



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

# Solid Waste Management Guideline for Local Authorities



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**JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)  
Ministry of Home Affairs, Provincial Councils and Local Government  
Democratic Socialist Republic of Sri Lanka**

**THE STUDY  
ON IMPROVEMENT  
OF SOLID WASTE MANAGEMENT  
IN SECONDARY CITIES  
IN SRI LANKA**

**SOLID WASTE MANAGEMENT  
GUIDELINE FOR LOCAL  
GOVERNMENTS**

**Volume IV**

**FINAL REPORT**

**DECEMBER 2003**

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*This is*

## ***SWM Guideline for Local Governments.***



In this report, the project cost is estimated using the September 2003 prices and at an exchange rate of 1 US\$ = 117.02 Japanese Yen = 95.28 Rupees

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# About This Guideline

## Objective of This Guideline

Solid waste problems is getting serious day by day with the economic development and solid waste management (SWM) has got one of the most important issues for local authorities to make the city development sustainable. However, there is scarcity of people in local authorities who have proper knowledge and experiences on this new subject. Many of references for solid waste management which are published in foreign countries are not applicable for the local conditions in Sri Lanka as it is due to the difference of the background. This guideline was, therefore, developed based on the actual experiences and lessons obtained through the implementation of pilot projects during the Study period.

Objectives of this guideline are as follows.

- To provide local authority staff with the basic knowledge on SWM.
- To facilitate local authority staff to improve their SWM system.
- To guide local authority staff to develop the SWM master plan.
- To guide local authority staff to develop the feasibility study for a particular project.

This guideline is useful for local consultants as well who assist local authorities. In addition, this guideline facilitate local authority for formulating an appropriate SWM project to satisfy the requirement of local loan.

## Structure of This Guideline

This guideline consists of the following four parts.

Part A : Overview of SWM

Part B : Factors Influencing SWM

Part C : SWM Action Plan Preparation

Part D : References

## Target waste of this guideline

The target waste of this guideline is mainly MSW.

### ***Definition of Municipal Solid Waste:***

Municipal solid waste means any solid waste generated from community activities, e.g. residential households, commercial and business establishments, fresh market, institutional facilities and construction and demolition activities, excluding hazardous and infectious wastes.



**Part A**

**Overview of SWM**

## A.1 Features of Waste

### A.1.1 Useful items and waste

#### Goods (Useful items have a positive value)

When you give something of use to somebody, you can get money from him because it gives him a benefit. For example, if you give a friend your camera, you can get some money from him in return for it, because it will give him pleasure.

#### Bads (Waste has a negative value)

When you give garbage to somebody, you have to pay money to him because it is a nuisance to him.

People often forget this simple theory.

### A.1.2 Everything becomes garbage sooner or later

A newspaper will be garbage the next day; a calendar will be garbage after a year; and a bicycle will be garbage in 10 years.

Everything becomes garbage sooner or later.

### A.1.3 The value of material depends on the person

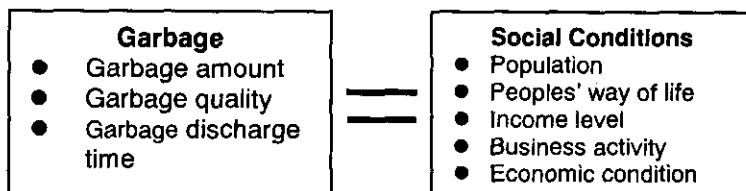
What is waste to one person may be a valuable resource to another. For example, once you read a newspaper it is no longer useful to you. However, some food shops need old newspaper for wrapping food. This characteristic makes “reuse” and “recycling” possible.

### A.1.4 Garbage reflects the society

Garbage is discharged by people, shops, etc. Therefore, garbage is closely related to the social conditions.

The amount of waste is mainly related to income level. When people become richer, they buy more things for usage or consumption and, as a result, discharge more garbage because everything becomes garbage sooner or later.

The composition of waste can change quickly with social change. Plastic bag waste and pet bottle waste increased suddenly after their introduction although there were no such types of garbage ten years ago. This makes it necessary to change the garbage storage system, collection equipment, composting system, landfill disposal system, etc.



## **A.2 Characteristics of SWM**

### **A.2.1 The SWM system must fit the social conditions**

The SWM systems in Japan, Europe, and the USA are all different because the social conditions are different. None of them are applicable to Sri Lanka as they are because they do not suit the social conditions there.

In the same way, the recycle system in Colombo cannot work in local towns as it is because the social conditions are not the same.

Taking the social conditions into consideration is essential to design an appropriate SWM system.

### **A.2.2 There is no permanent solution in SWM**

Social conditions often change due to economic development, the development of new products, population growth, etc. When that happens, the SWM system has to change to fit the current social conditions.

There is no permanent solution in SWM.

### **A.2.3 O&M is much more important than investment**

For road projects, the required O&M cost is small although the investment amount is huge.

However, in SWM projects, the O&M cost required is huge. If you purchase or even get a grant for waste collection equipment, you have to pay for petrol, the salaries of drivers and workers, spare parts like tires, etc. Similarly, if you get a grant for a compost plant, you have to pay for the salaries of workers, electricity, spare parts, the disposal of rejects, etc.

In this regard, a SWM project is similar to a factory project. Good planning of a project from an O&M aspect is the most important. Managerial capability is also essential.

### **A.2.4 SWM is an interdisciplinary subject**

Knowledge in the following areas is necessary:

- Economics
- Society
- Management
- Legislation
- Engineering (civil, mechanical, chemical)
- Sanitation, environment, etc.

Therefore, one person cannot handle SWM by himself. Strong organisation is essential, i.e. good governance

### **A.2.5 Required functions of the Solid Waste Management Dep./Sec.**

- Planning function
- Operation and maintenance function
- Supervision function
- Public relations & education function
- Decision-making function

Most LAs only have an O&M function. Good Governance is essential.

### **A.2.6 Public involvement is essential**

- The community should be involved at all stages of the project cycle from identification of the need for a project, the planning and design of a facility, its implementation and construction, through to its operation. There is potential for the community to be effectively involved in many aspects of the waste management process including source reduction and recycling, collection and transportation as well as the siting, design, operation and management of waste disposal facilities such as landfill sites. In addition, charging systems will only work only if there is public environmental awareness. Central to the success of public participation exercises, however, is the need to educate and motivate communities. Involvement is the key to effective education.
- Effective education is done through participation in an actual program. Recycling programs are appropriate for this purpose. A cost effective recycling program like a “Recycle Bank” is recommended. To start such a program, public involvement should be handed over to successive projects. In such a way, community movements can be activated like a rolling stone.

## **A.3 Present SWM Conditions in Sri Lanka**

### **A.3.1 Dominant SWM Problems**

The following problems are seen widely in Sri Lanka:

- 1) Widespread scattering of waste in the towns
- 2) Terrible conditions of landfill sites
- 3) Huge SWM expenditure, approximately 20% to 30% of LA's total budget
- 4) Difficulty in controlling the many waste collection workers, which account for approximately 30% of all LA employees
- 5) Very high absentee and turnover rate, ranging from 10% to 20%
- 6) Little remaining capacity of existing landfill sites
- 7) Many complaints from citizens
- 8) Lack of public cooperation

Most of these are not technical issues but institutional ones. Technology alone cannot solve these problems.

In other words, much improvement can be made through institutional and managerial capacity building, without spending much money.

Good governance is the key.

### **A.3.2 Causes of these problems**

The causes of these problems are as follows:

- 1) Insufficient understanding of the importance of SWM works and the low status of the section in charge of SWM works in LAs
- 2) Weak organisation due to lack of a cost control function, planning function, public affairs function, etc.
- 3) Insufficient utilization of existing materials and equipment
- 4) Lack of waste discharge rules
- 5) Lack of a future plan
- 6) Lack of utilization of external resources. Most LGs deal with the majority of issues with their own resources such as staff and equipment, without considering the utilization of external resources such as the involvement of citizens. Therefore, they tend to solve problems by increasing the number of employees and/or making requests to donor agencies for equipment.
- 7) Insufficient knowledge of SWM works
- 8) Insufficient knowledge of management

- 9) Political intervention
- 10) Technology-oriented approach with lack of consideration to important social and economic aspects
- 11) Lack of financial sources

This implies the following.

Concerning the solid waste problems in Sri Lanka, the institutional causes are much more important than the technical causes. Therefore, the SWM problems cannot be dealt with by technical improvements alone; institutional improvements must be executed as well.

In other words, the governance quality of LAs is well reflected in the efficiency of SWM works. Consequently, the improvement of governance is very important for the improvement of SWM works.

### **A.3.3 General improvement strategy for LAs**

#### **A.3.3.1 Scenario**

There are two main problems LA face in solid waste management:

- 1st issue: The waste amount is rapidly increasing, which means you have to collect more and more waste.
- 2nd issue: The standard environmental requirements for landfills are becoming much stricter. Therefore, you cannot simply dump waste any more. You have to improve landfill operation to reduce the environmental impact.

Both incur an increase in solid waste management costs. However, you cannot increase the solid waste management budget. This conflict needs to be solved.

Many countries have encountered this conflict in the past. The key to dealing with it is public cooperation.

In developed countries, most towns/cities are generally very clean, despite the fact that

- the amount of waste discharged per person is much more than in Sri Lanka.
- there are fewer street cleaning workers
- garbage collection is less frequent than in Sri Lanka

The main reason is that:

- These towns/cities have appropriate waste discharge rules linked to an efficient waste collection and disposal system.
- Public participation is good - almost all people are disciplined enough to follow these rules or know they will be punished if they do not comply with these rules.

- LAs perform their duties well, collecting the discharged garbage on time and according to schedule.

The introduction of a similar system will greatly improve the current waste problems.

The new waste discharge rule to be introduced will ask people to discharge waste only on waste collection days. As this is more inconvenient for citizens than the present system, strong public cooperation is required.

Some people will most probably complain to the local authority or council members without understanding the purpose of the discharge rule. If that occurs, it is not enough to simply listen to their complaints. The reason why the LA has to introduce the new rule must also be explained. The success or failure of the new waste discharge rule is highly dependent on council members' assistance. If it succeeds, the following three targets can be achieved in one shot:

- the reduction of solid waste management costs,
- the reduction of the environmental impact of landfill operation; and
- the creation of a beautiful city

#### **A.3.3.2 Top Priority Measure**

The institutional and organisational development of LAs is the top priority in most cases. Without it, no improvement measure can succeed.

In other words, many improvements can be achieved without spending much money if the organisation is strengthened.

#### **A.3.3.3 Conclusion**

The conditions of solid waste management clearly reflect the LA's level of governance.

Therefore, the enhancement of the LA's governance level is essential for overcoming waste problems.

#### **A.3.3.4 Recommended Actions**

- 1) Full utilization of internal resources
  - Staff (PHI, CDO, DEO, supervisor), labourers
  - Equipment
- 2) Full utilization of external resources
  - Citizens
  - Other institutions, organizations
  - Business entities

- Private sector
- NGOs
- Donor agencies

#### A.3.3.5 Strategy

The waste collection cost should be reduced through public cooperation. The saved expenditure can be spent for landfill disposal.



**Part B**

**Factors**

**Influencing SWM**

## B.1 Introduction

### B.1.1 Definition

Solid waste (garbage) is anything that someone does not want and throws away. It is of no value to them. However, it may be of value (i.e. a resource) to someone else.

This manual is mainly concerned with municipal solid waste (MSW), which is solid waste produced within towns and cities within Sri Lanka.

It is based on the results of investigations and experience gained from the JICA (Japan International Cooperation Agency) Study on the Solid Waste Management for Secondary Cities in Sri Lanka, which covered Badulla, Chilaw, Gampaha, Kandy, Matale, Negombo and Nuwara Eliya.

### B.1.2 Types of Solid Waste

Solid waste comprises a wide range of materials. It's composition is often expressed in terms of the categories shown below. This table also provides an assessment of the potential of each waste type to be composted or recycled – their “resource recovery” potential.

Table B-1: Solid Waste – Composition and Resource Recovery Potential

Category	Compostable	Recyclable
Food/kitchen/vegetable waste	++	++ (for animal feed)
Garden/wood waste	+	++ (coconuts)
Paper/cardboard	+	+
Hard plastic		++
Soft plastic		+
Glass		++
Metal		++
Textiles		+
Leather/rubber		+
Ceramic/stone		+
Other (dust, ash, sweepings, etc.)		
Hazardous waste (e.g. batteries, fluorescent tubes, aerosol cans, etc.)		++ (car batteries)

Note: ++ = very good; + = average

### B.1.3 Sources of Solid Waste

Where does MSW come from? Its main sources are households, commercial enterprises, markets, institutions, industries and “other” (public spaces, road and drain/canal cleaning).

Tree cuttings/garden wastes, construction/demolition wastes and hazardous wastes are generated by many of these sources. It is often useful to consider such wastes separately from normal garbage. Each of these sources is briefly described below.

Table B-2: Main Waste Generation Sources

Source	Description
Household	Waste generated from domestic activities, including food preparation, cleaning, fuel burning, yard sweeping, gardening and other (e.g. old clothing, appliances, etc.). It does not include any very unsanitary wastes (e.g. human or animal excrement).
Commercial	Waste generated by trade, service and some manufacturing enterprises.
Markets	Waste from markets selling a high proportion of vegetables, fruit, meat and/or fish (i.e. fish and vegetable markets).
Institutions	Wastes from schools, other educational institutes, hospitals, government offices (including the LA), police, prison and religious places. Hospital waste includes some hazardous wastes (see below).
Industries	Wastes from industrial enterprises.
Other	<ul style="list-style-type: none"> <li>• Waste from public spaces – playgrounds, sportsgrounds, parks, beach, etc.</li> <li>• Road/drain/canal cleaning waste.</li> </ul>
Tree cuttings/garden waste	Wastes arising from gardening works. Such wastes are difficult to collect together with normal garbage and are generally suitable for processing or treatment (e.g. tree cuttings → firewood, garden waste → composting) rather than disposal.
Construction/demolition wastes	Wastes originating from construction, rehabilitation and demolition activities, etc. Such wastes should not be collected together with normal garbage and are suitable for reuse (e.g. filling material).
Hazardous (special)	Potentially dangerous wastes coming from various sources, including household items (e.g. batteries, spray cans, etc.). Healthcare wastes are of particular concern.

## B.2 Waste Generation, Discharge and Composition

### B.2.1 Waste Generation

Waste generation is often expressed in terms of a **waste generation rate**, this being the quantity of waste produced per person per day (kg/person.d). The waste generation rate is very useful for planning and comparison purposes. For example, it shows the following general trends:

- Household waste generation increases with income.  
  
This Study found household waste generation in Kandy and Matale to be 0.50kg/person.d and 0.42 kg/person.d respectively. This is within the typical range for developing countries.
- Household waste generation varies between low and high income communities within the same town/city. For example, this Study obtained the following waste generation rates for Kandy:
  - Low income: 0.37kg/person.d.
  - Middle income: 0.47kg/person.d.
  - High income: 0.67 kg/person.d.
- Municipal waste generation is always greater than household waste generation, as it includes waste generated from all sources within the town/city. This Study found the average waste generation rate in seven study towns to be 0.98kg/person.d, ranging from 0.88kg/person.d in Matale to 1.18kg/person.d in Kandy.
- Municipal waste generation is also closely related to the state of the town/city economy, increasing during times of rapid economic growth and decreasing during times of economic recession.
  - Developing countries: 0.3 – 1.0 kg/person.d.
  - Developed countries: 1.0 – 2.5 kg/person.d.
- Waste generation is also affected by a number of other factors, including:
  - The floating population, this being the number of people who pass through a town/city during the day, but live outside its limits.
  - Season. Vegetable/fruit generation changes with season.
  - Festivals and other special occasions, such as the Sinhala/Tamil New Year, Esala Perahera (Kandy), international cricket matches.

The waste generation rate may also be used for SWM planning purposes, such as:

- To estimate the total amount of waste generated in different areas of the town/city by multiplying the generation rate by the population in these areas.

- To predict future waste generation based on expected population and economic growth rates.

## B.2.2 Waste Discharge

After waste is generated, people may dispose of it in a number of ways:

- On-site disposal – burning and/or burial.
- On-site composting.
- Recycling, generally involving individual collectors visiting peoples' premises (homes, shops, etc.) or people selling items directly to middlemen shops.
- Discharge for LA collection.
- Illegal dumping.

LAs are most interested in the amount of waste discharged for collection. This may be expressed in terms of the **waste discharge rate** – the quantity of waste discharged for collection per person per day (kg waste/person.d). The waste discharge rate is always less than the waste generation rate.

The amount of waste discharged for collection also increases with economic growth. However, it is also strongly dependent on local conditions and the relative proportions of waste disposed of by other means.

The waste discharge rate may be used for SWM planning in a similar way to the waste generation rate. This is shown in the following example for Kandy:

### **Current situation:**

- 2001 population = 110,049.
- MSW 2001 waste generation rate = 1.18kg/person.d.
- MSW 2001 waste discharge rate = 0.84kg/person.d (also determined by survey).
- Current MSW discharge =  $110,049 \times 0.84 = 92,441 \text{ kg/d} = \mathbf{92.4 \text{ T/d}}$ .

### **Future situation (2012):**

- Estimated population growth rate = 0.97%.
- Estimated average economic growth rate (next 10 years) = 2.8%
- Estimated increase in waste discharge rate = 80% of economic growth rate = 2.2%.
- Expected population in 2012 =  $110,049 \times 1.0097^{10} = 121,202$
- Expected MSW discharge rate in 2012 =  $0.84 \times 1.022^{10} = 1.04 \text{ kg/person.d}$
- Expected MSW discharge in 2012 =  $121,202 \times 1.04 = 126,050 \text{ kg/d} = \mathbf{126 \text{ T/d}}$ .

**Increase in MSW discharged for collection = 36% in 10 years.**

## B.2.3 Waste Composition

### B.2.3.1 Physical Composition

The physical composition of solid waste also varies between different societies and with income, as shown below.

Table B-3: Household Waste Composition

Waste Type	Kandy	Matale	Auckland, New Zealand	Tokyo, Japan
<b>Compostables:</b>				
• Food/kitchen	69.9	66.5		26.6
• Grass/wood	11.7	15.7		9.0
• Total	81.6	82.2	53.5	35.6
<b>Recyclables:</b>				
• Paper	6.9	7.0	22.0	52.5
• Plastic	5.1	3.6	8.5	6.9
• Glass	1.1	1.3	4.1	0.2
• Metal	1.0	0.4	3.9	0.4
• Textile	1.1	1.3	---	4.0
• Demolition	---	---	5.1	---
• Total	15.2	13.6	43.6	64.0
Hazardous	--	--	0.5	--
Other	3.2	4.2	2.6	0.4

**Notes:**

1. Kandy and Matale data from JICA survey (2002).
2. Auckland, New Zealand data from 1998-99.
3. Tokyo, Japan from 1999

### B.2.3.2 Other Composition Data

The following composition data is also useful in SWM:

- Waste bulk density: used for selecting and sizing garbage storage containers, public bins and collection vehicles and for converting vehicle trips data to tonnages.
- Moisture: used for looking at treatment options, especially composting and incineration.
- Carbon:nitrogen ratio: useful for composting.

## B.2.4 Summary and Implications for Sri Lanka

The following table summarises typical waste generation and composition data for developing and developed countries.

Table B-4: Comparative Waste Generation and Composition Data

Item	Developing Country	Developed Country
Waste generation (kg/person.d)	0.3 – 1.0	1.5 – 2.5
Waste composition:		
• Compostables	40 – 85	20 – 50
• Recyclables	7 – 45	25 – 80
• Other	1 – 40	1 – 20
Bulk density (kg/m <sup>3</sup> wet wt)	250 – 500	100 – 170
Moisture content (wt %)	40 – 80	20 – 30

Sri Lankan waste generation and composition lies within the typical range for developed countries.

Sri Lankan MSW is:

- Highly organic and moderately wet. Hence, it is suitable for composting BUT composting costs money. Typical investment costs for a windrow compost plant processing 4T/d of garbage are 3.6M Rs, while operation and maintenance costs are around 500Rs/T of waste composted. Even more importantly, you must develop and prove the market – this is the MOST difficult part. You must think and plan very carefully before embarking on a composting project – there are many failed composting plants around Sri Lanka!
- Contains much less recyclables than in developed countries. In fact, the traditional recycling system in Sri Lanka, based on individual collectors visiting households, shops, etc. and collecting recyclable items which they sell to middlemen for subsequent reuse/recycling works very, very well. Most valuable recyclables (metals, glass bottles, hard plastics, some paper) are already being recovered, leaving mainly less valuable recyclables to be collected by the LA – dirty paper, soft plastics and some textiles.
- Relatively dense. This means that collection by compactor truck is less appropriate than in developed countries where the waste is less dense.

However, Sri Lanka is becoming more urbanised and the economy is growing. Hence, waste generation will increase and the composition will change. Your waste will gradually become less organic, while the proportion of recyclables will increase. Hence, SWM will have to change – incineration may become more feasible while recycling will become more important. SWM is a dynamic field!

## **B.3 Objectives of Solid Waste Management**

SWM may be broadly considered to have two main objectives:

- Sanitation.
- Environmental protection.

Good SWM is essential for protecting people's health and the sustainable development of the town/city. LAs are responsible for achieving these objectives at the minimum cost. **Hence, through your work, you are contributing greatly to society.**

### **B.3.1 Sanitation**

Sanitation is the most fundamental SWM objective. It involves the following:

- Protecting human health.
- Protecting public places/private property from nuisance/danger (e.g. obstruction, odour, vermin, fire).
- Keeping the town/city clean.

In achieving these objectives, the LA and/or their contractor must provide an effective/efficient garbage collection and disposal service for the minimum acceptable cost.

Many people in developing countries have a low awareness of the health problems that can be caused by garbage. In fact, people are the dominant cause of garbage related problems. For example, in Sri Lanka, it is very common for people to discharge their garbage:

- In any container or none.
- At any time, even recently after a collection vehicle has passed.
- At any place, including at the roadside, into drains, onto vacant land, public land or in waterbodies.

The public seems to expect the LA to collect their garbage regardless of how or where or when they throw it. However, such practices and attitudes combined with the lack of a garbage collection service or infrequent/unreliable collection result in health and environmental problems and make the town/city look dirty.

The main health/environmental risks associated with poor SWM are listed below:

- Organic waste rots quickly and smells. If it is thrown anywhere, flies, rats and other pests come. They spread diseases such as typhoid, cholera, and can also cause diarrhoea, eye problems, skin disease, etc.
- Waste thrown into drains blocks them, causing them to fill up with water. This will cause floods during heavy rains.



- Insects, especially mosquitoes, breed in the stagnant water. These cause disease, especially malaria, filaria and dengue.
- Water gets trapped in tins, plastic bags and tyres that have been thrown away - more mosquitoes, even more disease.
- Water that touches garbage becomes polluted, including water in blocked drains, rain which passes through waste (leachate), any streams, rivers, lakes and wells with garbage thrown into them. Using such water can make you sick. It can also kill or poison fish.
- Some waste is dangerous – rusty tins, broken glass, hospital waste (syringes, needles, etc.).
- Other waste is hazardous. It may explode (e.g. aerosol cans), be poison or toxic (e.g. household cleaners), give off dangerous fumes if burned (e.g. tyres, PVC), or leach harmful chemicals into the environment (e.g. batteries).

### **B.3.2 Environmental Protection**

Good sanitation should provide many benefits to many people within the town/city: clean neighbourhoods – reduced disease – healthy life – beautiful environment.

However, often the collected garbage is got rid of by dumping at one place, usually in the open with no soil cover being applied or any other environmental protection measures being taken (**open dumping**). This creates serious hardship for people living near the disposal site – their homes are full of flies, their children get sick more often and they have to put up with the smell of rotting garbage and the fumes or smoke from burning garbage.

As society develops, more waste is generated, making the disposal problem worse. At the same time, the general public becomes more educated, aware and vocal, while national and state environmental legislation becomes increasingly strict. Together, these factors often lead to the LA taking or being forced to take action to “protect the environment”, particularly in relation to the negative environmental, social and health effects associated with poor landfilling. This requires gradually improving landfilling standards, as follows:

- Discontinuing open dumping.
- Implementing **controlled tipping**, which at the very least involves applying soil cover to the waste daily.
- Progressing to **sanitary landfilling** over a number of years, involving site security works, leachate treatment, landfill gas management, stormwater/groundwater management, etc.

Better SWM for environmental protection requires significantly more money and resources than just for sanitation. In particular, sanitary landfilling is expensive. At the same time, the general

public are both willing and disciplined enough to cooperate with the LA in SWM. Hence, the LA should encourage **public participation** in SWM (e.g. discharging waste according to rules, using litter bins, sweeping the road outside their homes, etc.) as a means of reducing their SWM costs, whilst raising public awareness at the same time.

Environmental protection also involves taking a broader perspective – looking at how we can minimise waste by:

- Reducing the amount of waste generated.
- Reusing waste materials as much as possible.
- Recycling waste materials into new useful items.
- Recovering energy from waste materials.

Waste minimisation requires public, LA, voluntary/non-governmental organisations and private sector cooperation in order to be successful. Examples of waste minimisation activities include the bottle deposit scheme currently operating in Sri Lanka, avoiding the use of polythene bags, source separation of garbage for subsequent recycling, home or centralised composting, etc.

## B.4 SWM – A Changing Field

A SWM system may be divided into a number of components as set out below.

Table B-5: SWM System Components

SWM Component	Description
Generation	Production of all waste by different sources.
Storage and Discharge	<ul style="list-style-type: none"> <li>Storage: generated waste is stored within the property of the people producing it for some time before discharge.</li> <li>Part or all of the waste generated is put out for collection either within the property of the source itself (e.g. local hotels, some institutions) or outside their property.</li> <li>Storage may also sometimes be used to refer to waste discharged into public bins or stationary trailers for subsequent collection.</li> </ul>
Collection and Transportation	Discharged waste is collected by the LA and/or their contractor for transportation to processing/treatment and final disposal.
Processing and Treatment	Some (often none) of the discharged waste may be transported for processing and treatment – e.g. materials separation and recovery, centralised composting, biogas generation, etc.
Disposal	Most (often all) of the collected waste is discharged at the final disposal site.

### B.4.1 Traditional SWM

Traditionally, SWM was just about collecting waste, carrying waste and disposing of waste. This was sufficient when:

- The waste discharge amount wasn't large.
- The waste was mainly biodegradable.
- The objective was only sanitation.

### B.4.2 Modern SWM

The situation in SWM has completely changed now for many reasons:

- The waste discharge amount has become very large, due to population growth and increasing waste generation per person.
- The waste composition is changing – it is becoming less biodegradable, while the amount of non-biodegradable wastes – paper, plastics, metal, glass, etc. - is increasing. This trend will continue.
- New things have been invented, which eventually become waste and which have created new SWM problems – e.g. polythene (silisili) bags, disposable nappies, computers, mobile phones, etc.
- Roading and drainage have been improved, which has made waste scattering more visible, ugly and problematic.

- People's concerns for the environment have been raised.
- People are getting more selfish.

In modern SWM, the LA has to fully utilize not only its own employees and collection vehicles but also public/private participation as much as possible. This includes:

- Citizens.
- Voluntary organisations (e.g. Lions).
- Non-governmental organisations (NGOs).
- Business and industrial enterprises.

Obtaining public/private sector participation is most effective up the point of waste discharge. LAs are generally responsible for waste from the point of discharge onwards.

Determining how to encourage public/private parties and gain their cooperation in SWM works is a major part of your job now and will become more important in the future.

## B.5 SWM Tasks

### B.5.1 Overview

SWM is an inter-disciplinary subject, requiring knowledge and experience in the following areas:

- Legislation.
- Management.
- Social aspects
- Finance and economics.
- Engineering (civil, mechanical, chemical, environmental).
- Health/sanitation.
- Environment.

One person can not handle all these tasks by themselves. Hence, strong organisation and good cooperation between different sections within the LA is important.

The following table gives an overview of the LA personnel involved in SWM and their responsibilities in terms of planning timeframes, geographical areas and work tasks.

Table B-6: LA Personnel involved in SWM and their Roles

Position	Responsible Timeframe	Responsible Area	Responsible Tasks
Mayor, Commissioner, MOH, ME, CPHI, Accountant	1 to 5 year plan	All LA, even outside LA limits	<ul style="list-style-type: none"> <li>• Policy making, including bylaws.</li> <li>• SWM planning, budgeting and accounting.</li> <li>• Staff training.</li> <li>• Liaison with central government and CEA on SWM issues.</li> </ul>
CPHI, PHI	Monthly plan	All LA	<ul style="list-style-type: none"> <li>• Execution of SWM works.</li> <li>• Supervision of supervisors.</li> <li>• Liaison with public.</li> </ul>
Supervisor	Weekly plan	Responsible area (collection zone)	<ul style="list-style-type: none"> <li>• Supervision of foremen/labourers.</li> <li>• Liaison with public.</li> </ul>
Foreman (Kangani)	Daily plan	Responsible area (collection sub-zone)	<ul style="list-style-type: none"> <li>• Supervision of labourers.</li> <li>• Liaison with public.</li> </ul>
ME, SW, TO, Mechanic	Daily plan 1 to 5 year plan	SWM vehicle fleet	<ul style="list-style-type: none"> <li>• Daily vehicle repairs/maintenance;</li> <li>• Vehicle replacement planning.</li> </ul>
MOH, DEO, CDO	Daily plan 1 to 5 year community development/ education plan	Community development/ education	<ul style="list-style-type: none"> <li>• Community, voluntary organisation and NGO participation in SWM.</li> <li>• Public education/awareness raising.</li> </ul>

**Notes:** CDO = Community Development Officer, CEA = Central Environment Authority, CPHI = Chief Public Health Inspector, DEO = Divisional Environment Officer, ME = Mechanical Engineer, MOH = Medical Officer of Health, SW = Superintendent of Works, TO = Technical Officer.

### B.5.2 Being Part of an Organisation and Team

PHIs, supervisors and foreman are part of an organisation (LA), a team (Health department) and have an individual job to do. Your job in SWM involves a wide variety of tasks, involving both individual and team work and dealing with other sections of the organisation.

Your ability to do your job requires:

- An effective organisation. An organisation is only as strong as its weakest link. The main parts of the organisation related to SWM are the Mayor, Council members, senior LA management, PHIs, supervisors, labourers, vehicles and equipment, workshop and stores. How strong is this chain in your LA? Which are the weakest links and why? Can anything be done to strengthen these weak parts.
- A good team. Good team work requires appropriate leadership, clear objectives and goals, agreed and understood procedures, fair allocation of work, active participation (by all), commitment, cooperation and support, honesty, openness and trust, self-review and an expectation of success. How good is your team? Where do you see yourself and others in your team in the following picture?; how could your team be improved?



Figure B-1: The LA "Bus" – Who are You?

### **B.5.3 PHI and Supervisors Job**

Every LA should have service conditions which set out the job conditions and requirements for all SWM staff – PHIs, supervisors, drivers and labourers.

Your job involves a combination of knowledge, experience, personal qualities and skills. A **skill** is something you do well. Your job involves many important skills, including communication; organising and directing; planning and time management; problem solving, negotiation, and conflict resolution; disciplining, motivating and giving praise and due recognition. Most of these skills are related to leading and managing subsidiary staff and the vehicles and equipment they need to do their jobs.

#### **B.5.3.1 Organising and Directing**

Organising and directing basically involves allocating and following up work, as follows:

- Assign authority and responsibility to the appropriate person (e.g. supervisor, foreman, driver).
- Give clear job instructions – who?, what?, how?, by when? and check these have been understood.
- Provide support, resources and followup.
- Check the task has been completed.
- Check if there are any problems, conflicts or other issues.
- Make sure you use appropriate forms of communication (e.g. oral or written).

Most LAs have established systems and procedures to make this process straightforward. For example, the typical daily cleaning routine involves a muster at the start of the day, where attendance is checked and the day's work is allocated by the PHI or Supervisors. Instructions are then given to the foremen, drivers and labourers and the work is then done. Problems and results are reported and another muster is carried out at the end of the day. It is important to consider:

- Are these current systems and procedures adequate?
- Are they followed? If not, why?
- Can they be improved? How?

#### **B.5.3.2 Daily Planning and Time Management**

Daily planning and time management are vital in many jobs, including yours! You should write out a "things to do" list and prioritise different tasks. Keep a "time log", checking what you did against what you had to do. Record reasons for not doing certain things and comments on how

you might improve. This process helps you to understand yourself, how you work now and how you might work better.

Not doing tasks or putting them off is most likely to occur with problems or things that we see as being difficult, inconvenient or scary. We may also think that what we can do individually will not make any difference – the whole problem is too big and difficult! The net results of such thinking are usually wasted time, missed opportunities, poor performance, self-blame and increased stress or conflict.

Some common remedies to putting things off include:

- Write down “excuses” and “realistic thoughts” side by side.
- Use positive self-statements.
- Don’t think the worst.
- Break down tasks into small manageable parts.
- Get organised.
- Take a stand.
- Use prompts (e.g. reminders in your diary, notes on a whiteboard, etc.).
- Reward yourself, after you have done it.

Do it now!

### B.5.3.3 Problem Solving and Negotiation

You will come across many problems in your job, which require solving. The following steps may be useful for this:

- Clarify and reach agreement on the problem(s).
- Look at the ideal outcome.
- List and choose options.
- Decide on the best option and make a plan for implementing it (who?, what?, by when?).
- Implement the plan:
  - Solved – good!
  - Not solved – revise the plan and implement again.
  - Too hard for now – put aside for later.
- Provide feedback to relevant people.

Try not to put off the problem – they tend to get bigger rather than just go away!

In making decisions during this process, it is important to wait until essential facts are available and then to decide. If you decide too quickly, the resulting decision may be poor; if you wait until all the facts are available, the resulting decision may be useless. How are decisions made in your LA? Can this process be improved?



#### B.5.3.4 Conflict Resolution

Conflict, whether we like it or not, is a part of life. Conflict is due to perceived difficulties between two or more parties that results in opposition.

Common thinking sees conflict as being harmful or undesirable and thus to be avoided or eliminated. This leads to a deterioration in working relationships first between those directly involved, then with other team members taking sides, leading to decreased motivation, productivity and effectiveness.

New thinking regards conflict as being inevitable and hence it must be managed. Conflict, if resolved, can help to develop relationships, sort out problems and increase motivation and energy.

Resolving conflict often involves some form of confrontation. A potentially useful approach to confrontation involves the following steps:

- The problem: Name the behaviour. Use non-personal language. What is the other person doing?
- Role definition: Define your role in dealing with this person/situation so that everyone is clear. “In my job as supervisor for this area, .....”; “with the responsibility I have for supervising drain cleaning works within the LA,.....”
- Do your homework:
  - Who is involved? – public, MC workers, MC mgmt, Council members, etc.
  - What do LA bylaws/procedures/practice say on this matter?
- Set the context:
  - When someone is clearly in the wrong, be clear about what you are going to tell them. E.g. “I want to tell you that when you are absent from work without applying for leave in advance, this will be a no-pay day for you and it will be recorded on your record”; “I want you to go home today because you are drunk and I am going to write a letter about this to go on your file. If this happens again, then we will suspend you”.
  - When the situation requires some compromise/accommodation, establish the context for a both-win conversation. Be clear about what you want as a result. Try to figure out what the other(s) may want also. State your goal in terms of a solution, not problem. E.g. PHI to supervisor “I am aware your wife is sick but this if the third time you have been absent from work without informing us in the last two weeks....”.
- Do you want a plan? No – just a sharing of feelings. Yes – something needs to happen as a result of this conversation. Will there be consequences if the plan is not followed? What do you think they will be? What will your next step be?

- Decide what you will do if there is no cooperation. Don't fight your inside and the outside at the same time.
- Be prepared - decide before you even open your mouth, what the bottom line is.
- Practise your first line. Write it, say it, think it. It's OK to share your concerns as an opener: "I'm worried about...".
- Have the conversation.
  - Listen well to the other person(s).
  - Maintain your balance (regardless of the other persons' behaviour).
  - Don't let personal feelings or thoughts come through when expressing yourself as a LA worker.
- Followup: record the results of the conversation. Copy to relevant people and file. Followup anything you need to check with the LA or other authorities.

In resolving conflict, some simple rules for "fair fighting" should also be followed:

- Hit "above the belt": keep on the topic of discussion and don't throw in other gripes; don't call them names you wouldn't like to hear used against you; don't get personal; don't get angry; watch for impacts.
- Practise good timing: do it more often rather than saving it up; do it long before you burst; choose the right time to do it.
- Be clear: state things simply; own what you say; invite questions; clarify and summarise as you go.
- Be specific: focus on behaviour rather than judgments and assumptions; focus on the here and now and the future – don't focus on "spilt milk" (the past); look at one thing at a time.
- Be assertive<sup>1</sup> when necessary and be cooperative when necessary.

Ideally, conflicts should be resolved in ways which avoid giving offence and maintain respect for all parties. If the going gets tough, some useful tips are listed below.

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<sup>1</sup> An assertive person is one who can state clearly and calmly what they want to say, does not back down in the face of disagreement and is prepared to repeat the point if necessary.

Table B-7: Handling Conflict – When the Going Gets Tough

Situation	Response
When they have all the power	Figure out what your best alternative is. Use threats if they are believable and can be carried through. Make sure you know your facts. Appeal to their sense of fairness.
When they won't cooperate	Keep them talking about their interests/concerns. Reinforce your willingness to cooperate with them Ask them if they will cooperate with you. Check if their bottom line is absolute. Ask questions. Use silence.
When they attack verbally	Use their attack as a basis for building suggestions. Ask them for options. Restrain anger. Redefine personal attacks onto the problem.
When they use dirty tactics	Talk about the process before you talk about the content. Focus on principles. Withdraw and give them time to think about it. Call in a neutral mediator.

#### B.5.3.5 Discipline

Discipline involves acting against bad behaviour to show that it is not acceptable. It may involve warnings, punishment, fines, etc.

Discipline in LAs generally seems to be poor, especially of labourers, and as the size of the LA increases. However, discipline is also often poor higher up in the organisation.

Discipline requires set rules and procedures for dealing with bad behaviour, which staff must be informed of and which must be implemented – otherwise, staff will know they can do what they like. Transferring problematic staff from one section to another may help, especially if accompanied with a warning, but sometimes simply shifts the problem elsewhere. Instead, strong management by the PHIs and supervisors is required, with support from LA management (Commissioner, MOH) and the Mayor and Council members. If any one of these factors is missing, failure is likely. How do you rate disciplining within your LA?

Two examples of how different LAs have improved labourer discipline are described below:

- In Balangoda UC, the PHI monitored labourer absenteeism for three months and then presented the results to a Council meeting, recommending that the labour force should be privatised due to the high absentee rate. This was supported by the Council and subsequently done, with UC labourers being transferred to other duties. Formal discipline procedures were then followed to get rid of bad labourers, resulting in a gradual reduction in UC labourers from 23 to 11. The remaining UC labourers work well.
- Chilaw UC took a tough approach to life labourer performance. This included preparing:
  - Service conditions and a duty roster for drivers.

- Making workers apply for leave in advance.
- Following a formal documented discipline procedure, issuing letters asking for explanation of poor behaviour, followed by warnings and dismissal.
- Frequent inspections of the town, marking labourers as absent if not found in their workplaces.
- Poor performing tractor labourers were swapped with drain cleaners.
- A drunk driver was sent home on “no pay” for 10 days.

#### **B.5.3.6 Motivation, Praise and Recognition**

Many people don't like the term supervision. It is often seen negatively, as checking up what is going wrong. This definition needs to be expanded to look at what people are doing right as well.

Valuing labourers improves working relationships and helps to lift their self-esteem and build self-respect. Tell them when they have done a good job and reward them for work well done (e.g. certificate for best labourer of the month, monthly award for cleanest area of the town to the supervisor and labourers working in that area).

It is also important to protect their health and safety. Supply them with appropriate equipment and safety devices (e.g. bright coloured aprons, boots, gloves, etc.) and provide them with free periodic medical checkups.

Give them some input into SWM, through periodic orientation, seeking their ideas and comments when considering changes to the current system, and inviting nominated representatives to “vertical meetings” involving all relevant people from senior management and Council members to labourers.

#### **B.5.4 New SWM Tasks**

Traditionally, the main focus of the SWM tasks undertaken by PHIs, supervisors and foremen has been staff and equipment supervision and management, as described above. New SWM tasks include:

- Reducing waste scattering.
- Improving garbage collection efficiency.
- Improving final disposal (sanitary landfilling).
- Improved healthcare waste management.
- Reducing SWM costs.
- Increasing public participation.
- Public education/awareness raising.
- Improved record keeping (performance monitoring).

Many of these tasks are inter-related. They require the same or new skills to those discussed above. Each task is addressed in the following sections of this manual.

## **B.6 Reducing Waste Scattering**

### **B.6.1 Strategy**

Waste scattering is a widespread problem throughout Sri Lanka. The following table sets out a strategy for addressing waste scattering that is relatively low cost and which relies on increased public participation to work.

**Table B-8: Strategy for Reducing Waste Scattering**

<b>Type of Waste</b>	<b>Prevention Measures</b>
1. Residential, commercial, market, institutional and industrial wastes	Establishment of new waste discharge system <ul style="list-style-type: none"> <li>• Bell collection</li> <li>• Kerbside collection</li> <li>• Door to door collection</li> <li>• Public waste bin collection</li> <li>• Handcart bell/horn collection</li> </ul>
2. Littering by pedestrians	Fixed public litter baskets for busy streets
3. Waste at parks, bus stations, etc.	Fixed public litter bins
4. Festival, special events, etc.	Movable public litter bins

### **B.6.2 Establishment of New Waste Discharge System**

Most towns/cities in developed countries are generally very clean even though there are few street cleaning workers and garbage collection is less frequent than in Sri Lanka. Why is this? The main reason is that these towns/cities have appropriate waste discharge rules linked to an efficient waste collection and disposal system. Public participation is good - almost all people are disciplined enough to follow these rules or know they will be punished if they don't comply with these rules. Similarly, the LA performs its duties well, collecting the discharged garbage on time and according to schedule.

Street cleaning, waste collection and drainage cleaning works are very easy if there is not much waste scattering – the town/city can be kept clean with relatively little work.

Hence, establishment of waste discharge rules in Sri Lanka can greatly reduce waste scattering, make garbage collection and road/drain cleaning much easier, leading to reductions in SWM costs. It will also make the introduction of any future source separation garbage collection system easier.

### B.6.2.1 Causes of Waste Scattering

The main causes of waste scattering are:

- People discarding litter/garbage at the roadside, in drains, on vacant or public land (parks/playgrounds), in streams, etc.
- Animals (dogs, goats, cows, crows, etc.) searching for food amongst the waste, scattering it in the process.
- Wind and rain, resulting in further waste scattering.

### B.6.2.2 How to Prevent Waste Scattering

Waste scattering can be prevented by asking people:

- Not to discard litter/garbage at the roadside, in drains, parks, streams, etc.
- To keep their waste within their premises until specified waste collection days.
- To discharge it for collection in a manner appropriate to the collection system and schedule operating in their area.

These are not special rules. People are following such rules in all developed countries such as England, Japan, Australia, etc. Why can't we do this?

### B.6.2.3 New Waste Discharge Rule

The main concept of the new waste discharge rule is to minimize the time between garbage discharge and collection, that is, the time that garbage is left outside peoples' premises, exposed in public spaces like at the roadside or in public garbage bins. People should keep their garbage within their premises as long as possible, ideally bringing it out directly to the collection vehicle as it passes their property or placing it out for collection a short time beforehand.

Such a new waste discharge rule also means a new collection system is required.

This concept can be implemented as follows:

- Prepare a waste discharge rule describing what citizens are required to do and what they must not do. Careful thought should be given to formulation of this rule. Examples of 1-2 waste discharge rules are given in References.
- Select areas of the town/city where the new collection system is to be introduced. A step by step approach is generally recommended, according to the LA's resources and capability and the size of the town/city. In deciding on the size of the first stage, the LA should consider the minimum number of collection vehicles it will ALWAYS have available for collection, allowing for vehicle breakdowns, driver absenteeism, labourer absenteeism, etc. Stage one

- areas can then be selected so that the LA should always be able to satisfy the requirements of the new collection system in these areas.
- Select specific waste collection days for different areas of the town/city. A collection frequency of 2-4 times per week is satisfactory for most residential areas. Ideally, the collection time should also be stated, usually expressed as a time range between which garbage should be discharged (e.g. 0800 – 1200).
  - Inform all people within designated “new collection system” areas of the waste discharge rule, the collection method and specified waste collection days and times for their area. This may be done using a wide range of methods including:
    - Via the Grama Sevaka Officers
    - *Community/public meetings.*
    - Informing people through religious places (e.g. temples, kovils, churches, mosques).
    - Using vehicles with loudspeakers.
    - *Distributing leaflets to all households.*
    - Installing public noticeboards.
  - In each area, people are only allowed to discharge their garbage:
    - *on the specified collection days.*
    - *within the specified time period.*
    - *in accordance with the given collection method.*
  - *The LA has to collect waste in accordance with the collection schedule. If this schedule is changed, even temporarily, people have to be informed of the revised schedule in advance. This is very important – the LA is asking the public for their increased participation in SWM, while the proposed changes to the collection system mean that the public will expect a more reliable and efficient garbage collection service. However, if the LA does not keep to the collection schedule, the public will think there is no point in cooperating and nothing will change for the better. The situation could actually become worse than before! Both the public and LA must fulfil their duties for this system to work.*
  - In the early stages of introducing the new waste discharge rule, many citizens may complain to the LA due to the inconvenience of the new rule. The LA should not give in to such people and collect their waste according to the old method. Instead, they should try to educate them – telling them about the many problems of the old system and the benefits of the new system.

Council members should also support their staff in this, making decisions consistent with the new rules.

#### **B.6.2.4 Discharge Rules for Difficult Wastes**

LA collection workers often complain about the difficulties of collecting tree cuttings/garden waste, construction/demolition waste, healthcare wastes and some industrial hazardous wastes.

Discharge rules should be established for tree cutting/garden wastes and construction/demolition waste, making it an offence to discharge such wastes for collection with normal garbage. Instead, such wastes should be collected separately by the LA on payment of a specified fee. This system must be enforced rigorously to work.

The discharge of very unsanitary wastes (e.g. human and animal excrement) should also be prohibited.

Healthcare waste management is discussed in more detail in a later section.

Domestic, commercial and institutional hazardous wastes are currently relatively few in number, comprising typical everyday items – batteries, spraycans, fluorescent tubes, etc. - but can be expected to increase in the future with increasing urbanisation. Consideration should be given at some future stage to collecting these wastes separately, particularly from any mixed garbage that is to be subsequently composted.

Industrial hazardous waste (e.g. roofing manufacturers → asbestos, boat builders → fibreglass) is generally site specific and discharge and collection arrangements should be made on a case by case basis.

#### **B.6.2.5 New Garbage Collection Methods**

The current garbage collection system in most towns/cities in Sri Lanka involves the LA collecting waste from wherever it is discharged, including at the roadside, in drains, public bins, etc. This Study found that loading takes up an average of 60% (range = 47-78%) of the total collection round time in all seven study towns. This is very high.

Hence, new garbage collection methods should be introduced at the same time as the waste discharge rule to improve the effectiveness and efficiency of garbage collection.

Typical garbage collection systems are described below.

##### **1. Vehicle Bell Collection**

This is a music based collection method, where garbage collection vehicles play “special music” as they collect garbage. The music is usually provided by a speaker/amplifier unit powered by the



vehicle battery<sup>2</sup>.

When people hear the music/horn, they should bring their garbage out from their premises and hand it directly to the collection vehicle workers.

If they are not going to be home on the scheduled collection day, they should place their garbage outside their premises in a closed bag/container ONLY on the morning of the collection day, ideally just before or within the specified collection time period.

This method is suitable for most areas of the town/city, provided they are accessible to motorised vehicles (handtractors, tractors, lorries, compactor trucks). It is not suitable for areas with multi-storey apartments or where few people are home during the collection time.

## **2. Kerbside Collection**

This method involves people placing their garbage outside their premises in a temporary or permanent closed container ONLY on the morning of the collection day. The collection workers will pick up these containers and empty them, returning any permanent containers to the point from where they were picked up.

This method is suitable for most areas of the town/city provided they are accessible to motorised vehicles.

## **3. Handcart Bell/Horn or Kerbside Collection**

In areas of the town/city that have narrow or congested roads, handcarts are often used for collection. Both of the above methods may be adapted for handcart collection:

- Bell/horn collection: the handcart may play a special horn or bell, with residents bringing their garbage out when they hear the bell/horn. The bell/horn may be a manual or battery powered device.
- Kerbside collection: as for No.2 above.

Normally, handcarts must transfer their loads to a tractor, lorry or compactor for transportation to the disposal site. The transfer step should take minimum time and effort, as discussed later. Generally, a stationary trailer should be used for this purpose (see No.6).

## **4. Door to Door Collection**

This method involves the LA labourers entering the premises, collecting garbage from a storage area and emptying it into the collection vehicle. This method is commonly used for large waste generators (e.g. local hotels, tourist hotels, schools and other institutions, industries) and/or potentially odorous waste (e.g. fish/meat waste from local hotels/markets).

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<sup>2</sup> As handtractors have no battery, either a battery must be fitted or an alternative sound producing system

## 5. Public Concrete Bin Collection

This method involves people carrying their garbage to a public concrete bin ONLY on the morning of the specified collection day(s). The garbage should be discharged into the bin in a closed disposable container (e.g. plastic bag). It should NOT be discharged loosely into the bin, as this makes subsequent collection difficult.

This system is suitable for densely populated areas and/or where handcart/vehicle access is difficult. In general, most people are willing to walk up to 50m to discharge their garbage into the nearest bin, while a reasonable number may be willing to walk as far as 100m.

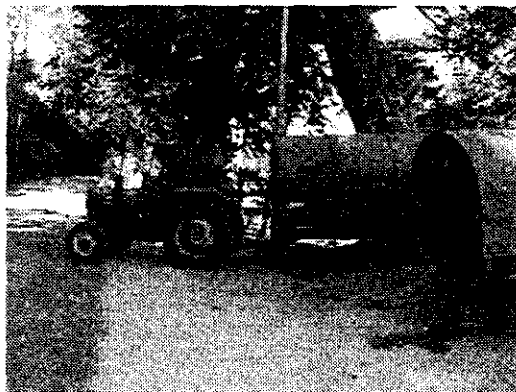
Problems associated with this system are described in the next section.

## 6. Stationary Trailer System

This is similar to the public concrete bin system, except that in this case, a stationary trailer is parked at a particular location on specified collection day(s) and/or times and people are required to discharge their waste into the trailer. The LA will subsequently come and remove the trailer for emptying. Any garbage discharged on the ground when the trailer is absent should not be collected.

Ideally, the stationary trailer should be a covered trailer to reduce nuisance while standing and waste scattering during transportation.

This system is suitable for densely populated and/or congested areas, including commercial areas, markets, etc. and for the transfer of handcart waste.



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used.

### B.6.2.6 How To Reduce the Number of Waste Scattering Sites

#### 1) Take appropriate action for each waste scattering site

Each waste scattering site will have different causes, such as:

- Nearby residents not following the garbage discharge rules.
- Outsiders from areas with no garbage collection service, dumping their garbage within the city limits at night time from their vehicles.
- Labourers refusing to collect the garbage due to very unsanitary wastes (e.g. human excrement) being mixed with normal garbage.
- Infrequent or irregular collection by the LA.

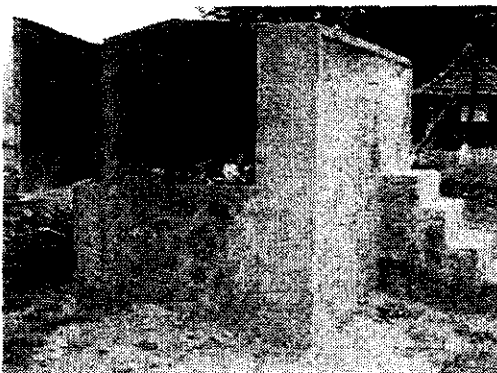
The number and location of waste scattering sites should be identified within each collection zone. Supervisors and foremen should then investigate these sites one by one to find the main causes and determine appropriate remedial actions.

#### 2) Reduce the number of public garbage bins

Public garbage bins are often difficult to empty, taking around 20-25min or longer to transfer the garbage from the bin to the collection vehicle. They are also very difficult to maintain clean and can quickly turn into mini-dumps, annoying nearby residents. Hence, the LA should consider the necessity for public garbage bins, one by one, and try to reduce the number of public garbage bins as much as possible.

In general, there should be no need for public bins in areas where the new waste discharge rule and bell/kerbside collection system are introduced. Such bins may be useful for housing scheme areas, or at junctions where several small, inaccessible byroads meet.

Where such bins are needed, it is recommended that enclosed bins be installed. These are like a box, with access steps, a hatch on the top for dumping waste inside, and an elevated side door for easy emptying.



### **B.6.3 Public Litter Baskets/Bins**

Public litter baskets/bins help to reduce waste scattering and the collection/street sweeping/drain cleaning work load. Some important factors to consider are listed below:

- These baskets/bins are for **litter** – e.g. lunch packet leftovers, lottery tickets, food packaging, etc. – not for garbage.
- The baskets/bins should be small-medium sized. Otherwise, people may discharge their household garbage into them as well, causing the bin to overflow and waste scattering.
- Both the size of the bin/basket and distance between them depends on how busy the location is. For example, Kandy Lake surrounds may require 40L bins at 25m intervals near the bus stand and Temple of the Sacred Tooth Relic, while 25L bins at 25m intervals may suffice for other parts of the Lake.
- The baskets/bins must also be emptied often. Hence, too many baskets will increase the collection work.

The final number, size and location of baskets/bins must take all these factors into account.

It is a good idea to paint these bins/baskets a common colour, so that people can recognise them instantly as litter bins. It may also be useful to show some or all of the following items on the bin:

- LA name.
- Litter bin logo or a simple slogan – e.g. “Keep our city clean”.
- Unique bin number.
- Date of issue (useful for checking the bin lifetime).

Words should be shown in English, Sinhala and Tamil as appropriate for the area. The bin number, date of issue and bin location should be recorded by the LA.

Consideration should be given to minimising the possibility of the bins/baskets being stolen, particularly if plastic bins are to be used. Preventive measures include:

- Fixing the bins in the ground (concreted post) or to a permanent structure, where possible and appropriate.
- Putting holes in the bottom of the bins. This is appropriate for metal bins and is also useful for draining any water from the bin.
- Making a nearby resident/shop owner responsible for the bin, with their name being recorded by the LA alongside the bin number, together with their signature, acknowledging this responsibility.

### B.6.3.1 Fixed Litter Baskets in Busy Streets

These are small baskets installed at regular intervals along busy streets.

- The baskets should be relatively small – typically 20-40 litres.
- They should be installed within relatively short distances of each other – typically 25-50m, making them easy and convenient for people to use.
- The baskets should be designed or used to simplify emptying. Common ways of doing this include:
  - Having a bottom that can be opened.
  - Having a detachable basket mounted on fixed supports.
  - Fitting a removable liner within each basket, which can be lifted out, emptied and replaced.

Only one person should be required to lift a full 20-40L basket (typical full weight = 8-20kg).



### B.6.3.2 Fixed Litter Bins for Parks, Bus Station, etc.

These are medium sized containers installed permanently (**i.e. fixed**) at busy public places (e.g. parks, children's playground, near temples, bus station, market, etc.).

- They should be about 60 to 100 litres in size. Hence, half metal barrels (100 L) are often used to make such bins.
- The top of the bins should be a certain height above the ground to prevent waste scavenging by animals. A suggested height is around 1m.
- As the bins are fixed in place, they should be designed to simplify emptying. This can be done by:
  - Letting the basket sit on fixed supports, so that it can be lifted up and emptied.
  - Fixing the basket on a rotating axle so that it can be rotated through 135-180° for emptying.

- Fitting a removable liner which can be lifted out, emptied and replaced.

One-two people may be required to empty a 60-100 L bin, depending on the emptying method (typical full weight = 12-40kg).

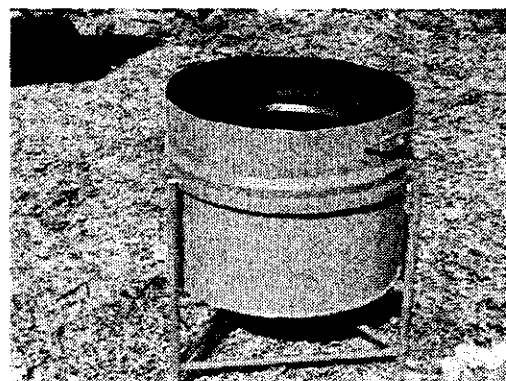
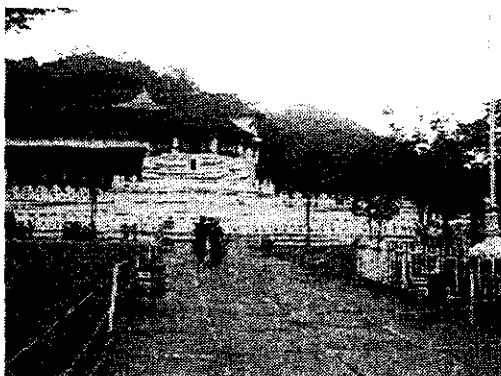


### B.6.3.3 Movable Litter Bins for Festival, Events, etc.

These are medium sized containers that can be shifted between locations. They are ideal for use when litter generation in a particular area increases dramatically due to special events (e.g. festivals, sports events, etc.). The bins should be put in place before the special event starts and be removed after it finishes. Generally, these bins require frequent emptying.

- These bins should be about 60 to 100 litres in size. Hence, half metal barrels (100 L) are often used to make such bins.
- The top of the bins should be a certain height above the ground to prevent waste scavenging by animals. A suggested height is around 1m.
- As the bins are movable, they are generally emptied by manually lifting them out of their support frame and emptying the bin. Alternatively, a removable liner may be fitted, which can be lifted out, emptied and replaced.

One-two people may be required to empty a 60-100 L bin, depending on the emptying method (typical full weight = 12-40kg).



## B.7 Improving Garbage Collection Efficiency

Garbage collection currently takes a long time due primarily to:

- Poor garbage storage/discharge. For example, garbage discharged loosely at the roadside or in public bins must be loaded again by LA labourers into collection vehicles. Often, it takes around 20-25min to transfer the contents of a full concrete bin into a tractor trailer.
- Inappropriate waste transfer from handcarts to tractor trailers. Typically, handcarts discharge their loads on to the ground, meaning it must be reloaded into the trailer. This transfer process takes at least 5min.
- Inappropriate waste transfer from hand tractors to four wheel tractors. Garbage in two wheel tractors must be emptied manually on to the ground, which takes around 20min. This garbage must then be reloaded into a trailer. It takes four labourers around one hour to fully load a 6m<sup>3</sup> trailer.

In all these examples, garbage is being **double handled**. Reducing double handling is the key to improving garbage collection efficiency.

### B.7.1 Residential Waste, Commercial, Institutional and Industrial Waste

People should be required to use some type of garbage container (plastic bag, dustbin, gunny sack, etc.) for discharging their waste for collection, as follows:

- Bell collection: container handed directly to LA labourers. Permanent containers are returned to owners after emptying.
- Kerbside collection: closed container placed on roadside for collection. Permanent containers are returned to pickup point after emptying.
- Door to door collection: labourers collect garbage from inside premises. Permanent bins are returned to premises after emptying.
- Public bin collection: closed disposable container placed in public bin. Permanent containers should not be placed in the bin. No garbage should be loosely discharged into the bin.
- Stationary trailer collection: garbage emptied into trailer by people. No permanent containers should be placed in the trailer.

In each case, no garbage should be discharged loosely at the roadside, into drains, onto vacant land, public land or into waterbodies. Such behaviour should be prohibited.

These conditions (what people should and should not do) must be incorporated into the waste discharge rule.

### **B.7.2 Market Waste**

Market traders should be required to keep their own dustbins in to which they discharge their wastes. These bins can then be emptied by market labourers into handcarts and transferred to a stationary trailer for subsequent collection, or preferably, the market traders can empty their own bins into the stationary trailers.



### **B.7.3 Street Sweeping and Drain Cleaning**

If street sweepings are left in small piles along the roadside waiting for collection, they will be scattered in a relatively short time. Sweeping must then be repeated. Street sweeping waste should be loaded into a handcart or other collection vehicle directly.

Similarly, drain cleanings are often left for long periods at the roadside following removal, again resulting in waste scattering or the cleanings being washed back into the drain when it rains. Such wastes should be loaded directly into a handcart or other collection vehicle.

### **B.7.4 Handcarts**

Handcarts generally undertake primary collection only, meaning that they must transfer their loads to a stationary trailer or collection vehicle for transportation to the final disposal site. This is much more preferable than handcarts emptying their loads to public bins or other community collection points.

Ideally, garbage should be loaded into handcarts:

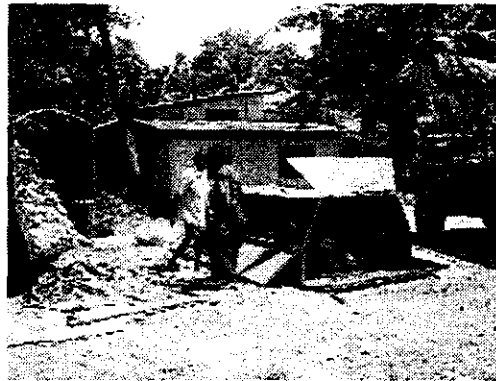
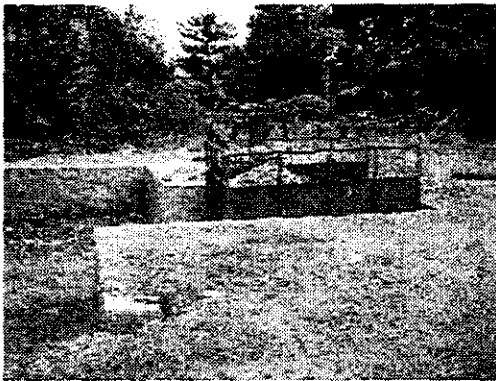
- In disposable bags, so that these may be easily transferred to transportation vehicles, or
- Loosely into six to eight 30-40 litre buckets within the handcart (a "bincart"), which can subsequently be lifted out and emptied one by one. This bincart system is most suitable for street sweeping waste, but is not suitable when handcarts collect lots of bulky garbage. It may also be used for collecting drain cleanings, but the buckets should be filled too much in this case, or else they will be too heavy to lift by one person.
- Loosely, if the handcart can be emptied into a trailer from above (i.e. using gravity).



### **B.7.5 How to Load Waste into Trailers**

There are basically two proper ways.

- To load waste from a higher place to a lower trailer making use of gravity.
- If the trailer must be higher than the handcart, waste should be loaded into the trailer using small containers, little by little.



## **B.8 Improving Final Disposal**

### **B.8.1 Introduction**

Final disposal involves getting rid of all waste that is neither reused, recycled, processed or treated. Such waste has no value and is typically disposed of to land in Sri Lanka. Final disposal is **for ever**. Some items decompose very quickly (e.g. food/kitchen waste), while some take a long time (e.g. plastic – over 100 years) and others are hazardous or toxic (e.g. batteries (lead and zinc), tubelights (mercury)). Hence, it is very important to practise good final disposal of waste for our sake and the sake of our children, grandchildren and their children.

### **B.8.2 Good Landfilling**

Good landfilling should aim “to dispose of waste in a way that minimises the associated environmental, health and social impacts at an acceptable cost”.

- Health and social impacts include odour, flies, rats, birds and other pests, smoke, waste scattering, illness and diseases, ugly view, etc.
- Environmental impacts include groundwater, surface water, soil and air pollution.

### **B.8.3 Landfilling Impacts – Leachate and Landfill Gas**

Most of the health and social impacts are very obvious and don't need to be explained further here. However, leachate and landfill gas are both major landfill hazards, but are less well understood. Hence, it is important to understand what these hazards are.

Leachate is contaminated wastewater produced mainly from rainwater soaking into deposited waste and also from the waste itself as it decays and has water squeezed out of it due to being compressed by the overlying garbage. It is toxic, containing many suspended solids, high levels of ammonia and some hazardous substances (e.g. lead, zinc, mercury). If it enters waterways, it will use up all the oxygen in them, killing fish and other animal life!

Landfill gas is a mixture of methane (50-60%) and carbon dioxide (30-40%), produced from decaying waste. It is another major landfill hazard. Methane is flammable and lighter than air, so it can accumulate in buildings or other enclosed spaces near to the landfill if not properly vented. There are many examples of explosions, fires, injury and human deaths around the world caused by methane from landfills. Gas migration sideways from the landfill through the ground can also cause nearby plants and trees to die by starving them of oxygen. Landfill gas, particularly methane, is also a major source of global warming, contributing an estimated 8-20% of the world's total greenhouse gas emissions<sup>3</sup>.

#### **B.8.4 Disposal Methods**

The most common method of final disposal in Sri Lanka is **open dumping**, where the garbage is dumped on land without any operational controls or measures to minimise the associated social, health and environmental effects. Open dumps are often sited on vacant, low lying marshy lands, often in order to reclaim land for subsequent development. This method is not appropriate for towns/cities in Sri Lanka but is very cheap.

**Controlled tipping** represents an improvement on open dumping. In this case, garbage is dumped on land in a controlled manner in accordance with minimum specified operational and environmental controls. The most common measure taken involves the daily application of soil cover, as this is the most effective means of minimising a number of the negative impacts of landfilling – odour, fire/smoke, vermin, pests, etc. waste scattering and an ugly view. Controlled tipping is the most affordable method of final disposal, based on existing and short-medium future conditions in Sri Lanka.

**Sanitary landfilling** involves the disposal of garbage on land within a partially or fully engineered landfill facility that is designed, constructed and operated so as to minimise significant social, health and environmental effects. This method should be applicable to Sri Lanka in the medium-long term future, based on the progressive upgrading of landfilling standards through controlled tipping and then various levels of sanitary landfilling over a 10-30 year period. The size of most Sri Lankan towns and the costs associated with levels 2-3 of sanitary landfilling

suggest that LAs should be looking at some form of shared regional landfill when this stage is reached.

Indicative design and operational requirements for controlled tipping and sanitary landfilling are summarised below.

**Table B-9: Potential Requirements for Different Levels of Landfilling**

<b>Landfilling Stage</b>	<b>Indicative Requirements</b>
Controlled Tipping	<ul style="list-style-type: none"> <li>• Application of daily soil cover (100-150mm).</li> <li>• Fill using the cell method to minimise the active filling area and reduce leachate generation<sup>4</sup>.</li> <li>• Chemical spraying to control pests and possibly odour.</li> <li>• Ban on burning waste.</li> <li>• Installation of movable net fence.</li> <li>• Establishment of temporary access road.</li> <li>• Full-time site supervisor.</li> <li>• Vehicle trips recording system.</li> <li>• Organisation of scavenging activities at site (if relevant).</li> <li>• Application of cover soil (300-600mm) to completely filled areas.</li> </ul>
Sanitary landfilling (level 1)	<p>As for controlled tipping plus the following:</p> <ul style="list-style-type: none"> <li>• Site clearing, prior to landfilling.</li> <li>• Establishment of all weather access and on-site roading.</li> <li>• Full-time tractor wheel loader for waste placement and compaction.</li> <li>• Development of basic Site Management Plan.</li> <li>• Enclosure of the active working area with a bund to divert stormwater from it, as appropriate.</li> <li>• Diversion of stormwater from surrounding areas away from the site and provision of on-site stormwater drainage, as appropriate.</li> <li>• Special pit for the disposal of hazardous healthcare waste (see later).</li> <li>• Application of intermediate cover soil (300mm) to partially filled areas that are not currently being used for filling.</li> <li>• Application of final cover (600mm) to completely filled areas.</li> <li>• Creation of a gently sloping landform during filling so that rain runs off the landfill rather than ponding and increasing leachate generation.</li> <li>• Construction of a boundary security fence and access gate to control site access.</li> <li>• Construction of further environmental protection facilities, including a buffer zone, litter and fire control and possibly bird control.</li> <li>• Provision of basic leachate treatment facilities.</li> </ul>
Sanitary landfilling (level 2)	<p>Basic facilities and activities as per controlled tipping and level 1 sanitary landfilling with the following changes/additions:</p> <ul style="list-style-type: none"> <li>• Preparation of comprehensive landfill management plan.</li> <li>• Provision of tarmac access road.</li> <li>• Excavation to maximise the available filling areas within site constraints and to facilitate landfill liner construction.</li> <li>• Installation of a low permeability clay landfill liner, overlain by a leachate collection/drainage layer and protective soil cover.</li> <li>• D4 bulldozer for waste placement and compaction.</li> <li>• Provision of more advanced leachate treatment facilities capable of</li> </ul>

<sup>3</sup> "Down to Earth, Solid Waste Disposal for Low Income Countries", WEDC, Loughborough University, 1999, pg. 96.

<sup>4</sup> Leachate generation is proportional to area. Hence, as the landfilling area gets bigger, more leachate will be generated.

	<p>meeting stricter environmental discharge standards.</p> <ul style="list-style-type: none"> <li>• Turfing and benching finished slopes and restoration of the landfill on completion of filling.</li> <li>• Provision of passive landfill gas vents.</li> <li>• Staff amenities.</li> <li>• Environmental monitoring (e.g. downgradient groundwater well).</li> </ul>
Sanitary landfilling (level 3)	<p>As for previous levels with the following changes/additions:</p> <ul style="list-style-type: none"> <li>• Advanced operational practices, including a weighbridge, water truck for dust suppression and leachate/groundwater/air monitoring.</li> <li>• Compactor for waste placement and compaction.</li> <li>• Creation of a more impermeable bottom liner by addition of a 1.5mm HDPE membrane liner above the clay liner (see level 2).</li> <li>• Stormwater treatment for sediment management.</li> </ul>
Sanitary landfilling + energy recovery (level 4)	<p>As for previous levels plus a landfill gas reticulation and power generation system.</p>

### B.8.5 Closure and Aftercare

Closure refers to properly closing the landfill on the completion of filling operations, while aftercare refers to ongoing maintenance and monitoring activities conducted after closure. Both are very important, as leachate and landfill gas will continue to be produced for 10-30 years after landfilling has stopped, while significant landfill settlement will occur as the waste decomposes – maybe as much as 30%, most of this occurring within five years of landfilling being completed.

Basic closure and aftercare procedures involve the following:

- Applying final cover of at least 600mm soil over the whole landfill.
- Landscaping of the entire landfill, according to the final land use, including benching and turfing or vegetating finished slopes.
- Regular inspections and maintenance, particularly of the leachate collection and treatment system, gas vents, stormwater drainage and landfill settlement. Remedial actions should be taken to address any problems, as required.
- Monitoring committee inspections at say yearly intervals, decreasing to 2-5 years over time.
- Ongoing environmental monitoring.

### B.8.6 Monitoring Committee

A monitoring committee should be established to continuously ensure good landfill operation and to demonstrate that to relevant stakeholders, thus increasing the LA's accountability.

This committee undertakes joint monitoring and evaluation of landfill operations, based on a site specific checklist (see References). These results are compiled into a monitoring report, which should be publicised and made available for public viewing. This process identifies actual and

potential problems with landfill operations, taking stakeholders concerns into account, with recommendations being made to improve landfill operations, as required.

The monitoring committee should comprise LA representatives (e.g. Deputy Mayor, MOH, Health Committee chairman, CPHI, Landfill/Area Supervisor), other government representatives (CEA, Grama Nilidari Officer), representatives of relevant authorities (e.g. Forest Department, Irrigation Department), representatives of nearby residents (e.g. community leader, religious leader), etc.

Recommended monitoring frequencies are:

- Once before any construction or upgrading works are started in order to understand and record the original condition.
- Every month during the first six months of operation.
- After this time, if the monitoring committee judges that performance is good, the monitoring frequency may be reduced. However, monitoring should be done at least every three months.

### **B.8.7 Procedures for Developing New Landfill Site**

Step by step procedures for developing a new landfill site are listed below, together with indicative time periods:

- Identification of new landfill site (3-6 months).
- Topographic and geological survey (3 months +).
- Design of sanitary landfill facilities (6 months).
- Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) (6 months +).
- Land acquisition (3-12 months).
- Agreement from neighbours (3-18 months).
- Construction of sanitary landfill site (6 months).

Some of these steps can run in parallel, but it is expected that the whole process will take a minimum period of about two years!

## B.9 Improving Healthcare Waste Management

### B.9.1 Introduction

Healthcare waste includes all the waste produced by a medical institution (public or private), a medical research facility or a laboratory. Good management of healthcare waste is very important, as it is more likely to contain potentially infectious agents (e.g. bacteria, viruses) or toxic products than normal municipal waste. Workers handling such wastes (e.g. medical institution cleaners, LA garbage collection workers, disposal site workers) often show a higher incidence of health problems (injury and disease) than the general population including fever, skin diseases, itching, nausea, loss of appetite, headache, bruises/cuts, etc<sup>5</sup>.

### B.9.2 National Policy for Healthcare Waste Management

The Ministry of Health has prepared a draft National Policy on Healthcare Waste Management for Sri Lanka (October 2001)<sup>6</sup>. This policy divides healthcare waste into three categories, as summarised below.

Table B-10: Categories of Healthcare Wastes

Category	Description	Examples
Non-risk (75-90%)  (Class 1)	All waste that has not been contaminated with potentially infectious agents or toxic products (similar to municipal waste)	Kitchen waste, coconut shells, packaging material, plastic/metal storage containers, saline bottles
Hazardous (10-25%)  (Classes 2,5)	All waste that has been contaminated with potentially infectious agents or toxic products	General: Laboratory cultures, waste from isolation wards, human tissues, equipment that has been in contact with infected patients
		Anatomical: Body parts, placentas
		Pathological: Blood, human fluids
		Chemicals, heavy metals and pressurised containers: laboratory reagents, solvents, broken mercury thermometers
Highly hazardous (<5%) (Classes 2,3,4, 5)	Sharps	Scalpels, needles, blades, infusion sets, broken glass
	Highly infectious wastes	Microbial cultures
	Genotoxic wastes	Mitotic inhibitors, alkylating agents
	Radioactive wastes	Urine and excreta from inpatients treated with radionuclides, contaminated glassware

**Notes:**

1. The percentages listed in the first column refer to the relative proportions of the different types of healthcare wastes.
2. Classes 1-5 are described in the following table.

<sup>5</sup> WASTE (1997), Hospital Waste Management in Pakistan, pg80

<sup>6</sup> This policy is completed by two other documents: National Guidelines (more technical oriented reference document) and National Action Plan (strategy and timeframe for implementation of policy).

The National Policy states:

- Every hospital is legally responsible for the proper management of the waste that it generates until its final disposal in accordance with the National Environment Act No47 (1980) and National Environmental (Amendment) Act No53 (2000).
- Major hospitals should set up internal healthcare waste management plans, while all medical institutions are encouraged to do so.
- Healthcare waste generation should be minimised as much as possible.
- Healthcare wastes should be identified and segregated as close as possible to the source, being sorted into containers or plastic bags coded with the international two colour (black and yellow) system (see Table 11). Note that The Ministry of Health and Indigenous Medicine has also introduced a more complex colour code system based on nine colours<sup>7</sup> which it is trialing at the Castle Street Hospital for Women in Colombo. The two colour yellow-black system is considered the **minimum** standard that medical institutions should adopt, being both practical and affordable while some hospitals may choose to follow a more complex colour code system of up to nine colours according to the scale of their operations and financial resources.
- In case off-site transportation is required to treat hazardous healthcare waste at a central facility, medical institutions should be responsible for the safe packaging and adequate labelling of the wastes to be transported.
- Current environmentally friendly, safe and affordable options may not be available for every situation in Sri Lanka. Incineration in double chamber incinerators may be considered as the technology that ensures the most reliable disposal of hazardous healthcare waste. Alternative technologies such as autoclaving and shredding are recommended in large health care facilities situated in populated areas.
- The following table summarises the recommended packaging and treatment requirements of different categories of healthcare wastes.

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<sup>7</sup> Nine colour system: Black = general waste for dumping/incineration; green = plastic for recycling; maroon = glass for recycling; red = foul and infected linen (to laundry); blue = soiled linen (to laundry); yellow = infected waste for burning/incineration; pink = pathological waste for burial/incineration; orange = surgical gloves for washing and autoclaving; bright red = sharps for burning/incineration.