Solid Waste Management & Resource Mobilization Center (SWMRMC)

Solid Waste Management Technical Guideline for Municipalities of Nepal

Government of Nepal
Ministry of Local Development
Solid Waste Management & Resource
Mobilization Center

SOLID WASTE MANAGEMENT TECHNICAL GUIDELINE FOR MUNICIPALITIES OF NEPAL

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Foreword

As per the Local Self-Governance Act, the municipalities of Nepal have been conducting the Solid Waste Management (SWM) activities within their jurisdiction which are so far limited to street sweeping, waste collection, transportation and final disposal. For effective and sustainable SWM, however, the activities related to 3R (Reduce, Reuse and Recycle) along with proper treatment of the waste are required for ensuring the decent sanitary conditions of the people and environment as a whole.

Owing to the rapid growth of population and unplanned urbanization, SWM has emerged as s serious environmental issue for local bodies. To confront with this problem, high priority should be accorded to SWM activities. In this connection, Ministry of Local Development (MLD) has already submitted a new legislation on SWM to the Parliament. Furthermore, MLD has been encouraging the municipalities to implement SWM activities, particularly for developing the landfill sites by providing substantial amount of assistance through the Local Development fund called "Reserve Fund" being operated under MLD.

In this regard, it is hoped that the Solid Waste Management Technical Guideline for Municipalities of Nepal, prepared by SWMRMC with the support of UN-HABITAT, will be helpful for municipal staffs and other concerned organizations to understand the basics of SWM system and implement it into their working fields as far as practicable within local conditions. This Guideline will help the concerned institutions perform their task effectively for the betterment of the people and the beautification of the city.

My sincere gratitude goes to the UN-HABITAT for supporting to develop this Guideline. MLD also looks forward to receiving similar support from UN-HABITAT in the future.

Krishna Gyawali
Secretary
Ministry of Local Development
(Municipal Management)

Foreword

Solid waste generation and management is closely related to human living that has followed humanity through its various phases of development. Solid Waste Management (SWM) is one of the high priority service sectors of local governments especially in urban areas of Nepal. The task is continuously growing as extensively heavier and costlier every year in all towns and municipalities due to uncontrolled urbanization, desegregated wastes, social political conflicts and lack of sound waste management laws,
policies and practices.

The policy of decentralizing solid waste management authority and service delivery responsibility to the local bodies has been institutionalized through the Local Self Governance Act (LSGA) 2055. Under the Act, municipalities are responsible for collection, transportation and final disposal of solid waste within their territory.

In response to LSGA, municipalities have been conducting SWM activities like street sweeping and collection and final disposal of wastes in dumping and landfill sites. However, due to the lack of policy guideline and inadequate financial, technical and human resources, scientific sustainable and environmentally friendly utilization of waste involving appropriate and technologies is still a for cry. Hence, it has become highly essential to make proper policy guidelines and build municipal capacity for effective and
sustainable solid waste management.

In order to provide basic and advanced solid waste management services to the public and also to save environment from degradation, waste management services provided by municipalities required simple and effective legislation and guidelines as well as enforcement mechanism. The policy and legislation should clearly identify the responsibilities of the concerned stakeholders including the government organizations, municipalities and communities and as well the private sector etc.

It is in this context that Solid Waste Management and Resource Mobilization Center is publishing the 'Solid Waste Management Technical Guideline for Municipalities of Nepal'. I believe that this Guideline will be helpful for the municipal staff and other stakeholders in dealing with solid waste management activities.

The Guideline is prepared with the technical support of UN-HABITAT and I would like to extend my sincere thanks to them for their cooperation, hoping that such kind of cooperation will continue in the future also.

Dr Sumitra Amatya
General Manager
Solid Waste Management & Resource Mobilization Center

Foreword

With the rapid urbanization in the world, Solid Waste Management has emerged as one of the major challenges of urban authorities of developing countries. Solid Waste Management is one of the core responsibilities of urban authorities. However, the challenge is triggered more due to the rapidly increasing volume of waste, insufficient availability of resources, expertise, and management mechanisms leading towards threatening the health of urbanites and urban environmental pollution. Municipalities of Nepal is also encountering the same challenges inregards of Solid Waste Management.

Although, few municipalities have developed innovative approaches to manage waste through effective participation of Local Communities and Private Sector but the challenge is to guide municipalities for effective and sustainable management of generated solid waste in environmentally friendly manner.

There are various national policies that have mandated municipalities for managing solid waste but no technical guidance in this field is reflected. Thus, in partnership with Ministry of Local Development / Solid Waste Management and Resource Mobilization Center "Solid Waste Management Technical Guidelines for Municipalities of Nepal" has been developed to provide basic guidance on general principles for managing urban Solid Waste.

In this regard, I believe that this technical guideline on municipal solid waste management will assist the policy makers and especially municipalities of Nepal to practise appropriate solid waste management system promoting local technologies. I also believe that this guideline serves as a valuable reference to the municipalities of Nepal that reflects practical steps for planning and implementing integrated solid waste
management more effectively and efficiently.

Andre Dzikus
Chief
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United Nations Human Settlements Programme (UN-HABITAT)

CONTENTS

Abbreviations

BCC	Behaviour Change Communication
BOD	Biochemical Oxygen Demand
CBS	Central Bureau of Statistics
CDM	Clean Development Mechanism
COD	Chemical Oxygen Demand
EIA	Environmental Impact Assessment
EM	Effective Microorganisms
HDPE	High Density Polyethylene
IEC	Information, Education and Communication
IEE	Initial Environmental Examination
ISWM	Integrated Solid Waste Management
LDPE	Low Density Polyethylene
PE	Polyethylene
PET	Polyethylene Teraphthalate
PVC	Polyvinyl Chloride
MLD	Ministry of Local Development
MSW	Municipal Solid Waste
NGO	Non Government Organization
NPC	National Planning Commission
SWM	Solid Waste Management
SWMRMC	Solid Waste Management and Resource Mobilization Centre
SWOT	Strength, Weakness, Opportunities and Threats
TNA	Training Needs Assessment

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Executive Summary

With rapid urbanization and changing consumption patterns, solid waste management (SWM) has become a major challenge in Nepal's urban entres, particularly the larger cities. Open waste piles are a common site and the work of municipalities' is often limited to sweeping the streets and dumping the waste in the nearest river or vacant land. Modern waste anagement techniques, such as source separated door-to-door collection, recycling facilities and sanitary landfills, have not yet been introduced in most cities and the municipalities generally do not have the necessary skills or resources to manage the waste in the proper manner. These guidelines aim to assist municipal solid waste managers as well as policy makers in establishing efficient and effective solid waste management system. The guidelines are based on the following basic principles:

- Integrated and sustainable waste management systems should be promoted.
- The 3-R principle (reduce, reuse and recycle) should be promoted at all levels.
- Waste should be segregated at source to maximize recycling.
- The practice of dumping waste on streets or open areas for collection should be stopped and more effective forms of waste collection that minimizes waste handling and exposure to waste should be promoted.
- Open waste dumps should be replaced by controlled dumps or sanitary landfilling.
- Recycling should be maximized and only non-recyclable waste should be landfilled.
- Environmental impacts of waste should be minimized.
- Polluters pay principle should be applied to minimize waste production, recover cost and make the SWM system as a whole sustainable.
- Participation of local communities and private sector in SWM should be encouraged.

These guidelines provide practical information for planning and implementing integrated solid waste management systems in the form of 10 steps

10 Steps for Effective SWM

The following steps should be taken to effectively manage municipal solid waste:

1. Assess the existing system of waste generation, collection, recycling and disposal as well as the institutional mechanisms and financial resources dedicated for SWM within the municipalities.
2. Formulate strategic and operational plans for integrated solid waste management.
3. Establish an effective and efficient waste collection system. Where possible, initiate source separated door-to-door waste collection systems, with participation of private sector and community groups.
4. Encourage individuals and industries to reduce and recycle waste at he source to the extent possible by providing information, training and incentives. The municipality should also establish community level and central level composting and recycling facilities.
5. If the municipality has an open dump site, where it dumps waste in a haphazard manner, convert it into a controlled dump by covering the waste by a layer of soil, diverting surface drainage away from the waste and fencing the site to prevent unauthorized people and animals from entering the site. Develop a sanitary landfill site at a suitable location for managing non-recyclable waste.
6. Develop a system for collection and management of hazardous waste, such as healthcare waste healthcare waste separately. Healthcare waste should be separated at source into at least three components: hazardous, non-hazardous and sharps. Non-hazardous or ordinary waste should be managed along with regular unicipal waste, while the hazardous waste should be disinfected or incinerated.
7. In order to raise public awareness and maximize public participation in waste management, initiate community mobilization programmes, especially targeted at youth, women and school children and support local initiatives.
8. Identify areas where private sector could get involved in waste management, conduct feasibility studies and initiate public-private partnership projects in a planed and transparent manner.
9. Establish a separate unit for waste management within the municipality, provide it with adequate human and financial resources, and build the capacity of the staff through training.
10. Initiate measures to make solid waste management cost effective and raise revenue from users to cover costs and to make the system as a whole sustainable.

Introduction

1.1 Urban Environment in Nepal

Urbanization is a relatively new phenomenon in Nepal. According to the 2001 ensus, 3.3 million people or 14.2 percent of the Nepalese population lived in the 58 municipalities of Nepal. Although these figures indicate that Nepal is still a predominantly rural country, the rate of urbanization is very high. Between 1991 and 2001, the municipal population increased by 94 percent or 6.8 percent per year. Similarly, during this period the number of settlements with population of more than 20,000 grew from 27 to 71. Part of the increase in urban population is due to the classification of 15 additional settlements as municipalities during this period. If the population of the Village Development Committees, which made up these new municipalities, were added to the municipal population of 1991, then the urban growth rate becomes 3.6 percent per annum, which is still much higher than the national population growth rate of 2.3 percent per annum. The government predicts that by 2011, 24 percent of the total population will be living in urban areas (NPC, 2003). The urbanization trend in Nepal is presented in Table 1 and general information on all 58 municipalities of Nepal is presented in Annex I.

Nepal's urban sector faces numerous challenges as rapid and haphazard urbanization is exerting immense pressure on urban environment and municipal mangers often do not have sufficient expertise and resources to deal with the rapid growth. With the enactment of the Local Self-Governance Act, 1999, municipalities have been given many additional responsibilities but adequate measures have not yet been initiated to enhance their capacities to deliver these services. As a result, many cities are facing environmental problems such as solid waste management, wastewater management and drainage. The problems are more critical in larger municipalities. Such as Kathmandu, but with increasing urbanization, smaller municipalities will also soon face major problems of environmental management and they have even less resources to deal with these challenges. Therefore, urban environmental management is an important issue that needs to be addressed immediately to protect the health of a growing urban population and boost the economic productivity of urban centres.

According to a survey done by Central Bureau of Statistics in 1996, most urban residents feel that solid waste management is the number one environment problem in their cities (CBS, 1997). This is followed by water pol-

Table 1.1: Urbanization in Nepal

Year	1952/54	1961	1971	1981	1991	2001
No. of Municipalities	10	16	16	23	33	58
Urban Population (million)	0.24	0.34	0.46	0.96	1.70	3.29
Urban Population(%)	2.9	3.6	4.1	6.3	9.2	9.2
Average Annual Increase (%)	- -	1.65	3.23	7.55	5.89	6.84

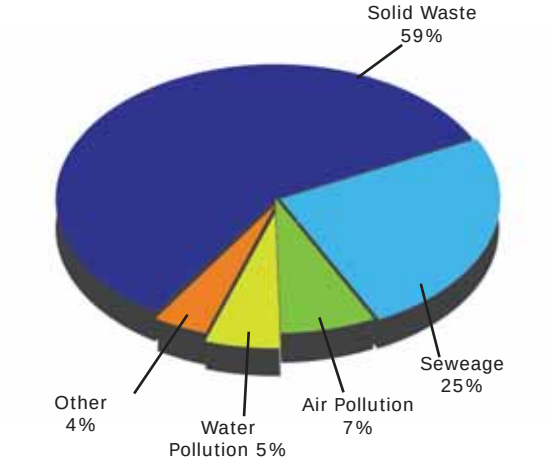
Source: CBS, 2003

lution/sewage and air pollution. Over the past ten years, these figures probably have not changed uch as very little has been done to improve the rban environment since then. Besides these technical issues, the more serious challenges are institutional and financial in nature as mobilization andeffective utilization of resources remain as critical issues in almost all municipalities.

1.2 Solid Waste & its Management

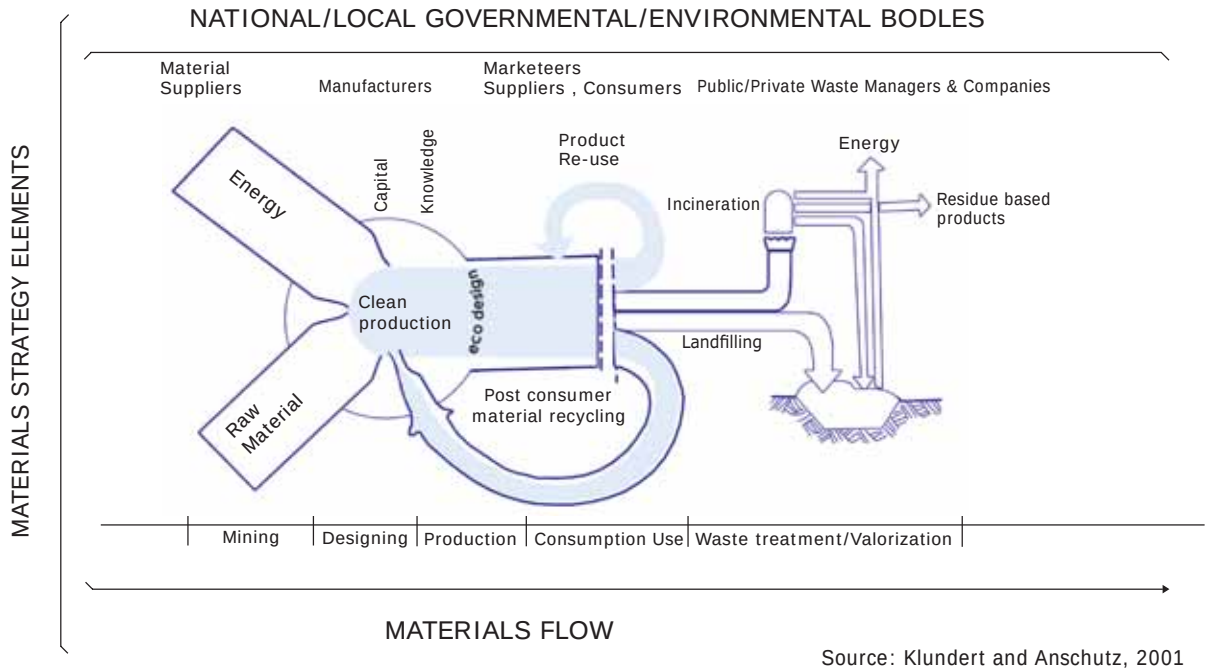
Waste is an inevitable by product of human activities. It is often defined as something that is no longer useful and has to be discarded. The Environmental Protection Act, 1997 defines waste as "Discharge of liquid, solid, gas, smoke, dust, radioactive elements or matter or similar other things which will degrade the environment." These definitions view waste as something that is useless and an environmental hazard. While this may be true to a certain extent, these definitions do not recognize the potential of waste to be used as a resource. Most waste materials can be used as a resource and need not be thrown away, nor will they degrade the environment, if they are properly managed. In this context, another way to define waste could be "a raw material in the wrong place." Therefore waste can be viewed as a resource that can be reused or a useless material that needs to be discarded. The flow of materials,production of waste, and various aspects of waste management are shown in Figure 1.2.

Figure 1.1: Public Opinion on Main Environmental Problems in Urban Areas



Source: CBS, 1997

Figure 1.2: Waste Generation, Recycling and Disposal



Source: Klundert and Anschutz, 2001

Solid waste can be of various types depending on their source and characteristics. Some of the main sources of solid waste are households, shops, institutions such as offices and schools, industries, agriculture, health care facilities and construction sites. The nature of waste generated from these sources can be quite different. For example, households and agriculture generally produce more organic waste while the nature of industrial waste varies significantly depending on the type of industry.

Solid waste management (SWM) is the process of managing waste materials so as to minimize their adverse impacts on environment and maximize their potential for reuse. More specifically, SWM is "associated with the generation, storage, collection, transfer and transport, processing and disposal of solid waste that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental conservation" (Tchobanoglous et al., 1993).

Some of the basic principles for effective solid waste management are as follows:

- Integrated and sustainable waste management systems should be promoted.
- The 3-R principle (reduce, reuse and recycle) should be promoted at all levels.
- Waste should be segregated at source to maximize recycling.
- The practice of dumping waste on streets or open areas for collection should be stopped and more effective forms of waste collection that minimizes waste handling and exposure to waste should be promoted.
- Open waste dumps should be replaced by controlled dumps or sanitary landfilling.
- Recycling should be maximized and only non-recyclable waste should be landfilled.
- Environmental impacts of waste should be minimized.
- Polluters pay principle should be applied to minimize waste production, recover cost and make the SWM system as a whole sustainable.
- Participation of local communities and private sector in SWM should be encouraged.

These principles need to be adopted by all municipalities in planning and implementing their waste management systems.

1.3 Solid Waste Management in Nepal

With rapid urbanization and changing consumption patterns, solid waste management has become a major challenge in most urban centres in Nepal, particularly the larger ones. Open waste piles are a common site and the work of municipalities' is often limited to sweeping the streets and dumping the waste in the nearest river or vacant land. Modern waste management techniques, such as source separated door-to-door collection, recycling facilities and sanitary landfills, have not yet been introduced in most municipalities and the municipalities generally do not have the necessary skills or resources to manage the waste in the proper manner. Some municipalities, however, have introduced innovative approaches such as private sector participation in Biratnagar, composting in Bhaktapur, and recycling and landfilling in Dang. The challenge is to replicate these good examples and develop simple and cost effective systems to manage SWM in an integrated manner through effective participation of local communities and private sector.

It is estimated that the total amount of municipal waste generated in the 58 municipalities of Nepal is about 500,000 tons per year. Less than half of this gets collected and almost all of the collected waste is dumped haphazardly in a crude manner. The collection systems are often inefficient and can be improved to reduce costs and improve effectiveness. According to a survey done by the Solid Waste Management and Resource Mobilization Centre, 21 municipalities dump their waste in river banks, 19 dump it in open piles and 10 have some sort of dumping site (SWMRMC, 2003). The country has only three engineered landfill sites, one for Kathmandu, one for Pokhara and one for Tribhuwannagar. Overall, most municipalities are concentrating their efforts only on sweeping the streets and dumping the waste at a convenient location. Therefore there is a need for municipalities to plan and implement integrated waste management systems in partnership with local communities and private sector.

Although, the potential for using solid waste as a resource and improving waste management systems in Nepalese municipalities is high, most municipalities have not yet been able to promote recycling in order to manage their waste. As about two thirds of the waste that is generated in Nepal is organic, composting of this waste could significantly reduce the cost and environmental impacts of waste management.

Composting is a simple and effective way of recycling waste that is already being practiced by many people and it can be replicated in all municipalities. There is a need to encourage and support more people to do household composting and at the same time establish larger composting facilities in partnership with the private sector and local communities. While promoting composting, there is also a need to ensure that the compost produced is of good quality and is marketed properly so as to make these operations sustainable. Besides composting, production of biogas can also be an option for recycling organic waste. Similarly, most of the inorganic waste such as plastics, metal and paper can be recycled by private sector in Nepal. Therefore, there is an urgent need to maximize the utilization waste as a resource instead of just dumping it.

The capacity of municipalities and the amount of resources they invest in SWM vary significantly. While some of the smaller municipalities do not have any section and staff within their organizations to manage solid waste, some larger municipalities have employed hundreds of staff and spend a large portion of their budget for waste management. Some municipalities such as Hetauda have initiated innovative measures such as source separated collection, healthcare waste management, household composting and plastic recycling, while others such as Khandbari do not have any programmes on waste management. As urban areas in Nepal continue to grow and more and more people migrate to cities in search of better opportunities, there is a clear need to strengthen the capacity of municipalities to manage solid waste in an effective and efficient manner so as to conserve resources and minimize impacts on environment and public health.

1.4 Objectives

These guidelines aim to assist municipal solid waste managers as well as policy makers in establishingefficient and effective solid waste management system. They describe practical steps for planning and implementing integrated solid waste management systems in Nepalese municipalities.

1.5 Organization of These Guidelines

The first part of these guidelines provides an overview of key issues related to urbanization and municipal solid waste management in Nepal.

The second part describes 10 steps for effective waste management. These steps include the following:

1. Assess existing situation
2. Prepare for strategic and operational plans for integrated SWM
3. Establish an effective waste collection and transportation system
4. Maximize recycling and composting
5. Implement sanitary landfilling for non-recyclable waste
6. Manage hazardous wastes, such as health care waste
7. Mobilize local communities and maximize public participation
8. Involve private sector in waste management
9. Strengthen institutions involved in waste management
10. Establish effective financial management for sustainable SWM system

Municipal solid waste managers or policy makers can use these guidelines as a tool for improving the waste management systems in their cities. Users may go through the guidelines sequentially through each of the ten steps or they may refer directly to the chapter that they are interested in.

STEP 1

Assess Existing Situation on Generation and Management of Solid Waste

2.1 Waste Generation Rate

The total amount of waste generated in a city is an important factor for planning waste management systems. Therefore estimation of the waste generation rate is usually the first step in developing a waste management plant. Waste generation rate varies with population, life style, economic activities and seasonal events. Usually, larger cities with modern life styles tend to have higher waste generation rates. Total waste generation rate is calculated by multiplying the per capita waste generation rate with the population.

Studies done by SWMRMC indicate that the average per capita waste generation rate in Nepal is 0.25 kg per day. This figure can be used to estimate the waste generation rate in Nepalese municipalities. However, as this is an average for all municipalities in Nepal and it only accounts for domestic waste, more accurate waste generation rate for a particular town or area can be estimated by conducting waste generation surveys. Waste generation rates for non-domestic waste such as commercial waste, institutional waste, industrial waste, and agricultural waste are more difficult to calculate as they vary significantly depending on location, type of activities and the extent of these activities in a particular municipality. As a general rule of thumb, the amount of waste other than household waste, in the municipal solid waste stream can be estimated to be 10 to 25 percent of the total waste stream. Therefore, the average waste generation rate for a fairly large city in Nepal with many institutions and significant commercial activities may be estimated to be 0.25/0.75 = 0.33 kg/person/day.

Waste generation surveys are conducted by collecting waste from selected households for a specific period and weighing it. The following process can be utilized to conduct waste generation surveys:

- Select areas where the survey is to be done. These areas should represent both rich and poor communities residing in the city.
- If the area selected does not have regular door-to-door waste collection system which requires the waste generators to store the waste at the source till it is collected, then people should be informed one day before the survey to store their waste in a bin or plastic bag.
- Prepare a questionnaire with just two simple questions: “How many people generated the waste” and “How many days’ waste is it?” The answers can be recorded in a table with three columns – one for house ID and the other two for recording the answer to the two questions.
- On the day of the survey, waste should be collected from the households in a separate container or vehicle and the short questionnaire should be administered to each household from where the waste is collected. Waste should be collected from at least 100 households.
- Once the waste is collected the per capita waste generation rate can be calculated by the weighing the total waste collected and dividing it by the total number of person days, which is calculated by multiplying the answer the answer to question one by the

answer to question two for each household and adding all of them.

- The density of the waste can be calculated by dividing the total weight of the waste by its volume.
- The waste that has been collected can be segregated and each component can be weighted to calculate the waste composition.

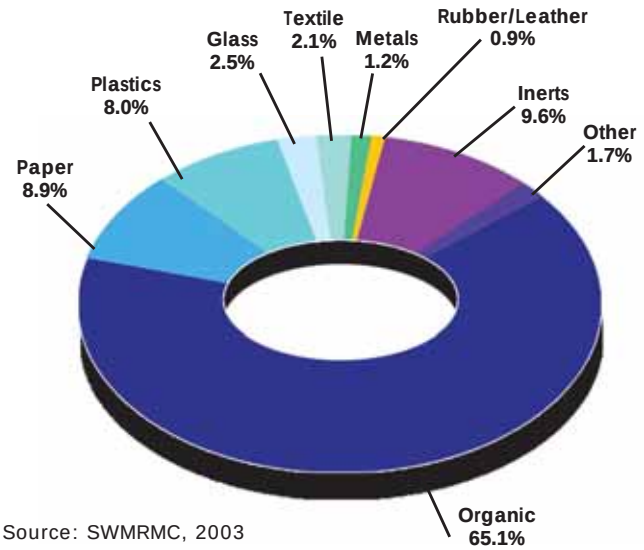
Municipalities should conduct waste generation surveys once every few years so as to estimate the total amount of waste being generated in the city and prepare plans on the basis of this estimate.

The waste generation rate in different municipalities of Nepal in 2003 is presented in Annex II. If a municipality has rural as well as urban areas and waste collection and management service in rural areas is not a priority, then only the urban population can be considered for calculating the amount of waste generated.

Municipalities also need to predict the waste generation rates in the future. The following steps should be used to estimate future waste generation rates:

- Calculate the annul population growth rate in the municipality based on census data.
- Estimate the per capita waste generation rate using the method described above.
- Estimate the rate of growth in per capita waste generation rate. This may be difficult to estimate in the absence of data from several years. If that is the case, an assumption that the waste generation rate is increasing at one percent per year can be made.
- Using the current population, annual population growth rate, current waste generation rate and the growth rate for waste generation, calculate the total waste generation in coming years.

Figure 2.2: Composition of Municipal Solid Waste in Nepal



Source: SWMRMC, 2003

2.2 Waste Characteristics

It is necessary to know the amounts of various materials in the waste stream to determine ways in which they can be best managed. Various studies have shown that the waste generated in Nepalese municipalities is primarily organic in nature. A study of waste composition in 58 municipalities conducted by SWMRMC shows that about 65 percent of the waste is organic in nature, while about 8 percent is plastics and 9 percent in paper. This indicates that organic waste management is the most important task in the process of managing municipal waste.

Waste composition can be calculated by segregating a fixed amount of waste manually and weighing each component. Waste composition studies can be done together with waste generation survey by segregating the collected waste into following components and weighing them:

- Organic waste
- Plastics
- Paper
- Glass
- Textile
- Metals
- Rubber/leather
- Inerts such as sand and stones
- Others

Another important waste characteristic is its density. The density of the waste is an important factor for estimating the volume of container or vehicle required for its collection, storage and transportation. The density of waste can vary significantly depending on the type of waste, the way it has been stored and the amount of compaction that has been done. Generally, waste tends to have low density at the point of generation but the density tends to increase during the waste collection, transportation and management process.

Previous studies done in Kathmandu have shown that the density of loose waste at the source, which is also known as curb-side density, is about 225 kg/m3. However, once the waste is put in a vehicle and compacted manually, the density increases significantly. The on-truck density of waste in Kathmandu is about 400 kg/m3. Therefore a container with a volume of 1 m3 can hold about 400 kg of waste. As an average person generates about 0.25 kg of waste per day, the 1m3 containers can accommodate waste from about 1600 people daily.

2.3 Assessment of Waste Management System

The municipality needs to conduct a thorough analysis of the existing waste management system.

This process should document the existing system, including institutional mechanisms, available equipment and manpower, and analyze the strengths and weaknesses of the system. It should also assess the performance of various aspects of the system and analyze the overall efficiency and effectiveness of the system.

The following checklist can be used to assess the existing waste management system:

General information

- Description of municipality and types of settlements (rural vs. urban)
- Number of household and population in the different wards of the municipality
- Population density and growth rate
- Number of institutions such as hotels, restaurants, shops and offices
- Infrastructure such as roads and the lengths of various types of roads
- Environmentally sensitive areas such as wetlands and forests
- Maps showing households, infrastructure and natural resources such as rivers and forests

Waste generation and composition

- Per capita waste generation rate
- Total amount of waste generated in the municipality
- Waste characteristics

Waste collection and transportation

- Amount of waste collected and collection efficiency
- Types of waste collection systems in various parts of the municipality
- Frequency of collection
- Equipment used for waste collection and transportation
- Management of transfer station
- Performance of waste collection and transportation systems

Waste reduction and recycling

- Description of household, communal and city level composting activities
- Market for compost
- Types of waste recycled
- Market rates for various types of recyclable waste
- Individuals or organizations involved in waste recycling
- Efforts made by municipality and other organizations to promote waste reduction and recycling
- Bottlenecks in waste recycling system

Waste disposal

- Description of existing and previously used waste disposal sites
- Amount of waste disposed
- Description of activities at the disposal site
- Environmental and social problems associated with waste disposal
- Plans for constructing new landfill

Special waste management

- Number of health care facilities, their type and number of beds
- Amount of healthcare waste generated
- Description of existing system for management of healthcare waste
- Amount and characteristics of industrial waste generated within the municipality
- Existing system for managing industrial waste
- Number of dead animals that need to be managed and existing system for managing dead animals
- Other types of special waste generated in the city

Community mobilization

- Description of NGOs or community based organizations involved in SWM or environmen-

tal management
- Existing activities done by the municipality or other organizations to raise public awareness and support public participation in SWM
- Number of schools in the city and description of environment related programmes in the schools
- Major newspapers, radio and TV stations in town and their reach

Private sector participation

- Existing policies on PSP
- Extent of PSP in waste management
- Description of private sector involved in waste management

Institutional and financial framework

- Main stakeholders involved in waste management
- Unit responsible for waste management within the municipality
- Description of human resources involved in waste management
- Human resource development mechanisms
- Information management system
- Cost of various aspects related to waste management and its trend
- Revenue generated through waste management and its trend
- Service fee that is currently being charged by various organizations
- Willingness to pay among waste generators for SWM related services
- Financial management system

Policies, regulations and their enforcement

- Level of political commitment
- Adequacy of existing policies and legislation
- System of rewards and punishment
- Enforcement mechanisms and their effectiveness

Analysis of key issues

- Strengths of the existing system
- Weaknesses of the existing system
- Opportunities for enhancing strengths and overcoming weaknesses

Maps, reports of previous studies, field observation and discussions with local people can be good sources of information for completing this checklist. Once all the information is obtained, they should be analyzed and compiled in the form of a report. The draft report should be shared with stakeholders and their comments should be incorporated into the report before finalizing it.

This report on the situational analysis will provide an important input in the process of formulating strategic and operational plans which is the next step for a clean city.

Box 2.4 Summary of Key Activities for Step 1

1 **Determine waste charactization**
- Conduct waste characterization study to determine the characteristics of waste.

2 **Estimate waste generation**
- Conducti waste generation surveys to calculate per capita waste generation rates and then multiply it by total population.

3 **Conduct assessment of waste management system**
- Use the checklist mentioned above to collect relevant information from reports, field observations and discussion with key informants and compile it in the form of a report.

4 **Consult with stakeholders to get feed back on draft report**
- A list of relevant stakeholders should be prepared and they should be invited to a workshop to review the draft report.

5 **Finalize the Situational Analysis Report**
- The report should be finalzed after incorporating all comments. This type of exercise should be done every year.

STEP 2

Prepare Plans for Integrated Solid Waste Management Systems

3.1 Why Plan ?

Many municipalities have not been able to provide effective SWM services in spite of investing a lot of resources mainly because SWM is usually done in an unplanned and ad hoc manner and most solid waste managers are constantly dealing with crisis management. Planning is an essential component of SWM because of following reasons:

- Waste management has become a difficult and complicated issue for many cities
- Most municipalities have limited resources and SWM requires significant resources
- Many stakeholders are involved in waste management
- SWM is an essential service directly related to people's daily lives.
- Poor management of solid waste can result in significant adverse impacts on environment and public health

3.2 Integrated Solid Waste Management

One of the main problems with solid waste management in Nepal is that most municipalities are only involved in two activities related to solid waste management: street sweeping and dumping of the collected waste. However, the definition of solid waste management needs to be broadened as SWM is a multidisciplinary subject that involves many different tasks that need to be done in an integrated manner. As mentioned earlier, Tchobanoglous et al. (1993) defines solid waste management as a "discipline associated with the generation, storage, collection, transfer and transport, processing and disposal of solid waste that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental conservation." Integrated solid waste management (ISWM) is therefore the process of optimizing the waste management system as a whole with application of a variety of suitable technologies. ISWM includes technical as well as managerial aspects of solid waste management.

Technical aspects of ISWM include the following activities:

- Waste handling & storage at source
- Waste reduction
- Waste separation
- Street sweeping
- Effective waste collection system
- Waste transfer
- Primary and secondary transportation
- Material recovery & processing
- Recycled product manufacturing & marketing
- Waste treatment
- Sanitary landfilling
- Hazardous waste management
- Special waste (construction debris, bulky waste, etc.) management
- Remediation of polluted sites

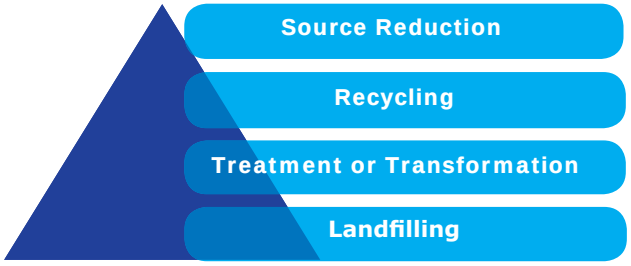
Similarly, managerial aspects of ISWM include the following activities:

- Formulation and implementation of policies

- Strategic and operational planning
- Community mobilization
- Public education
- Private sector participation
- Dispute resolution
- Enactment of legislation & standards
- Enforcement of regulations
- Monitoring and evaluation
- Organizational development
- Human resource management & capacity building
- Cost reduction and revenue generation
- Management of information & communication

ISWM seeks to integrate various aspects of SWM by involving all stakeholders to optimize all the elements of the waste management system as a whole.

Figure 3.3 ISWM Hierarchy



3.3 Hierarchy of ISWM

ISWM has hierarchy of various waste management practices that rank them in order of preference in terms of environmental and economic efficiency. This hierarchy is shown in Figure 3.3. As per this hierarchy, in ISWM systems, source reduction should be the first priority, followed by recycling, waste transformation and then only landfilling. ISWM programmes and systems should be developed in which the elements of the hierarchy are interrelated and selected to complement each other (Tchobanoglous et al., 1993).

3.4 Integrated Sustainable Waste Management

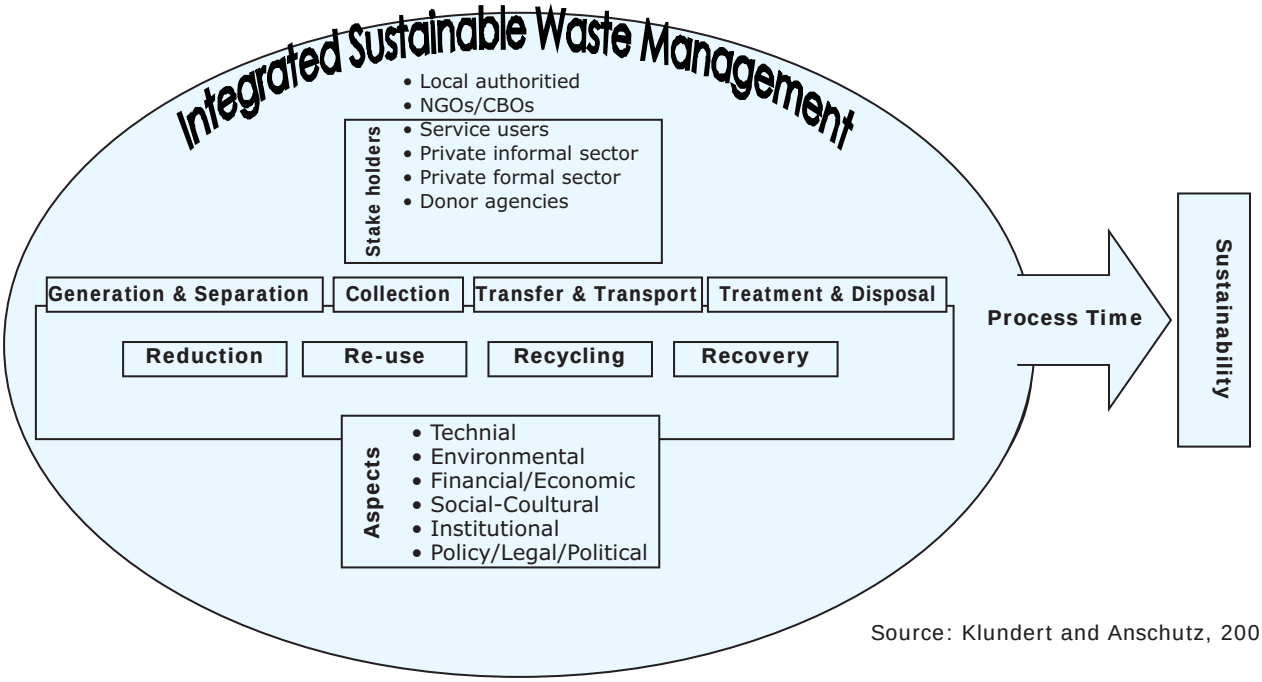
Sometimes ISWM is also interpreted as Integrated Sustainable Waste Manament. This model recognizes three important dimensions of waste management:

(1) stakeholders,
(2) waste system elements and
(3) sustainability aspects, which are shown in Figure 3.4.

The concept is based on following four basic principles (Klundert and Anschutz, 2001):

- **Equity:** All citizens are entitled to an appropriate waste management system for environmental health reasons.
- **Effectiveness:** All waste is removed as planned, recoverable materials are recovered and the rest is safely managed.
- **Efficiency:** The model will maximize benefits, minimize costs and optimize the use of resources.

Figure 3.4: Integrated Sustainable Waste Management Model



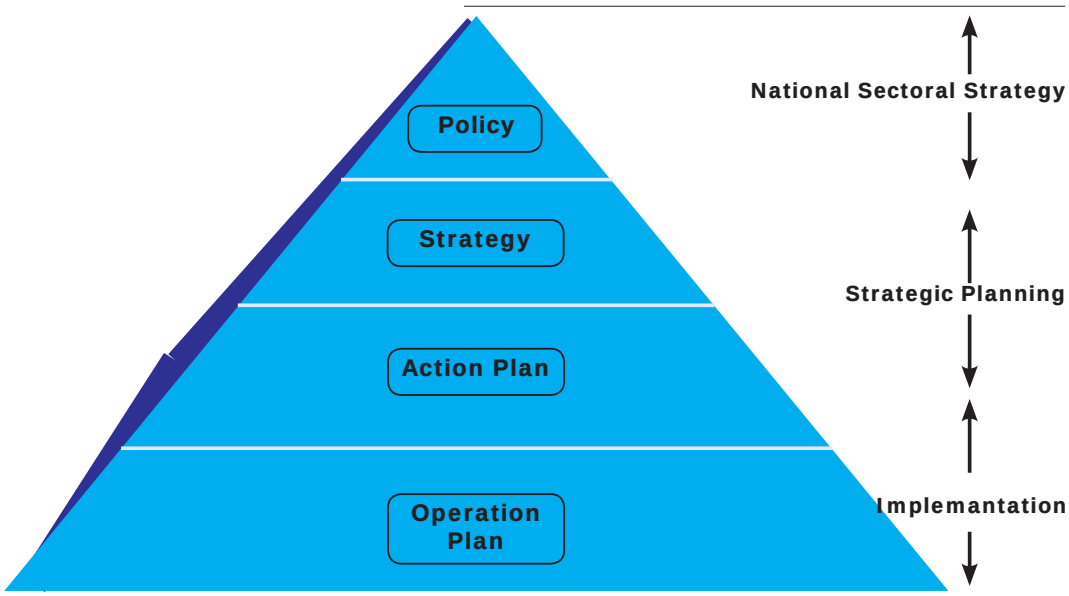
Source: Klundert and Anschutz, 2001

- **Sustainability:** The system is appropriate to the local conditions and feasible from a technical, environmental, social, economic, financial, institutional and political perspective. It can maintain itself overtime, without exhausting the resources upon which it depends.

3.5 Planning for ISWM

As ISWM requires several activities to be implemented simultaneously, it requires careful planning. Municipalities need to prepare two types of plans – strategic plan and operation plan – for effective solid waste management. Strategic plans provide an overall framework and direction for solid waste management while operational plans provide detailed work plan for implementation the strategy.

Figure 3.6: Planning Hierarchy



The strategic planning process provides answers to the following three major questions:

1. Where are we?
2. Where do we want to go?
3. How do we get there?

The answer to the first question is a situational analysis. It presents a clear picture of the current situation of waste management. This can be done by using the checklist presented in Step 1 of these guidelines. Information related to each of the points in the checklist can be obtained through available reports or it can be gathered in a participatory manner by assessing the situation in the field and through interaction between all key stakeholders in a participatory workshop. Several tools such as Strength, Weakness, Opportunities & Threats (SWOT) analysis, and Stakeholder Analysis can be used in this process.

The Stakeholder Analysis is done to identify key stakeholders, their interests and ways to address these interests. Key stakeholder in solid waste management may include households, industries, waste collectors, waste recyclers/dealers, municipality, and private organizations or NGOs involved in waste management.

SWOT analysis is a common tool to assess the current situation within the organization as well as the external environment. Identification of strengths and weaknesses provides an assessment of the organization itself and also lays the ground for agreeing on ways to build on the strengths and overcome the weaknesses. Similarly, an analysis of opportunities and threats gives a picture

These are shown in the planning hierarchy in Figure 6. As planning is a process and not an event, plans need to be regularly reviewed and updated. The objective of the overall process of planning should be to make the SWM system efficient, cost effective, and responsive to the needs of the people.

3.6 Strategic Planning

Strategic planning is a logical process that involves an analysis of the existing situation, formulation of a broad mission or goal, a set of objectives to achieve the mission, and activities designed to accomplish each objective. Strategic planning is best done in a participatory manner by involving all key stakeholders so as to incorporate inputs from all sectors and ensure ownership. Each municipality should have a clear strategic plan to guide all solid waste management related activities.

of the surrounding environment in which the SWM system exists. SWOT analysis is best done in a participatory manner with the involvement of all key stakeholders.

Once the situational analysis is complete, the next step is to answer the second question: "Where do we want to go?" This is done by identifying a common goal or mission and a set of objectives to achieve this goal. This is best done through a workshop process that involves all stakeholders.

The goal should be ambitious but achievable. Determination of the goal should be followed by developing objectives to meet the goal. The objectives should be clear and comprehensive.

The goal and objectives provide the necessary guidance for preparing an action plan. Once the goal and objectives have been agreed by all stakeholders, an action plan should be prepared to achieve the stated objectives. The action plan should list the required activities and also the time period in which the activities need to completed.

The strategic planning workshop is an important event in the process of formulating a SWM strategy.

All key stakeholders, including relevant government agencies, NGOs and community groups, and private sector, should be invited to the workshop, which should be two or three days of intense discussions and analysis. The agenda of the workshop may include the following topics:

- Introduction to the workshop and its objectives
- Introduction to ISWM
- Presentation and discussion on current situation of SWM in the city
- SWOT analysis of SWM system
- Formulation of vision or mission for SWM
- Identification of objectives to achieve the vision or mission
- Preparation of a plan of action to achieve each objective

The workshop should be moderated by a trained facilitator who will have to ensure that the process is participatory and productive. The output of the workshop will be a strategic plan that is understood, agreed upon and owned by all stakeholders.

3.7 Operational Planning

Operational planning is the process of preparing detail plans for a specific period such as a year or month in order to achieve defined outputs or targets. It establishes precise arrangements for the implementation of the strategy and action plan. The plans should specify tasks to be accomplished, deadlines, resources required and responsible persons. Municipalities need to prepare annual plans and budgets for solid waste management each year and these can form the basis of the operational plans.

EXAMPLE OF A STRATEGY FOR SWM

The following goals and objectives were formulated as part of a strategy developed by the Kathmandu Metropolitan City for SWM in the city:

Goal: Establish an efficient and sustainable integrated solid waste management system with active participation from local communities and private sector

Objectives:

- Establish and efficient and effective waste collection and transportation system throughout the city with participation from private sector and local communities
- Maximize waste reduction and recycling to minimize the costs and environmental impacts related to waste management
- Landfill non-recyclable waste in an environment friendly sanitary landfill
- Manage hazardous waste, particularly health care waste, in a way that minimizes risks to public health and environment
- Formulate policies and regulations for SWM and ensure that it is effectively enforced
- Mobilize local communities and student to maximize public participation in SWM
- Conduct activities related to organizational development to ensure that the Environment Department is well managed and the staffs are effective and efficient
- Strengthen financial management system to make the SWM system financially sustainable

Action Plan: Short term and long term plans with time bound activities were then defined for meeting each of the objectives.

Box 3.8 Summary of Key Activities for Step 2

1 **Assess the current situation related to waste management in the city**

- Collect information on the existing SWM system from reports, field observations and interaction with stakeholders and prepare a draft report. This is done as part of Step 1.

2 **Organize a strategic planning workshop with all key stakeholders**

- Discuss the report on the current situation of SWM, conduct a SWOT analysis, agree on a mission statement and objective, identify key issues and draft a strategic plan.

3 **Prepare an operation plan**

- Based on the strategic plan, prepare an operational plan for one year to improve the SWM in line with the strategy.

4 **Get approval of the strategy and operation plan from the Municipal Board**

- The strategy and plans should be presented to all stakeholders and the Municipal Board and their formal endorsement should be acquired to ensure proper implementation.

5 **Monitor the implementation of the strategy and plans**

- The SWM unit with assistance from stakeholders should monitor the implementation of the plans and plans should be revised based on the monitoring results.

STEP 3

Design and Implement an Effective Waste Collection System

Waste collection is the most expensive and visible part of any waste management system. It is also the part of the waste management system that involves the most extensive and direct involvement of the people. It is a therefore the most important component of solid waste management system and is usually the first task for municipalities or solid waste management service providers. Rural areas or scattered settlements may not require waste collection systems as the waste is often managed at the source. However, in urban settings, waste has to be collected from households and other sources and transported to a transfer station, waste processing or recycling plant or a disposal site.

Waste collection systems include following components:

- Waste segregation and storage at source
- Waste collection from source
- Street sweeping
- Primary transportation
- Waste transfer
- Secondary transportation

4.1 Waste Separation & Storage at Source

Waste generators need to store the waste at the source till it gets collected. This is best done in a plastic or metal container with a lid. The size of the container depends on the amount of waste generated and frequency of collection. As the average per capita waste generation rate in Nepal is about 1 litre per day, for an average household, a 10-litre capacity container is sufficient, if waste is collected on a daily basis or on alternate days.

In order to assist in waste recycling and management, waste should be separated at the source into various components. Separating the waste into different components will make recycling of these components easier by reducing the need for sorting and cleaning the recyclable waste. However, segregation at source can be a bit inconvenient for the consumer and waste collector if the waste has to be separated into too many components. Therefore, it is recommended that waste is only separated into two components: organic and inorganic at the source. The inorganic waste can be further sorted into its various components such as plastics, metals etc., by the waste collector or processor.

The municipality can provide or sell the required containers for waste separation and storage or it can be left to the consumers. If the municipality provides two colour-coded waste containers or bins to each household at a subsidized rate, this can be a tool for public awareness and an incentive for the people to store, separate and recycle waste at the source. However, the municipality should clearly mark these containers and there should be a hole at the bottom of the containers so that they cannot be used for other purposes.

4.2 Waste Collection System

The following systems can be used to collect waste from households and other sources:

Door-to-door collection – In this system, waste collector goes to each house and collects waste from the source and places it directly into the

waste collection vehicle. The system is very convenient for waste generators and is effective for collecting source separated waste. It is also a good system for collecting a service fee as the consumers of the service can be easily identified and the consumers receive a regular and convenient service in return for the fees they pay. As the waste collector goes to each household on a daily basis, there is regular interaction between the collector and consumer, which provides an opportunity for improving services and makes the waste collector responsible towards the consumer. Although this is a very effective system for waste collection, it may also be a fairly expensive system. Therefore, door-to-door collection has to be linked with a service fee, which should cover the operation cost of waste management.

On-time collection – In this system, a waste collection vehicle goes around a neighbourhood at a specific time, and alerts the people using a bell, siren or whistle. People then bring the waste from their houses and put it directly in to the vehicle. This is a very simple waste collection system that requires very little resources and can be quite effective if the people cooperate and bring the waste to the vehicle when it arrives. The main disadvantage of the system is that it requires people to be present when the waste collection vehicle arrives. It is also difficult to charge a service fee in this type of collection system because the users of the service cannot be easily identified.

Communal containers – In this type of collection system, a large container or tractor trailer is placed in a public place or near the source of waste. The volume of the container depends on the amount of waste generated and the available equipment of the waste collector. Waste generators are required to put their waste in the container. The waste collector replaces the container when it is full. Container system for waste collection is most effective for bulk generators of waste, such as institutions, apartment buildings, industries, and construction sites, and in slum areas where door-to-door collection is not technically and/or financially feasible. Separate containers can also be placed for source separated waste, but it will be difficult to monitor the waste going into these containers and valuable materials in the waste can easily be stolen from the containers. In this system, it is difficult to charge a service fee if the container is placed in a public place, but for private containers, the waste collector can easily charge a fee. The main disadvantage of the system is that it may be difficult to find an appropriate place for the container in a public place and the site of the container often becomes dirty. Vandalizing of public containers is also a common problem.

Road-based collection – In this system, consumers simply dump the waste along the road or at designated open spaces. The waste collectors then sweep the streets and collect the waste on their vehicles. This is a very simple type of waste collection as it does not require any specific containers or door-to-door service. However this is a very inefficient and ineffective type of collection system as the waste has to be handled many times during the collection process and open waste piles on the streets make the streets look dirty. Although this is the most ineffective system for waste collection, unfortunately, this is the most common type of waste collection in Nepalese municipalities.

4.3 Equipment for Waste Collection and Transportation

Various equipment and vehicles can be used for waste collection ranging from simple brooms and hand carts to complex hydraulic compactors and vacuum cleaners. The selection of equipment depends on available resources, amount of waste, type of waste, type of collection system used and travel distance. Simple equipment used for solid waste management includes brooms, dust pan, baskets, shovels, forks, and sorting spikes. Vehicles used for SWM include: wheel barrows, handcarts, cycle carts, tractors, tillers, trucks, tippers, container trucks, and compactor trucks. The advantages and disadvantages of different types of vehicles are presented in the table below.

4.4 Sweeping of Streets and Public Places

Waste is also generated in streets and public places and sometimes waste generated in households or institutions also end up on the streets, which is not a desirable but it is a common practice in Nepalese municipalities. Therefore, streets and other major public places such as parks and plazas need to be regularly cleaned. The presence of waste on streets or other public places is not a pleasant site, but cleaning the streets regularly can be an expensive task. Therefore the need for street sweeping should be reduced to extent possible while keeping the main city areas free from litter. Usually street sweeping is done every day in city centres and market areas and every other day in residential areas. In rural areas, street sweeping may not be necessary. The need for street sweeping can be minimized by stopping waste from being dumped on the streets. This can be done by implementing an effective door-to-door or on-time waste collection systems and

Table 4.0 Equipment for waste collection and transportation

Vehicle	Description	Advantage	Disadvantage
Wheelbarrow	Simple equipment with one wheel Capacity; about 50 kg Range: about 100 m	• Inexpensive • Easily available • Easy to use and unload	• Very low capacity • Can be unstable
Handcarts	Cart with two to four wheels that is pushed or pulled. Capacity: about 100 kg Range: about 500 m	• Simple and inexpensive	• Handcarts with small wheels and poor bearings may be difficult to push
Cycle carts	Modified tri-cycle with a container Capacity 200-500 kg Range: about 2 km	• Simple and inexpensive • Larger capacity and longer range than handcarts	• Slightly more expensive than carts
Electric three wheelers (Safa Tempo)	A three-wheeler electric vehicle with a container Capacity: 1to 1.5 tons	• Environment friendly vehicle • Good for stop and go traffic • Does not depend on imported fuel	• Maintenance may not be available in some places
Tractor trailers	A tractor with a detachable trailer Capacity: about 2 tons	• Relatively inexpensive compared to other motorized vehicles • Trailers can be detached and used as containers • Tractors can be used for other purpose as well • Can be used for rough terrain	• Relatively slow speed compared to other motorized vehicles
Pick-up trucks	A small truck Capacity: 1 to 2 tons	• Good for narrow roads • Low loading height	• Low capacity compared to other motorized vehicles
Trucks	Capacity more than 3 to 5 tons	• Good for long distance hauling • Large capacity	• Not useful for narrow roads • Loading height may be high
Tipper	Capacity: about 3 tons	• Good for long distance hauling • Large capacity • Easy to unload	• More expensive than trucks
Compactors	Capacity: 2 to 5 tons	• Large capacity • Low loading height • Waste is not visible	• Not very suitable for dense waste • Very expensive • Difficult to maintain

having dust bins in places, such as parks and markets, where a lot of waste can be generated.

Street sweeping crew should be equipped with brooms with long handles and dust pan made of metal for picking up waste. The handles should be 1.5 m. in length and should be made of strong wood or bamboo. Generally one sweeper should be allocated for about 500 meters length of roads in city centres, 1 km streets in other areas.

In urban areas with open drains, the street sweeping crew is also responsible for keeping these drains clean. In order to keep the drains fl owing, waste should not be disposed in the drains and the drains should be covered with concrete slabs to the extent possible.

4.5 Waste Transportation

The transportation of waste from the source to the transfer point is called primary transportation. While transportation of waste from the transfer point to the treatment or disposal site is called secondary transportation. Primary transportation is usually done in small vehicles such as handcarts or cycle carts, while secondary transportation is usually done in large vehicles such as trucks. If the distance from the waste source to the treatment or disposal site is not far, primary and secondary transport can be combined into one task. For the purpose of primary transportation, the vehicle should have a low loading height and should be easy to operate in the city streets. The main requirement for secondary transportation vehicles is that they should have large capacity and range.

4.6 Waste Transfer

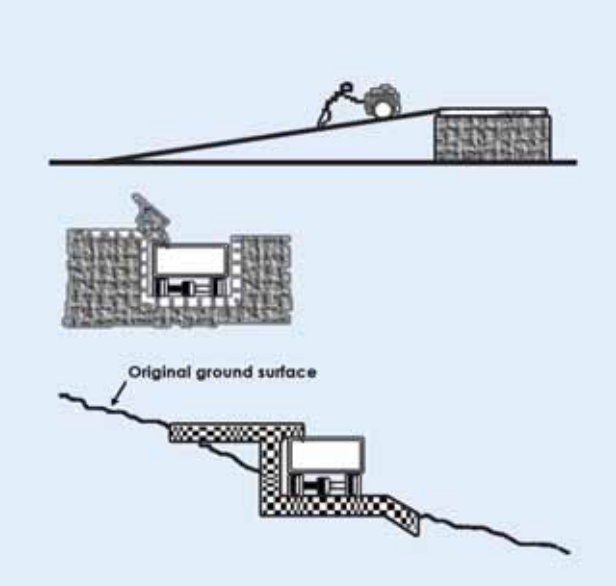
The act of transferring waste from a primary vehicle such as handcart to a secondary vehicle such as a truck is called waste transfer and this is usually done at a transfer location or transfer station.

Waste transfer operation should be designed so that waste handling and the time required for the transfer is minimized and the waste does not end up on the ground. If waste is to be emptied from the primary collection vehicle directly in to a larger vehicle, timing is critical to so that vehicles don't end up waiting for one another.

The following methods can be used for waste transfer:

- **Platform:** In this method waste from the primary collection vehicle is unloaded on to a platform or the ground and then it scooped up again either manually or by a mechanical loader and placed into a large container. Although this is an inefficient method of waste transfer, it is the most frequently used method because it is a simple process and does not require any infrastructure.

Figure 4.6: Split Level Transfer Operation



- **Split level:** In this method waste from a primary vehicle is taken up a ramp and the waste is unloaded directly into a larger vehicle or container that is placed at a lower level. This is a generally a quicker system for waste transfer and it keeps the waste from being scattered. However, construction of the ramp and split levels can be expensive.
- **Container:** If waste is collected in small bins or sacks within the primary collection vehicle, it can then be transferred manually directly into a secondary vehicle or larger container. This is a very efficient way to transfer waste and it avoids littering.

4.7 Planning and Implementing Efficient Waste Collection Systems

The following issues need to be considered while designing and implementing waste collection systems:

Containerization:

As waste that is collected in an open area does not look good and can cause pollution, waste should always be collected and stored in a container. Therefore, all places where waste is generated, including households, institutions and public spaces, should have dust bins. The

dustbins should
be inexpensive and easy to handle while transferring waste from the bins
to the collection vehicles.
In the case of public spaces, the dustbins should also be designed so that they cannot be easily vandalized or stolen.

Collection system:

Municipalities often need to provide a combination of different types of collection systems to meet the needs of various people. In general, municipalities should avoid road-based collection systems and provide container system, on-time collection system or door to door collection system. If collection of service fee is a major objective, a door-to-door collection system will probably be most suitable.

Source separation:

In order to facilitate recycling, organic and inorganic waste should be separated at source. This will require the municipality or waste collector to have a system to collect organic and inorganic waste separately. This can be either be done by having separate compartments or containers within the waste collection vehicles to collect organic and inorganic waste, or by arranging the collection schedule so that organic and inorganic waste is collected on different days.

The municipality should also have a public awareness campaign to inform the waste generators of their responsibility and the collection system.

Frequency of collection:

Waste can be collected on a daily basis, on alternate days, or weekly depending on available resources, population density, waste generation rates and type of waste. For scattered settlements, waste can be collected less frequently as taking the collection vehicle to these places can be expensive and most houses in these settlements usually manage their waste, particularly organic waste on their own. In dense settlements, it is advisable to collect organic waste on a daily basis or on alternative days, while inorganic waste can be collected weekly.

Collection equipment:

he equipment used for collection should be determined based on available resources, amount of waste, type of waste, type of collection system used and travel distance. For small municipalities, a combination of simple brooms with long handles handcarts and tractor trailers may be most appropriate. In larger municipalities, handcarts can be used to collect the waste from dense settlements or narrow lanes and then this waste can be transferred on to a large vehicle for transportation to the processing facility or landfill site. The vehicles should also have the provision of covering the waste during transportation. The municipality should also have a system for proper handling, storage, and maintenance of the equipment.

Collection schedule:

Collection schedule be fixed so that it is convenient for the waste generator as well as the collector. Early morning is usually the most suitable time for waste collection from household. Morning and evening rush hours need to be avoided.

Collection crew:

Usually a team of two people – one driver and one loader – are required for collecting waste from a particular route using a large vehicle. For small vehicles such as handcarts or rickshaws one person is usually sufficient.

Collection route:

The collection route should be designed so that waste can be collected quickly and easily. Some points to consider while designing collection routes are as follows:

- Collection should begin at the point furthest away from the unloading or transfer point.
- Busy routes with heavy traffic should be avoided to the extent possible
- If there is a steep gradient, it will be better to have a light load going uphill and a heavier load while going downhill.
- It will be better to minimize right-turns so as to avoid traffic.

Box 4.8 Summary of Key Activities for Step 3

1 Stop the practice of dumping waste on the streets

- Waste should be collected straight onto collection vehicles or containers from the source. Introduce door-to-door or on-time collection service or communal containers.

2 Improve efficiency of waste collection

- Use appropriate collection vehicles and plan the collection route so as to maximize the amount of waste collected with available resources.

3 Introduce source separated waste collection

- Collect organic and inorganic waste separately so as to encourage recycling.

4 Establish transfer stations at appropriate locations

- It the waste processing or landfilling site is far from the city centre and separate hauling vehicles are necessary for waste transportation, establish a transfer station.

5 Enforce regulations to stop littering and keep the city clean

- Establish a system for regular monitoring of public places and strictly enforce regulations so as to punish people who litter or dump waste in an haphazard manner.

STEP 4 Maximize Waste Reduction, Composting and Recycling

5.1 Waste Reduction

Reducing the amount of waste at source is the most effective method of waste management. As Nepalese in general generate very small amounts of waste; the opportunities for waste reduction are fairly limited. But, considering the increasing use of plastics and other packaging materials as well as disposable products, in urban areas the following activities can be done to reduce the amount of waste generated:

Waste collection systems include following components:

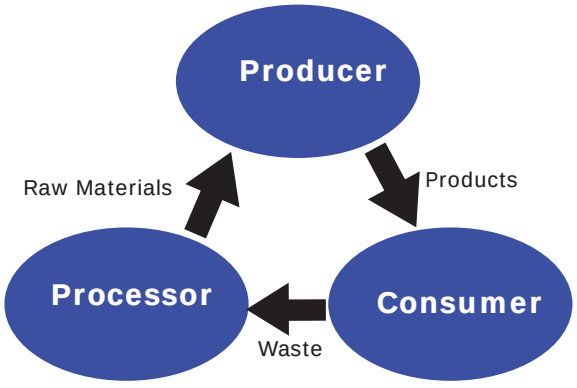
- Reduce the amount of packaging, particularly plastic bags, by promoting reusable cloth bags. Municipalities can work with community groups and shop owners for such campaigns.
- Discourage the use of disposable materials through financial disincentives and awareness campaigns.

5.2 Principles of Waste Composting and Recycling

Recycling is the process of treating waste as a raw material and converting it into a valuable product for consumption. It therefore sends materials around a continuous cycle of consumption, processing and treatment. The consumers buy products from the market and convert them into waste. The waste is then converted into raw materials by the processors and this raw material is converted back into products and supplied to the consumers by producers (see Figure 5.2).

Almost all waste can be a resource if its value is recognized and it can be utilized for productive purposes. In most cities, there are waste buyers who collect inorganic waste such as plastics, metal, paper and glass for recycling. Many of them go door-to-door looking for these valuable materials that can be sorted out of the waste stream. These materials are sorted, cleaned and packed and in this process it is converted from waste to a raw material. This is then sold to waste dealers who then sell it to industries. The industries process the materials to produce new products. Organic waste however, is often not sold as it is difficult to handle and the process of recycling organic waste usually results in relatively low value products.

Figure 5.2: Recycling of Materials



5.3 Recycling of Inorganic Waste

Metals such as aluminum and iron or steel are often melted to produce new products from the same material. Using recycled metal is a relatively simple process that costs less and uses less energy compared to using virgin ore. As recyclable metals have a high market price and recyclable metals are relatively easy to collect, most of the metals get picked up by waste collectors or buyers before it ends up in the waste stream.

Similarly, different types of plastics such as low density polyethylene (LDPE), high density polyethylene (HDPE), polyethylene teraphthalate (PET) and poly vinyl chloride (PVC), can also be recycled. These plastics have to be collected separately or sorted once it is collected. It is then cleaned, and heated to form pellets, which are then used to make new plastics. Sometimes plastic waste is also used to make various types of handicrafts.

Different types of paper such as newspapers, printing papers, magazines and corrugated cardboard boxes can be recycled to produce new paper products. While recycling paper it is first mixed with water and stirred vigorously to make pulp, which is cleaned and then laid on screens to make various types of paper. The paper can then be used to make products such as cards, folders, etc. Paper recycling can be done in large factories or in small units or cottage industries.

Glass can also be recycled by melting it and making new glass products. Normally, plate glass and glass bottles cannot be mixed for recycling and different coloured glass bottles need to be recycled separately.

As most types of inorganic waste are being recycled by the private sector, the municipality does not need to invest too much in this activity. However, municipalities can support and encourage recycling by the private sector by doing the following activities:

- Initiate source separated collection so that recyclable materials remain clean at the source and there is a regular system to collect them
- Establish a material recovery facility at the transfer station so that valuable materials in the waste can be picked up for recycling
- Establish community recycling centres where local people can sell their recyclable waste and also learn about recycling.
- Buy recycled products whenever possible to expand the market for these products

5.4 Recycling of Organic Waste

Organic waste can be recycled to produce the following products:

- ***Animal Feed:*** Some types of organic waste such as food waste can be directly fed to animals such as pigs, while waste such as bones from slaughterhouses can be processed to produce chicken feed. This does not require very high investment or technology and is practiced widely Nepal. However, only certain types of waste can be used as animal feed and possible contamination of waste should be avoided.
- ***Compost:*** Compost is a soil stabilizer that is produced by degrading any type of organic matter. This is the most common method of recycling organic waste as it is simple and any type of organic waste can be composted. Composting can be done in an aerobic environment or in an anaerobic environment. Vermi composting using worms is another type of composting.
- ***Energy:*** Organic waste can be converted in to energy by either direct combustion, or converting it into briquettes/pellets or by digesting it in anaerobic environment to produce combustible methane gas. Production of energy from all types of organic waste, however can be difficult and require significant investment. Incineration of waste to generate electricity is not suitable for a country like Nepal as the waste generated in Nepal has very low calorific value and the process is very expensive and complicated. Incineration will also result in air pollution that will be extremely difficult to control.

  Pelletization is also not a commercially viable option as the process in expensive and combustion of pellets made from waste could result in air pollution. Digestion of organic waste to produce biogas is good option for areas such a vegetable markets where there is a regular flow of waste of a uniform type. Biogas is also a good option for rural households which generate animal waste such as cow dung. In Nepal about 180,000 household biogas plants have been established which are effectively managing animal waste as well as human excreta from toilets. Some fairly large biogas plants have also been established to manage organic solid waste and toilet waste from institutions such as hotels and schools. Very large scale biogas plants are however expensive and difficult to maintain.

- ***Other products:*** Some types of organic waste can be converted into products such as handicrafts. Straw and various other types of fibres can be converted into mats, or other products. Some bones and horns can be converted into buttons. Although recycling of organic waste to produce handicrafts results in very high value products, only a limited amount of organic waste can be recycled in this manner because of technical difficulties and limited market for these products. Among these, composting is the most common form of organic waste recycling as it is simple, relatively inexpensive and suitable for all types of organic waste. Composting can be at the household level as well as institutional, communal and municipal level. At the household level, simple composting bins or vermi composting units can be used to manage organic waste produced from the kitchen or garden. At the municipal level, large mechanized compost plants with capacities of up to 1000 tons per day can be set up to manage all of organic waste at a central location.

5.5 The process of composting of organic waste involves the following steps:

- ***Preparation of waste to produce raw materials suitable for composting:*** This is done by separating the organic waste from the waste stream, cutting the waste in to small pieces if necessary, adjusting the moisture content, adjusting the carbon nitrogen ratio and adding a starter such as compost, soil or effective microorganisms.
- ***Decomposition of waste to produce compost:*** This may be done in a variety of ways in pits, piles or vessels. The prepared waste is placed in one of these places and then allowed to decompose while adjusting the moisture and ensuring proper aeration.
- ***Packaging of the compost for effecting marketing:*** In order to ensure proper marketing of the compost, it is screened either manually or in machines, and packed in bags of different sizes.

Table 5.0 Comparison of different levels of composting

Vehicle	Advantage	Disadvantage
City-level Composting (5 to 500 tons per day)	• Can process large amount of waste • Production cost is less because of economies of scale • Private sector could invest in setting up the plant and operating it • Can significantly reduce landfilling cost.	• Requires large land area (approximately 2 ha per 100 ton/day of waste processed) • Complex equipment, such as mechanized screening plant is required. • Trained manpower required • Effective marketing required
Community Composting (0.1 - 5 ton per day)	• Requires relatively less area • Simple manual-based technology	• Land may not be available in many communities • Quality control and marketing of compost may be difficult
Household Composting (0.5 - 1 kg per day)	• No transportation required • No public space required • No public opposition • Low establishment and operating cost • Compost production at home can encourage people to increase greenery	• Need to reach out to all households, which can be difficult • Some investment required by households

5.6 Guidelines for Preparing Waste for Composting

The following issues need to be considered when preparing waste for composting in order to ensure that the composting process is quick and efficient.

- ***Sorting:*** Inorganic waste should be sorted and removed
- ***Moisture content:*** The moisture content of the waste should be about 50 percent, which means that the waste should be damp but water should not be dripping from it. If the moisture content is high some dry materials such as saw dust or ash should be added or the waste should be dried for a while. If the waste is too dry, water should be added.
- ***Carbon nitrogen ratio:*** The carbon to nitrogen ratio in the waste should be about 25. Generally, if the waste has too much green leaves or grass, it means that it has high nitrogen content and therefore some materials with high carbon content, such as saw dust should be added. Similarly, if the waste has a lot of brown materials, it probably has high carbon content and therefore some material having high nitrogen content such as urine or green grass should be added.
- ***Size:*** If the size of the waste is large, it should be cut into small pieces
- ***Starter:*** Some starters such as old compost or effective microorganisms (EM) should be added to the waste to assist the decomposition process.

5.7 Guidelines for Making Compost from Waste

TWaste can be decomposed either in an aerobic or anaerobic environment. Normally aerobic composting is better as it is quicker and more robust. Anaerobic digestion is suitable for digesting waste of uniform composition such as that from animal farms, slaughterhouses or vegetable market to produce biogas. In general waste can be composted using the following methods:

- ***Compost Pit:*** This is very simple and traditional method for making compost, where waste is put in pits that are about 1 meter deep and then covered by soil. The main advantage of this method is that the waste and compost is not visible from outside and therefore the chances of foul smell and complaints from neighbours are reduced. However, composting using this method takes a long time – six months to a year.
- ***Pile or windrows:*** This is a simple and common method for composting, where is put in piles or long windrows. The height of the windrow or pile could be 1 to 2 meters and the width could be 1 to three meters. Windrows are better when the amount of waste being composted is very high. The windrows may have perforated pipes or A-frames at the bottom to assist in aeration. The windrows are turned after about one week to allow aeration and then it has to be turned once again after about three weeks. The turning can be done manually or mechanically using a loader or especial turning machines. Alternatively, windrows can be aerated mechanically by blowing air through a perforated pipe under the heap. This however is a bit more expensive.
- ***Compost box:*** A compost box can be made from bricks with a honey comb structure as shown in figure --. The method is similar to the windrow method, except the waste is contained in boxes and aeration is allowed from the bottom of the box as well as the sides. The width of the box is about 1 meter and the height is also about 1 meter. The length of the box may vary depending on the available space and amount of incoming waste. The waste is placed in the boxes for about 45 days and then it is removed from the boxes and allowed to mature for about a month.
- ***Compost bin:*** Various types of vessels or bins can be used to make compost. At the household level, 60 to 200 litre capacity bins made of plastic or metal can be used to make compost. Larger bins can be used for community level compost plants. The bins normally have two compartments: one to put the waste and the other to store the compost. The top compartment of the bins, where the waste is placed should have holes on the side and grates at the bottom to facilitate natural aeration.
- ***Compost Chamber:*** Compost chambers can be built using brick masonry. The camber usually has two or three compartments. The two compartment chamber is a larger version of the compost bin where waste is put in the top compartment and after a few months, compost is pulled from the bottom compartment. The top compartment has holes in the side and grills at the bottom to assist in aeration. In a three compartment chamber, waste is dropped to the lower compartment after about 10 days and then it is once again lowered to the bottom compartment after another 10 days. Then it is allowed to mature for about a month. The capacity of compost

chambers according to its size, but it general it can accommodate 100 to 500 kg of waste per day.

- ***Vermi composting:*** This is a process that utilizes special types of earthworms to produce worm castings, which can be a very useful organic fertilizer. The most commonly used earthworm for vermin composting is Eisenia foetida, also known as red worms. These creatures live near the surface and have a heavy appetite for organic waste. Given the right conditions (temperature ranging from 15 to 35° C and moisture content of about 50 percent), the worms will multiply rapidly and consume waste equal to their body weight on a daily basis to produce casting which is considered to be 8 to 10 times better than conventional compost. As the worms move up and down the waste pile, it aerates the waste and therefore the waste does not need to be further aerated or turned. As the worms are very sensitive to the surrounding environmental conditions, vermi composting requires more care than ordinary composting but if the system is working well, there is less chance for foul smell and the end product is a lot better.

  Vermi composting is best done at a household or institutional level, but experience from India has demonstrated that vermin composting can be done at the community level or on a larger scale to process about 100 tons of waste per day. At the household level, vermi composting can be done in a plastic tub, a wooden box, or bamboo basket. The container should have a few holes at the bottom so that excess water can drain out. The container should have a bed for the worms by spreading a two-inch layer of coconut husk or shredded newspapers or straw, at the bottom of the container. Some water should be added to the bed so that it is moist but does not drip. Then add a thin layer of compost or soil should be added and then a few hundred worms of the species Eisenia foetida should be put in the bin. Organic waste should then be fed to the worms on a regular basis. Worms can normally eat waste equivalent to their own body weight. Therefore, about one kg of worms will consume about one kg of waste per day. Once the container is full of compost, or after about three months, the compost can be harvested by emptying the box on a piece of plastic and piling the compost into the shape of a cone. As the worms hate light, they will go down and compost can harvested from the surface.

5.8 Marketing Compost

Once the compost is prepared it should be screened manually or mechanically and then packed for marketing. Compost prepared at the household level can be used at the household level can be used at the household level itself. However, for communal or municipal level plants, an effective marking strategy is essential. Most large scale compost plants fail because they are unable to effectively market their products. Effective marketing requires careful research of the potential market segments and development and implementation of an effective marketing strategy.

Guidelines for preparing a marketing strategy for compost

- Identify the market segment in which the compost will be sold and conduct a research on the volume of the market, competing products in the market and willingness to pay among potential consumers
- Design the product, in terms of type of packaging, size of packaging and type of product to suit the needs of the targeted market segment.
- Fix a pricing structure that includes adequate profit margins for whole sellers as well as retailers.
- Identify an appropriate distribution network that will make the product accessible to the consumers
- Design a promotional campaign to raise awareness about the product and motivate people to buy the product.

Box 5.9 Summary of Key Activities for Step 4

1

Encourage waste reduction

- Mobilize local communities, business groups and schools to promote cloth bags and other reusuable items

2

Promote home composting and recycling

- Raise awareness on the need for composting and recycling, provide training to community groups and distribute compost bins or vermi composting kits.

3

Establish community based composting and recycling

- Establish community based compost plants of 0.5 to 3 tons per day capacity at various locations and establish biogas plants in vegetable markets.

4

Assist in collection of inorganic waste such as plastics

- Establish community recycling centres and initiate plastic collection programmes to motivate people to recycle inorganic waste.

5

Establish large scale composting and recycling facility

- Call proposals from private parties and establish a large scale composing and recycling facility to manage all recyclable waste.

STEP 5 Develop and Operate Sanitary Landfill for Non-Recyclable Waste

Safe disposal is waste is usually the final step in solid waste management. Many municipalities in Nepal simply dump the collected waste in a haphazard manner in nearby water bodies or in open spaces. This is an unacceptable practice that needs to be stopped immediately as it can cause serious damage to local environment and public health. Municipalities should at least convert their dump sites in to controlled dumps where potential adverse impacts on the environment are reduced using very simple measures and start developing plans for a sanitary landfill.

Landfills may be divided into various categories based on environmental protection and mitigation measures adopted. The difference between a controlled dump and a sanitary landfill is presented in Table 6.0 and described in the sections below.

6.1 Controlled Dumping

A controlled dump is an area where waste is disposed but some very simple measures are taken to reduce the potential environmental impacts of the waste. These simple measures include covering the waste, managing the drainage system and stopping unauthorized personnel from entering the area. Although these measures do not reduce the risks as much as an engineered landfill site, it is far better than a controlled open dump and it can be an interim measure while initiating the process to develop a sanitation landfill site.

Steps to convert a dump site in to a controlled dump

- Dig a pit to bury the waste. The pit should not be located close to water sources, including groundwater, and settlements. The size of the pit will depend on the amount of land available and the amount of waste being disposed.
- Cover the waste with at least 5 cm layer of soil at the end of each day.
- Develop a drainage system around the site so as to channel the runoff away from the waste
- Put a fence around the site to restrict entry to authorized personnel only

Table 6.0: Controlled Dump and Sanitary Landfill

Facility	Controlled Dump	Sanitary Landfill
Soil cover	✓ (periodic)	✓
Embankment	✓	✓
Drainage facility	✓	✓
Gas venting		✓
Liner		✓
Leachate collection		✓
Leachate treatment		✓

6.2 Sanitary Landfill

Sanitary landfilling is the process of isolating the waste from the surrounding environment until it is rendered innocuous through biological, chemical and physical processes of nature. It is a controlled disposal of waste on land so as to minimize exposure of the detrimental effects of solid waste to humans and environment. Sanitary landfills must meet the following three basic conditions:

- Compaction of waste
- Daily covering of waste
- Control and prevention of negative impacts on environment and public health

The basic components of a sanitary landfill designed to meet these three basic conditions is shown in Figure 5.2 and listed below:

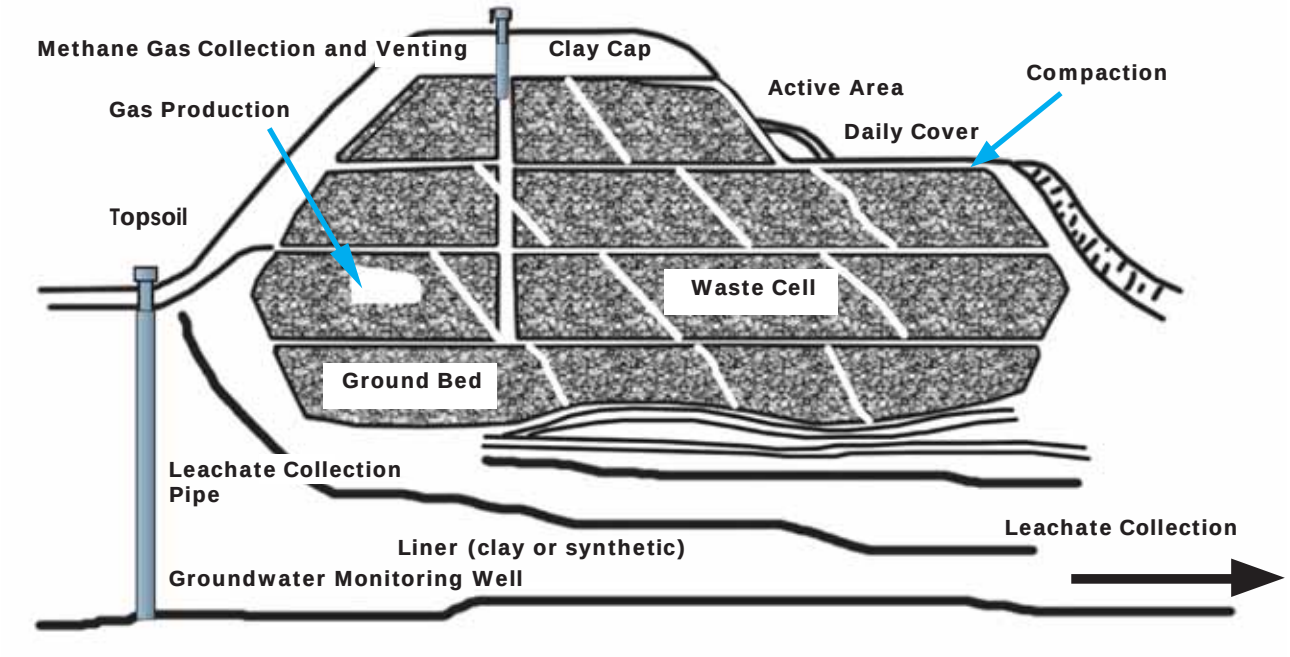
- Waste weighing and recording facilities
- Roads and parking areas for vehicles
- Waste unloading zone
- Cells of compacted waste
- Daily cover
- Liners
- Gas venting system
- Leachate collection and treatment system
- Buffer zone
- Fencing

Landfills can be categorized based on how and where it has been developed or the type of reactions that happen within the landfill system.

Based on the microbial environment existing in a landfill and the reactions happening in it, landfills can generally be classified into the following two categories:

- ***Anaerobic landfill:*** This is the most common type of landfill system where the waste is allowed to degrade in an anaerobic environment. Although these landfills are equipped with systems for leachate and collection and treatment, the reactions happen slowly.
- Anaerobic landfill: This is the most common type of landfill system where the waste is allowed to degrade in an anaerobic environment. Although these landfills are equipped with systems for leachate and collection and treatment, the reactions happen slowly.
- ***Semi-aerobic landfill:*** These landfills are designed to allows air to be drawn into the landfill by natural ventilation through the leachate pipes and gas vents. The pipes are larger and the gas vents are connected to the leachate collection pipe, the outlet of which always remains exposed to air. As aerobic conditions exist in certain parts of the landfill, particularly around the leachate collection and gas collection pipes, this allows rapid stabilization of waste and improved leachate quality. Originally developed in Fukuoka, Japan, this method has been applied in the Sisdol landfill for Kathmandu Valley, is also known as the Fukuoka method for landfilling.

Figure 6.2: Sanitary Landfill



Similarly, landfilling can be done using the following methods:

- ***Area method:*** Here waste is piled onto the existing ground surface and then covered with soil. This is most applicable in areas where land is not a major constraint and ground water table is high.
- ***Trench method:*** In this type of landfill a trench is dug and waste is buried into it. The trench is lined with impermeable clay or plastic and provision is made for collecting and treating the leachate and landfill gas.
- ***Canyon method:*** in this method a canyon or gorge is covered with waste and subsequently covered up. The surface of the canyon is lined with impermeable clay or plastic to prevent the leachate from seeping into the ground water and there are provisions for collecting and treating the leachate and the landfill gas.

6.3 Site Selection for Sanitary Landfills

Sanitary landfill sites are designed to minimize the impact of waste in the environment by covering the waste, collecting and treating leachate from the landfill, and collecting the landfill gas. As this is normally an expensive and environmentally sensitive process, careful considerations need to be made during the process of landfill site selection. Proper site selection can minimize environmental impacts as well as costs associated with landfilling. The following points need to be considered while selecting a site for a sanitary landfill:

- As a sanitary landfill is a major investment, ideally, the site should have a life of at least 10 years.
- The site should be away from human settlements in order to minimize adverse impacts, but it should not be very far away from the city centre either. Preferably the haulage distance from the city centre to the sanitary landfill should be between 5 to 10 km and the landfill site should be at least 100 away from the human settlements.
- The site should be located at a distance of least 3 km from airports and should not lie within 13° from the landing or take off path of airplanes.*
- The site should be at least 100 meters away from surface water sources
- The site should have soil with low permeability such as clay.
- Cover soil should be available at or near the site.
- The groundwater table should not be very high
- The site should not be located in a very windy place.
- The local people should be supportive of the landfill project.

The municipality should first identify five to ten potential sites, which meet most of the above mentioned criteria and a pre-feasibility study should be done on these sites, along with an Initial Environmental Examination (IEE) to assess potential impacts and select sites that are most feasible. In this process, environment and socio-economic experts should visit the potential sites, gather relevant information, and hold discussions with the local people to assess the feasibility of the sites. Once the number of potential sites is narrowed down to one or two, an Environmental Impact Assessment (EIA) should be conducted based on the Environmental Protection Act, 1996 and the EIA Guidelines for Landfill Sites prepared by the Solid Waste Management and Resource Mobilization Centre.

6.4 Development of a Sanitary Landfill

The following points need to be considered while developing a sanitary landfill:

- The landfill should have an all weather access road up to the site. Within the site, there should be gravel roads to allow vehicles to access the disposal area.
- The base of the landfill should have a layer of compacted clay or a plastic liner designed for landfills.
- A network of perforated pipes should be placed above the liner and these pipes should be covered with gravel. The leachate should be collected in a pond and either pumped and recirculated within the landfill or treated.
- Gas vents should be provided for collection of landfill gas.
- The landfill should have areas for parking vehicles, and storing covering material and equipment.
- The landfill should be surrounded by a buffer zone. The area of the buffer zone should be at least as big as the landfilling area. The buffer zone can be planted with trees and be used for income generating activities such as bee farming.

** Subtitle D of the Resource Conservation and Recovery Act as adopted by the US EPA states that sanitary landfills should be at least 10,000 ft [3.048 km] away from airports used by turbo jet aircrafts and 5,000 ft away from airports used by piston type aircrafts. Any landfills closer will have to demonstrate that they do not pose a bird hazard to aircrafts (Tchobanoglous et al., 1993).*

6.5 Leachate Management

Leachate collection and treatment is a difficult process as it can be complex and expensive. This process includes the following steps:

- Selection of the type of bottom liner to be applied
- Estimation of quantity and quality of leachate that will be generated at various times
- Design of system for collection, removal and storage (if required) of leachate
- Design of an appropriate treatment system

Bottom liner: Clay soil with low permeability (maximum hydraulic conductivity of 1x10-7 cm/sec) or flexible membrane liners made of synthetic materials such as polymeric sheeting can be used as liners in a sanitary landfill. In the case of Nepal, clay liners will be more cost effective. Clay liners are normally constructed as a layer 0.3 to 1 m thick. The clay must be mixed with some other granular soils and placed with proper moisture content and compacted in a series of layers.

Leachate quantity and quality: The rate of formation of leachate is calculated by performing a water balance that accounts for all the water entering and leaving a landfill. The primary sources of water in a landfill are: water entering the landfill through the cover (precipitation), moisture in the cover material, groundwater inflow, inherent moisture in the solid waste, and a small amount of water formed as a byproduct of decomposition. Water leaves a landfill in the form of saturated vapour in landfill gas, transpiration and leachate.

The quality of leachate depends on the type of waste, degree of compaction, depth of the landfill and age of waste. Typically, leachate has very high concentration of contaminants, including organic matter and metals.

Leachate Collection system: The leachate collection system should be designed to collect all the leachate generated in a landfill while minimizing the chances of clogging. The collection channels typically include perforated pipes in a bed of packed gravel having size in the range of 3.5 to 5 cm (Diaz, et al., 2003). The channels should have a 1 to 2 % slope to facilitate the transport of the leachate to the collection point. Leachate can be removed from the landfill by having a collection pipe at the bottom of the landfill.

Leachate treatment: As leachate treatment can be difficult and expensive, the best approach to manage leachate is to avoid generating it in the first place. Leachate generation can be minimized by adopting the following practices:

- Composting of organic waste and disposal of only non-recyclable dry inorganic waste in the landfill
- Drainage control in order to minimize the percolation of surface runoff into the landfill
- Make sure that there are no water sources such as springs in or near the landfill

Once leachate is generated and collected, it can be treated using the following options:

- ***Evaporation ponds –*** In this system, leachate is retained in a pond for a long time and allowed to evaporate.
- ***Recirculation –*** In this system, the leachate is pumped and recirculated through the landfill in order to enhance evaporation and reduce contaminants such as organic compounds in the leachate. Although this is a relatively simple option, some disadvantages include the potential of polluting surrounding environment due to migration of leachate and build up of heavy metals, salts and other undesirable compounds in the leachate.
- ***Treatment –*** Leachate can be treated using a variety of physical, chemical and biological systems. Physical systems include screening and sedimentation and biological systems such as aerated lagoons, facultative ponds and constructed wetlands are the most appropriate types of leachate treatment systems for Nepal.

6.6 Landfill Gas Management

Gases that are generated in a landfill, mainly as a result of anaerobic decomposition of waste, can either be allowed to disperse or they can be collected through a system of gas vents. The collected gas can be put into some use, flared or vented into the environment. Utilizing the landfill gas for productive use such as energy usually requires significant investment. Flaring is done to reduce the greenhouse potential of the landfill gas by converting the methane to carbon dioxide. In most cases, landfill gas is simply vented into the environment.

Landfill gas collection systems are designed so as to minimize hazardous conditions that may result from the uncontrolled accumulation and dispersal of highly inflammable methane gas in a landfill. Gas collection pipes are normally gravel-packed wells with 0.6 to 1 m diameter.

6.7 Operation of a Sanitary Landfill

The following points need to be considered while operating a landfill site:

- Proper record should be kept of the amount of waste that is brought into the landfill and the source of the waste. This has to be done on a daily basis as trucks enter the landfill
- The landfill should have roads for waste vehicles as well as unloading platforms. This is especially important during the monsoon season.
- The landfill site should have necessary equipment. This includes equipment for handling and compacting the waste, and for excavation and handling cover soil. The minimum equipment required depends on the type of the landfill and amount of waste being landfilled. The most common equipment used at a landfill is a bulldozer to distribute and compact solid waste and to handle cover soil. Steel wheel compactors are better for compacting waste, but they are normally expensive and a bulldozer is more versatile. A loader or excavator is necessary if cover soil needs to be excavated. A tipper truck will be necessary to transport cover soil.
- Besides the necessary equipment, the landfill should also have basic facilities for equipment maintenance.
- The waste should be put in the landfilling area in layers or cells and it should be compacted immediately after it is placed.
- At the end of the day, the waste should be covered with a layer of soil.
- The landfill should be fenced and entry should be restricted to authorized personnel.
- If scavengers collect recyclable waste from the landfill, occupational safety should be considered. They should be provided with protective clothing space should be allocated for sorting the waste, before it is buried.
- A committee involving the municipality as well as members of the local communities from the landfill affected area should be formed to monitor the environmental impacts of the landfill. The landfill affected communities will be identified in the course of the EIA study that has to be done during the planning stages. Maintaining good community relations is essential for smooth operation of landfill site. The committee should regularly interact with local communities and ensure that community grievances are addressed in time.

6.8 Landfill Closure

Once a landfill is filled, it needs to be closed in a proper manner. The following points need to be considered while closing a landfill:

- The landfill should be covered with about 60 cm of clay soil and capped with about 30 cm of top soil and then planted with grass or other plants to convert it into a park or garden.
- The top of the covered landfill should have a slope of at least 5 percent and a proper drainage system so as to keep surface runoff from going into the landfill.
- Buildings or other physical infrastructure should not be built on top of old landfills.
- The quality of surface and ground water around the landfill should be monitored every year to ensure that it is not contaminated.

6.9 Environmental Monitoring

As landfills are environmentally sensitive facilities, their impact on the environment should be regularly monitored during their operation as well as after their closure to ensure that potential impacts are minimized. The following parameters need to be monitored during the operation of the landfill and after the closure of the landfill:

Leachate – The amount of leachate generated should be monitored weekly and its quality should be tested in a lab on a quarterly basis during the operation of the landfill and annually after the closure.

Groundwater quality – Monitoring wells should be established at strategic locations around the landfill to monitor the quality of the groundwater over time and see if it is being contaminated by leachate. The exact location of the wells and their depth will depend on site conditions and they will be determined during the EIA study. This monitoring should be done quarterly during the operation of the landfill and annually after the closure.

Surface water quality – If there are surface water sources near the landfill, which could get contaminated by the landfill, these sources should also be monitored. This monitoring should also be done quarterly during the operation of the landfill and annually after the closure. Water quality parameters to be monitored include: pH, specific conductance, total dissolved solids, nitrate, chloride, total hardness, BOD, COD, and heavy metals.

Box 6.10 Case Study: Karauti Danda Landfill: A Model Local Initiative

While most municipalities in Nepal are simply dumping their waste in rivers or other public places, Tribhuwan Nagar, a mid-sized town in western Nepal has demonstrated that an environment friendly sanitary landfill can be built and operated successfully through a partnership between local community and the municipality. Tribhuwan Nagar is one of only three municipalities in Nepal that has an engineered landfill for waste management; the others are Kathmandu and Pokhara. What makes Tribhuwn Nagar's effort unique is that the landfill was built through local efforts and it is currently being managed by a community based group with active involvement of municipality and the private sector. While the landfill in Kathmandu and Pokhara often face problems and conflicts with the local community, the Tribhuwan Nagar landfill has been operating smoothly since its establishment and has become a model for other municipalities in Nepal.

Karauti Danda Landfill at Tribhuvan Nagar

The landfill, which is spread over 20 ha of land at Karauti Danda in ward 9 of Tribhuwan Nagar Municipality, was established in 2005. The landfill is connected to the main town, which is about five kilometers away by a paved road and there are no houses in the immediate vicinity of the landfill.

Sunflower garden at Landfill site

About five tons of waste is collected daily by the municipality and brought to the landfill in covered vehicles. At the landfill the waste is first sorted to remove plastics and other recyclable materials. The organic waste is composted in pits and the remaining waste is landfilled and covered with soil.

The landfill has drains for collecting storm water runoff and leachate along with a facility for treating leachate. Although the treatment facility is not functioning as the amount of leachate produced is very small, it is a good initiative. The area designated for waste disposal is surrounded by a buffer zone with forest as well as a garden. The landfill also has many bee hives and a sunflower garden for the bees, which adds to the esthetics of the area. Overall the landfill is clean and well managed.

The special features of the Karauti Danda Landfill at Tribhuwn Nagar are as follows:

- The landfill is spread over a large area that can accommodate waste for many years.
- As the landfill is only about 5 km from the town centre the transportation cost is fairly low.
- Although the landfill is located within ward 9 of the municipal; the landfill does not have any settlements nearby.
- The landfill has a barbed wire fence around it to clearly demarcate its boundary and only authorized persons are allowed to enter the landfill.
- The landfill also has facilities for waste segregation and storing of recyclable materials such as plastics.
- Organic waste is composted within the landfill.
- Runoff and leachate is collected by a network of drains and the landfill also has leachate treatment system.
- A buffer zone that includes a forest and garden surrounds the landfill.
- A sunflower garden and numerous bee hives make the landfill very attractive.
- An office building has been built for administrative purposes as well as convenience of the staff.
- The landfill is managed by a committee involving local community, municipality and the local-chamber of commerce.

Figure 6.9: Process of Landfill Development and Operation

Box 6.11 Summary of Key Activities for Step 5

1

Convert existing dumping site to a controlled dump

- If the municipality does not have a landfill, at least the waste should be covered and drainage controlled at the existing dump site to reduce its impacts.

2

Search for potential sites for landfill

- 5-10 potential sites for landfill should be identified based on criteria mentioned in this section.

3

Conduct Feasibility study and EIA

- IEE should be conducted for all the potential sites and then EIA should be conducted for one or two sites as per Government regulations.

4

Mobilize funds and community support for landfill construction

- Funds should be mobilized from internal and external sources for landfill construction and an agreement should be reached with local communities around the landfill site.

5

Construct & operate landfill site

- The landfill site should be built and operated to manage non- recyclable waste as per the guidelines mentioned above.

STEP 6 Establish a System for Special & Hazardous Waste Management

7.1 Generation of Hazardous Waste

Although all waste can have harmful effects if it is not managed properly, some types of waste can have immediate impacts that are very harmful on environment or public health. Waste that are either toxic, infectious, flammable, corrosive or radioactive are generally known as hazardous waste. In Nepal, the most common type of hazardous waste is healthcare waste from health care institutions. Other types of hazardous waste include household chemicals, pesticides, medicines, and chemical waste from industries. As hazardous waste can contaminate other waste as well they need to collected and managed separately.

7.2 Management of Health Care Waste

All waste generated during the process of examining and treating patients, immunization and conducting research in health care facilities (hospitals, clinics, medical research centres, and laboratories) is known as health care or healthcare waste. About 80 percent of such waste is normally ordinary or non-hazardous in nature, while about 20 percent is hazardous. The hazardous component includes infectious waste, pathological waste, chemical waste and sharps.

One of the most important aspects of health care waste management is proper separation of the waste at the source. Although only about 20 percent of the health care waste is normally hazardous, if all the waste is mixed together, all of the waste becomes hazardous. Health care waste should be separated at the source into at least three components: ordinary waste, hazardous waste and sharps. If there is a separate system such as autoclave to disinfect waste that cannot be incinerated, the hazardous component should be further segregated into “hazardous waste suitable for incineration” and “non-burnable hazardous waste.”

7.3 Guidelines for Health Care Waste Management

Waste minimization

As proper management of hazardous waste can be difficult and expensive, the first step for managing hazardous waste is to minimize its generation. The following steps can be taken to minimize waste generation in health care institutions:

- Effectively separate hazardous and non-hazardous waste at the source to reduce the amount of hazardous waste.
- Maximize recycling of non-hazardous waste. Hazardous waste, however should not be recycled.
- Reusable items should be used to the extent possible. However, before reusing an item, it should be properly sterilized.
- Minimize the consumption of hazardous substances
- Properly manage the procurement, storage and use of necessary supplies so as to minimize wastage.

Waste Segregation and Collection

Guidelines for separation and storage of health

care waste at source

- Waste should be segregated at the source and stored in a bin with a lid.
- For collection of hazardous waste, the bin should be lined with a thick plastic bag
- Sharps should be stored in a puncture proof and unbreakable plastic or metal container with a tight lid.
- Adequate number of bins should be provided at places where waste is generated.
- Bags with hazardous waste should be closed once it is three fourth full
- All bags and containers with hazardous waste should be coloured yellow and clearly marked with the international sign for hazardous waste.
- All bags and containers used for collecting health care waste should be colour coded.

Storage and transportation of hazardous healthcare waste

- Waste should be removed from the waste collection bins on a daily basis
- Plastic bags filled with hazardous waste should be held at the top and should be transported in large bins or trolleys with wheels.
- Hazardous waste should be transported via a route that avoids contact with human beings to the extent possible.
- Every hospital should have a central storage facility for hazardous waste. The facility should have a cement or tile floor with proper drainage.
- Only authorized personnel should have access to the hazardous waste storage room
- Transportation of hazardous waste outside the hospital should be done in a separate vehicle with closed bins. Ordinary municipal waste collection vehicles should not be used for this purpose.
- A daily log should be maintained on amount of waste collected and its source.
- People involved in waste collection should wear proper protective clothing including hats, thick gloves, masks, long-sleeved shirt, plastic apron, trousers and boots.

Waste treatment

- In the absence of a central medical health care treatment system, infectious waste should first be disinfected using autoclave or other technologies then it should be managed in a similar manner as ordinary waste.
- Sharps such as needles, should be disinfected by dipping it in one percent chlorine solution and then destroyed using a needle destroyer so that it cannot be reused. It can then be buried.
- Hazardous waste that can be incinerated should be incinerated in a modern double chambered incinerator if possible or buried in a separate pit that is at least 2 meters deep.

Autoclaving

Autoclaving is the process of utilizing saturated steam within a pressure vessel at temperature high enough to kill infectious microorganisms. Autoclaving is most effective for sterilizing low-density materials, such as plastics or shredded waste, but it is not appropriate for pathological waste and will not efficiently treat chemical or pharmaceutical waste. The main benefit of autoclaving is that it will not produce potential harmful by products such as chemicals or air pollutants. The following precautions should be taken when using steam sterilization of autoclaving:

- Special autoclavable bags should be used to put the waste in the autoclave. Plastics bags should be placed in a rigid container to prevent spillage.
- To facilitate steam penetration, bags should be opened and caps and stoppers should loosen immediately before they are placed in the autoclave.
- Care should be taken to separate autoclavable infectious waste from other hazardous waste such as pathological and chemical waste that cannot be autoclaved.
- Operators of autoclaves should be trained in handling waste and using the autoclave and they should also be equipped with protective clothing.
- Autoclave temperature should be checked to ensure that the proper temperature is being maintained.
- Autoclaves should be regularly inspected and serviced and the process should be routinely monitored.

Encapsulation

This is a method for treatment or containment of waste, particularly pharmaceuticals, chemicals and sharps, so that it is safe for disposal in a landfill. The waste is deposited in drums made of metal or rigid polyethylene and when the containers are ¾ full, an immobilizing agent such as cement mortar is poured into it. Once the material is dry the container is sealed and disposed in a landfill.

Incineration

Incineration is the process of destroying waste using high temperature. This disinfects the

waste and reduces its volume. Incineration can be used to treat pathological waste, infectious waste and certain types of other hazardous waste. However, as incineration can cause air pollution, the following precautions should be taken while using incineration for waste treatment of hazardous waste:

- Always use a double chambered incinerator. In the first chamber, the waste should be burnt at a temperature of 800 ± 50°C and in the second chamber, the gas should be exposed to a temperature of 1050 ± 50°C for at least one second.
- The incinerator's efficiency should be at least 99 percent.
- Waste that have been treated with hypochlorite and waste containing PVC plastic should not be incinerated. This can result in the production of toxic gases such as dioxins and furans.

Similarly, red plastic bags should not be incinerated as these may contain cadmium.

- Ash from the incinerator should be buried in a separate pit.
- Incinerator should not be placed in the middle of dense settlement.
- The incinerator should only be operated by a trained person.

Safe Burialt

When there are no other options for waste treatment, hazardous health care waste can be buried in a separate pit. Hazardous health care waste should not be buried along with other municipal waste in an ordinary landfill. It requires a separate monofill. The following guidelines should be followed while using this option:

- The pit should be located in an area with clay soil and away from settlements.
- If the area has sandy soil, the pit should be lined with a layer of clay.
- The depth of the pit should be about 2 meters.
- After waste is put in the pit, it should be covered with a 10 cm layer of soil every day.
- After 1 to 1.5 meters of the pit is filled with hazardous waste; it should be covered with a layer of lime and then soil.
- In order to avoid rainwater from draining into the pit, the pit should be surrounded by a drain and the top of the pit should have a slope of at least 1.5 percent.
- The pit should have a secure fence around it access should be restricted to authorized personnel only. Scavenging should be prevented.

Occupational health and safety

As handling of hazardous waste can be a major occupational health and safety risk, appropriate precautions need to be taken to minimize this risk to the extent possible. Health workers, janitors in hospitals, waste collectors, maintenance workers and all other workers who could come in contact with healthcare waste are workers at risk. These personnel should receive proper training on waste handling and there should be provision for protective clothing, washing facilities, emergency response and immunization for workers against viral hepatitis B and tetanus.

7.4 Steps for Effective Health Care Waste Management

Assign responsibility: Form a health care waste management committee and assign a health care waste management officer. The person should be provided with a clear job description.

Assess the current situation: The current situation regarding the generation and management of health care waste should be assessed. This should include information on the types and amounts of waste being generated per day from various sources and the current practice for managing various types of health care waste from generation to final disposal.

Prepare a health care waste management plan: A comprehensive plan should be prepared based on the assessment of the current situation. The plan should include provisions for waste collection, storage, transportation, treatment and final disposal. It should also explain management systems such as staff responsibilities, training needs, and information management systems.

Provide training and ensure occupational safety: Staff involved in health care waste management should be provided with adequate training as well as protective clothing and immunization.

Minimize hazardous waste: Minimize the amount of hazardous waste generated by minimizing the use of hazardous chemicals and materials, properly managing procurement of supplies and segregating waste at source.

Segregate the waste at source: Colour-coded bins should be provided to separate the waste into at least three components: ordinary waste, hazardous waste and sharps.

Destroy used needles: Used needles should be disinfected in chlorine solution and destroyed immediately after use using a needle destroyer.

Recycle non-hazardous waste: Non-hazardous waste should be composted or recycled to the extent possible.

Treat and safely destroy hazardous waste: Hazardous waste should be incinerated or disinfected. In large health care institutions, this can be done by the institutions themselves within their premises and for small institutions a central treatment facility should be established along with a system for collecting hazardous waste in a safe manner and transporting it to the central facility.

Monitor and evaluate: Proper records should be maintained of all amount and type of waste managed and the performance of the entire waste management system should be regularly monitored and evaluated.

7.5 Management of Industrial Waste

Industries generate a wide variety of waste, much of which can be recycled easily as it is generally not contaminated and it is generated in bulk amounts. The amount and characteristics of waste that needs to be disposed depends on the nature of the industry. Agro-based and forest-based industries generate more organic waste that can be converted to energy compost. Chemical industries generate various types of chemicals which need to be handled and managed properly. Industries are responsible for managing their own waste, but municipalities must ensure that all industries do not dispose their waste in a haphazard manner. As treatment of industrial waste can be difficult and expensive cleaner production or pollution prevention measures need to be promoted so as to minimize the amount of waste and conserve resources. For this waste audits need to be conducted in the industries and based on these audits, opportunities for reducing waste are identified and evaluated.

7.6 Management of Construction and Demolition Debris

Construction and demolition debris is treated as special waste as it is often generated in bulk amounts and need to be collected separately. However, much of this waste is not hazardous and can be recycled as covering material in

Box 7.7 Case Study: Health Care Waste Management in Hetauda

Hetauda is a mid-sized municipality in central Nepal with a population of about 80,000. While most municipalities do not have a separate system to manage medical waste, Hetauda Municipality has developed a simple and sustainable way to manage the medical waste generated by drug stores, clinics and pathology labs in the city. All drug stores, clinics and pathology labs in the city are required to separate their waste in to three categories - ordinary, hazardous and sharps - and store it in a safe manner till it is collected. The municipality has a separate rickshaw for collecting the hazardous medical waste on a daily basis. Currently, the hazardous waste is taken to a location away from human settlements and burned, but the municipality is in the process of constructing a simple double chambered incinerator to manage the waste. The incinerator, which is based on a design developed by De Montfort University in the UK, is being installed within the premises of Hetauda Hospital. It will be able to treat hazardous medical waste from the hospital as well as the waste collected by the rickshaws from the city. As the whole system is managed by a local NGO and the service fee (Rs. 50 to 200 per month) collected from the waste generators is sufficient for operating the system, it is a simple and sustainable system that can be model for other municipalities.

landfills. The municipality can earn revenue by providing collection service for construction and demolition debris and the collected material can be a useful product.

7.8 Management of Animal Waste

Animal waste such as cow dung and urine can be a valuable resource. In rural areas or small towns, dung is either used to make compost or burned for energy. One of the best ways to utilize animal waste such as dung is to digest it to produce biogas, which can be used for cooking, and slurry, which can be used as compost. Or the cow dung can be composted with other organic materials.

Listed below are some guidelines for proper management of animal waste:

- For making a biogas plant, the services of a professional government authorized company, should be used and the government norms should be strictly followed. The size of the plant should be based on the amount of dung and other organic waste that is produced. Normally, a 4 m3 plant is appropriate for a house with two to three cows. Similarly a 6 m3 plant is appropriate for a house with three to four cows.
- If animal manure is to be composted, the composting site should be located as close to the cowshed as possible.
- Urine should be collected and used as a fertilizer – after mixing it with water – or co-composted with other materials such as agricultural residue.
- Compost and urine should be kept covered in order to reduce the loss of nutrients.
- Compost piles should be kept well aerated.
- Only mature compost should be used in the fields.

7.9 Management of Dead Animals

Dead animals such as street dogs, stray cows and animals killed by road accidents are often left on the streets or public places and need to be collected. These animals should be buried separately.

Box 7.10 Summary of Key Activities for Step 6

1 **Identify potential sources and amounts of special and hazardous waste**
- Conduct a survey of health care facilities to estimate the amount of health care waste generated and other potential sources such as industries.

2 **Encourage health care institutions to manage their waste**
- Health care institutions should follow the ten steps mentioned aboveto manage their waste. The municipality can provide training and guidance if required.

3 **Establish a central treatment facility and a collection system**
- A central autoclave and or incinerator, along with a separate collection system, should be established to manage hazardous waste from small health care institutions. Service fee should be changed to recover the O&M cost and sustain the service.

4 **Establish a system for collection and management of C&D and bulky waste**
- A system, preferably with large containers should be established to collect bulky waste from construction sites and other places and the waste generators should be required to pay for this service.

5 **Establish a system for collection and managing dead animals**
- The municipality should have a system for collecting and burying dead stray animals from the city. This job can be contracted out to a private party.

6 **Promote Cleaner Production and management in rural areas**
- In order to minimize industrial waste, cleaner production should be promoted and industries should be required to manage their own waste.

7 **Promote effective animal waste management in rural areas**
- Systems for improved animal waste management, including biogas systems should be promoted to reduce waste in rural areas of the city.

STEP 7 Mobilize Local Communities

8.1 Objectives of Community Mobilization

As generation and management of waste involves people and communities, it is essential to mobilize community participation for effective waste management. The main objectives of community mobilization and participation in SWM are as follows:

- Raise public awareness on various aspects of SWM
- Encourage people to segregate and recycle waste at the source
- Assist citizens to adopt environment-friendly behavior
- Mobilize local resources to reduce the cost of waste management
- Develop a sense of ownership among the people
- Minimize the controversies and problems associated with SWM
- Make SWM system sustainable
- Make municipality and waste management service providers accountable to the people.

8.2 Tools for Community Mobilization

The municipality or SWM service provider should use a combination of interpersonal and mass communication tools in order to raise public awareness, change behavior of the people and support community involvement in solid waste management, particularly composting and recycling at the household or community level. Mass communication tools such as posters, pamphlets and mass media are useful for disseminating information to a large number of people at once. The main disadvantage of mass communication is that this is a one-way communication and is not a very effective way of interacting and learning new skills. Interpersonal communication involves direct communication with people in meetings, interviews, household surveys, exhibitions or focus group discussions. This is a more effective form of communication for imparting skills and changing behavior but it is a slow process.

As the process of changing behavior is a long continuous process, the municipality should have a regular programme to work closely with a variety of stakeholders in the city. Behaviour change communication (BCC) is an interactive process with communities that develops tailored messages and approaches using a variety of communication channels so as to develop positive behaviours; promote and sustain individual, community and societal behaviour change; and maintain appropriate behaviours. The various stages of behavior change are shown in Figure 6.9. Municipalities need to design programmes that will take people from stage 1 all the way to stage 7. The strategies that can be used during each of these stages is presented in Table 8.0.

8.3 Guidelines for community mobilization and participation

The following activities can be conducted to mobilize public participation in SWM:

- Establish eco-clubs or children's clubs in schools to provide practical education to the children and encourage them to organize various activities such as clean up campaigns and collection of recyclable materials. The eco-clubs should be led by an executive committee formed by the children themselves and a teacher should be assigned to provide guidance to the club. The municipality's community mobilization unit can facilitate the process of forming eco-clubs, provide technical and financial support if necessary to the eco-clubs and coordinate among various eco-clubs.

Figure 8.0: Stages of Behaviour Change

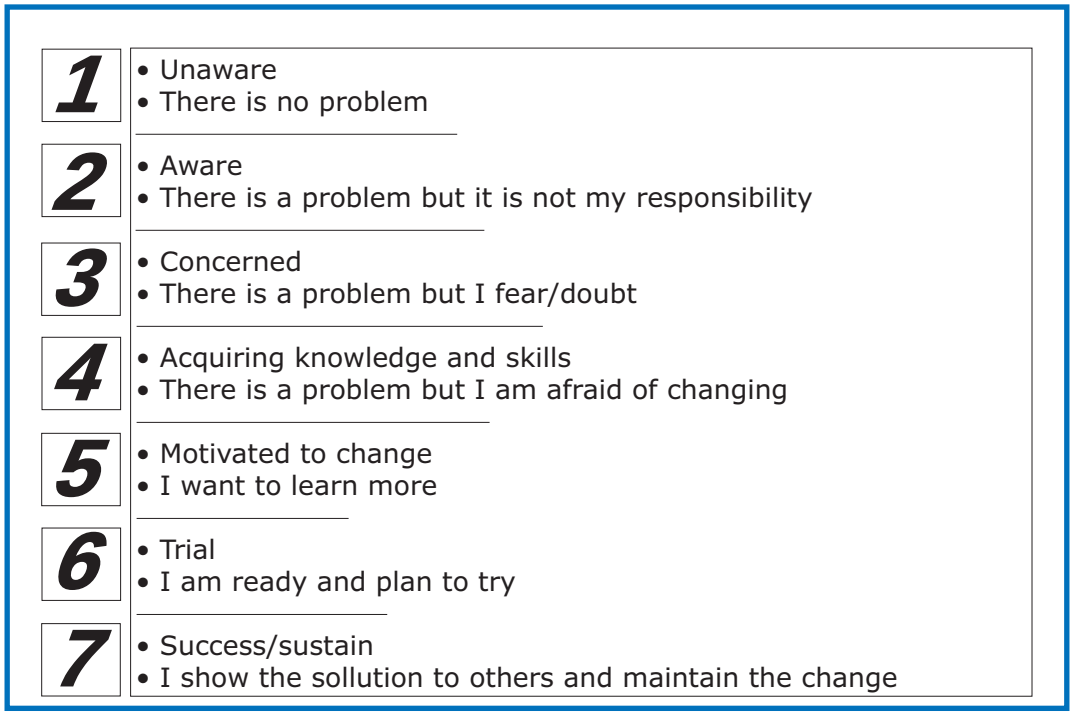


Table 8.0: Strategies for Various Stages in Behaviour Change Communication

Stages of Behaviour Change	BCC Strategy
Unaware	Provide basic information on present situation; e.g. causes andconsequences of unmanaged solid waste
Aware	Encourage the adoption of positive steps; present them with behaviour change options
Concerned	Tell them what to do next in changing their own behaviour, e.g. go to municipality to receive SWM options
Acquiring knowledge & skills	Motivate the community to act, e.g. inform them of the benefits of SWM
Motivated to change	Point/Direct community to available services and encourage use. Tell clients the benefits of using the service.
Trial assessment of new behaviour	Provide opportunity to practice new skills and reinforce what community will do to continue with new behaviour
Sustained behavioral change	Tell community they are doing the right thing Create/ encourage environment that promotes new behaviour

- Develop and distribute a variety of information, communication and education (ICE) materials such as posters, pamphlets, and brochures to raise public awareness on SWM. The materials should be simple, attractive and reader friendly. They should provide useful information such as methods for composting or recycling at home, and they should be able to motivate the public to take action.
- Use mass media for regularly providing information to the public and provide orientation to journalists to raise awareness on SWM. The municipality should maintain a list of journalists and media personnel and should involve them in important events.
- Provide training to community groups, particularly women, on practical aspects of SWM such as household composting and recycling. The training should be organized at times suitable for the participants and should be demand driven.
- Promote the use of appropriate technologies such as household compost bins by facilitating the supply of these technologies and creating demand for their use.
- Reward institutions and individuals who have made significant contributions to SWM. This can be done once a year during an important event such as World Environment Day to encourage people who have done a good job and motivate others to follow.
- As community mobilization is a long term activity; municipalities should have a separate unit with dedicated staff and resources for this purpose. The staff should receive training on solid waste management, community mobilization, social marketing and behavior change communication.

Box 8.4 Summary of Key Activities for Step 7

1 Establish community mobilization unit and formulate strategy & action plan
- As community mobilization is a long term process, a separate unit should be established for this with dedicated human resources and adequate financial resources.

2 Mobilize and support community groups
- Community groups such as Tole Development Committees and women's groups should be mobilized for promoting composting and recycling and they should be provided with technical and financial support where required.

3 Engage school children in waste management related activities
- Establish eco-clubs in schools to provide practical education to the children and encourage them to organize activities such as clean up campaigns and recycling projects.

4 Reward successful initiatives
- Reward institutions and individuals who have made significant contributions to SWM in order to encourage them and motivate others to follow.

5 Use mass media to promote people's participation in waste management
- Maintain a list of journalists, involve them in important events, and encourage them to cover issues related to solid waste management and people's participation.

STEP 8 Encourage Private Sector Participation

Private sector, including private companies and non-government organizations, can be involved in developing new infrastructures related to SWM or in operating existing systems for waste management. The main benefits of involving the private sector are as follows:

- Mobilize financial investment and human resources for SWM
- Share risks associated with implementation of existing or new SWM systems
- Improve effectiveness and efficiency

A capable private organization can be involved in almost all areas of SWM in coordination with the municipality. The following activities can be implemented with the participation of the private sector:

- Waste collection
- Waste transportation
- Waste processing and recycling
- Landfill management
- Hazardous waste management

9.1 Types of Private Sector Participation

The private sector can be involved in SWM in different way. The following are the most common types of private sector participation in SWM:

Management Contract: The management responsibility of a system or service can be given to a private organization for a fixed time at a fixed rate. In this type of arrangement, the risk for the private sector is very low as it does not have to make any major investments and receives a fixed fee from the municipality on a regular basis. This is a very simple form of private sector participation and can be useful for involving the private sector in managing a portion of the SWM system if it can provide the service in a more effective and efficient manner than the municipality. This type of arrangement is especially useful when the private companies are not strong enough to make major investments.

Franchise: In this type of arrangement, a private organization is given the responsibility to provide waste management services and collect revenue from a fixed locality for a fixed duration. The organization is required to make all the investments for providing the service and collecting the service fee. The service provided is selected through a competitive process but for the duration of the contract the selected service provider than functions as a monopoly. Compared to a simple management contract, in the franchise system the private service provider has to make more investment and take on more risks. Therefore, the duration of contract is usually longer in the franchise system.

The most common example of this type of arrangement is when the responsibility for waste collection as well as service fee collection from a particular section of the town is given to a private organization. The municipality then does not have to many any investment in this area and it may also receive a portion of the revenue as royalty or management fee.

Open competition: In this arrangement, capable private organizations are first short listed and then they are allowed to compete freely in the market for providing certain ser-

vices. In this form of private sector participation, the role of the municipality is very limited and the private organizations make their own arrangement with the clients. This system is useful for providing specific services such as collection of waste from large institutions or providing septic tank cleaning services, but is not very effective when the service has to be provided to all the people.

Concession: In this system, the private company invests in building the necessary infrastructure and also operates the infrastructure for a fixed time. As the private organization has to make a big investment and also take a large portion of the risk associated with the project, the duration of the contract is usually 15 to 30 years or longer, depending on the size of the investment. The best example for this type of arrangement is the establishment and operation of a large scale compost plant by a private organization.

9.2 Risks Associated with Private Sector Participation

Although private sector participation can have many benefits, these benefits can only be realized the process is well planned and implemented in a transparent and competitive manner. The main risks associated with private sector participation are as follows:

- The municipal workers, particularly the labour unions, often oppose the introduction of private parties because the fear of insecurity, more work and less incentives.
- Private companies may not have necessary skills and investment capabilities.
- If there is no competition; the private sector may not be effective and efficient.
- If the process of selecting a private operator is not transparent, this may cause controversies and oppositions.
- In the absence of proper monitoring by the municipality, the quality of service may not be good and the private operator may not be responsive to the needs of the public

9.3 Process of Involving Private Sector

The process for involving the private sector in waste management is shown in Figure 9.0. The Ministry of Local Development has issued Public Private Partnership Policy, 2060 and Public Private Partnership Guidelines 2061, which should also be followed in the process of involving private organizations in solid waste management.

Generally the process of involving private sector includes the following steps:

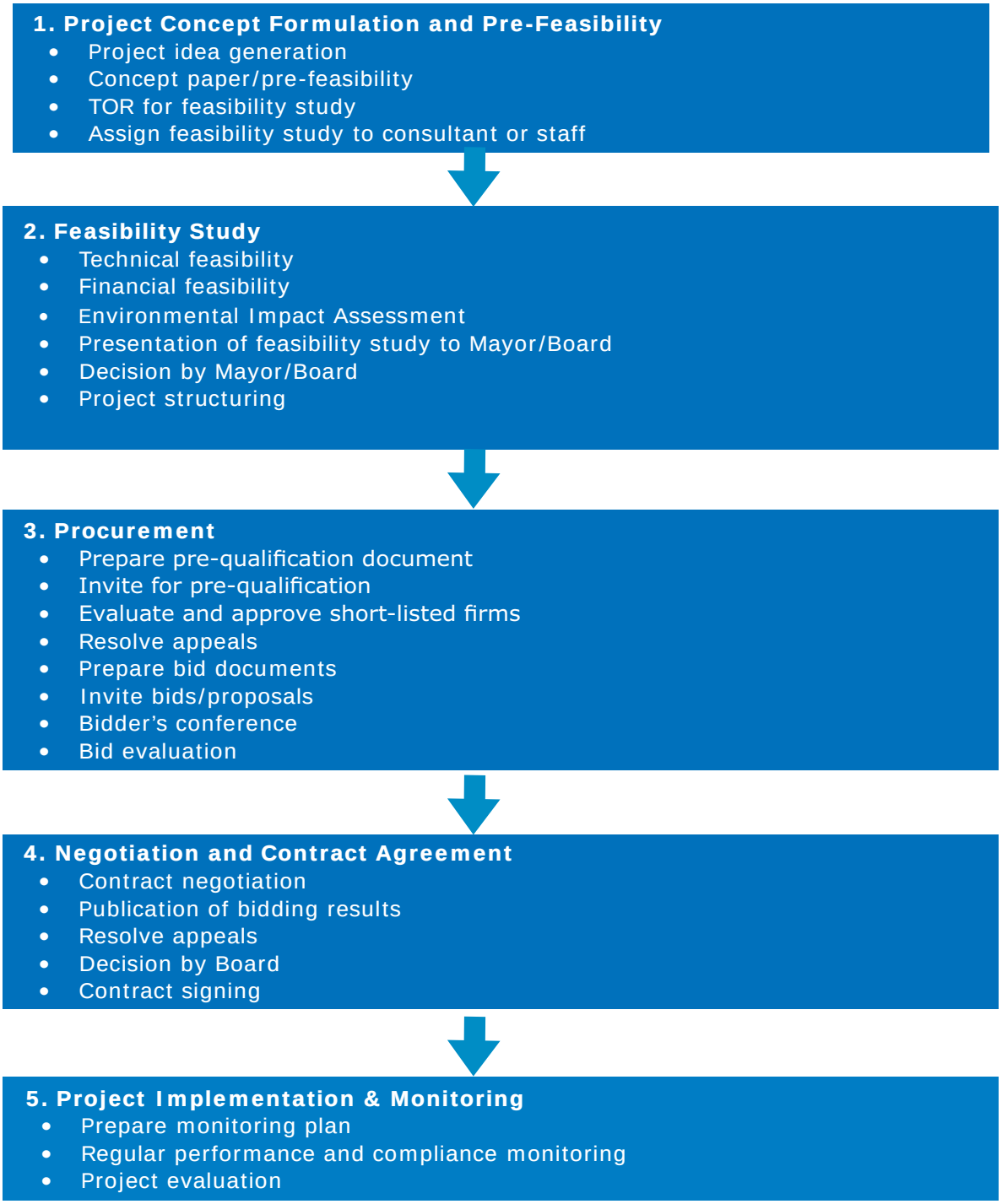
- ***Concept formulation and pre-feasibility:*** This is the first step in involving the private sector in waste management. In this step potential areas for involving the private sector are identified, a concept note for each potential project is prepared and the process of conducting a detail feasibility study is initiated. This is usually done by the municipal staff based on their experiences as well as experiences from cities.
- ***Feasibility study:*** At this stage the technical and financial feasibility of the project along with the potential environmental impacts are analysed in detail. The study should also assess the appropriate form of partnership and the process for procuring the services of the private sector. Overall it should provide a broad framework for the development and implementation of the project in partnership with the private sector. A checklist for conducting the feasibility study is presented in Annex 4. The output will be a feasibility study report which should be presented to the Mayor or Board.
- ***Procuring the services of private partner:*** This should be a transparent and competitive process in order to obtain the most appropriate partner and the most beneficial terms of service. The process of procuring the service provider may be done through a request for proposals or through a two step process including pre-qualification of potential bidders and bidding from the short listed firms.
- ***Negotiation and contract agreement:*** Once the private sector is selected a contract should be signed between the private party and the municipality. This is a very important document and it should clearly specify the terms and conditions under which the project will be implemented.
- ***Project implementation and monitoring:*** Once the project is implemented, the municipality should regularly monitor the project activities and the performance of the service provider to ensure that they are in compliance with the terms and conditions in the contract and the desired impact is being achieved. For this a monitoring schedule with key indicators and monitoring methods to be used should be developed.

9.4 Role of Municipality in PSP

Involvement of private sector in waste management does not mean that the municipality will be relieved from its responsibilities. Although private parties may provide some or all of the services related to SWM, the municipality will continue be to be ultimately responsible for solid waste management in the city and will continue to be accountable to the citizens. The nature of the responsibilities of the municipalities will however change with the involvement of private sector in waste management. The main responsibilities of the municipalities will be as follows:

- Maintain service standard
- Protect public interest
- gulation and monitoring of services
- Create an environment to enable the private operator to provide its services
- Show accountability to the public

Figure 9.0: Recommended Process for Private Sector Participation in SWM



Box 9.5 Summary of Key Activities for Step 8

1

Prepare policy, strategy & action plan for PSP

- Once the municipality decides to engage the private sector in waste management a clear policy, strategy and action plan should be prepared in consultation with key stakeholders including the municipal staff involved in SWM.

2

Buide the capacity of SWM staff i PSP

- The key staff of the municipality should be trained in various aspects of PSP particularly the role of the municipality and orientation should also be given to local policy makers.

3

Prepare concept papers and pre-feasibility studies for potential projects

- Potential projects for PSP, such as waste collection from certain areas or establishment of compost plants should be identified and a pre-feasibility study should be done.

4

Prepare detail feasibility studies

- A feasibility study, including technical and financial assessment as well as EIA/IEE if necessary should be prepared and this should be approved by the Mayor or Municipal Board before proceeding further.

5

Implement PSP projects

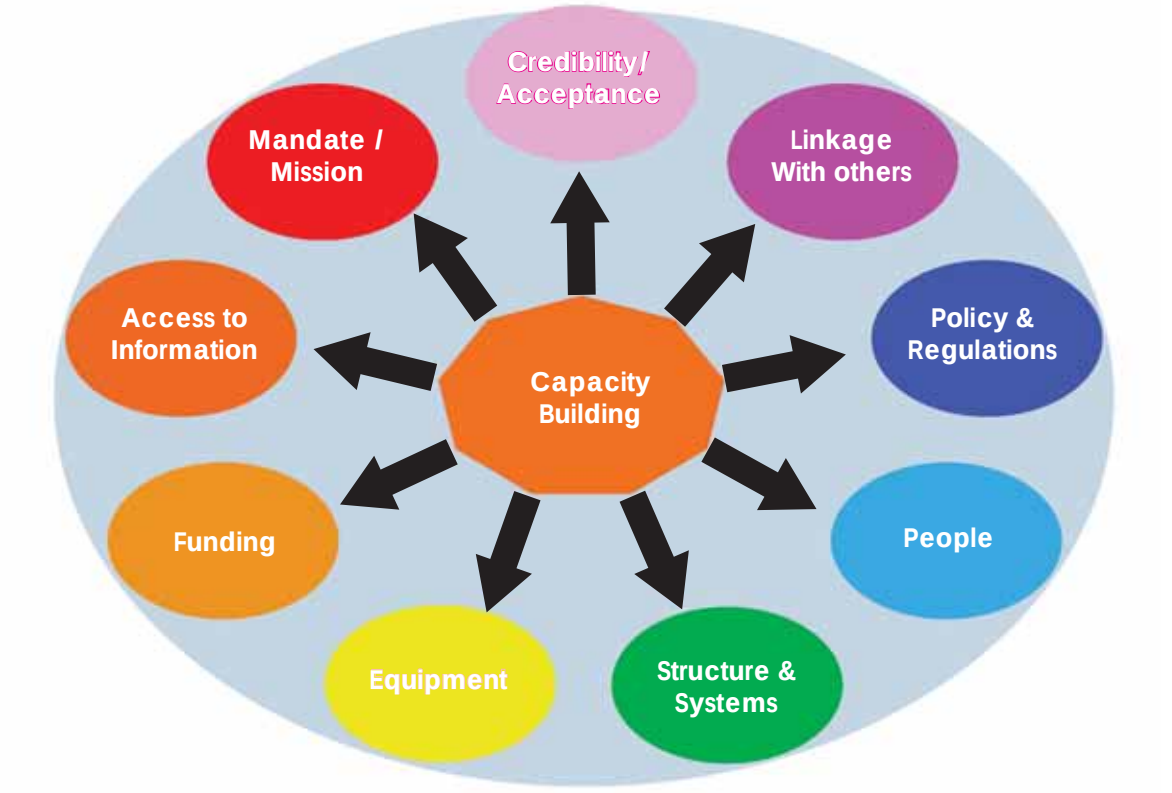
- A private party should be selected based on a competitive bidding process and the municipality should closely monitor the process to ensure that it is successful.

STEP 9 Strengthen Institutional Framework

Organizations involved in solid waste management in Nepal include Solid Waste Management and Resource Mobilization Centre (SWMRMC), municipalities, private operators, NGOs and community groups. Among these, legally municipalities have the main responsibility for SWM.

Therefore, municipalities need to have the institutional capacity to plan and implement effective waste management systems. Institutional capacity includes appropriate organizational structure, capable human resources, effective management systems, proper equipment, adequate financial resources, access to information, as well as linkages with other groups. Some of the key elements of effective organizational capacity building are shown in Figure 10.0.

Figure 10.0: Elements of Organizational Capacity Building



10.1 Organizational Structure

As SWM is a major responsibility of the municipality as well as a very sensitive issue that is directly related to environment and public health municipalities need to establish a separate unit for waste management within the municipality's organizational structure and provide it with adequate human and financial resources so that it can manage waste in an effective and efficient manner. Furthermore, the municipality should have a plan for developing the capacity of the staff through regular training.

The SWM unit can be established as a separate section directly responsible to the Executive Officer or it can be a unit within the Environment Section or Community Welfare Section. In large municipalities, the unit should be headed by an officer level staff and it should include technical as well as administrative staff. The number of staff in the unit depends on the amount waste to be managed and the involvement of other organizations such as community and private groups in this sector.

The SWM unit can have different sections for planning and monitoring; operations; community mobilization; and administration. The planning and monitoring section should be responsible for regularly monitoring the performance of the SWM system as a whole, preparing strategic and operational plans, and developing new projects for improving the services. The operations section should be responsible for the day-to-day operation of the SWM system, including waste collection, transportation, processing and landfilling. The Operations Section may have several subsections to manage the different components of the waste management system. The Community Mobilization Section will be responsible to working with communities to involve them in waste management.

10.2 Human Resource Management

Human resources are the most important resources within any organization. Municipalities must be able to recruit and retain capable staff and they also need to keep their staff motivated. However, due to institutional regulations, hiring qualified human resources, particularly specialists, is a major challenge for municipalities. In such a case, municipalities need to concentrate on training their existing staff and keeping up the motivation level of the staff. Furthermore, municipalities can work in partnership with NGOs or private organizations to acquire the services of specialists as and when needed. Some of the key areas where municipalities need to develop expertise are as follows:

- Strategic and operational planning
- Resource (human and financial) planning and management
- Technical skills related to waste collection, recycling and landfilling
- Monitoring and evaluation
- Private sector participation, including contract negotiations and monitoring
- Community mobilization and participation

Municipalities should develop and implement a human resource development plan. The plan should assess the capacity of existing human resources, identify gaps and training needs and propose a series of activities to overcome the gaps. Based on the plan the municipalities should offer on-the job and external training opportunities to the staff.

Although regular training for the staff as well as other stakeholders involved in waste management is important, this by itself is not enough. In order to enhance staff performance and provide tangible benefits to the organizational capacity, there must be an enabling environment that supports the staff in applying their skills and knowledge. Such supports should be systematically institutionalized within the organization and followed up with regular monitoring and interaction between the supervisor and staff. Some of the important factors that create an enabling environment for the staff and enhance their motivational levels are as follows:

- Clear job descriptions
- Regular interaction among staff and between supervisor and staff to share experiences and provide feedback
- Selection of appropriate staff for training opportunities
- Encouragement from the management for application of new learning
- Appropriate operational systems to apply new learning
- Opportunities for career growth

10.3 Information Management

Access to up to date and reliable information on various aspects of SWM is essential for planning and management. This requires collection of relevant information on a regular basis, proper storage of the information, processing the information to assist in planning and making the information available to key stakeholders. Computerization can make the information more manageable and

accessible. In large cities, Geographic Information System (GIS) can be used and integrated with Management Information System (MIS) to make the information management system as a whole more efficient and effective.

The following types of information needs to be collected for effective waste management

- General information of the city and wards
  - Population
  - Population growth rate
  - Number of houses, shops and institutions
  - Road length and width
- Waste generation & collection
  - Total amount of waste generated
  - Characteristics of waste generated
  - Amount of waste collected from various wards
- Waste storage and transportation
  - Type and number of storage containers provided in each ward
  - Number of vehicles in operation
  - Number of trips made by each vehicle
  - Amount of waste in transfer stations
- Waste composting and recycling
  - Amount of waste composted or recycled
  - Amount of compost produced and sold
  - Types of waste recycled
- Sanitary landfill
  - Amount of waste landfilled
  - Available space in landfills
  - Amount of leachate generated
  - Environmental impacts of landfills
- Special waste management
  - Amount of health care waste generated
  - Amount of health care waste managed
  - Number of dead animals managed
  - Amount of other types of special waste generated and collected
  - Environmental impacts from management of special waste
- Human resource management
  - Number of staff and their positions
  - Human resource development related activities
- Financial management
  - Cost of various components of SWM
  - Revenue generated from SWM

The municipality should prepare an annual report based on the information collected and make this report available to all stakeholders.

Box 10.4 Summary of Key Activities for Step 9

1 Establish a SWM unit and recruit qualified staff
- The municipality should have a section for SWM that has separate units with adequate manpower for Planning and Monitoring; Operations; and Community Mobilization.

2 Conduct Training Need Assessment
- In consultation with all the staff members, a training need assessment (TNA) should be conducted and a human resource development plan should be prepared.

3 Provide training to staff
- Based on the TNA, training should be organized for all staff on a regular basis. Senior staff may require training on SWM techniques and management while, junior staff may require training on SWM management and their responsibilities.

4 Establish an information management system
- As access to relevant information is very important for planning and building organizational capacity, a system should be developed for acquiring and managing information related to waste management.

5 Create an enabling environment to motivate staff
- All staff should be given clear job descriptions as well as necessary guidance and support for doing their jobs. There should be regular interaction among staff and their concerns should be addressed to the extent possible.

STEP 10 Strengthen Financial Management for SWM

11.1 Cost of SWM

SWM is a resource intensive activity and mobilizing adequate financial resources is always a major challenge for municipalities. Amount funds that municipalities spend on SWM vary significantly based on the services they provide and the efficiency of the services provided. As municipalities generally have very limited funds and SWM is an unavoidable activity, there is a need to improve cost effectiveness and strengthen financial management, so as to provide effective and efficient services in a sustainable manner.

11.2 Improving Cost Effectiveness

The amount spent to manage a unit of solid waste can vary significantly depending on the systems used. The municipality needs to analyze where the money is being spent and seek out opportunities for reducing cost and generating revenue. The following guidelines can be followed to reduce the cost of solid waste management and improve the efficiency of services provided.

Improve waste collection system: As waste collection is always the most expensive part of any solid waste management system requiring 50 to 90 percent of the total cost of SWM, improving efficiency of waste collection can have significant impact on cost effectiveness. Most municipalities practice road-based collection system, which is an inefficient system as waste has to be handled several times and this requires large number of collection crew and sweepers. Switching to door-to-door or on-time collection system can save significant resources.

Use efficient vehicles and equipment: Operation of vehicles and equipment is a significant cost associated with solid waste management. Therefore, municipalities need to analyze the costs involved in using various types of vehicles and equipment and select the most cost effective option. Complex equipment or vehicles are often very expensive to maintain and therefore should be avoided. For example, vehicles with hydraulic loading and compaction systems may not be the most effective for municipalities where the solid waste is already very dense and need not be compacted.

Establish transfer stations at appropriate locations: Where the final disposal site is located far away from the source of the waste and small vehicles are used to collect the waste, a transfer station where waste is loaded onto large vehicles and sent to the landfill can save costs. In large cities, several transfer stations are necessary so as to minimize the cost of transportation.

Encourage recycling: Recycling of waste will minimize the amount of waste that needs to be transported and landfilled and therefore reduce the cost of waste management. As almost all waste generated in Nepalese cities can be recycled, encouraging recycling can be a way to significantly reduce waste. Municipalities need to encourage recycling by the private sector by separating the waste at source and providing some incentives where necessary and it should also encourage households to compost and recycle waste at the source.

Involve private sector: Private sector is often more efficient than public sector if it is selected through a competitive process and its performance is carefully monitored. Municipalities should therefore seek opportunities to involve private sector in a well panned and transparent manner. Waste collection and establishment in waste treatment systems are areas where potential for private sector participation is high.

11.3 Financing Solid Waste Management

There are two types of costs associated with solid waste management: capital investments and recurrent costs or operation and maintenance (O&M) cost.

In order to make SWM systems sustainable, waste generators should pay for at least the O&M costs of providing waste management services. Waste generators can pay for SWM services, either indirectly through municipal taxes or directly through SWM fees.

Financing SWM services through municipal taxes may be a simple process but it is not the best process, as the revenue collected from taxes may not be used solely for SWM and the service provider (municipality or private operator) is not directly accountable to the people. As the tax revenue goes directly to a central municipal fund, it may not be accessible for SWM operators when needed.

Collection of a direct service fee for SWM services ensures that the collected amount gets spent on solid waste management and makes the system as a whole more sustainable. The revenue can be collected on a monthly basis from the consumers either by the private operator or the municipality. If the private sector providing the service collects the revenue, there should be a system for sharing of the revenue with the municipality. The private sector can give part of the revenue to the municipality for the services provided by the municipality or the municipality can charge the private party a tipping fee at the waste transfer station or landfill if these facilities are operated by the municipality.

While charging a service fee, it is essential that the fee is charged to all households but the amount of fee can vary depending on the amount of waste collected. However, especial considerations may have to be made for poor communities. In such communities, the municipality can encourage the residents to manage the waste on their own at the household or community level and provide the initial capital cost. Or it can put community containers and ask the residents to pay a small amount for the service.

The amount of service fee depends on the cost of services and the willingness to pay among waste generators. Surveys can be done to find the willingness to pay among various groups. In Nepal, currently the service fee charged by municipalities or private operators range from Rs. 30 to 200 per household per month.

Municipalities can also raise revenue by providing special services such as collection of construction and demolition debris, collection of institutional or commercial waste, and cleaning of septic tanks. As these types of waste are generally generated in bulk amounts and the generators of these types of waste can usually afford to pay more for this service, this can be a good source of income if the quality of service is good.

Another possible source of income can be fines and punishment for violators of regulations regarding waste management. The Local Self Governance Act, 1997 allows municipalities to fine individuals or organizations who dump waste in a haphazard manner up to Rs. 15000 plus the cost of cleaning up the waste. This authority is rarely exercised by the municipalities. The municipality should develop a system for fining people who dispose waste against the municipal regulations.

The system should include the amounts of fines to be charged for various types of offence, and the means through which the fines are to be paid. In order to encourage public participation in this activity, a system can be made where a part of the revenue collected through the fines can go to community groups who help in identifying offenders and collecting the fines.

Financing capital investments can be a very difficult task for the municipality as capital costs for equipment and facilities can be very high. The following methods can be used to mobilize funds for capital investments:

- ***Reserves:*** This comes from the municipality's own savings or savings of a portion of current revenues.
- ***Bonds:*** This is a way of raising investment from private investors. Different types of tax-exempt bonds such as general obligation bonds, revenue bonds or lease revenue bonds can be issued with guarantee repayments to raise funds. Although this type of financing is popular in developed countries, it has not yet been tried in Nepal.
- ***Loans/Grants:*** The municipality could take loans from banks or apply for grants from various institutions. This will require the municipality to prepare a business plan or proposal outlining the project in detail and future revenue sources in the case of loans. Town Development Fund can provide low interest loans and loans for SWM related facilities.
- ***Private sector participation:*** Municipality can call proposals from the private sector to build a facility under a concession contract such as Build Own Operate and Transfer (BOOT). This type of financing is possible for facilities which can generate revenue, such as compost plants or landfill site with tipping fee.
- ***International Carbon Market:*** Haphazard

disposal of waste results in the generation of methane, which is a greenhouse gas and contributes to global climate change. Waste management facilities such as compost plants, biogas plants or sanitary landfills with gas capture can reduce the emission of methane and therefore qualify for carbon financing either through the Clean Development Mechanism (CDM) or Voluntary Emission Reduction schemes. Raising funds from the international carbon market, however, can be long and complex process that requires intensive studies on baseline emissions and future emissions. Some countries such as Bangladesh, India and Pakistan have initiated this process and Nepal should learn from their experience. Municipalities interested in exploring possibilities for financing through the international carbon market should work closely with the Ministry of Environment, Science and Technology which is the Designated National Authority for CDM in Nepal.

11.4 Financial Management

Besides reducing costs and generating revenue, municipalities also need to have efficient and effective financial management systems so as to reduce the chances of leakages and inefficiencies, provide financial information for decision making and make financial transactions transparent for municipal managers as well as tax payers. The following steps should be taken to improve financial management:

- Proper planning and budgeting should be done for all activities
- All financial regulations of the municipality should be followed for procurement of goods and services
- Financial transactions should be done in a transparent manner
- Financial records should be kept up to date using standard accounting practices
- All financial records should be audited annually and the audit report should be made public

Box 11.5 Summary of Key Activities for Step 10

1 Reduce cost of SWM
- Costs of various components of the SWM system should be analyzed and measures for reducing costs should be identified and implemented. This includes increasing efficiency of the collection system, establishing transfer stations and promoting recycling.

2 Collect service fee for SWM related services
- Service fee should be collected for SWM related services such as door-to-door waste collection and collection of bulk waste.

3 Improve financial management system
- The financial management system should be improved by having a proper accounting system and following the government's financial regulations.

4 Mobilize private sector participation for capital investment and cost reduction
- Private companies should be invited to invest in compost plants and other SWM related services. See Step 8 for details regarding PSP.

5 Explore other financing options for capital investment
- Options such grants and government and donor agencies as well as CDM for financing projects such as compost plants and landfill sites. For this the municipality should conduct project feasibility studies and prepare project proposals.

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NHRC/WHO, 2002: National Health Care Waste Management Guidelines, Nepal Health Research Council, Kathmandu.

UNEP ITEC, 1996: International Source Book on Environmentally Sound Technologies for Municipal Solid Waste Management, United Nations
Environment Programme International Environmental Technology Centre, Osaka/Shiga. http://www.unep.or.jp/ietc/estdir/pub/msw/index.asp

Tchobanoglous, G., Theisen, H., Vigil, S. A., 1993: Integrated Solid Waste Management Engineering Principles and Management Issues, McGraw –Hill, Inc., New York.

Tuladhar, B., Bania, A., 1997: Technical and Economic Analysis of Bhaktapur Compost Plant – Nepal, Urban Waster Expertise Programme, WASTE, Gouda, the Netherlands

Further Information

13.1 Useful Institutions

Government Organizations

1. Solid Waste Management & Resource Mobilization Centre
(SWMRMC)
Ministry of Local Development
Pulchowk, Lalitpur
Phone: 5544404

2. Ministry of Environment, Science & Technology
Singha Durbar, Kathmandu
Phone: 4225596

3. Nepal Health Research Council
Ram Shah Path, Kathmandu
Phone: 4254220/4227460
Email: nhrc@nhrc.org.np

Non-Government Organizations

4. Municipal Association of Nepal
Dilli Bazar, Kathmandu
Phone: 4436725; 4420559
Email: info@muannepal.org.np

5. Solid Waste Management Association of Nepal
(SWAMA Nepal)
Phone: N/A

6. Biogas Support Partnership Nepal
(BSP-N)
Bakhundol, Lalitpur
Phone: 5529840; 5524665
Email: bspnepal@wlink.com.np

7. Nepal Biogas Promotion Group
(NBPG)
Pulchowk, Lalitpur
Phone: 5550147
Email: nbpg@nbpg.wlink.com.np

8. Women Environment Preservation Committee
(WEPCO)
Kupundol, Lalitpur
Phone: 5520617

9. Nepal Pollution Control & Environment Management Centre
(NEPCEMAC)
Ekantakuna, Lalitpur
Phone: 5520512; 5541976
Email: nepcemac@mail.com.np

10. Environment and Public Health Organization
(ENPHO)
Baneshwor, Kathmandu
Phone: 4493188; 4468641
Email: enpho@mail.com.np

13.2 International Organizations/Projects

11. Urban Development through Local Efforts (UDLE)
Baneshwor, Kathmandu
Phone: 4482969; 4780378

12. UN-HABITAT Water for Asian Cities Programme
Pulckhowk, Kathmandu
Phone: 5536699

13.3 Useful Books & Reports

CKV JICA, 2005: Public Private Partnership (PPP) Municipal Solid Waste Management Operational Handbook

This book provides detailed guidelines as well as sample contract documents for involving private sector in Waste management. Available at SWMRMC.

CPHEEO, 2000: Manual on Municipal Solid Waste Management (First Edition), Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, Government of India, New Delhi.

This 755-page manual for SWM in India can also be useful for Nepalese Municipalities. Available at Jain Book Agency, New Delhi. www.jainbookagency.com

Eawag Sandec & Waste Concern, 2006: Decentralized Composting for Cities of Low and Middle Income Countries A Users' Manual, Dhaka.

A useful manual for setting up a community based compost plant. Available at www.sandec.ch

Klundert, A., Anschutz, J., 2001: Integrated Sustainable Waste Management – The Concept Tools for Decision Makers Experiences from the Urban Waste Expertise Programme,

A useful book for planning waste management systems. Available at www.waste.nl

NHRC/WHO, 2002: National Health Care Waste Management Guidelines, Nepal Health Research Council, Kathmandu

This is very useful for setting up a health care waste management system. Available at NHRC.

UNEP ITEC, 1996: International Source Book on Environmentally Sound Technologies for Municipal Solid Waste Management, United Nations Environment Programme International Environmental Technology Centre, Osaka/Shiga.

A comprehensive book on appropriate technologies for waste management along with case studies. Available at http://www.unep.or.jp/ietc/estdir/pub/msw/index.asp

Tchobanoglous, G., Theisen, H., Vigil, S. A., 1993: Integrated Solid Waste Management Engineering Principles and Management Issues, McGraw –Hill, Inc., New York.

This is a standard textbook on solid waste management for college students. Available in bookstores in Kathmandu.

13.4 Useful Web sites

1. www.sandec.ch : This is the site for EAWAG/SANDEC, Switzerland, which is involved in research on decentralized composting

2. www.waste.nl : The official site of WASTE, a Netherlands based organization involved in waste management.

3. www.wasteconern.org: Waste Concern is a Bangladeshi organization that is involved in conducting research as well as projects related to waste collection, composting, and CDM.

Glossary*

Aerobic composting: Biological degradation of organic waste controlled environment using microorganisms that need oxygen.

Anaerobic digestion: Process by which biodegradable waste components are decomposed under controlled conditions by microorganisms in the absence of oxygen.

Autoclaving: Sterilization of mainly infectious healthcare waste, via a pressurized, high temperature steam process.

Behaviour Change Communication (BCC): An interactive process designed to develop tailored messages and approaches using a variety of communication channels in order to develop and sustain positive behaviour change in individuals and communities.

Biodegradable waste: Waste which can be naturally degraded aerobically or anaerobically.

Biochemical Oxygen Demand (BOD): A measure of organic content in wastewater, BOD is the mass of dissolved molecular oxygen required by microorganisms for the aerobic oxidation of organic substances to carbon dioxide and water. Generally in water quality analysis BOD is determined at 20° C with 5 days incubation period. This is also known as BOD5.

Biogas: Mixture of gases produced by methanogenic bacteria while digesting biodegradable material in an anaerobic condition. Biogas consists of 50 to 70 percent methane, 30 to 40 percent carbon dioxide and some other gases. It burns with a blue flame and can be used for cooking, lighting and other purposes.

Brown waste: Biodegradable waste which has high carbon content. Typical examples are saw dust, dry leaves, and dry agricultural residue.

Bulky waste: Large wastes such as appliances, furniture, and trees or branches that cannot be handled by normal MSW collection systems.

Cell: The basic unit by which a landfill is developed. It is where incoming waste is tipped, spread, compacted and covered.

Chemical Oxygen Demand (COD): This parameter which indicates the organic content in water is a measure of the total oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant.

Clean Development Mechanism (CDM): One of the three flexible mechanisms built within the Kyoto Protocol that allows industrialized countries to invest in projects that reduce green house gasses (GHGs) in developing countries and get credits towards meeting their Kyoto requirements. CDM thus creates a channel for emission credits to flow from developing countries to industrialized countries and funds for GHG reducing projects to flow from industrialized countries to developing countries. According to Article 12 of the Kyoto Protocol, the purpose of CDM “shall be to assist Parties not included in Annex I [developing countries] in achieving sustainable development andin contributing to the ultimate objective of the Convention and to assist Parties included in Annex I [industrialized countries] in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.”

Collection efficiency: Amount of waste collected divided by the amount of waste generated.

Communal collection: A waste collection system where waste generators bring their waste directly to a central point, from which it is collected.

**This glossary draws extensively from UNEP IETC, 1996 and Eawag/Sandec & Waste Concern, 2006.*

Compost: A stabilized organic product produced by a controlled biological decomposition process, which may be used as a soil conditioner.

Composting: Process by which biodegradable organic waste is decomposed under controlled conditions by microorganism (mainly bacteria and fungi) to produce a soil-like product.

Compactor vehicle: A collection/transportation vehicle that uses high-power mechanical or hydraulic equipment to reduce the volume of solid waste.

Curbside collection: A collection system where waste is put by the waste generator at the edge of the sidewalk in front of a residence or shop from where it is collected by the collection crew.

C:N Ratio: The ratio of carbon to nitrogen in organic waste. Microorganisms need carbon for energy and nitrogen for growth. The ideal C:N ratio for composting is 25 to 40 (25-40 parts carbon to 1 part nitrogen in terms of dry weight).

Door-to-door collection: A collection system where waste collectors collect the waste directly from the door of the waste generators.

Dry waste: A term often used for inorganic waste.

Environmental Impact Assessment (EIA): A process designed to identify, predict and analyze the potential impacts, both positive and negative, of an action or project on the environment andpropose mitigation measures to minimize potential adverse impacts. The process of conducting EIAin Nepal is governed by the Environmental Protection Act and Regulations, 1997, which also listprojects that need to go through an EIA project and provide detail guidance for conducting EIA.

Franchise system: A system where a private organization is given the responsibility to provide waste management services and collect revenue from a fixed locality for a fixed duration.

Health care waste: Waste generated during the process of examining and treating patients, immunization and conducting research in health care facilities (hospitals, clinics, medical research centres, and laboratories)

Incineration: The process of burning waste under controlled conditions to reduce its weight, volume and make it sterile. Incineration can also be used to generate energy from waste.

Initial Environmental Examination (IEE): A process of designed to quickly identify, predict and analyze potential environmental implications of an action or project based on available information and suggest if an EIA is required or not. In Nepal, the Environmental Protection Act and Regulations, 1997, lists projects that require IEE and also provides the steps to be followed while conducting an IEE.

Inorganic waste: Waste composed of materials other than plant or animal matter, such as sand, dust, glass and metal.

Integrated Solid Waste Management (ISWM): Coordinated use of a set of waste management methods, each of which plays an important role in making the overall waste management system effective and efficient.

Landfill gas: Gases, mainly methane, carbon dioxide and hydrogen sulfide, generated by decomposition of organic wastes in a landfill

Leachate: Highly contaminated liquid (which is partially produced by decomposition of organic matter) that has seeped through a landfill, waste dump or compost pile.

Liner: A protective layer, made of clay and/or synthetic materials, installed along the bottom and sides of a landfill to prevent or reduce the flow of leachate into the ground.

Methane: An odourless, colourless and fl ammable, gas – CH4 – produced by anaerobic digestion of organic matter in a landfill or biogas digester.

Municipal solid waste (MSW): All waste generated in a municipal area, except industrial and agricultural waste. Sometimes it includes waste from surrounding rural areas as well as special wastes such as construction and demolition debris and healthcare waste, which enter the municipal waste stream.

Organic waste: Technically, waste containing carbon, including food waste, yard waste, wood, paper and plastics. But in practice, only waste materials that are directly derived from plant or animal sources and can be easily decomposed by microorganisms are categorized as organic waste. This usually does not include paper and plastics.

Pathogen: An organism capable of causing disease.

Polluter pays principle: A principle where polluters are made to pay for the damage caused by the pollution they generate and the cost of cleaning up the pollution.

Primary transportation: Transportation of waste from the source to a transfer point or transfer station.

Recycling: The process of transforming waste materials into raw materials and processing them for manufacturing new products, which may or may not be similar to the original product.

Sanitary landfill: An engineered facility for disposing solid waste on land in a manner that minimizes its impact on the surrounding environment and meets specifications such as proper site selection, extensive site preparation, proper leachate and gas management and monitoring, compaction, daily and final cover, access control and record keeping.

Secondary transportation: Transportation of waste in large haulage vehicles from a transfer station or transfer point to a processing facility or disposal site.

Semi-aerobic landfill: A landfill system that allows air to be drawn into the landfill by natural ventilation through the leachate pipes and gas vents. Originally developed in Fukuoka, Japan, this method has been applied in the Sisdol landfill for Kathmandu Valley, is also known as the Fukuoka method for landfilling.

Special waste: Waste that are normally considered to be outside municipal waste stream but which sometimes enter it and must be dealt with municipal authorities. These include household hazardous waste, healthcare waste, construction and demolition debris, tires, slaughterhouse waste, and industrial waste.

Source separation: Practice of segregating compostable and recyclable materials from the waste stream before they are collected with other solid waste so as to facilitate recycling and composting.

Tipping fee: A fee for unloading or dumping waste at a facility such as landfill, transfer station or processing site.

Tipping floor: Unloading area for vehicles carrying solid waste to a transfer station, waste processing facility or landfill site.

Total Dissolved Solids (TDS): TDS is a parameter to test water quality. It consists mainly of inorganic substances such as calcium, magnesium, sodium, bicarbonates, chlorides, and sulfates.

Transfer point: A designated point, often at the edge of a neighbourhood, where small collection vehicles transfer waste to larger vehicles for transportation.

Transfer station: A facility where waste is transferred from small collection vehicles to larger vehicles for transportation.

Vectors: Organisms that carry disease-causing pathogens. At landfills or waste dumps rodents, flies and birds are the main vectors that spread pathogens beyond the waste pile.

Vermicomposting: An aerobic composting process where biodegradable organic waste components are decomposed and fed to earthworms to produce vermicompost or worm castings.

Waste characterization study: An analysis of samples from waste stream to determine its composition.

Waste reduction: All means of reducing the amount of waste that is produced and must be collected by solid waste management authorities. This ranges from legislation and product design to local programmes designed reduce, reuse and recycle waste.

Wet waste: A term often used for organic waste.

Windrows: A long low triangular line of materials that have been piled for aerobic composting.

Worm casting: A material produced from the digestive tract of worms as they live in earth or compost piles. The castings are rich in nitrates, phosphorous, potassium, calcium and magnesium.
3R: Reduce, Reuse & Recycle – A popular principle for waste minimization.

ANNEX 1

15.0
Basic Data on Municipalities

S.N.	Municipality	District	Total Area(ha)	Roads (km)	Total wards	Urban Wards	Pop.	Household	
1	Amarghadi	Dadeldhura	10774	39	11	NA	18,804	4,000
2	Baglung	Baglung	1405.77	61.1	11	6	22,208	3,812
3	Banepa	Kavre	618.68	22.29	11	10	16,576	2450
4	Bhadrapur	Jhapa	531	41.83	15	11	18,797	2,891
5	Bhaktapur	Bhaktapur	688	16.6	17	NA	75,002	12,133
6	Bharatpur	Chitwan	7500	495.2	14	5	98,539	14,606
7	Bhimeshwor	Dolakha	5781.7	34	13	5	22,489	4521
8	Bidur Nuwakot	Nuwakot	3493	64.4	11	6	21,732	3684
9	Biratnagar	Morang	59904	616	22	22	175,333	33678
10	Birendranagar	Surkhet	3600	76.1	12	6	33,401	7,335
11	Birgunj	Parsa	3510	260	19	NA	124,032	19910
12	Butwal	Rupandehi	7953.1	78	15	12	83,851	23127
13	Damak	Jhapa	7513	532.5	19	6	55,417	9,039
14	Dasharathchand	Baitadi	5720	34.5	13	3	18,404	3,001
15	Dhangadi	Kailali	2967.45	297.64	14	6	73,213	9,430
16	Dhankuta	Dhankuta	4887	20.9	9	8	21,473	3,360
17	Dharan	Sunsari	2112	61	19	17	102,446	12,759
18	Dhulikhel	Kavre	1087	30.9	9	6	11,897	2005
19	Dipayal	Doti	43339	23	14	7	24,771	9,761
20	Gaur	Rautahat	3189.8	93	13	6	26,508	3,963
21	Gorkha	Gorkha	5955	92.5	11	4	26,958	5093
22	Gularia	Bardia	9119	260	14	5	49,912	7,939
23	Hetauda	Makwanpur	5548.4	NA	11	5	71,858	14,272
24	Ilam	Ilam	2700	82	9	2	16,924	2785
25	Inaruwa	Sunsari	2,850	43.5	10	4	24,262	3,701
26	Itahari	Sunsari	4177	276.56	9	3	44,905	9,791
27	Jaleshwor	Mahottari	3680	35.88	13	6	22,936	3620
28	Janakpur	Dhanusha	2608	NA	16	13	78,852	17622
29	Kalaiya	Bara	1137	52	14	6	36,056	3982
30	Kamalamai	Sundhuli	20512	64.5	18	6	34,857	6,447
31	Kapilvastu	Kapilvastu	3083.1	83	14	5	29,797	5,153
32	Kathmandu	Kathmandu	4830	794.13	35	35	737,588	82,298
33	Khandbari	Shankhuwashava	12420	NA	13	3	22,452	4,314
34	Kirtipur	Kathmandu	1400	110	19	NA	43,055	9,487
35	Lahan	Siraha	2111	33.75	10	6	29,804	5262
36	Lalitpur	Lalitpur	1547	519.4	22	12	174,504	34,996

S.N.	Municipality	District	Total Area(ha)	Roads (km)	Total wards	Urban Wards	Pop.	Household
37	Lekhnath	Kaski	7,893	136	15	11	44,084	9,362
38	Madhyapur Thimi	Bhaktapur	1147	11.1	17	17	51,740	9551
39	Mahendranagar	Mahendranagar	19640	18	19	4	85,231	13,985
40	Malangawa	Sarlahi	997.93	38	10	4	19,501	3,141
41	Mechinagar	Jhapa	5583	117.88	13	5	51,878	8,201
42	Narayan, Dailekh	Dilekh	6591	43.38	9	3	20,286	3,217
43	Nepalgunj	Banke	1314	107.36	17	8	59,703	10,592
44	Panauti	Kavre	3378	86	13	4	26,725	4,247
45	Pokhara	Kaski	5510	223	18	13	172,578	24,764
46	Putalibazar	Syanja	6451	145.1	13	4	30,491	5,673
47	Rajbiraj	Saptari	1163	11.5	10	6	31,753	4961
48	Ramgram	Nawalparasi	3120	184	13	5	23,457	3,646
49	Ratnanagar	Chitwan	3184	136	13	6	41,008	5996
50	Siddharthanagar	Kapilbastu	3679.8	150	13	6+2SU	55,669	7858
51	Siraha	Siraha	2829.6	39	9	4	24,436	4,000
52	Tansen	Palpa	2200	55.8	15	10	22,164	3,437
53	Tikapur	Kailali	10,489	212.25	9	1	42,050	4,341
54	Tribhuwan Nagar	Dang	5642	357.14	11	NA	46,672	4,609
55	Triyoga		20,978	221	17	NA	59,752	9,604
56	Tulsipur	Dang	9500	433.97	11	5	36,715	3,364
57	Vyas	Tanahun	5900	130	11	3	30,226	5039
58	Waling	Syanjya	12495.4	8	11	6	21,248	4292

Source: SWMRMC, 2003

ANNEX 2

Estimates of Waste Generation & Collection in Municipalities

S.N.	Municipality	Per-capita waste Generation		+Estimated Population (2003)	Total Municipal Waste Generation	Total Municipal Waste Collection**	Municipal Collection Coverage
		Household	*Municipal				
		(kg/cap./d)	*(kg/cap./d)*	*(nos.)*	*(ton/d)*	*(ton/d)*	*(% by wt.)*
1	Amargadhi	0.29	0.39	18,804	5.80	79.77	7.27
2	Baglung	0.19	0.25	22,208	1.50	26.66	5.63
3	Banepa	0.23	0.31	16,576	4.00	78.69	5.08
4	Bhadrapur	0.35	0.47	18,797	NA	NA	8.77
5	Bhaktapur	0.39	0.52	75,002	20.00	51.28	39.00
6	Bharatpur	0.28	0.37	98,539	11.00	29.90	36.79
7	Bhimeshwor	0.34	0.45	22,489	4.00	39.23	10.20
8	Bidur Nuwakot	0.24	0.32	21,732	6.00	86.28	6.95
9	Biratnagar	0.17	0.23	175,333	35.00	88.07	39.74
10	Birendranagar	0.17	0.23	33,401	4.00	52.83	7.57
11	Birgunj	0.70	0.93	124,032	25.00	21.60	115.76
12	Butwal	0.21	0.28	83,851	18.20	77.52	23.48
13	Damak	0.18	0.24	55,417	3.00	22.56	13.30
14	Dasrathchand	0.27	0.36	18,404	0.50	7.55	6.63
15	Dhangadhi	0.14	0.19	73,213	1.50	10.98	13.67
16	Dhankuta	0.19	0.25	21,473	2.00	36.77	5.44
17	Dharan	0.36	0.48	102,466	7.00	14.23	49.18
18	Dhulikhel	0.14	0.19	11,897	1.00	45.03	2.22
19	Dipayal	0.28	0.37	24,771	3.00	32.44	9.25
20	Gaur	0.20	0.27	26,508	1.07	15.14	7.07
21	Gorkha	0.26	0.35	26,958	1.50	16.05	9.35
22	Gularia	0.11	0.15	49,912	NA	NA	7.32
23	Hetauda	0.25	0.33	71,858	9.00	37.57	23.95
24	Ilam	0.49	0.65	16,924	3.60	32.56	11.06
25	Inaruwa	0.42	0.56	24,262	2.00	14.72	13.59
26	Itahari	0.41	0.55	44,905	NA	NA	24.55
27	Jaleshwor	0.28	0.37	22,936	1.20	14.01	8.56
28	Janakpur	0.15	0.20	78,852	NA	NA	15.77
29	Kalaiya	0.40	0.53	36,056	9.00	46.80	19.23
30	Kamalamai	0.15	0.20	34,857	0.50	7.17	6.97
31	Kapilvastu	0.13	0.17	29,797	1.86	36.01	5.16
32	Kathmandu	0.39	0.52	737,588	250.00	65.18	383.55
33	Khandbari	0.19	0.25	22,452	NA	NA	5.69

S.N.	Municipality	Per-capita waste Generation		+Estimated Population (2003)	Total Municipal Waste Generation	Total Municipal Waste Collection**	Municipal Collection Coverage
		Household	*Municipal				
		(kg/cap./d)	*(kg/cap./d)*	*(nos.)*	*(ton/d)*	*(ton/d)*	*(% by wt.)*
34	Kirtipur	0.34	0.45	43,055	19.52	NA	NA
35	Lahan	0.32	0.43	29,804	12.72	10.00	78.64
36	Lalitpur	0.54	0.72	174,504	125.64	48.00	38.20
37	Lekhnath	0.37	0.49	44,084	21.75	NA	NA
38	Madhyapur Thimi	0.11	0.15	51,740	7.59	3.58	47.18
39	Mahendranagar	0.39	0.52	85,231	44.32	4.00	9.03
40	Malangawa	0.09	0.12	19,501	2.34	1.50	64.10
41	Mechinagar	0.29	0.39	51,878	20.06	3.76	18.74
42	Narayan, Dailekh	0.23	0.31	20,286	6.22	1.20	19.29
43	Nepalgunj	0.18	0.24	59,703	14.33	10.00	69.79
44	Panauti	0.18	0.24	26,725	6.41	1.00	15.59
45	Pokhara	0.14	0.19	172,578	32.21	12.36	38.37
46	Putalibazar	0.08	0.11	30,491	3.25	3.00	92.24
47	Rajbiraj	0.12	0.16	31,753	5.08	4.40	86.61
48	Ramgram	0.24	0.32	23,457	7.51	2.50	33.31
49	Ratnanagar	0.13	0.17	41,008	7.11	4.50	63.31
50	Siddharthanagar	0.13	0.17	55,669	9.65	4.00	41.45
51	Siraha	0.11	0.15	24,436	3.58	0.50	13.95
52	Tansen	0.43	0.57	22,164	12.71	4.00	31.48
53	Tikapur	0.09	0.12	42,050	5.05	0.92	18.23
54	Tribhuwan Nagar	0.25	0.33	46,672	15.56	NA	NA
55	Triyoga	0.10	0.13	59,752	7.81	1.20	15.37
56	Tulsipur	0.25	0.33	36,715	12.24	2.00	16.34
57	Vyas	0.31	0.41	30,226	12.49	3.00	24.01
58	Waling	0.21	0.28	21,248	5.95	NA	NA
	Total	**14.58**	**19.44**	**3,487,000**	**1,369**		
	Average	**0.25**	**0.34**				

Source: SWMRMC, 2003

Note:

* : Household waste assumed to cover - 75% of total municipal waste generation in average.

\+ : Population projection based on census 2001 and growth rate of period (1999 - 2001).

** : Information on amount of waste collected is based on estimate provided by the municipality. It is not necessarily a measured or calculated figure.

ANNEX 3

Example of a Proposal for 3 ton/day Community Compost Plant

This is a summary of a proposal prepared by Hetauda Municipality and Environment and Public Health Organization (ENPHO). It can be used as a guide for other municipalities to produce similar proposal or concept papers for community based composting.

17.1 Background

Hetauda is a mid-sized industrial city located at the intersection of Tribhuwan Highway and East-West Highway. According to the 2001 census, Hetauda had 14,865 households and the total population was 68,752, which was growing at an annual rate was 4.51 percent. At this rate, the population of Hetauda would be approximately 89,585 in 2007. Hetauda Municipality wants to develop composting and recycling facilities for managing its waste and dispose non-recyclable waste in a landfill. In this process, it has recently signed an agreement with the Neureni Community Forest Users Group to establish a composting facility within an open space with an area of approximately 500 m2 in the forest area. The Municipality has also signed agreement with two private parties to collect waste from Municipality and compost the waste.

17.2 Objectives

The main objective of this initiative is to demonstrate public-private partnership for establishing a mid-sized composting facility to manage organic waste and produce a valuable product. The specific objectives of the project are as follows:

- Initiate source separated waste collection service with the help of private service provider.
- Design a 3 ton per day composting facility at Neureni that is technically sound, environmentally friendly, socially acceptable and financially cost effective.
- Mobilize support from public sector, private sector, funding agencies, technical experts and local communities to establish the composting facility.
- Produce about one ton per day of good quality compost from garbage on a regular basis.
- Prepare and implement a marketing strategy to market the compost
- Demonstrate the viability of public-private partnership model for processing waste to produce a valuable product in a sustainable manner.

17.3 Description of compost plant

The design is primarily based on local adaptation of the model used by Waste Concern of Bangladesh to develop plants of similar capacity in Dhaka and other cities. It involves decomposition of organic waste through aerobic composting using natural aeration systems. The plant consists of a large shed that includes facilities for waste sorting, composting in honeycomb boxes that allow natural aeration, areas for maturation, sieving, storage, and packaging of compost, as well as office space and toilets. The facility will also have rainwater harvesting system to meet the water needs of the facility.

The offices and storage facilities will be located towards the front so that the waste is not immediately visible from the outside. Inside the shed, incoming waste will be immediately sorted, processed so that it is suitable for composting and then placed in the honeycomb boxes. It will remain in the boxes, which allows aeration from the sides as well as the bottom, for about 40 days. The compost will then be allowed to mature for about a month in the maturation area. Finally it will be

screened manually on inclined screens with mesh size of about 8mm. The final product will then be packed in 1kg and 30 kg bags and sold in the market.

17.4 Activities

- Design of composting facility
- Stakeholder consultation
- Resource mobilization
- Construction of composting facility
- Preparation of compost marketing plan
- Operation & maintenance
- Monitoring and evaluation

17.5 Work Plan

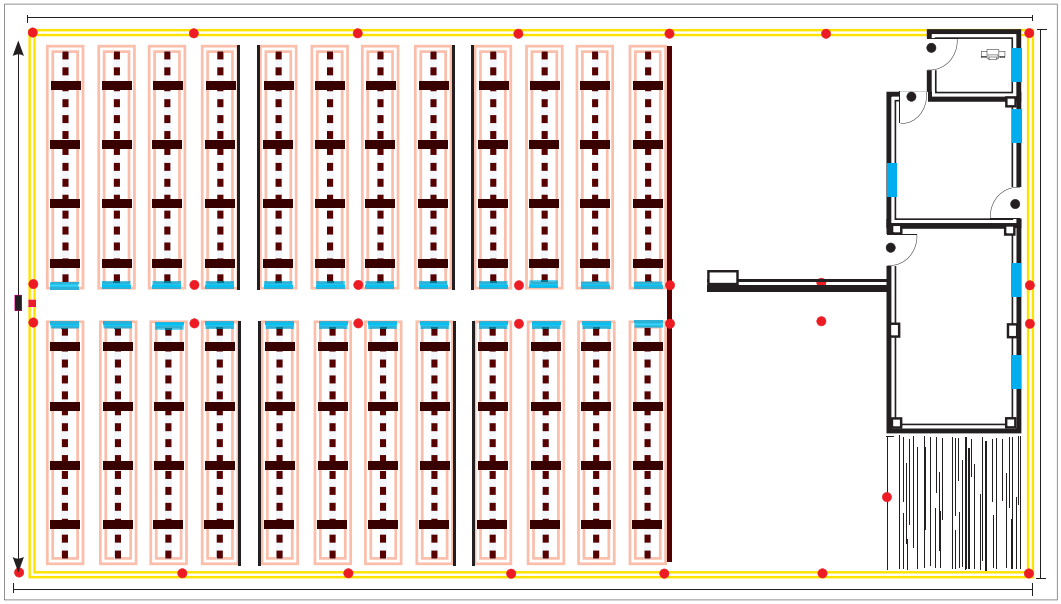
Activity	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Design of composting facility	●											
Resource mobilization		●										
Construction of composting facility			●	●								
Preparation of marketing plan			●	●								
Operation & maintenance					●	●	●	●	●	●	●	●
Monitoring and evaluation					●	●	●	●	●	●	●	●

17.6 Budget

SN	Items	No.	Unit-Cost	Total-Cost
1	Design of composting facility	1	50,000	50,000
2	Lease of 500 m^2 land for composting facility	12	10,000	120,000
3	Construction of composting facility	month		
3.1	Composting Chambers	24	11,287	270,879
3.2	Office block	1	177,646	177646
3.3	Shed (556 sq. m)	1	1,082,816	1,082,816
3.4	Rain water harvesting system	1	54,699	54699
3.5	Toilet	1	26,986	26986
3.6	Site improvement	1	20,000	20000
4	Preparation of marketing plan	1	50,000	50,000
5	Operation & maintenance (annual)	12	40,000	480,000
6	Monitoring & evaluation (annual)	1	30,000	30,000
	Total			**2,363,026**

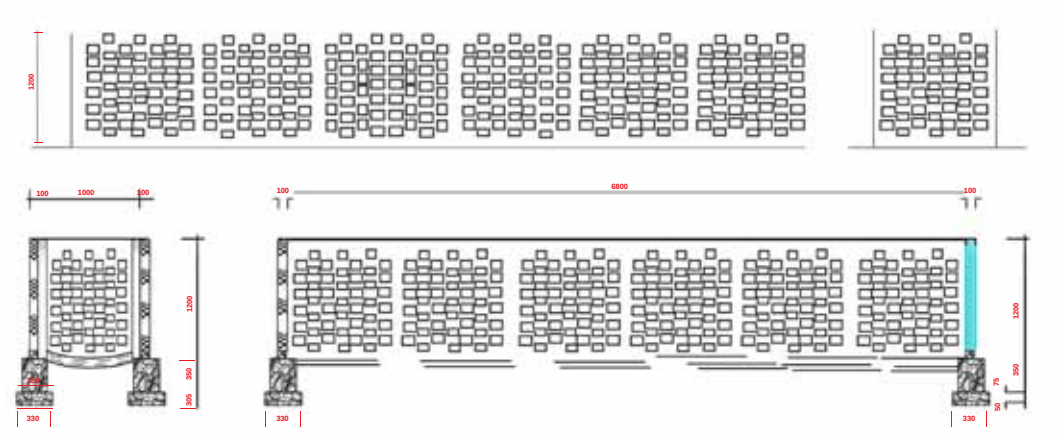
17.7 Drawing

Plain View of Compost Plant



Front View of Compost Plan

Cross Section & Elevation of Compost Box



ANNEX 4

Checklist for Feasibility Study of Public Private Partnership Projects[3]

A feasibility Study should cover the following:

18.1. General information

- Detail analysis of existing SWM service delivery in the focused ward, community or area.
- Analysis of the strength and problem areas of the SWM service in the present situation.

18.2. Technical feasibility study

Technical feasibility study is a technical description of all the relevant components of the SWM project. The following descriptions of the selected products/services are sought in this analysis:

- Technical analysis of all the components of the project
  - Working procedure and description of every step of the project
  - Human resources, materials, equipment and facilities required to perform each step of the project
  - Capacity of the project
- Cost estimate of the components of the project A procurement plan and proposed procurement methods, procurement schedule and budget, and reasons for selecting the proposed procurement schedule
- Project implementation process pursued by the municipality and plans and schedule for partner consultation
- Project implementation schedule including an analysis of the expected problems in service delivery

18.3. Financial feasibility study

The following are the fundamental objectives of financial study of the selected SWM projects:

- Quantify the assumptions on the level of SWM activity
- Provide and maintain available funds to support planned activities at the minimum cost possible
- Determine optimum mix of resources (human resources, materials and facilities) and ensure adequate return on partner's investment
- Provide the desired financial result of operation and estimated financial condition

The financial feasibility study should provide detail information on the following:

- Finance required to put the project into operation. Normally, it could be classified into three broad categories:
  - Fixed assets: land, building, equipment, vehicles
  - Working capital initially: cost of project operation and maintenance until revenue starts coming in; and
  - Pre-operating cost: Expenses incurred in preparing project study, registration, etc.
- Source financing including the analysis of partners' investment required, loan (if any), cost of money, terms, risks and expected rate of return
- A cost benefit analysis covering the comparative analysis of the expected cost and benefits of the project over the expected duration of the project

18.4. Social impact and environmental sustainability analysis

- A description of the beneficiaries of the project, including willingness and ability to pay for the service
- Identification of the potential private service providers, their possible issues and methods/ways to address the issues
- Social assessment identifying both expected positive and negative impacts on various areas of ward and community including the municipality
- Environmental impact, including the measures for mitigation if any adverse impact is expected

18.5. Risks and benefit analysis

- Identification of major risks that might arise while implementing the SWM services, to the municipality and partners
- Proposition of methods for mitigation and distribution of those risks

18.6. Institutional and contractual analysis

- Assessment of managing capacity of municipality to undertake the proposed partnership project. Generally the municipalities require enhancing their capacity to perform the following:
  - Conduct the partnership procurement
  - Carryout contract negotiation
  - Make agreement and performance monitoring
  - Develop plan for capacity/skill enhancement if necessary
- Recommendation of the form of partnership (Private sector or CBO/NGO etc.)
- Proposal for contractual arrangement, its duration and reasons

Technical Guideline 2008

Government of Nepal
Ministry of Local Development / Solid
Waste Management Resource
Mobilization Center

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