Chapter 7

Solid waste management

Solid waste refers here to all non-liquid wastes. In general this does not include excreta, although sometimes nappies and the faeces of young children may be mixed with solid waste. Solid waste can create significant health problems and a very unpleasant living environment if not disposed of safely and appropriately. If not correctly disposed of, waste may provide breeding sites for insect-vectors, pests, snakes and vermin (rats) that increase the likelihood of disease transmission. It may also pollute water sources and the environment.

7.1 Associated risks

7.1.1 Disease transmission

Decomposing organic waste attracts animals, vermin and flies. Flies may play a major role in the transmission of faecal-oral diseases, particularly where domestic waste contains faeces (often those of children). Rodents may increase the transmission of diseases such as leptospirosis and salmonella, and attract snakes to waste heaps.

Solid waste may also provide breeding sites for mosquitoes. Mosquitoes of the *Aedes* genus lay eggs in water stored in discarded items such as tins and drums; these are responsible for the spread of dengue and yellow fevers. Such conditions may also attract mosquitoes of the *Anopheles* genus, which transmit malaria. Mosquitoes of the *Culex* genus breed in stagnant water with high organic content and transmit microfilariases (Médecins Sans Frontières, 1994), appropriate conditions are likely to arise where leachate from waste enters pooling water.

In times of famine or food scarcity, members of the affected population may be attracted to waste heaps to scavenge for food; this is likely to increase the risk of gastro-enteritis, dysentery and other illnesses.

7.1.2 Pollution

Poor management of the collection and disposal of solid waste may lead to leachate pollution of surface water or groundwater. This may cause significant problems if the waste contains toxic substances, or if nearby water sources are used for water supplies.

Where large quantities of dry waste are stored in hot climates this may create a fire hazard. Related hazards include smoke pollution and fire threat to buildings and people.

7.1.3 Effect on morale

The effect of living in an unhygienic and untidy environment may lead people to become demoralised and less motivated to improve conditions around them. Waste attracts more waste and leads to less hygienic behaviour in general.

7.2 Sources and types of solid waste

7.2.1 Sources of solid waste

In most emergency situations the main sources of solid waste are:

- Medical centres
- Food stores
- Feeding centres
- Food distribution points
- Slaughter areas
- Warehouses
- Agency premises
- Markets
- Domestic areas

Appropriate solid waste management strategies may vary for institutional, communal and domestic sources, depending on types and volumes of waste. Waste from medical centres poses specific health hazards and for this reason is considered separately in Chapter 8.

7.2.2 Type and quantity of waste

The type and quantity of waste generated in emergency situations varies greatly. The main factors affecting these are:

- the geographical region (developed or less-developed country or region);
- socio-cultural practices and material levels among affected population;
- seasonal variations (affecting types of food available);
- the stage of emergency (volume and composition of waste may change over time); and
- the packaging of food rations.

In general, the volume of waste generated is likely to be small and largely degradable where the population is of rural origin and the food rations supplied are unpackaged dry foodstuffs. Displaced urban populations are more likely to generate larger volumes of non-degradable waste, especially where packaged food rations are provided.

Guideline values suggest that each person is likely to produce 0.5-1.0 litres of refuse per day with an organic content of 25 to 35 per cent and a moisture content between 10 and 60 per cent (Adams, 1999). However, this is likely to vary greatly and estimates should be made locally.

Different categories of solid waste include:

Organic waste:	Waste from preparation of food, market places, etc.
Combustibles:	Paper, wood, dried leaves, packaging for relief items, etc. (high organic and low moisture content)
Non-combustibles:	Metal, tin cans, bottles, stones, etc.
Ashes/dust:	Residue from fires used for cooking
Bulky waste:	Tree branches, tyres, etc.
Dead animals:	Carcasses of domestic animals and livestock
Hazardous waste:	Oil, battery acid, medical waste
Construction waste:	Roofing, rubble, broken concrete, etc.



Children and solid waste in a refugee camp, Turkey



Collected market waste, Tanzania

7.3 Initial steps

In order to establish effective solid waste management in the affected area the following process should be used:

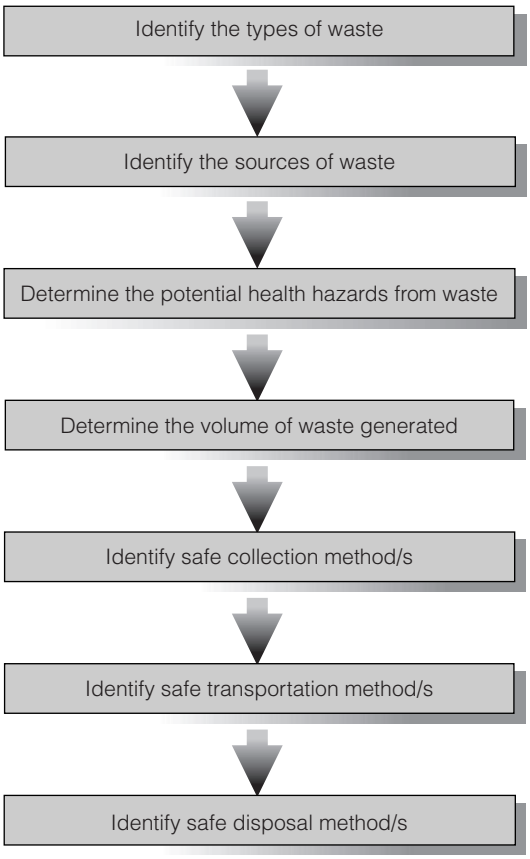


Figure 7.1. Initial steps in solid waste management

7.4 Key components of solid waste management

Solid waste management can be divided into five key components:

- Generation
- Storage
- Collection
- Transportation
- Disposal

7.4.1 Generation

Generation of solid waste is the stage at which materials become valueless to the owner and since they have no use for them and require them no longer, they wish to get rid of them. Items which may be valueless to one individual may not necessarily be valueless to another. For example, waste items such as tins and cans may be highly sought after by young children.

7.4.2 Storage

Storage is a system for keeping materials after they have been discarded and prior to collection and final disposal. Where on-site disposal systems are implemented, such as where people discard items directly into family pits, storage may not be necessary. In emergency situations, especially in the early stages, it is likely that the affected population will discard domestic waste in poorly defined heaps close to dwelling areas. If this is the case, improved disposal or storage facilities should be provided fairly quickly and these should be located where people are able to use them easily. Improved storage facilities include:

- Small containers: household containers, plastic bins, etc.
- Large containers: communal bins, oil drums, etc.
- Shallow pits
- Communal depots: walled or fenced-in areas

In determining the size, quantity and distribution of storage facilities the number of users, type of waste and maximum walking distance must be considered. The frequency of emptying must also be determined, and it should be ensured that all facilities are reasonably safe from theft or vandalism.

7.4.3 Collection

Collection simply refers to how waste is collected for transportation to the final disposal site. Any collection system should be carefully planned to ensure that storage facilities do not become overloaded. Collection intervals and volumes of collected waste must be estimated carefully.

7.4.4 Transportation

This is the stage when solid waste is transported to the final disposal site (see 7.6 for more details). There are various modes of transport which may be adopted and the chosen method depends upon local availability and the volume of waste to be transported. Types of transportation can be divided into three categories:

- Human-powered: open hand-cart, hand-cart with bins, wheelbarrow, tricycle
- Animal-powered: donkey-drawn cart
- Motorised: tractor and trailer, standard truck, tipper-truck

7.4.5 Disposal

The final stage of solid waste management is safe disposal where associated risks are minimised. There are four main methods for the disposal of solid waste:

- Land application: burial or landfilling
- Composting
- Burning or incineration
- Recycling (resource recovery)

The most common of these is undoubtedly land application, although all four are commonly applied in emergency situations. Details of disposal on-site and off-site can be found in Sections 7.5 and 7.7 respectively.

7.5 On-site disposal options

The technology choices outlined below are general guidelines for disposal and storage of waste on-site, these may be adapted for the particular site and situation in question.

7.5.1 Communal pit disposal

Perhaps the simplest solid waste management system is where consumers dispose of waste directly into a communal pit. The size of this pit will depend on the number of people it serves. The long-term recommended objective is six cubic metres per fifty people. The pit should be fenced off to prevent small children falling in and should generally not be more than 100m from the dwellings to be served. Ideally, waste should be covered at least weekly with a thin layer of soil to minimise flies and other pests. Figure 7.2 illustrates a simple communal pit.

Advantages: It is rapid to implement; and requires little operation and maintenance.

Constraints: The distance to communal pit may cause indiscriminate disposal; and waste workers required to manage pits.

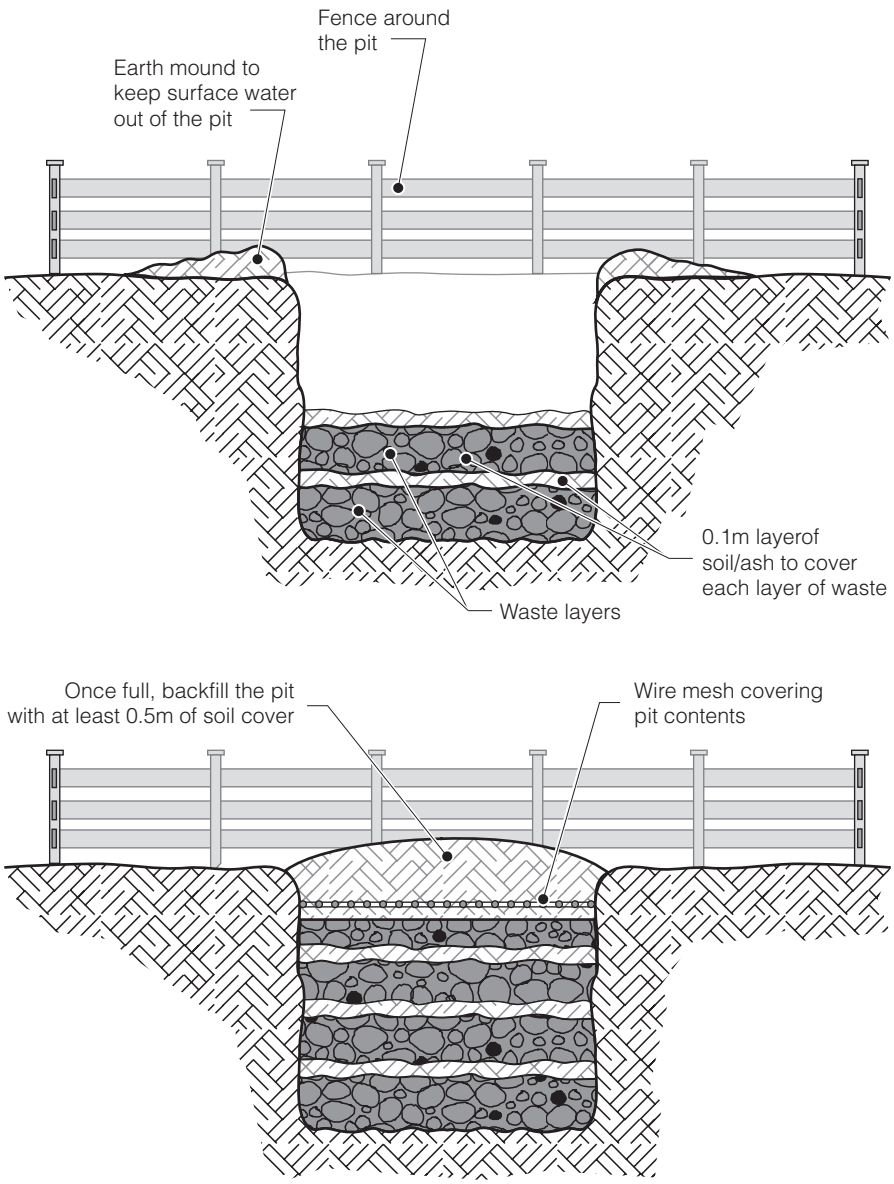


Figure 7.2. Communal solid waste pit

7.5.2 Family pit disposal

Family pits may provide a better long-term option where there is adequate space. These should be fairly shallow (up to 1m deep) and families should be encouraged to regularly cover waste with soil from sweeping or ash from fires used for cooking. This method is best suited where families have large plots and where organic food wastes are the main component of domestic refuse.

Advantages: Families are responsible for managing their own waste; no external waste workers are required; and community mobilisation can be incorporated into hygiene promotion programme.

Constraints: Involves considerable community mobilisation for construction, operation and maintenance of pits; and considerable space is needed.

7.5.3 Communal bins

Communal bins or containers are designed to collect waste where it will not be dispersed by wind or animals, and where it can easily be removed for transportation and disposal. Plastic containers are generally inappropriate since these may be blown over by the wind, can easily be removed and may be desirable for alternative uses. A popular solution is to provide oil drums cut in half (Figure 7.3). The bases of these should be perforated to allow liquid to pass out and to prevent their use for other purposes. A lid and handles can be provided if necessary.

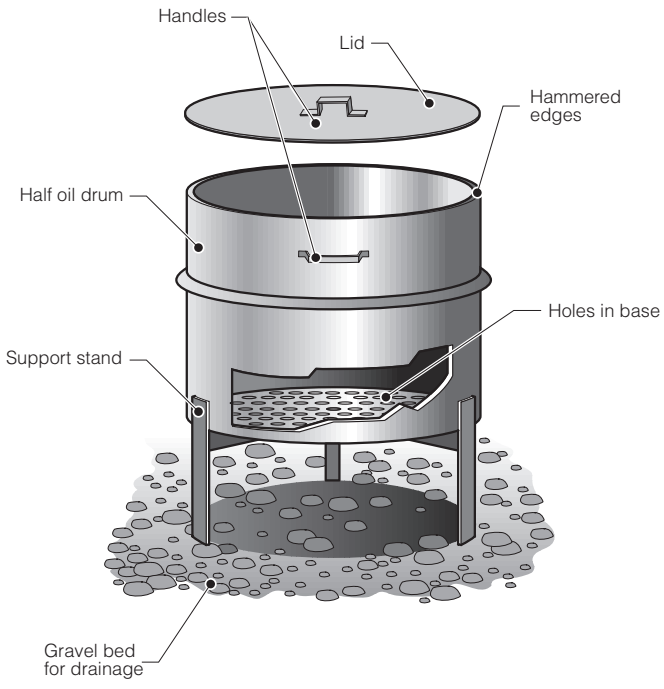


Figure 7.3. Communal bin made from an old oil drum

In general, a single 100-litre bin should be provided for every fifty people in domestic areas, every one hundred people at feeding centres and every ten market stalls. In general, bins should be emptied daily.

Advantages: Bins are potentially a highly hygienic and sanitary management method; and final disposal of waste well away from dwelling areas.

Constraints: Significant collection, transportation and human resources are required; system takes time to implement; and efficient management is essential.

7.5.4 Family bins

Family bins are rarely used in emergency situations since they require an intensive collection and transportation system and the number of containers or bins required is likely to be huge. In the later stages of an emergency, however, community members can be encouraged to make their own refuse baskets or pots and to take responsibility to empty these at communal pits or depots.

Advantages: Families are responsible for maintaining collection containers; and potentially a highly sanitary management method.

Constraints: In general, the number of bins required is too large; significant collection, transportation and human resources are required; takes time to implement; and efficient management essential.

7.5.5 Communal disposal without bins

For some public institutions, such as markets or distribution centres, solid waste management systems without bins can be implemented, whereby users dispose of waste directly onto the ground. This can only work if cleaners are employed to regularly sweep around market stalls, gather waste together and transport it to a designated off-site disposal site. This is likely to be appropriate for vegetable waste but slaughterhouse waste should be disposed of in liquid-tight containers and buried separately.

Advantages: System rapid to implement; there is minimal reliance on actions of users; and it may be in line with traditional/usual practice.

Constraints: Requires efficient and effective management; and full-time waste workers must be employed.

7.6 Transportation options

Where bins or collection containers require emptying, transportation to the final disposal point is required. As described, waste transportation methods may be human-powered, animal-powered or motorised.

7.6.1 Human-powered

Wheelbarrows are ideal for the transportation of waste around small sites such as markets but are rarely appropriate where waste must be transported considerable distances off-site. Handcarts provide a better solution for longer distances since these can carry significantly more waste and can be pushed by more than one person. Carts may be open or can be fitted with several containers or bins.

7.6.2 Animal-powered

Animal-powered transportation means such as a horse or donkey with cart are likely to be appropriate where they are commonly used locally. This may be ideal for transportation to middle distance sites

7.6.3 Motorised

Where the distance to the final disposal site is great, or where the volume of waste to be transported is high, the use of a motorised vehicle may be the only appropriate option. Options include tractor and trailer, a standard truck, or a tipper-truck, the final choice depending largely on availability and speed of procurement.

Figure 7.4 illustrates a number of refuse collection vehicles and containers.

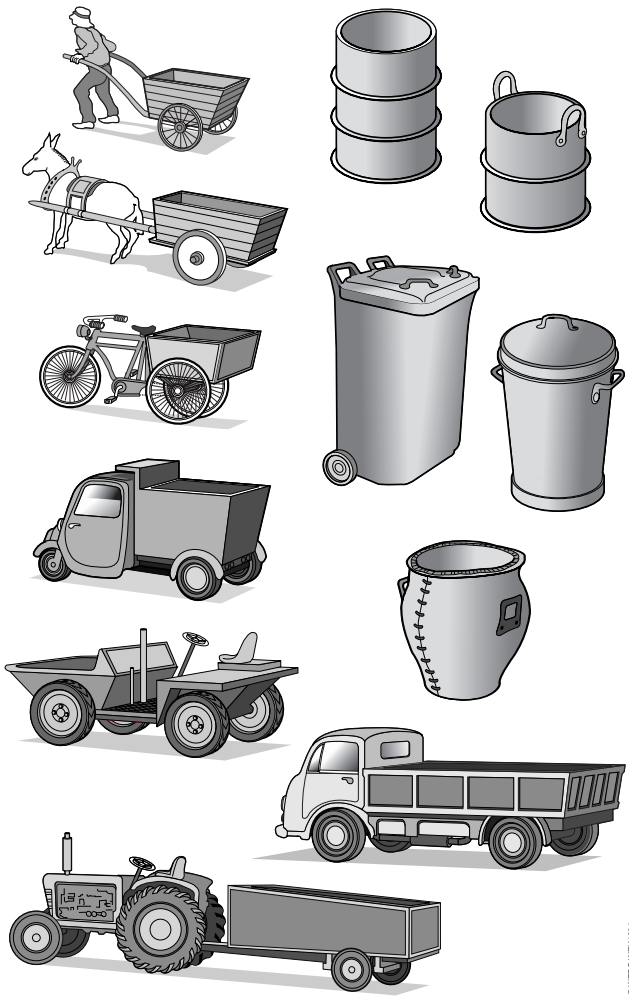


Figure 7.4. Refuse collection containers and vehicles

For large volumes of waste it may sometimes be appropriate to have a two-stage transportation system requiring a transfer station. For example, waste is transported by handcart to a transfer station where it is loaded into a truck to be taken to an off-site disposal site several kilometres away (Figure 7.5).

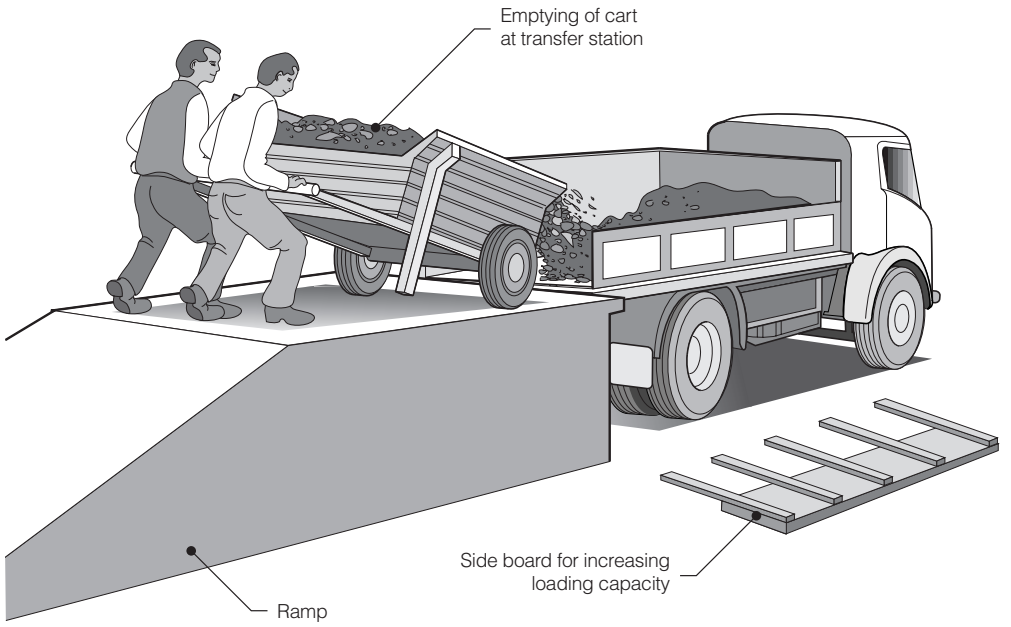


Figure 7.5. Emptying a cart at a transfer station

7.7 Off-site disposal options

The technology choices outlined below are general options for the final disposal of waste off-site.

7.7.1 Landfilling

Once solid waste is transported off-site it is normally taken to a landfill site. Here the waste is placed in a large excavation (pit or trench) in the ground, which is back-filled with excavated soil each day waste is tipped. Ideally, about 0.5m of soil should cover the deposited refuse at the end of each day to prevent animals from digging up the waste and flies from breeding (Figure 7.6).

The location of landfill sites should be decided upon through consultation with the local authorities and the affected population. Sites should preferably be fenced, and at least one kilometre downwind of the nearest dwellings.

Advantages: A sanitary disposal method if managed effectively.
Constraints: A reasonably large area is required.

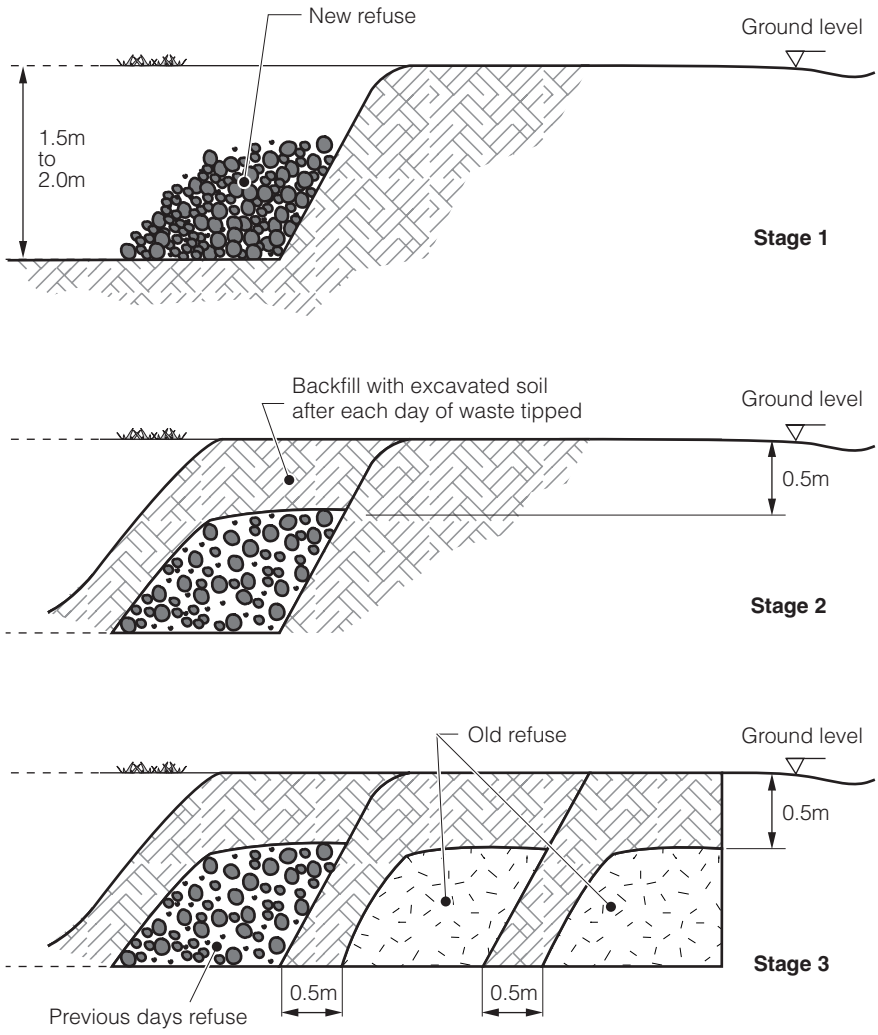


Figure 7.6. Simple landfilling

7.7.2 Incineration

Although burning or incineration is often used for the disposal of combustible waste, this should generally only take place off-site or a considerable distance downwind of dwellings. Burning refuse within dwelling areas may create a significant smoke or fire hazard, especially if several fires are lit simultaneously. Burning may be used to reduce the volume of waste and may be appropriate where there is limited space for burial or landfill. Waste should be ignited within pits and covered with soil once incinerated, in the same manner as landfilling. The same constraints for siting landfill sites should be applied here also.

Advantages: Burning reduces volume of combustible waste considerably; and it is appropriate in off-site pits to reduce scavenging.

Constraints: There can be smoke or fire hazards.

7.7.3 Composting

Simple composting of vegetables and other organic waste can be applied in many situations. Where people have their own gardens or vegetable plots, organic waste can be dug into the soil to add humus and fibre. This makes the waste perfectly safe and also assists the growing process. This should be encouraged wherever possible, particularly in the later stages of an emergency programme.

Properly managed composting requires careful monitoring of decomposing waste to control moisture and chemical levels and promote microbial activity. This is designed to produce compost which is safe to handle and which acts as a good fertiliser. Such systems require considerable knowledge and experience and are best managed centrally. In general, they are unlikely to be appropriate in emergencies.

Advantages: Composting is environmentally friendly; and beneficial for crops.

Constraints: Intensive management and experienced personnel are required for large-scale operations.

7.7.4 Recycling

Complex recycling systems are unlikely to be appropriate but the recycling of some waste items may be possible on occasions. Plastic bags, containers, tins and glass will often be automatically recycled since they are likely to be scarce commodities in many situations. In most developing country contexts there exists a strong tradition of recycling leading to lower volumes of waste than in many more developed societies.

Advantages: Recycling is environmentally friendly.

Constraints: There is limited potential in most emergency situations; and it is expensive to set up.

7.8 Intervention levels

Table 7.1 indicates general intervention strategies for the storage and disposal of solid waste in different emergency scenarios.

Table 7.1. Recommended interventions for different scenarios

Scenarios and recommended interventions	*The affected population go through a transit camp immediately after a disaster*	*The affected population remain in a temporary location for up to six months*	*The affected population stay in the affected area immediately after a disaster*	*The affected population move to a new area and are likely to remain for more than a year*
Immediate action	■ Clearing of scattered waste ■ Burning and burial of waste on site ■ Temporary communal pits ■ Temporary communal bins and off-site disposal ■ Repairing or upgrading of existing facilities			
Short-term measure	■ Communal pits ■ Family pits ■ Communal bins and off-site disposal			
Long-term measure			■ Communal pits ■ Family pits ■ Communal bins and off-site disposal ■ Repairing or upgrading of existing facilities ■ Recycling	

7.9 Protective measures

In order to minimise disease transmission there are several protective measures that can be undertaken. These concern equipment for staff and the siting and management of disposal sites.

7.9.1 Staff

It is important that workers employed to collect and transport solid waste are provided with appropriate clothing and equipment. Gloves, boots and overalls should be provided wherever possible. Where waste is burned, or is very dusty, workers should have protective masks. Water and soap should be available for hand and face washing, and changing facilities should be provided where appropriate.

7.9.2 Siting of disposal sites

The location of all disposal sites should be determined through consultation with key stakeholders including local government officials, representatives of local and displaced populations, and other agencies working in the area. Appropriate siting should minimise the effects of odour, smoke, water pollution, insect vectors and animals.

On-site disposal is generally preferred since this requires no transportation and staff needs are low. This is appropriate where volumes of waste are relatively small, plenty of space is available and waste is largely organic or recyclable.

If the volumes of waste generated are large, or space within the site is severely limited, it may be necessary to dispose of waste off-site. Where off-site disposal is to be used the following measures should be taken in selecting and developing an appropriate site:

- Locate sites at least 500m (ideally 1 kilometre) downwind of nearest settlement.
- Locate sites downhill from groundwater sources.
- Locate sites at least 50m from surface water sources.
- Provide a drainage ditch downhill of landfill site on sloping land.
- Fence and secure access to site.

Careful assessment should be made to determine who owns the proposed site and to ensure that apparently unused areas are not in fact someone's farm or back yard.

References and further reading

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