CHAPTER 8
Water Supply and Environmental Sanitation

Water supply and sanitation problems created by emergencies vary widely in different parts of the world.

8.1. PERSONNEL

The type of organization and personnel required for this activity have been described in Chapter 4.

8.1.1. Professional sanitary engineers and health officers are needed only at policy-making levels—for technical advice, baseline surveys, and highest-level supervision.

8.1.2. Trained sanitarians are required to assist sanitary engineers in making surveys; and as supervisors of the work of auxiliary personnel in the control of water quality, food sanitation, waste disposal installations, and vermin control.

8.1.3. Auxiliary sanitation personnel are needed to look after all sanitary installations, food sanitation, vermin control operations, disinfection, health education, and supervision of volunteer workers. Although they have been given prior training of two to four weeks, the auxiliaries should continue to receive in-service training. These personnel will carry out the bulk of the field work.

8.1.4. Voluntary workers (helpers) should receive orientation instruction and on-the-job training in specific activities. They should always work under supervisors.

8.2. SANITARY MEASURES DURING EVACUATION

During evacuation, there are a few sanitary measures that can be taken. If people are being moved to temporary shelters/camps and if the journey is long, food (which does not require cooking) and water should be provided at fixed points along the route. The water brought by tankers may be rationed at a minimum rate of three liters per person per day; in hot desert climates, the ration may be increased to six liters per person per day.

If water distribution is not possible, people should be instructed to *boil for five to ten minutes* whatever water they find en route before drinking it.

Alternatively, evacuees should be provided with:

Bleach solution (5%). One drop for one liter clear water or three drops for turbid water. Stir and allow to stand for 30 minutes. A distinct smell/taste of chlorine is an indication that the water is safe for drinking.

Purification tablet. Tablets that release iodine or ozone. One tablet for clear water and two tablets for turbid water in one liter.

Tincture of iodine. Three drops for clear water (one liter) and 10 drops for turbid water, mix and allow to stand for 30 minutes.

Sanitary excreta disposal and refuse collection and disposal are not possible when people are on the move. At rest points, however, sanitation squads should use an all-purpose trench for burying excreta and solid wastes: depth 60 cm; width 45 cm; length 3m—for each 1,000 persons.

8.3. WATER SUPPLY

The following figures are intended as a guide in calculating minimum water requirements for drinking, cooking, and basic cleanliness:

1. Field hospitals and first-aid stations: 40-60 liters per person per day.
2. Mass feeding centers: 20-30 liters per person per day.
3. Temporary shelters and camps: 15-20 liters per person per day.
4. Washing installations: 35 liters per person per day.

With no restrictions, water use should be liberalized to approach 100 liters per person per day.

8.3.1. Selection of Water Sources. A thorough search should be made for all the possible sources of surface and ground water within reasonable distance. It is important to select sources that are least exposed to contamination. Possible sources include:

8.3.1.1. Municipal system. This is recommended for use once the system has been put back into operation. After floods, the chlorine concentration should be increased to protect the distribution system from polluted water.

8.3.1.2. Private systems. Private water supply systems in the vicinity such as deep wells, with or without a private treatment plant. Water from these sources, with necessary chlorination, can be connected to a distribution system or hauled to the points of consumption.

8.3.1.3. Springs and wells (dug wells and tube wells). Ground water from deep wells and certain springs will be free from contamination and may not need any special treatment. However, great care should be taken to prevent contamination. Springs are simpler to exploit, as no pumping is needed to bring the water to the surface. Limestone and certain rocks are liable to have holes and cracks, especially after an

earthquake, that may induce contamination in ground water. Springs are also exposed to contamination from flood waters. Proper location and well-built protection structures are therefore necessary to safeguard ground water supply. It is impossible, depending on the geological conditions of the area, to sink different types of wells[22]—dug wells or tube wells to provide a dependable source of water that can also be used in the rehabilitation phase. The range of available equipment is extensive; a rough guide to well construction methods suitable for specific conditions is given in Table XIII.

The well (tube or dug) should be located at least 30m from any potential source of contamination, and should be situated at a higher level than all such sources. The upper portion of the well must be protected by an external impervious casing, extending at least 3m below ground level and 30cm above ground level.

The casing should be surrounded by a concrete platform at least 1m wide that slopes to allow drainage away from the well; it should connect to a drain that will carry the spilled water away. The opening for drop pipes should be sealed to prevent outside water from entering the well. The rim of manholes should project at least 8cm above the surrounding surface, and the manhole cover must overlap this rim. The well should be protected by a fenced area (radius 50 m) all around.

Immediately after construction or repair, the well should be disinfected. First, the casing or lining should be washed and scrubbed with strong chlorine solution containing 100 mg. of available chlorine per liter. A stronger solution is then added to produce a concentration of 50-100 mg./liter in the water stored in the well. After adequate agitation, the well water is left to stand for at least 12 hours, then pumped out. The well is then allowed to refill. When the residual chlorine of the water drops below 1 mg./liter, the water may be used.

The above methodology also applies to the location and protection of springs. The following additional points may be noted for spring wells:

- The entrance of sun light should be prevented, so as to inhibit internal growth of vegetation.
- The entrance of surface water should be prevented, especially at times of heavy rainfall.
- The manhole cover and gates should be locked.
- Before using the water, the collection chamber should be disinfected with chlorine solution.
- An area around the spring should be fenced off to prevent contamination.

Wells may vary in diameter from 32 mm to 6 m or more, while their depths may be as shallow as 15 m or less, to 308 m or more; these parameters will affect the method of construction. A further factor to be considered is the characteristics of geological formation through which the well will be sunk

The table below provides a rough guide of well construction methods suitable for specific conditions; the given limits of size and depth, however, may be exceeded for specific conditions or locations.

TABLE XIII: General Data on

Characteristics	Dug	Bored	Driven
Type of geologic formation:			
Clay	Yes	Yes	Yes
Silt	Yes	Yes	Yes
Sand	Yes	Yes	Yes
Gravel	Yes	Yes	Fine
Cemented gravel	Yes	No	No
Boulders	Yes	Yes, if less than well diameter	No
Sandstone	Yes, if soft and/or fractured	Yes, if soft and/or fractured	Thin layers only
Limestone			No
Dense igneous rock	No	No	No
Practical depths (general order of magnitude)	150 ft (46 m)	150 ft (46 m)	50 ft (15 m)
Diameter	3-20 ft (1-6 m)	1½-30" (40-800 mm)	1¼-2" (32-50 mm)

From UNICEF Guide List OLGA Rural water supply and sanitation in the developing countries (prepared in consultation with WHO) 1975, UN publication OSU 6400 This guideline gives details of equipment, supplies and material provided by UNICEF to support rural sanitation/water supply projects and includes brief notes on relevant aspects.

3.3.1.4. Surface waters. Surface water should be used as a supply source only as a last resort. Water from surface sources should be disinfected and, if possible, treated to remove turbidity, color, and impurities. If the usual purification equipment is not available, improvisation is necessary. Measures should be taken to protect the watershed from pollution by animals and people. As it is usually difficult to enforce control regulations, the point of intake for water supply should be located above any tributary carrying grossly contaminated water. The pump intake should be screened off and so

placed that it will not take in mud from the stream bed or floating debris. This device can be extremely simple, such as a perforated drum fixed in the middle of the stream.

8.3.2. Water Treatment. Water treatment should be improvised according to the materials and equipment available and the impurity of the water. It may take various forms, and is described briefly in Appendix 11.

Methods of Well Construction

	Drilled		
		Rotary	
Jetted	**Percussion**	**Hydraulic**	**Air**
Yes	Yes	Yes	No
Yes	Yes	Yes	No
Yes	Yes	Yes	No
¼" pea gravel	Yes	Yes	No
No	Yes	Yes	No
No	Yes, when in firm bedding	(Difficult)	No
No	Yes	Yes	Yes
No	Yes	Yes	Yes
No	Yes	Yes	Yes
150 ft. (46 m)	1,000 ft. (305 m)	1,000 ft. (305 m)	750 ft. (230 m)
1½-12" (40-300 mm)	4-18" (100-600 mm)	4-24" (100-600 mm)	4-10" (100-250 mm)

8.3.3. Water Storage. Emergency storage of water can be improvised in canvas, rubber-coated nylon, and plastic containers, with capacities up to 10 m. Polyethylene containers, erected in pits dug to size, can provide up to 50 m storage capacity. If the purpose of storage is only to provide contact time after chlorination, the minimum capacity should be such as to assure contact of at least 30 minutes. The total storage capacity for water distribution should be equal to the amount required for 12-24 hours. Elevated tank containers can be set up quickly by using steel drums, iron sheeting, or asbestos-cement tanks.

Wooden poles, timber, or iron tubing can be used for supports.

In long-term camps, all reservoirs should be covered—primarily for protection from sunlight and consequent growth of algae that produce tastes in the water; and secondarily, for protection from birds, insects, and dust.

8.3.4. Water Distribution. Water should be distributed from tankers. Each family may be issued a water container made of plastic or galvanized iron. A tanker with storage tank(s) located at the site should be able to provide water for 1,000 persons. The tankers and the tanks should be filled from acceptable sources in a hygienic manner and chlorinated under supervision. The tanks should have a capacity of 200 liters or more and should be so spaced that people need not walk more than 100 m to draw water. Taps fixed to each tank will ease distribution. Tanks should be mounted on stands at a height enabling easy access.

If there is a municipal distribution system within reasonable distance, it may be possible to extend the system to a temporary camp. In long-term camps, distribution pipes may be laid to feed water points. Water points usually have two or more taps; one tap should be provided for every 100 persons. In emergency situations, the physical protection of water supplies and other related facilities is important and will depend on the local situation.

8.4. EXCRETA DISPOSAL

The following environmental problems may be created if excreta are not disposed of promptly:

- Creation of fly breeding-places.
- Development of unpleasant odors
- Contamination of soil and of sources of water
- Contamination of food by flies and dust.
- Increase in the incidence of disease, especially enteric and helminthic diseases.

Applicable measures depend on the nature of existing facilities.

8.4.1. Communal Latrines, necessary in many emergency situations, are also difficult to keep clean. They should therefore be used only when the emergencies are not expected to last long. To make cleaning practicable, communal latrines should be provided with water. Five seats should be provided for every 100 persons, in separate blocks for men and women. Latrines should be located downhill from any water source, and at least 15 m away. In the presence of limestone formations and fissured rocks, additional precautions are necessary to protect sources of water supply. The site should be dry, well drained, and be above flood level. The immediate surroundings of latrines should be cleared of all vegetation, wastes, and debris

8.4.2. Shallow Trench Latrines. The trench should be 30 cm wide and 90-150cm deep. The length depends on the number of users: 3.5m are necessary for each 100 persons. Separate trenches should be provided for men and women. The earth from the trench should be piled up at the side. Shovels should be left at the site, and people should be instructed to cover feces with earth each time they use the latrine. The sanitation squad should complete its work twice a day in order to keep flies and odors under control. It may be necessary to place lumber or boards along the sides of the trench to provide for footing and to prevent the walls from collapsing. Privacy may be provided through the use of brush, canvas, wood, or sheet-metal fencing. Toilet paper or ablution water (depending on local custom) should be provided.

8.4.3. Deep Trench Latrines. This type of latrine is intended for camps of longer duration, from a few weeks to a few months. The trench should be 1.8-2.5m deep and 75-90cm wide. The top of the trench is to be covered by a fly-proof floor. Depending on the local custom, a seat or a squatting hole is provided. A good superstructure will provide privacy and protection. Other requirements are the same as for shallow trenches.

8.4.4. Bore-Hole Latrines. Where the subsoil does not contain rock, this type of latrine offers a fast solution for excreta disposal in emergencies. It consists of a bore-hole over which a squatting slab is placed and housed. One bore-hole is required for every 20 persons. Mass production of concrete slabs for the latrine floor may be undertaken on the site. The bore-hole should be approximately 6m deep, with a diameter of 49 cm. A hand-operated auger is needed as special equipment.

8.4.5. Pit Privies. Where the subsoil is loose and easy to dig up, a pit privy may be built for each family or for each tent sheltering a few families. If tools are provided, the refugees can do most of the work themselves. Mass production of flat concrete slabs for the latrine floors may be undertaken at the camp site. In long-term camps and in localities where the custom is to use water for cleansing, a water-seal could also be incorporated in each slab. A more permanent type of superstructure can also be built.

8.4.6. Urinals. These may be provided for men in a communal block of latrines to reduce the number of seats needed. One urinal space for 25 males is recommended. Odors from urinals can be kept under control by applying chlorine solution and by constructing a soakage pit.

8.5. SOLID WASTE DISPOSAL

There is a correlation between the improper disposal of solid waste and the incidence of vector-borne diseases. If the disaster area is urban and possesses a proper collection and disposal service—or if the area is close to a municipal system—efforts should be made to restore or extend the

existing system. Solid waste includes refuse, manure, and animal carcasses.

8.5.1. Refuse. It is advisable to provide separate containers for storing organic wastes and for inorganic wastes. The containers for organic wastes should be made of heavier material than those for inorganic wastes, and should be washable, water-tight, and provided with tight-fitting, overlapping covers. Empty foodstuff containers and disposable water-resistant paper bags may be used for short periods. The capacity of containers should not exceed 100 liters. Three or four containers should be provided for every 100 persons. They should be distributed so that each family has a container within easy reach. The containers should stand off the ground, preferably on wooden racks. In large emergency feeding centers, garbage stores may be practicable. These should have concrete floors and walls, floor drains, and a water supply; they should be emptied and washed daily.

8.5.1.1. Collection of refuse. An estimate should be made of the quantity and types of refuse to determine frequency of collection, number and size of collection, vehicles needed, personnel required, method of final disposal, and selection of sites. In emergencies, all types of trucks may be used. Compacting-type refuse trucks will reduce the number of trips and the hazards associated with the scattering of refuse. A truck with a capacity of 10 cu.m, manned by one driver and two helpers, can make three trips per day, and thus serve 5,000-8,000 people.

8.5.1.2. Disposal of refuse. Refuse may be disposed of by sanitary landfill, burial, incineration, and open dumping.

Sanitary landfill. For most situations, sanitary landfill is the preferred method of final disposal. Heavy earth-moving equipment may be available from the army or public works department.

Refuse is compacted and promptly covered with earth, which is compacted in turn. Three methods are used in this operation:

- The trench method: a long trench is dug out and the excavated earth is used to cover the compacted refuse.
- The ramp method: the covering material is obtained from the working face of the fill.
- The area method: this method is used for filling land depressions, and especially in swampy areas where soil conditions do not allow the use of heavy equipment.

Burial. This method is suitable for small camps where earth-moving equipment is not available. A trench 1.5m wide and 2m deep is excavated; at the end of each day the refuse is covered with 20-30cm of earth. When the level in the trench is 40cm from ground level, the trench is filled with earth and compacted, and a new trench is dug

out. The contents may be taken out after four to six months and used as fertilizer. If the trench is 1 meter in length, it should be filled in about one week for every 200 persons.

Incineration. Where burial is not practicable, refuse should be incinerated. If the refuse is very wet, fuel will be needed. Refuse from first-aid stations and hospitals that contains pathogenic material should be incinerated, regardless of the method adopted for disposal of garbage and rubbish. A basket incinerator, which is simply a wire basket standing on an iron drum or stone support, may be used for this purpose. Incinerators made of corrugated iron sheets or of bricks and stones are more suitable for long-term use. A little kerosene or fuel oil may be added to ensure complete combustion.

In the construction of incinerators used for the final disposal of any kind of refuse, it is essential to observe the following points:

- The incinerator should be located away from and downwind of the camp or temporary shelters.
- The incinerator should be built on an impervious base of concrete or hardened earth.
- The air intake must be sufficiently large; it should be funnel-shaped, narrow, and project inwards so as to produce a blower effect.
- The fire bars should be placed loosely on their supports to allow for expansion.
- The stoking gates should be suitably situated so that fresh material can be added from above.
- The raking openings must allow sufficient room for efficient raking and for thorough cleaning of the interior.
- A long chimney is necessary for a closed incinerator, so as to ensure a good draught.

Open dumping. This method should be used only as a last resort. Refuse may be hauled to a suitable site for dumping and burning, provided that sanitation personnel supervise the operation. Cans should be crushed flat to prevent mosquito breeding, and burnt refuse should be covered to deter flies and rodents.

8.5.2. Manure. In rural disaster areas, attention should be paid to the collection and disposal of manure. If left open, manure attracts flies and provides them with a good breeding place. Pits with concrete floors and cement-lined walls may be built for manure collection. Each pit should be sufficiently large to hold one day's manure; two pits must be provided so that one can be cleaned and washed while the other is in use. The floor should slope towards a drain connected to a soakage pit. The owners of animals should be responsible for hauling the manure

to these collection points. Daily removal for final disposal should be carried out by the camp's sanitation team.

Manure—together with other refuse—may be disposed of by burying, composting, and incineration. In emergencies, the most practicable method is to bury the manure in trenches similar to those described for refuse. The contents of these trenches may be removed and used as soil conditioners after four to six months of anaerobic decay.

8.5.3. Animal Carcasses. The problem of disposing of dead animals may assume serious proportions in certain disaster situations, particularly floods. Burial is slow and laborious: a pit 3m deep is required for a dead horse. When there are many carcasses, it is difficult to bury all of them unless heavy excavation machinery is available. The burning of small animals, like cats and dogs, is feasible. The burning of larger carcasses, however, is difficult unless special incinerators are built. Efforts should therefore be made to obtain heavy equipment for burial. If equipment is not available, a combination of burial and burning should be used: i.e., burial of the internal organs and burning of the carcass with the aid of fuel. To aid supervision, operations should be centralized in suitably located animal burial areas. Carcasses awaiting burial should be sprinkled with kerosene or crude oil to protect them from predatory animals.

8.6. WASTE WATER DISPOSAL

Waste water from field hospitals, mass-feeding centers, and water points requires proper disposal. The usual way is to discharge it into a seepage pit. To prevent rapid clogging of the pit, an absorption trench may be constructed in advance of the pit. Liquid wastes from feeding centers and bath houses contain grease and soap and, even where the soil is very porous, seepage pits become clogged in time. It is therefore necessary to install a grease trap at the upper end of the inlet pipe to the drain and pit. Dry water-courses may also be used if precautions are taken to prevent the breeding of mosquitos. Subsurface drainage can be recommended only for semi-permanent camps. In areas where the soil is impermeable and the climate hot and dry, the waste water may be disposed of by evaporation, care again being taken to prevent mosquito breeding.

8.7. VERMIN CONTROL

This program should be undertaken *in close collaboration with expert medical and public health teams working in the relief camps*. There are three areas on which information should be obtained:

- Mosquito-breeding areas
- Fly-breeding areas
- Rodent harborages

The control program should follow a definite plan and with the expert advice of national/international organizations concerned with vector control and research. Supervision of vermin control measures should be carried out by competent personnel only.

8.7.1. Health Hazards and Precautions. All pesticides in current use are to some degree toxic to man. Persons preparing pesticides, or applying sprays or powders, should take care to avoid inhaling the dust, sprays, or fumes, and should avoid skin contact as far as possible. Spray operators should wear protective clothing, such as rubber gloves, broad-brimmed hats, and overalls. Insecticides spilled on the body or hands should be removed immediately with soap and water. Unusual signs of nervousness, dermatitis, and loss of appetite should be reported immediately. A medical examination should follow the appearance of these symptoms.

8.8. BURIAL OF THE DEAD

The work to be carried out consists of:

1. **Removal.** The removal of dead bodies from the scene of disaster should be carried out by the rescue teams. Where necessary, sanitation personnel should cooperate with other workers as the situation demands. Quick and quiet removal of bodies from public view plays an important role in maintaining morale.
2. **Identification of the dead.** Efforts should be made to identify dead bodies or at least to obtain all possible information.
3. **Preparation of an official record of death.** An identity tag should be affixed to the body and all available information recorded in a special book.
4. **Final disposal of the body.** Mass burials in a common grave should be avoided. The location of graves should be charted on maps and identified with tag numbers. A suitable burial ground, with a good depth of soil and as high and well-drained as possible, should be selected at a distance of about half a mile from the periphery of the camp. It must not be located on the bank of, or near any water source. The graves should be dug at least five feet deep and four feet apart in any direction. A sufficient number of graves must always be dug in advance so as to prevent any delay in burying corpses. In epidemics, efforts should be made to arrange for the burning of the corpses in all cases where there is no religious objection and fuel is procurable.
5. **Return of valuables and personal effects.** The next of kin should receive the valuables and personal effects of the dead. In the event of epidemics, personal belongings should be disinfected before they are returned.

The following items are required for burial work: stretchers, leather gloves, rubber gloves, overalls, boots, caps, soap and disinfectants, cot-

tion cloth, picks and shovels; heavy earth-moving machines and trucks also may be needed.

Precautions should always be taken in handling dead bodies, particularly when death occurred from a contagious disease. In epidemics, strict supervision should be maintained at all stages of handling the dead. Personnel should have special working clothes; at the end of a day's work, they should wash themselves thoroughly with a disinfectant soap.

8.9. MISCELLANEOUS INSTALLATIONS

In temporary shelters and camps, communal facilities for maintaining personal cleanliness should be provided. These may include showers, washrooms, laundries, and disinfestation and disinfection rooms. Such facilities will help to prevent skin diseases and infestations that lead to vector-borne diseases. Disinfection rooms are necessary for halting the spread of infectious diseases transmitted through fomites. The proper operation and maintenance of these services depends on constant supervision by sanitation personnel.

8.9.1. Baths and Showers. Showers are preferable to baths. One shower head should be provided for every 100 persons. Bath registers or bath tickets may be used for ensuring that all residents of the camp bathe at least once a week. In hot climates, cold water should be sufficient and daily washing/bathing should be encouraged. Overall consumption of water for bathing should be calculated on the basis of 30-35 liters per person per week. The use of common towels should not be permitted unless arrangements are made for washing and disinfecting after each use. For both hygienic and economic reasons, communal baths should be located near the disinfestation and disinfection rooms. Proper arrangements should be made for the disposal of waste water from baths. Temporary shower baths can be set up within a reasonably short time. If tanks or ponds are available these may be used provided the same source is not used for drinking water.

8.9.2. Laundries. In temporary encampments, people could wash their clothes in plastic or iron tubs. In long-term camps, however, it becomes necessary to provide communal laundries. Where disinfection rooms are needed, these should be housed together with the laundries. Whenever possible, hot water should be provided. One washing stand for each 100 persons is recommended. It will be necessary to establish a schedule for the use of laundries on a family basis; otherwise, the facilities will be crowded at some times and left idle at others. Proper drainage and traps for grease and soap should be provided for waste water.

8.10. DISINFECTION AND DISINFESTATION

Disinfection is the process of destroying disease germs. Disinfestation

is the process of removing or killing insects, their eggs, and other vermin that transmit disease or create a nuisance. Disinfection methods will be effective for disinfestation, but the reverse does not hold true. In practice, disinfestation is more often used than disinfection. The methods employed in disinfestation will destroy vermin, but will not necessarily kill the disease germs carried by vermin such as lice; when there is any risk that vermin may cause an epidemic, it is safer to employ disinfection.

Effective disinfection requires trained personnel, and failure to carry out properly any of the various steps of the disinfection process will defeat the purpose. *Well-trained and experienced sanitarians should therefore be in charge of disinfection and disinfestation operations.*

Methods of disinfection and disinfestation involve the use of physical agents such as ultra-violet light, dry heat, boiling water, and steam; or chemical agents such as sulfur dioxide, ethylene oxide, formaldehyde, formol, cresol, phenol, and carbolic acid. Some of these agents are dangerous, and should be used only under expert supervision.

The area or building used for disinfection should be divided into a "dirty" side—for the receipt of infected articles, and a "clean" side—for the distribution of disinfected articles; communication between these two sides should be permitted only through a disinfection/laundering room or through a bathroom. (See Figure 12.)

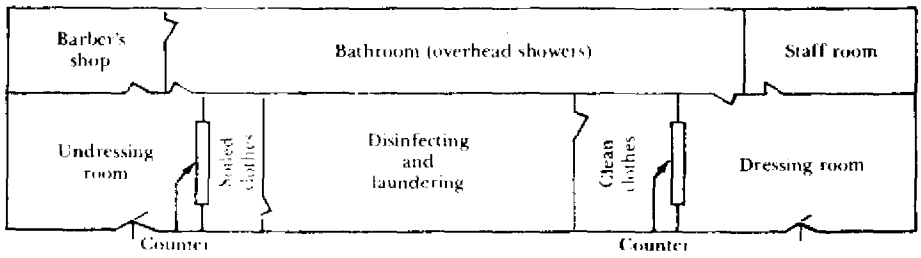

Figure 12: A Set-Up for Disinfection.

Arrangements should be made on the "dirty" side for disinfecting vehicles used for the transport of infected materials. Personnel employed in handling infected materials must be suitably protected against infection. On the "clean" side, storage space should be available for disinfected articles.

All articles not likely to be damaged are to be disinfected by steam. The steam flow can be either downward or upward. Leather goods, clothing with leather facings or strappings, furs, rubber, and other mate-

rials that may be damaged by steam, should be sprayed with a 5% formol solution.

The layout of a disinfestation unit is the same as that of a disinfection unit. Disinfestation will not be effective unless infested individuals have been previously segregated; otherwise the entire camp population will require disinfection.

8.11. ABATTOIR

Because of the absence or shortage of refrigeration equipment, it often becomes necessary to make simple slaughtering arrangements in camps. The site should be secluded but kept under close supervision. The floor should be of concrete or asphalt, sloping towards a central drain provided with a trap or strainer to collect solids. The liquid waste may be discharged into a seepage pit. Ample water should be provided for washing. Hooks hung on a horizontal beam at a height of about 2m—supported by two vertical poles— will provide a means for skinning of carcasses.

Offal, bones, and other solid wastes should be buried, or burnt in a closed incinerator. In the case of burial, a series of pits should be dug and the offal covered with at least 90cm of earth— thoroughly treated with heavy oil and well compacted.

8.12. EDUCATION OF DISASTER VICTIMS IN SANITATION

Experience has shown that sanitary installations provided as part of the relief work after disasters do not always fulfill their purpose because they are either misused or underused. Among the most important reasons for this lack of appreciation among disaster victims are:

1. Psychological effects of the disaster, manifested mainly in an apathetic attitude.
2. Contrasts with victims' living conditions before the disaster.
3. Victims' lack of knowledge as to the use and maintenance of the installations provided.

The provision of sanitary installations in itself, therefore, is not enough to solve the problem; the people must use them properly so that an adequate level of personal cleanliness and of environmental hygiene is attained. It therefore becomes the responsibility of all environmental health workers to participate actively in educating the disaster-stricken people to use the sanitary installations properly, to comply with the rules of personal hygiene, and to safeguard the health of the community.

A number of points concerning education should be borne in mind:

1. To be successful, education should be based on the trust and collaboration of the people. To gain their confidence, it is extremely important that the health workers have a sympathetic disposition: rigid attitudes will be detrimental.

2. The sanitary installations used should be of a type easily understood by the people. Simple and accessible solutions can generally be devised without sacrificing the basic principles of sanitation. If a complex installation is unavoidable, patient and constant instruction is necessary to make it understood and to ensure that it is used properly.
3. On-the-spot education is most effective.
4. In relief situations of short duration, there is not enough time to start educational processes; in such cases, the proper operation of sanitary installations will depend on effective inspection. Young people from the afflicted area and from welfare agencies should be brought in to help professional inspectors. Systematic and regular inspections must be established.
5. Education through mass media should be undertaken.
6. Full participation in all these activities by the people involved is necessary.
7. The sanitation education will include:
   - Avoidance of using contaminated water.
   - Avoidance of wasting water.
   - Cooperation in distributing water.
   - Cooperation in protecting the water supply system.
   - Cooperation in using the excreta disposal installations properly and in keeping them clean.
   - Avoidance of scattering refuse and observance of rules for its proper collection.
   - Cooperation in reducing insect populations.
   - Cleanliness of the shelters and camp.
   - Cleanliness of food containers, dishes, utensils.
   - Observance of personal hygiene rules (body and clothing).
   - Proper collection of manure.
   - Participation in community clean-up work.

NOTE TO CHAPTER 8

[22]A large number of bamboo tube wells have been sunk in several districts of Bihar, India. These tube wells are inexpensive and can be sunk rapidly using simple drilling rigs. They require a sandy soil and a shallow water table. The tube well is made from split bamboo lengths, iron rings, coir string, and iron nails. Sinking requires the help of specialist engineers and requires a pumping set equipped with 5HP diesel engine. A bamboo tube well can deliver 26,000-30,000 liters of water per hour. The useful life of a bamboo tube well is three to five years.

CHAPTER 9
Post-Disaster Rehabilitation and Development*

9.1. THE PROBLEM

An obviously close correlation exists between levels of economic development and a community's ability to cope with disasters. Moreover, frequent and cyclical emergencies can cause a country's economy to regress further. In some disaster-prone countries, recurrent natural disasters can cancel out any existent economic growth. Thus, disasters are a development problem of major significance. They require action at the national level and the formulation of a strategy of prevention or mitigation.

Areas prone to the effects of natural phenomena such as floods, cyclones, and droughts are usually inhabited by people belonging to sectors of the community which are chronically poor, ill-housed, illiterate, and nearly always without political power. Their problems have to be approached through properly designed community development programs, staged to stimulate awareness of needs. Any strategy of pre-disaster planning should include not only provision for rehabilitation to pre-disaster levels, but should also offer guidelines for social and economic development of the area (even though the perspective in time becomes somewhat prolonged). Indeed, disasters have consistently provided opportunities for the initiation of radical changes in poor societies that enhance development far beyond the normal pre-disaster pace. Cluster villages built in the coastal areas of Bangladesh, acceptance of new high-yield cereals in pest-stricken areas, and extensive reforestation programs following floods are examples of successful development projects brought on in the wake of disasters.

General Assembly Resolution 2816 (XXVI), paragraph 1 (i) requires the Disaster Relief Coordinator (UNDRO) not only "to phase out relief

*This chapter is intended to provide a brief introduction to the important subject of post-disaster development. Development of suitable projects is a complex task and the reader should seek the additional assistance of UNDRO for obtaining any available publications in the field.

operations under his aegis as the stricken country moves into the stage of rehabilitation and reconstruction, but to continue to interest himself, within the framework of the responsibilities for relief, in the activities of the United Nations Agencies concerned with rehabilitation and reconstruction."

9.2. ORGANIZATIONAL ARRANGEMENTS

In view of its magnitude and complexity, integrated socioeconomic development should cover all sectors which promote productivity and economic growth of the area. In countries that have an organization for development planning (e.g., planning ministry), the above tasks will be undertaken by them. Although such offices are independent of NDRO in drawing up plans and implementation of national programs, the office of NDRO and its Coordinator should be given an active role in the design, coordination, and implementation of relevant programs As stated in Chapter 2, planning ministries should also associate themselves closely with NDRO in disaster planning for preparedness, prevention, and during relief operations and rehabilitation. This close association and shared responsibility will facilitate appropriate sequencing and synchronizing of the several rehabilitation steps and of the development program in the affected area By writing development plans with sufficient time flexibility for labor-intensive components, the entire plan can be accelerated in the wake of disasters. The plan can thus expedite the provision of additional jobs and likewise reduce the need for specific new disaster-work programs. Both offices should receive the advice and guidance of all departments with a potential role to play in the programs

9.3. EXTERNAL ASSISTANCE

The success of the development program will rest squarely upon the availability of resources such as personnel, materials, and money. Countries that do not possess the required technical know-how may seek assistance from United Nations Agencies through UNDP/UNDRO Thus, even during transitional periods, formulation of aid arrangements and technical support can be determined. Financing requires a nucleus fund at the national level. This allocation will be reflected in the annual or period/plan budgets of the appropriate planning department or commission. Additional resources may be sought from international organizations or bilateral agencies.

9.4. THE STRATEGY

This involves the establishment of the necessary infrastructure for improvement of social services and for increasing income through productive employment. Strategy development should attend to the following factors:

1. Development of plans in advance, specific to the disaster-prone area, laying out projects in detail. Projects should be labor-intensive,

development-oriented, and organized to mutually support each other. They should also promote ecological balance.

2. Promotion of community participation, with local persons providing necessary leadership, guidance, and implementation. Vested interests should be eliminated and the population should be kept aware of the programs and reconsulted periodically.
3. Provision of easy credit for purchases of necessary inputs.
4. Monitoring and evaluation should be integrated with the projects.

9.4.1. Improvement of Social Services. The basic elements here are local production and consumption of higher-quality foods; provision of minimum preventive and curative health services; safe water supply and waste disposal; measures to meet the basic educational needs of the community; introduction of simple energy-saving technologies to lighten the community's work burden; and the provision of special educational and social programs.

Since the rudiments of some of these services will already be available as part of the post-disaster relief effort, attempts should be made to continue and progressively develop existing activities. The participating communities should be expected to make contributions in cash or kind to cover at least part of the expenses and cost of supplies. They should be encouraged to assume greater responsibility in time. If properly planned and implemented, the measures will together constitute the first-stage developmental operation and should provide opportunities for steady advancement to improved levels of living.

9.4.1.1. Production and consumption of higher-quality foods. This goal should be an essential part of nutrition programs. For a long time to come, production—with better use of locally-produced foods—will be the sole avenue for the majority of poor to improve the nutritional quality of their diets. Lack of knowledge of food values and conservatism in eating habits require vigorous educational programs. Practical nutrition activities in areas such as production and consumption of vegetables, legumes, fruits, poultry, dairy products, and fish—accompanied by nutrition education to improve food habits—are important components of action. The special food needs of the vulnerable groups should be emphasized through education. The importance of breast feeding of infants and better food preparation and preservation should also be stressed.

It may be necessary to organize special feeding programs for selected needy groups.

9.4.1.2. Preventive and curative health services. The emphasis here should be on simple preventive measures; health education; the health care needs of vulnerable groups; the use of simple, acceptable forms of medical and health technology; and the appropriate incor-

poration of traditional forms of health and medical care. The primary health care workers selected from and by the community should receive simple training to start with, followed by regular refresher courses. The communities should be able to participate in both the planning and operation of the services.

9.4.1.3. **Safe water supply and waste disposal.** Provision of a safe and convenient water supply is an important element in the improvement of the people's well-being. Clean water is essential for drinking, personal hygiene, and for domestic use; therefore, the supply should be adequate. Its convenient location is another major factor in stimulating people to use this facility. The development of facilities for proper disposal of human waste and encouragement of their regular use will reinforce the benefits derived from using clean water. Both measures are integral parts of health care and should receive highest priority.

9.4.1.4. **Basic educational needs.** Education, a life-long learning process, should not be confined to formal schooling. Education should be practical and functional and should help to reach sources of knowledge that are of direct use to the community—bulletins on simple agricultural techniques, health, and other "how-to-do it" manuals should enable them to do things better. They should be helped to read and write, to express ideas and needs, to perform common computations, to develop knowledge and skills for self-reliance, and to raise the level of the family's participation in community affairs.

9.4.1.5. **Introduction of simple energy-saving technologies.** New technologies should comprise concepts that relate to traditional activities but that will enable tasks to be performed easier and more effectively. Materials used should be locally available, should be amenable to local management, and should be compatible with local resources. Some examples of needed innovations are:

1. Methods for crop drying and storage.
2. Techniques for threshing and grinding cereals and other food products.
3. Simple methods of home-cooking, using less fuel and safe from accidents.
4. Techniques for harnessing wind and water power to run simple machines.
5. Development of heat energy through utilization of solar radiation.
6. Development of simple transporting carts to move heavy loads.

9.4.2. **Employment and Income Generation.** During the early stages of post-disaster relief, the affected population can perform several simple vocational tasks under appropriate supervision. Examples include: tasks related to rescue; clearing damaged structures, roads,

water sources; construction of camps, shelters, and homes; building latrine facilities, food preparation and distribution. This work will put additional cash at their disposal, facilitating more rapid rehabilitation.

During the **later stages of relief**, when the population is recovering several types of activities can be organized for volunteer participation, thus further hastening the process of recovery and rehabilitation. Such tasks may be relevant to crop production; development of home community gardens; development of new water resources and improvement of existing ones; building permanent and/or semi-permanent structures; laying of new roads. A careful selection of projects, made well in advance, will assure success. Workers for different types of tasks should receive appropriate short training prior to employment.

When the population is rehabilitated and is almost back to the pre-disaster situation, the more important task begins of launching programs to develop the affected regions. These projects should be interlinked and carefully planned in advance. Some should be a continuation, with considerable expansion, of activities initiated at an early stage. These programs should enable the population to upgrade the quality of their lives and achieve balance with the environment. Needless to say, they should also help in future disaster prevention or mitigation.

Aside from projects and programs to accelerate socioeconomic development, disaster mitigation and prevention require the local initiation of certain general preventive measures. Additionally, scientific research into natural phenomena, and development and organization of warning systems on a national and/or global scale, should be undertaken. Such programs have been briefly listed in Chapter 1.

9.4.3. Socioeconomic Development. A uniform strategy of development cannot be evolved to suit all disaster-prone areas. An integrated plan for agricultural development, animal husbandry, and restoration of ecological balance are important strategies. They should include programs in the fields of meteorology, water development, pasture improvement and range management, livestock protection and development, irrigated agriculture, seed multiplication and plant protection, reforestation and human resettlement. The restoration of the ecological balance may take years to achieve and require a great deal of investment. Nevertheless, the money spent on promoting the growth of plant life and the conservation of soils and moisture promises to yield rich dividends.

A number of measures have to be taken to create irrigation resources and to develop methods for optimum use of limited water supplies. The major emphasis should be to harness and cooperatively manage

local surface or ground water. Planting of crops requiring excessive moisture should be avoided. Agronomists will advise the farmers regarding the varieties to be sown and their timing (if the cropping season can be forecast). Alternative cropping strategies and agronomic practices should be developed to suit different weather models. In particularly unfavorable climatic periods, the inputs should be changed to produce at least some food supplies. Although it may be difficult to produce food crops in an arid area, every effort should be taken to exploit the agricultural potentialities of the surrounding moisture zones, with proper planning, investment, and inputs.

Pasture development, regulated rotational grazing, and creation of grass reserves also constitute important steps in the rehabilitation of desert areas. Provision should be made for fodder banks to store grass reserves.

Constant migration results in loss of livestock, and will also affect the collection, processing, and marketing of livestock products. The approach to livestock development should be based on three considerations:

- Reducing, if not containing, cattle population in the area so as to eliminate inferior cattle draining limited resources of fodder.
- Augmentation of food and fodder resources within the area itself in order to ensure adequate supply of food to the animals.
- Training of population in techniques of cattle breeding.

The economy should be primarily based on animal husbandry. Appropriate schemes for production of meat, wool, or milk and milk products should be undertaken. Marketing facilities for products should be developed.

Establishment of agro-service centers will provide certain essential services to the rural people and enable farmers to obtain agricultural inputs and consumer goods and to utilize repair and maintenance facilities for agricultural machinery. These centers should be located at existing meeting points of roads and railways.

Roads of several types (arterial, sub-arterial, and feeder roads and alignments) may be considered for interlinking the disaster-prone regions. In laying roads, attention should be paid to the major locations which need to be interconnected—markets, agro-service centers, livestock installations, seed banks, grass and fodder reserves.

A crucial objective of development programs for disaster-prone areas is that benefit ought to be broad-based and shared by the large mass of rural population, particularly small farmers, marginal farmers, and agricultural laborers. It is therefore necessary to build into the development program special provisions for their benefit. Disaster-prone

areas have poor resource endowments and they usually suffer from a stagnant rural economy. The institutional structure of cooperative or commercial banking facilities may be weak Special provisions for local financing should be made as part of the development plan.

Apart from the considerations of administrative coordinating structure, availability of financial resources, and personnel, the success of the program will hinge on community action. It is essential that appropriate schemes be launched for the creation of awareness amongst the community with regard to the development plans. Community leaders and officials in the area may be instructed in motivation orientation and other such training as necessary. The importance of public participation cannot be overstated.

After the introduction of the program, monitoring and evaluation processes may be introduced. Success stories in one region may be disseminated to motivate the people of another region. Similarly, any draw-backs or lessons emerging from monitoring and evaluation should be utilized to rectify the shortcomings in plans