Education	Hygiene Measures	Barrier Methods (bed nets)	Chemical Control (spraying)
Feasibility of long-term (Low = 1, High = 3)	3	2	2	1
Community acceptance (Low = 1, High = 3)	3	2	2	1
Cost (High = 1, Low = 3)	1	3	2	1
Effectiveness (Sceptical = 1, High = 3)	1	3	2	2
Total Additive Score	**8**	**10**	**8**	**5**
Total Multiplicative Score	**9**	**36**	**16**	**2**

Each vector control intervention is scored according to four criteria — **feasibility of long-term implementation**, **community acceptance**, **cost of implementation**, and **effectiveness of intervention**. The four scores are then added together to obtain the *total additive score*. If two or more interventions have the same total additive score, then multiply the four scores to obtain a *total multiplicative score*. In the above chart, hygiene measures are considered to be the highest priority, and chemical control as the lowest.

Defining Goals and Objectives

Environmental health programs should be based on set goals and objectives that address the priority public health problems. The following goals may be considered for the environmental health program:

1. To preserve the overall wellbeing of the affected population living under high risk conditions.
2. To restore the environmental health conditions and services to levels with reduced risk of disease outbreaks.

Table 5-10: Examples of Program Objectives and Targets

Objective	Target
To provide sufficient quantities of acceptable quality water	Supply at least 2 l/p/d of potable water, while aiming for at least 15 l/p/d for domestic use and personal hygiene.
To establish adequate sanitation services to contain faeces	Provide a minimum of 1 latrine per family or 1 per 20 people, sufficiently close to households
To increase the affected population's awareness of the basic rules of sanitation	Promote appropriate use of water and sanitation facilities and increase awareness of hygiene risks
To protect the population from excessive exposure to disease-bearing vectors and pests	Provide insecticide treated nets and minimise potential breeding sites

The above table defines objectives that may be considered for environmental health programs. In extreme emergency situations, it may be difficult to meet priority needs (provide sufficient drinking water and sanitation facilities). A phased approach may be necessary, which ensures survival while aiming to achieve minimum standards for environmental health programs, as much as existing constraints or resource limitations allow.

Defining the Plan of Action

The next step is to define a plan for implementing the environmental control actions that will achieve set objectives. Complement and build on local capacities by asking the affected population to define the methods that they are familiar with. Local authorities should be consulted to ensure the program is developed within the local context. Key staff members should be made responsible for critical tasks. For example, materials and supplies can only be procured after a water engineer has designed the appropriate water and sanitation systems. The following worksheet outlines a possible plan of action for an environmental health program:

Table 5-11: An Example of an Action Plan for an Environmental Health Program

STRATEGY	ACTIVITY	TASKS	WHEN	BY WHOM
Set up an interim water supply while organising medium term measures	Protect existing water sources	Prevent direct contact with users or excrement, Chlorinate if risk of outbreak of water-borne disease is high	From day #1...	Water team
	Organise regular water supply	Short-term water trucking, Design water supply system, Prepare sites for tanks & pipes	First 4-6 weeks	Water engineer, Community leaders Water team, Contractor
	Extend distribution procedure	Provide water vessels Put up water reservoirs, Spread water collection points, Ration water supply	From week #2...	Logistics team, Water team
Set up temporary sanitation facilities while organising for medium term measures	Control indiscriminate defecation	Localise defecation areas, Equip for anal/hand cleansing, Supervise & maintain, *IEC for proper latrine use	Day #1-3...	Sanitation team,
	Arrange for permanent facilities	Design suitable latrines, Provide tools & materials for latrine construction	Week #2...	Sanitation technician, Community leaders, Logistics team
Control vector breeding	Environmental measures	Encourage changing of stored water for domestic use every 7 days, Reduce breeding sites (cans, jars, packages, etc.)	From month #1	Community leaders, CHWs, community, Sanitation team
	Promote personal and household hygiene	Provide soap, *IEC on personal and household cleanliness and refuse disposal	From week #1	Community leaders, CHWs, community, Sanitation team
	Chemical measures	Residual spraying of shelters, Spraying latrines, refuse pits	From month #1	Section leader, Spray team, Community leaders

*IEC – Information, education and communication

Consider Alternatives

All selected environmental control measures should be justified against possible alternatives, such as:

- temporarily trucking water to control a critical emergency situation while arranging for installation of a water pipeline or sinking of wells.

  Note: *Water trucking is very expensive and may experience interruptions.*

- conducting bucket chlorination while preparing to protect the water source or to set up a water treatment program.
- contracting donkey carts to transport water to areas with poor access roads rather than moving large non-immune populations closer to water sources where they may be at increased risk of malaria.

Identifying Resources

Resources for carrying out environmental control measures should be based on the identified health needs, protocols of the host country, and minimum standard of services. It is important to use materials and techniques that can be managed and maintained by local resources.

Material Resources

The equipment and established facilities should be sensitive to the traditional practices of the affected population and should ensure a minimum level of dignity and comfort. Resources for an environmental health program can be estimated by applying the total population size to Sphere Project's minimum standards, e.g.:

- *Water supply*: provide to each household two water collecting vessels (10-20 L) plus water storage vessels (20 L) vessels. All vessels to have narrow necks and/or covers.
- *Hygiene*: provide 250 g of soap per person per month; and 1 washing basin per 100 persons where communal laundry facilities are necessary.
- *Refuse*: provide one refuse container (100 litres volume) per 10 families, where domestic refuse is not buried on site; also provide refuse pits, bins or specified areas at markets and slaughtering areas.
- *Tools*: provide sufficient numbers of appropriately designed tools to people for small drainage works and maintenance where necessary.
- *Shelters*: All populations at risk of vector-borne diseases have access to shelters equipped with insect-control.

The materials and equipment for the water supply system can be determined after estimating the total water requirements for the displaced population. The following table shows the Sphere standards for water quantity based on various needs:

Table 5-12: Minimum Standards for Water Quantity/Consumption (Sphere Project)

Need	Minimum Standards for Water Quantity
Health centre	5 litres/outpatient 40-60 litres/inpatient Additional water for laundry, toilets, etc.
Therapeutic feeding centre	15-30 litres/person/day 15 litres/care/day, if appropriate
Cholera centre	60 litres/patient/day 15 litres/carer/day, if appropriate
Community health needs: • Religious centres • Livestock	 5 litres/visitor/day 20-30 litres/large or medium animal/day 5 litres/small animal/day
Public toilets	1-2 litres/user/day for hand washing 1-2 litres/person/day for anal washing 2-8 litres/cubicle/day for cleaning toilet

Human Resources

Staff recruitment should be based on the estimated workload, the skills of the local environmental health workers, and the capacity of the displaced population to actively participate in program implementation. Short job descriptions should be written before hiring the environmental health team. The environmental health team that is recruited should include the following staff and volunteers:

- A technical and management team — water and sanitation engineer, public health technician, public health nurse.
- Community health team — community leaders, community health workers or HITS (health information teams) to mobilise the community, promote hygiene and gather information.
- Manual labourers — construction workers, sprayers, water and sanitation workers, refuse collectors, cleaners and guards. They must be adequately equipped and supervised when carrying out their tasks.

To ensure successful implementation of the environmental health program, resources should be identified for training staff to perform the required tasks as well as to ensure they are adequately managed and supported.

Implementing

Emergencies demand very quick action. The priority actions should be to set up functioning water and sanitation systems. However, implementing an environmental health program is not simple. The following approach may be useful:

- Promoting co-operation and collaboration
- Getting organised
- Recruiting and training staff
- Contracting services
- Building facilities
- Addressing constraints
- Monitoring environmental health activities (see next section)

Promoting Co-operation and Collaboration

Before implementing an environmental health program, the relief agency should seek the support of the affected population, other relief sectors and agencies, representatives from central authorities and the host population. It is not enough to get approval to use land to settle displaced people. It is also essential to seek permission from local authorities and individual landowners to exploit the land, for example, to extract ground water or to lay pipelines.

Getting Organised

Key resources must be available for environmental health activities (water supply, sanitation, etc.) to be carried out. It may be necessary to arrange for staff accommodations, transport, and communication. All equipment (e.g., pumps, water testing kits, spraying equipment, etc.) should be in working order and maintenance and repair technicians should be identified from the beginning. Essential supplies should be available on demand (e.g., by arranging for storekeepers on weekend calls). Supplies for environmental control require the appropriate storage and security, and must be monitored regularly to minimise loss (from spoilage or theft). In addition, safety precautions for handling all chemicals (chlorine, pesticides) should be enforced according to supplier guidelines and international protocols.

Recruiting and Training Staff

It is important to take advantage of local skills, since people usually know their own areas well. Trained technicians can be found who are experienced in dealing with the local environmental conditions and understand the local variability of vector-borne diseases. However, on-the-job training of the environmental health team may be required in the following areas:

- the proper use and minor repair of equipment (e.g., water quality kits, sprayers, etc.)
- following standard procedures (e.g., water chlorination, seeking permission before spraying shelters, etc.)
- carrying out health education activities related to water, sanitation and personal hygiene
- data collection and recording – for monitoring environmental health activities
- safety precautions and first aid measures – to ensure safety of volunteers, train staff and all who are involved in environmental health activities.

Contracting Services

Environmental control measures may involve hiring contractors, particularly at the beginning of a relief response or in an insecure region. These services may include trucking water, drilling boreholes or building communal latrines. All contracts should be drawn carefully, clearly identifying the expected output. For example, the amount of water trucking to be contracted could be determined as follows:

$$\text{Number of truck loads per day} = \frac{\text{Total amount of water required per day}}{\text{Capacity of 1 truck}}$$

$$\text{Number of trucks required per day} = \frac{\text{Number of truck loads}}{\text{Maximum number of trips per day}}$$

Standards for each contracted service should be specified and safety measures enforced. Close monitoring is necessary to minimise delivery of low quality services. Contractors should be paid only for services that were delivered satisfactorily and incentives or penalties may be issued, according to the quality of their services.

Construction

The affected community should be involved in designing, building and maintaining the environmental health facilities. Locally available materials should be used whenever possible. To ensure access, these facilities should be organised according to the following minimum standards of the Sphere Project (with consideration to the terrain and available space):

- No dwelling should be further than 50 M from a toilet and toilets should be available in public places.
- No dwelling should be further than 500 M from any water point.
- No dwelling should be further than 15 M from a refuse container or household refuse pit, and no further than 100 M from a communal refuse pit.

Other considerations when setting up environmental health facilities include the following:

- Water distribution points should have concrete pads and wastewater trenches that lead to soakaway pits to minimise mosquito breeding and contamination of water sources.
- Latrine slabs should be used for construction of all latrines
- Communal latrines should be built at all public places (health facilities, feeding centres, markets, etc.)
- Environmental control plans should consider possible future population growths as well as the eventual closure of the relief program.

Addressing Constraints

The following are examples of constraints that may need to be addressed:

- Staff may be required to maintain hygiene at public facilities (health facilities, feeding centres, markets, and communal latrines).
- People selling items such as soap or bed-nets meant for health promotion
- Staff should meet regularly with the affected community to identify any obstacles (e.g., why latrines, refuse pits, or bednets are not used as required).
- Separate water source may be required for domestic animals.
- Provide lemons or chlorine so that people can treat their water during a cholera outbreak.

ENVIRONMENTAL HEALTH SURVEILLANCE

The performance of water supply and sanitation program should be monitored and evaluated in order to:

- Evaluate the coverage and effectiveness of the program in responding to health problems related to water and sanitation.
- Guide the implementation of environmental health interventions.
- To identify changes in health needs and priorities.
- Provide early warning of water-borne disease outbreaks.

Monitoring

Monitoring provides information about the effectiveness of the program in meeting identified health needs. The process of collecting information keeps workers in touch with the people they are servicing. This enables them to notice additional issues. Only the most useful information that can be acted upon should be collected; either daily or weekly during acute emergency phase or a severe disease outbreak, and monthly thereafter.

Key environmental health indicators always call for a numeric estimation as follows:

1) **Access to Excreta Disposal Facilities**

The ratio of number of people per latrine can clearly show both the availability of latrines and the amount of sharing that is occurring. This ratio may be determined from information collected from walking around the camp or interviewing a representative group of people:

- If people are being interviewed in, for example, a food distribution line, people who say they have a family latrine should be asked how many members are in their family and if anyone else shares that latrine.
- Where communal latrines are used, sanitation coverage is the total number of people using latrines divided by the number of latrines being used.
- If people are living in their apartments or houses but not everyone's toilet is working, monitoring the fraction of households with a functioning toilet or latrine is a reasonable way of estimating the sanitation coverage.

2) **Water Consumption**

Water consumption depends both on water availability and the people's ability to obtain the water. Shortage of buckets, concern for security, and long lines can all prevent plentiful water sources from being used fully. Water consumption is always stated in terms of *litres per person per day*.

- Water consumption estimates can be obtained by carrying out 24-hour recall interviews with a representative sample of the population, or by
- Water consumption can also be estimated by monitoring how much water is collected at the various sources and dividing this by the number of people being served.

3) **Percentage of People Consuming Safe Water**

The host government or concerned UN agency usually has a microbiologically-based criteria for considering water safe. If none is available, consider water to be safe if it has less than 10 faecal coliforms per 100 ml. of water. Any water with a detectable amount of free chlorine residual should also be considered safe. The fraction of people who are getting "safe" water at the time it is collected should be monitored. In a piped system, water samples should be taken throughout the system at various water points, with each sample being taken to represent a similar number of people (e.g., 1 sample per 10,000 people). In this case, the fraction of water samples that are safe corresponds to the fraction of people whose water arrives at the water point safe.

In settings where groundwater supplies at wells or springs are determined to be safe, monitoring should report the fraction of people obtaining water from the safe sources versus unsafe surface water or other sources.

Note: *Collecting safe water at the well does not assure that the water is still safe when consumed.*

4) **Other Indicators**

- *Incidence of waterborne diseases* should be monitored. By far, the greatest risk associated with unsafe drinking water is the spread of diarrhoea, dysentery, and infectious hepatitis. For more details, please refer to the *Diarrhoeal Disease Control* chapter.
- *Incidence of water-washed diseases* such as eye infections, scabies and other skin infections that often arise where there is lack of water may also be monitored.
- *Fuel* and *soap availability* need to be monitored only when necessary (e.g. outbreaks of diarrhoeal diseases). In unusual settings, where people live in houses that have electricity, and people depend on electricity for fuel, monitoring the average hours of electrical service is a better indicator of the availability of fuel.

In the post-emergency phase, program monitoring may be expanded to include indicators of other environmental health activities:

- **Vector control** (total units sprayed, quantity of insecticide used, total surface area treated — refer to the chapter on Vector Control for further details)
- **Solid waste management** (quantity and frequency of disposal)
- **Waste water drainage** (including drainage of storm water)
- **Hygiene promotion** (hygiene promotion activities, hygiene risks and behaviours)

To detect significant changes resulting from the program, the indicators should be analysed as follows:

- Comparing what was done against what was planned (the targets).
- Following trends of indicators over time (e.g., increasing consumption of ORS, abnormal increase in diarrhoea, unusual weather conditions).
- Assessing access and availability of services through population surveys

Giving feedback about the surveillance to the environmental health team can help to improve their performance by identifying mistakes and making them feel accountable. Because the success of the environmental health program also depends on the support and co-operation of the affected community and other sectors, systems should be in place to enable the regular exchange of information and feedback. Results should be graphically displayed in a public location. This will increase the awareness of the environmental health efforts underway. Programs showing positive results will inspire other relief efforts, while programs that are not meeting their goals may get sound advice or encouragement from others.

It is only by determining that the water available is not enough that relief organisations can request for more resources to tackle the problem. Failure of relief NGOs to assess the amount of water available for displaced populations may result in loss of available resources to other less severe but better managed crises. Monitoring household levels of free chlorine by IFRC in Dushanbe during the latter part of 1997 through 1998 was largely responsible for confirming the effectiveness of adding enough chlorine to the water and thus avoided another widespread typhoid outbreak during 1998.[ii]

Evaluating

Programs should be evaluated in order to assess the achievements of the environmental control measures with reference to stated objectives and agreed standards (e.g., the Sphere standards). Evaluation is important for:

- Assessing the effectiveness and impact of the control measures on the affected population.
- Ensuring that the environmental control technology and resources used match the scale and nature of the program.
- Measuring the program's long-term consequences on the environment.
- Identifying lessons for future environmental health programs.
- Promoting accountability to stakeholders (e.g. donors, beneficiaries)

Evaluation may be carried out in two ways:

1. **Internal program evaluation**: normally carried out by staff in form of regular review of monitoring information. The implementing agency must also evaluate the effectiveness of its programs and compare them across different situations.
2. **External evaluation** may be part of a wider evaluation exercise by many agencies and donors and may be carried out, for example, after the acute phase of the emergency.

The resources and techniques used for the evaluation should be consistent with the scale and nature of the program. A report of the evaluation should be written that describes the methods used and the processes followed to reach conclusions about the program. The report should be disseminated to all the stakeholders, including the affected population.

SUMMARY OF GENERAL WATER AND SANITATION PRINCIPLES

While all situations are different, there are several guiding principles that almost always apply. While judgement must be used in applying these principles, the following points are generally true:

- In the absence of an ongoing epidemic waterborne illness, the highest priority in environmental services is to provide the displaced population with access to sanitary facilities.
- Providing people with more water is typically more important for maintaining health than providing people with cleaner water. 15 litres per person per day should be seen as a minimum acceptable amount.
- Displaced population settlements should be located where sufficient water is at or near the site because accessing and transporting water can be logistically difficult and expensive.
- Chlorinating water is the best way to assure its quality, both at the time of collection and for some hours thereafter. Whenever an outbreak of a potentially waterborne disease occurs, the water supply must be treated with chlorine.
- Environmental monitoring should be established and displayed publicly from the first day of the crisis. Sanitation coverage, water consumption, and water quality should be monitored on a regular basis.

REFERENCES AND SUGGESTED READINGS

1. The following are excellent general texts for suggesting facility designs and guiding construction activities. Specific details on well and latrine construction can be found in other texts.

   - Engineering in Emergencies: A Practical Guide for Relief Workers. Davis J and Lambert R. Intermediate Technology Publications, 1995.
   - Environmental Health Engineering in the Tropics, 2nd Ed. by Cairncross S. and Feachem R. (John Wiley & Sons Ltd., 1993)
   - Public Health Engineering in Emergency Situation (1994) by Medecins Sans Frontieres
   - Water Manual for Refugee Situations, Programme and Technical Support Section, UNHCR, Geneva 1992.
   - Emergency Water Sources, Guidelines for Selection and Treatment by House S and Reed B. Water Engineering Development Centre (WEDC), Loughborough University, 1997.

2. The following are excellent texts for reviewing general principles and standards of water and sanitation programs:

   - International Federation of the Red Cross and Red Crescent Societies, Emergency Response Units. Basic Health Care: Water and Sanitation Module.
   - International Federation of Red Cross and Red Crescent Societies. The Sphere Project: Humanitarian Charter and Minimum Standards in Water Supply and Sanitation.
   - International Committee of the Red Cross. Water and War, Report on the Symposium on Water in Armed Conflicts (Montreux, Nov. 1994)
   - Handbook for Emergencies. Second edition, UNHCR, Geneva, 2000.
   - Guidelines for Drinking Water Quality. Second edition, WHO, Geneva, 1993.

[i] Humanitarian Charter and Minimum Standards were produced by the Steering Committee for Humanitarian Response, InterAction and other agencies. They aim to improve the effectiveness of assistance and accountability to stakeholders.
[ii] ICRC. Water and War