Da Zhu
P. U. Asnani
Chris Zurbrügg
Sebastian Anapolsky
Shyamala Mani

Improving Municipal Solid Waste Management in India

A Sourcebook for Policy Makers and Practitioners

WORLD BANK INSTITUTE
Promoting knowledge and learning for a better world
WBI Development Studies
THE WORLD BANK

WBI DEVELOPMENT STUDIES

Improving Municipal Solid Waste Management in India

A Sourcebook for Policy Makers and Practitioners

Da Zhu
P. U. Asnani
Chris Zurbrügg
Sebastian Anapolsky
Shyamala Mani

The World Bank
Washington, D.C.

1818 H Street, NW
Washington, DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org
E-mail: feedback@worldbank.org

1 2 3 4 5 10 09 08 07

ISBN: 978-0-8213-7361-3
eISBN: 978-0-8213-7362-0
DOI: 10.1596/ 978-0-8213-7361-3

Library of Congress Cataloging-in-Publication Data has been applied for.

Contents

Boxes

Figures

Tables

Foreword

Efficient delivery of public services and infrastructure are pressing issues for municipalities in most developing countries; and in many countries, solid waste has become a top priority. Solid waste management (SWM) is costly and complex for local governments, but it is so essential to the health, environment, and quality of life of the people—in particular, the poor—that municipalities cannot afford to get it wrong. Bad waste collection practices and improper solid waste disposal contribute to local episodes of disease, regional water resource pollution, and global greenhouse gases.

This book addresses the problem by focusing on India. A country such as India, with its high economic growth and rapid urbanization, requires immediate solutions to the problems related to mismanagement of urban waste. City managers are actively trying to understand the problem and are seeking effective ways of intervening. They realize that such interventions are essential to improving the quality of their cities and to reducing adverse health and environmental impacts. For cities to be sustainable and to continue their economic development, they must be clean and healthy. They need to improve their SWM systems by adopting good collection coverage, appropriate transfer methods, and healthy disposal practices.

Although municipalities should take the lead in improving their SWM systems, the problem also has global significance. Climate change and the effects of greenhouse gas emissions have made SWM one of the most pressing environmental challenges globally as well as locally. It is well understood that inappropriate SWM practices, such as improper incineration and uncontrolled disposal of waste, are major contributors to greenhouse gas emissions: the anaerobic degradation of waste in landfills produces methane, a gas that is 21 times more potent than carbon dioxide.

This book takes a practical approach to SWM. It analyzes the issues from a technical point of view and suggests policy changes that will help local government officials and solid waste managers come to grips with the following challenges:

- Dealing with weak financial capacity and financial management systems
- Involving all stakeholders, such as the local government, the private sector, nongovernmental organizations, and the public
- Becoming an enabler of solid waste services rather than a provider
- Attracting private sector participation as a means of increasing the efficiency of public services while reducing costs
- Strengthening institutions so that they can monitor and enforce service provision
- Using a regional approach that allows for service and cost-sharing among municipalities
- Educating waste generators so that they can play a role in reducing, reusing, and recycling
- Providing economic incentives for waste minimization or recycling

Although this book is about SWM in India, we expect that its contents will also help local governments throughout the developing world to plan and implement sustainable solutions to the waste management challenge.

Constance Bernard
Director, Sustainable Development
South Asia Region, The World Bank

Rakesh Nangia
Acting Vice President
World Bank Institute, The World Bank

Acknowledgments

This publication was prepared by a team that included Da Zhu (task team leader, World Bank); P. U. Asnani (Infrastructure Professionals Enterprise); Chris Zurbrügg (Department of Water and Sanitation in Developing Countries, Swiss Federal Institute for Aquatic Science and Technology, or Sandec); Sebastian Anapolsky (consultant, World Bank Institute); and Shyamala Mani (Centre for Environment Education). Specific contributions have been received from Anil Bansal (Infrastructure Professionals Enterprise); Amit Sardana (Infrastructure Professionals Enterprise); Hans Lauritzen (consultant, World Bank Institute); and Silke Rothenberg (Sandec) on chapter 4, "Institutional Aspects of Solid Waste Management," and on chapter 6, "Reduce, Reuse, and Recycle," as well as on data analysis and the case studies. The publication was produced with support from Konrad von Ritter, sector manager, Sustainable Development Unit, World Bank Institute.

The team received valuable advice and comments from a World Bank peer-review committee consisting of Sandra Cointreau, Allan Rotman, Oscar E. Alvarado, and Sanjay Srivastava and from various consultations held with central and state governments in India.

Many people inside and outside the World Bank provided helpful comments, support, and other contributions. They include Sunila Andrews, Songsu Choi, Charles Joseph Cormier, Shubhagato Dasgupta, Michele E. De Nevers, David Hanrahan, Abha Joshi-Ghani, Mohini Malhotra, Barjor Mehta, Paul Procee, A. N. Purandare, Venkata Ramana Putti, A. S. Ramakrishna, Yamini Sharma, Laura Tlaiye, Anup Wadhawan, and Bintao Wang.

The photos that illustrate this publication were taken by P. U. Asnani, Shyamala Mani, Anil Basal, Da Zhu, and Sebastian Anapolsky, or were provided by World Bank staff and the World Bank photo library. John P. Didier, as well as Laura Glassman, Lise Lingo, and Linda Stringer of Publications Professionals LLC, helped with the editing work.

The publication was funded by trust funds from the World Bank–Netherlands Partnership Program, from the Swiss government, and from the Danish government.

Abbreviations

3R	reduce, reuse, and recycle
ANPE	National Agency of Environmental Protection (Tunisia)
ASMARE	Association of Paper, Carton, and Recyclable Material Pickers Belo Horizonte
BMW	biomedical waste
BOO	build, own, and operate
BOOT	build, own, operate, and transfer
BOT	build, operate, and transfer
CBO	community-based organization
CDM	clean development mechanism
CEE	Centre for Environment Education
CEE-ERU	Centre for Environment Education Ecofriendly Reuse and Recycling Unit
CER	certified emission reduction
CIDCO	City and Industrial Development Corporation
CLA	Contract Labor (Regulation and Abolition) Act 1970
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
DBO	design, build, and operate
DSD	Duales System Deutschland
EPA	Environment Protection Act 1986
GHG	greenhouse gas
IEC	information, education, and communication
JICA	Japan International Cooperation Agency
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
MOA	Ministry of Agriculture
MOEF	Ministry of Environment and Forests
MSW	municipal solid waste
MSWM	municipal solid waste management
NEERI	National Environmental Engineering Research Institute
NGO	nongovernmental organization
NIMBY	not in my backyard
O&M	operation and maintenance
PCB	pollution control board
PET	polyethylene terephthalate
PK	*pourakarmika*
RWA	resident welfare association
SECO	State Secretariat for Economic Affairs
SMS	Stree Mukti Sanghatana
SWM	solid waste management
UIDS & MT	Urban Infrastructure Development for Small and Medium Towns
ULB	urban local body

UNEP	United Nations Environment Programme
YUVA	Youth for Unity and Voluntary Action

Currency Equivalents

US $1 = Rupees (Rs.) 45.31 (2006 annual average rate, IMF)

Unit Equivalents

1 Crore = 10 million rupees or 100 lakhs
1 lakh = 100,000 rupees

Introduction to Solid Waste Management

An Urban Challenge

Human activities create waste, and the ways that waste is handled, stored, collected, and disposed of can pose risks to the environment and to public health. Solid waste management (SWM) includes all activities that seek to minimize health, environmental, and aesthetic impacts of solid waste.

In urban areas, especially in the rapidly urbanizing cities of the developing world, problems and issues of municipal solid waste management (MSWM) are of immediate importance. Most governments have acknowledged the importance of MSWM; however, rapid population growth overwhelms the capacity of most municipal authorities to provide even the most basic services.

According to a United Nations Development Programme survey of 151 mayors of cities from around the world, the second most serious problem that city dwellers face (after unemployment) is insufficient solid waste disposal (UNDP 1997). Typically one- to two-thirds of the solid waste that is generated is not collected. The uncollected waste is dumped indiscriminately in the streets and in drains, contributing to flooding, breeding of insect and rodent vectors, and spreading of diseases. Even waste that is collected is often disposed of in uncontrolled dumpsites or burned, polluting water resources and the air.

In many cities, municipal solid waste (MSW) contains human and animal excrement as well as hazardous chemical pollutants and sharps. All facilitate disease and injury, especially among children, rag pickers, and employees in the waste management sector. Studies have shown that a high percentage of workers who handle refuse and of individuals who live near or on disposal sites are infected with gastrointestinal parasites, worms, and related organisms. Contamination of this kind is likely at all points where waste is handled. Although it is certain that vector insects and rodents can transmit various pathogenic agents (amoebic and bacillary dysenteries, typhoid fever, salmonellosis, various parasitoses, cholera, yellow fever, plague, and others), it often is difficult to trace the effects of such transmission to a specific population. The implementation of MSWM practices benefits both public health and environmental quality directly and substantially.

The organic, biodegradable component of MSW is important, not only because it constitutes a sizable fraction of the solid waste stream in a developing country but also because of its potentially adverse impact on public health and environmental quality. One major adverse impact is its attraction of rodents and vector insects, for which it provides food and shelter. Impact on environmental quality takes the form of foul odors and unsightliness. These impacts are not confined merely to the disposal site; they pervade the surrounding area and anywhere that wastes are generated, spread, or accumulated. Unless organic waste is managed appropriately, its adverse impact continues until it has fully decomposed or otherwise stabilized.

Poor, inaccessible, and marginal urban areas suffer most from deficiencies in service and infrastructure, thus worsening poverty, ill health, and social marginalization. In low-income or squatter settlements, waste collection is often nonexistent, either because the settlements are informal, unplanned, and possibly unauthorized or because the strategies and technologies adopted for service provision are inappropriate for operating in settlements with narrow and unpaved streets and lanes.

Many factors that vary from place to place must be considered in the design of a SWM system. They are described in the following sections.

Waste Amount and Composition

Typically, domestic waste from industrial countries has a high content of packaging made of paper, plastic, glass, and metal, so the waste has low density. In many developing countries, domestic waste contains a large proportion of inert materials, such as sand, ash, dust, and stones, and has high moisture levels because of the high usage of fresh fruit and vegetables. These factors make the waste very dense (high weight per unit volume). Vehicles and systems that operate well with low-density wastes in industrial countries are not suitable or reliable for heavy wastes. The combination of the extra weight, the abrasiveness of sand, and the corrosiveness caused by the water content can lead to very rapid deterioration of equipment. Waste that contains a high proportion of moisture or is mostly inert material is not suitable for incineration, ruling out one treatment option. Recycling or salvaging operations often reduce the proportion of combustible paper and plastic in waste before it reaches the treatment stage, further reducing its suitability for incineration.

Access to Waste for Collection

Many sources of waste are inaccessible, reached only by roads or alleys unsuited for certain methods of transport because of their width, slope, congestion, or surface. Those barriers are especially critical in unplanned settlements, such as slums or low-income areas, and thus largely affect the selection of equipment.

Awareness and Attitudes

Public awareness of and attitudes toward waste can affect the entire SWM system. All steps in SWM—from household waste storage to waste segregation, recycling, collection frequency, amount of littering, willingness to pay for services, and opposition to the siting of treatment and disposal facilities—depend on public awareness and participation. Thus, awareness and attitudes are crucial to the success or failure of a SWM system.

Institutions and Legislation

Institutional issues include current and anticipated legislation and the extent to which laws are enforced. Standards and restrictions may limit the technological options that can be considered. Government policy on the role of the private sector (formal and informal) should also be taken into account. The strength and concerns of trade unions can also have an important influence on what can be done.

The Solid Waste Management System

Solid waste can be defined as nonliquid material that no longer has any value to the person who is responsible for it. The words *rubbish*, *garbage*, *trash*, or *refuse* are often used as synonyms when talking about solid waste.

In urban areas, solid waste is generated by domestic households, commercial and industrial enterprises, and health care and institutional activities, as well as on the streets. Street refuse contains a mixture of refuse from many sources, because streets are used as dumping grounds by all generators of waste. Where sanitation facilities are lacking and a large animal population roams the streets, street refuse contains a lot of human fecal matter and manure. Streets are also often used for extensive dumping of construction and demolition debris—attracting further dumping of solid waste.

The term *municipal solid waste* refers to solid waste from houses, streets and public places, shops, offices, and hospitals. Management of these types of waste is most often the responsibility of municipal or other governmental authorities. Although solid waste from industrial processes is generally not considered municipal waste, it nevertheless needs to be taken into account when dealing with solid waste because it often ends up in the MSW stream.

A typical waste management system in a low- or middle-income country includes the following elements:

- Waste generation and storage
- Segregation, reuse, and recycling at the household level
- Primary waste collection and transport to a transfer station or community bin
- Street sweeping and cleansing of public places
- Management of the transfer station or community bin
- Secondary collection and transport to the waste disposal site
- Waste disposal in landfills
- Collection, transport, and treatment of recyclables at all points on the solid waste pathway (collection, storage, transport, and disposal)

In the past, these important elements of waste management were often regarded only from an engineering and technical viewpoint. It is essential to realize that these elements are embedded in the local institutional, sociocultural, and economic context, which is further influenced by national politics, policies, and legislation as well as national and global and economic factors.

Physical handling of solid waste and recyclables (storage, collection, transport, treatment, and so on) is just one SWM activity; it alone cannot fulfill the requirement for sustainable and integrated solutions. Other activities are equally important:

- Making policy, as well as setting and enforcing standards and regulations
- Evaluating data on waste generation and characterization for the purposes of planning and adapting system elements
- Ensuring that workers and planners get training and capacity development
- Carrying out public information and awareness and education programs
- Identifying and implementing financial mechanisms, economic instruments, and cost-recovery systems
- Incorporating formal and informal elements of the private sector as well as community-based activities and nongovernmental organizations (NGOs)

Service Coverage for Waste Collection

MSW collection schemes of cities in the developing world generally serve only a limited part of the urban population. The inhabitants who are left without waste collection services are usually in the low-income population. Lack of financial resources and planning capacity to cope with increasing urban population growth affects the availability or sustainability of a waste collection service. Operational inefficiencies, inappropriate technologies, or deficient management capacity of the institutions involved also give rise to inadequate service levels. With regard to the technical system, often the conventional collection approach—developed and used in industrial countries—is applied. The vehicles are sophisticated, expensive, and difficult to operate and maintain, and after a short time of operation usually only a small part of the fleet remains in operation.

More and more, involving private companies in SWM is seen as an easy way out. However, an important factor in the success of private sector participation is the ability of the client—usually a municipal administration—to write and enforce an effective contract. Three key components of successful arrangements are competition, transparency, and accountability.

As an alternative to large (often international) companies that can provide most or all of the solid waste services in a city, microenterprises, small enterprises, or community-based organizations (CBOs) can provide services at the community level (neighborhoods or the small city administrative zones). They use simple equipment and labor-intensive methods; therefore, they can collect waste in places where the conventional trucks of large companies cannot enter.

Recycling

Recycling of inorganic materials from MSW is often well developed through the activities of the informal sector, although municipal authorities seldom recognize such activities. Some key factors that affect the potential for resource recovery are the cost of separating recyclable material and the separated material, its purity, its quantity, and its location. The costs of storage and transport are major factors that determine the economic potential for resource recovery. Recycling is often well established in the informal sector because it is done in a very labor-intensive way and provides very low incomes.

Disposal

Most of the MSW in developing countries is dumped on land in a more or less uncontrolled manner. Those dumps make very uneconomical use of the available space and often produce unpleasant and hazardous smoke from slow-burning fires. The present disposal situation is expected to deteriorate even more as, with rapid urbanization, settlements and housing estates encircle existing dumps and the environmental degradation associated with the dumps directly affects the population. Waste disposal sites are, therefore, also subject to growing opposition, and it is becoming increasingly difficult to find new sites that meet public approval and are located a reasonable distance from the collection area. Siting landfills at greater distances from the central collection areas implies higher transfer costs, as well as additional investments in road infrastructure, hence intensifying the financial problems

of the responsible authorities. Any increase in service coverage will aggravate the disposal problem, if the amount of waste cannot be reduced by waste recovery.

Other reasons for inadequate disposal are mostly noncompliance of guidelines for siting, design, and operation of new landfills, as well as the lack of recommendations for ways to upgrade existing open dumps. The safe alternative is a sanitary landfill, where solid wastes are disposed of at a carefully selected location that is constructed and maintained using engineering techniques that minimize pollution of air, water, and soil and other risks to people and animals. Loans or grants to construct sanitary landfills do not necessarily result in disposal of waste at sanitary landfills. As important as site location and construction are well-trained personnel and the provision of sufficient financial and physical resources to allow a reasonable standard of operation.

Health Care Waste and Hazardous Waste

Health care waste is generated as a result of activities related to the practice of medicine and sale of pharmaceuticals. Much health care waste coming from hospitals or institutions is similar to domestic solid waste and may be called *general health care waste*. The remaining types of waste pose serious health hazards because of their physical, chemical, or biological nature. Such waste is known as *hazardous health care waste*. In many cases, the most dangerous items in health care waste are needles from syringes and drips, because needles shield viruses from chemical disinfectants and the harsh external environment, and the sharp points allow easy access for the viruses into the bloodstream of anyone who is pricked by the needle.

Many strategies for treatment of hazardous health care waste rely solely on the use of incinerators or similar technologies. Such strategies have several weaknesses, because often the hospitals and health care facilities cannot afford to pay the operating costs of the treatment plant. Plants may be left unused or not repaired when they break down. Furthermore, much of the risk of exposure occurs before the waste gets to this final stage and therefore is not reduced by the provision of treatment equipment. The key to improving health care waste management is to provide better storage methods and to train the staff to adopt safer working practices and segregate hazardous health care waste from general health care waste.

Some waste materials need special care and treatment because their properties make them more hazardous or problematic than general waste. The management of hazardous chemicals is not only a technological and legislative issue but also a matter of enforcement, funding, and financial instruments. Changing to processes that use less hazardous substitutes and minimizing hazardous waste quantities that are discarded can be seen as the preferred options in dealing with any difficult waste.

Principles of Sustainable and Integrated Solid Waste Management

A more systematic way of thinking and looking at waste management is provided by an approach called *sustainable and integrated solid waste management* (Cointreau 2001). Sustainable and integrated SWM puts into a focal matrix the urgent planning aspects—including the environmental, sociocultural, institutional, political, and legal aspects—as well as the important role of stakeholders (rag pickers, the

informal recycling sector, small-scale enterprises, women heads of household) and the other elements of the waste management system, such as prevention, reuse and recycling, collection, street sweeping, and disposal.

Sustainable and integrated SWM is an integral part of good local governance because it is one of the most visible urban services influencing local perceptions of governance. It is conducted in a transparent and accountable manner to minimize opportunities for corruption and unwarranted political interference. Based on the principle of equity, integrated SWM provides a minimum level of acceptable service to all urban residents and establishments and is responsive to the service levels and conditions desired by those residents and establishments, with higher levels of service where there is either a greater need (for example, in terms of business development or tourism) or a greater desire to pay for a higher level.

Sustainable and integrated SWM recognizes that willingness to pay is affected by perceptions of the service quality received and by the involvement of stakeholders in decision making; it therefore places a high priority on keeping stakeholders informed about and involved in issues and proposals. Furthermore, it looks for ways to enable communities to be responsible and for individuals to take action in ways that build public cooperation with the service. Sustainable and integrated SWM is open to all viable parties, including women and microenterprises, that can contribute to the economic provision of services. It also allows for the flexible service levels and conditions desired by the residents and establishments receiving service. Sustainable and integrated SWM provides workers with uniforms and safe working conditions and defines clear collection routes and verifiable performance tasks and outputs. To do so, it establishes management information systems that enable cost-effective accounting and overall cost-related performance monitoring.

Sustainable and integrated SWM provides economical service delivery and establishes cost-recovery mechanisms for long-term sustainability. A modern SWM program can be implemented for a reasonable cost. This fact is important because there are ample numbers of developing countries where SWM costs are high and the level of service low. But if the underlying reasons for these situations are analyzed, one can see in many cases that cost-effective waste management systems would result if the deficiencies identified in the systems were remedied.

To provide economic service delivery, sustainable and integrated SWM considers (a) decentralized or bundled services as needed to optimize such economies; (b) comprehensive cost analysis and planning for continuous rationalization of routing, crew sizes, and technologies; and (c) selection of systems and equipment according to local conditions and preventive maintenance of vehicles and facilities.

Sustainable and integrated SWM ensures cost recovery through a range of revenue sources, including direct fees, indirect general taxes, and revenues from recycling and resource recovery. Furthermore, it establishes tariffs that ensure cost recovery but are adapted according to the ability to pay, the service provided, and the level of waste pollution generated. Segregated accounts for solid waste revenues further ensure that a reliable cash flow is available to meet service needs.

Sustainable and integrated SWM minimizes resource use and environmental impact. It is conducted in an environmentally conscientious manner that conserves natural resources and recovers waste where appropriate. For all equipment required by the service, including vehicles, machines, and parts, sustainable and integrated SWM encourages the use of indigenous manufacturing capacity. It also provides

incentives for waste minimization, recycling, and resource recovery at source or as near to the source as possible. Sustainable and integrated SWM optimizes segregation of recyclable materials at the source of waste generation and encourages the development of markets for recyclable materials in major centers of waste generation, including incentives for increased industrial demand for secondary materials as feedstock.

Sustainable and integrated SWM involves environmental impact assessment and public involvement for all new transfer, treatment, and disposal facilities, and it ensures that those facilities are designed to meet environmentally cost-effective discharge and impact standards. It monitors the emissions and environmental changes related to all waste storage, handling, and disposal activities and uses systems to track and document hazardous waste. Those systems ensure that significant quantities are not mixed with other waste but are instead taken to secure facilities for treatment and disposal.

Sustainable and integrated SWM embraces public participation: planning and operations are participatory and enable continuous feedback from those involved in receiving and in providing service. It sensitizes the public to environmental issues, occupational health and safety issues, waste minimization opportunities, and the values of recycling and resource recovery.

Sustainable and integrated SWM builds institutional capacity. Adequate local authority and autonomy is provided to enable good municipal governance of the solid waste sector and self-sustainable financing and cost recovery. Sustainable and integrated SWM also allows local governments to enter multiyear private sector arrangements that match periods of depreciation for investments and that strengthen local capacity in planning, operation, and rationalization of operations.

Scope and Organization of This Book

This book is organized into seven chapters covering the crucial aspects of SWM in India. They are complemented by our introduction and case studies.

- Chapter 1 gives an overview of the SWM situation in Indian cities, highlights the legal framework, explores the major challenges that municipalities face, and outlines the causes of deficient SWM and noncompliance with the mandatory rules for management and handling of solid waste. Furthermore, it recommends steps toward compliance with India's SWM rules.
- Chapter 2 describes the traditional financial resources of municipal authorities in India and highlights the system of levying and collecting taxes and charges—a system that results in the poor financial health of urban local bodies. It provides suggestions for improving financial discipline and elaborates on methods for assessing funding requirements for various SWM services. It also advises on strategies for financing through user fees or taxes and suggests ways to minimize the cost of service by enhancing community, NGO, and private sector participation.
- Chapter 3 discusses the advantages and disadvantages of private sector participation, the various contract options available, and the key requirements for private sector participation in different services. It also describes the process of project preparation, bid solicitation, bid evaluation, and contract

award and provides guidelines for monitoring contracts for various SWM services. This chapter also contains national and international case studies and experiences with private sector participation in SWM.

- Chapter 4 describes the condition of SWM institutions in India and provides a set of guidelines for strengthening institutional capacity to perform SWM services more efficiently.
- Chapter 5 looks at regionalization as a way for small municipalities to build regional landfills. Generally, the regional approach minimizes the scope of public objections, facilitating the construction of large landfills that can be managed professionally and cost-effectively.
- Chapter 6 shows the amount of recyclable materials currently available in the waste stream and brings to the fore the unacknowledged services provided by informal rag pickers in India in conserving national resources. It discusses various ways by which their contribution in this sector can be enhanced. The chapter describes pathways that lead to improved recovery, reuse, and recycling and that are for obtaining more and better secondary raw materials for the production sector.
- Chapter 7 discusses strategies for achieving effective public participation in SWM in cities. It also explains the various information, education, and communication options available and steps to follow in order to achieve effective community participation and mass action.

References and Suggested Readings

Cointreau, Sandra. 2001. "Declaration of Principles for Sustainable and Integrated Solid Waste Management (SISWM)." http://siteresources.worldbank.org/INTUSWM/Resources/siswm.pdf.

UNDP (United Nations Development Programme). 1997. "Survey of Mayors: Major Urban Problems." UNDP, Washington, DC.

1

Current Situation in Indian Cities and Legal Framework

Indian municipalities have overall responsibility for solid waste management (SWM) in their cities. However, most of them are currently unable to fulfill their duty to ensure environmentally sound and sustainable ways of dealing with waste generation, collection, transport, treatment, and disposal. The failure of municipal solid waste management (MSWM) can result in serious health problems and environmental degradation. Because of deficient collection services, uncollected waste—often also mixed with human and animal excreta—is dumped indiscriminately in the streets and in drains, thereby contributing to flooding, breeding of insect and rodent vectors, and spreading of diseases. Furthermore, even the collected waste is disposed of in uncontrolled dumpsites or burned openly, thus contributing to severe environmental impacts including pollution of water resources and air.

The problem of SWM in India, when combined with rapid urbanization and unplanned development, is expected to be of such magnitude that significant reasons exist to initiate immediate action for improvement of this appalling situation.

This chapter elaborates on the existing SWM situation in Indian cities, highlights the existing legal framework, explores the major challenges that municipalities face, and outlines the causes for deficient SWM and noncompliance with the mandatory rules for the management of and handling of solid waste. Furthermore, it recommends steps toward compliance with SWM rules.

Some Facts about Municipal Solid Waste Management in India

The total Indian urban population amounts to approximately 285 million (see table 1.1). There are 4,378 cities and towns in India. Of those cities, according to the 2001 census, 423 are considered class I, meaning that the population exceeds

Table 1.1 Indian Census, 2001

Area of country	*Population (million)*			*Percentage of total population*
	Persons	*Males*	*Females*	
Total	1,027	531	496	100
Rural	742	381	361	72
Urban	285	150	135	28

Source: http://www.censusindia.net/results/rudist.html.

100,000. The class I cities alone contribute to more than 72 percent of the total municipal solid waste (MSW) generated in urban areas. Class I cities include 7 mega cities (which have a population of more than 4 million), 28 metro cities (which have a population of more than 1 million), and 388 other towns (which have a population of more than 100,000).

The population growth rate in urban India is high. The percentage of the total population living in urban areas shows a continuous increase. For 2015, a value of 32.2 percent is predicted (see table 1.2).

Although there are no comprehensive data on waste generation rates, collection coverage, storage, transport, and disposal volumes and practices, the Central Public Health and Environmental Engineering Organization (CPHEEO) estimated a per capita waste generation in Indian cities and towns in the range of 0.2 to 0.6 kilograms per day.

A World Bank publication (Hanrahan, Srivastava, and Ramakrishna 2006) estimated that in 2000 urban India produces approximately 100,000 metric tons of MSW daily or approximately 35 million metric tons of MSW annually.

Data concerning the physical composition of MSW are shown in table 1.3. Comparing 1996 with 2005 shows how the physical composition of MSW can change over time along with the changing lifestyle and economic growth of the country.

Although the typical urban growth rate has been determined at around 2.5 percent annually (Globalis 2005), the growth of waste generation is outpacing the urban population growth in Indian cities (Singhal and Pandey 2001). Therefore, urban population growth as well as increasing per capita waste generation will continue to amplify the waste problem. To prevent future problems, India must take immediate steps to control waste generation, to enhance recycling recovery and reuse, and to ensure better collection and sustainable disposal.

Table 1.2 Increase in Urban Population in India

	1950	*1960*	*1970*	*1980*	*1990*	*2000*	*2005*	*2015 (estimation)*	*2030 (estimation)*
Urban population (%)	17.3	18.0	19.8	23.1	25.5	27.7	28.7	32.2	41.4

Source: http://globalis.gvu.unu.edu/.

Table 1.3 Physical Composition of Municipal Solid Waste

	Composition (%)							
Year	*Biodegradables*	*Paper*	*Plastic rubber*	*Metal*	*Glass*	*Rags*	*Other*	*Inerts*
1996	42.21	3.63	0.60	0.49	0.60	—	—	45.13
2005	47.43	8.13	9.22	0.50	1.01	4.49	4.016	25.16

Sources: For 1996 results, NEERI 1996; for 2005 results, http://www.cpcb.nic.in.
Note: — = not available.

According to the Central Pollution Control Board (CPCB), average collection coverage ranges from 50 to 90 percent. Furthermore, of all collected waste, 94 percent is disposed of in an unacceptable manner without any consideration of state-of-the-art engineering principles. Hence, there is severe degradation of groundwater and surface water through leachate, as well as degradation of air through uncontrolled burning of waste.

Legal Framework of Solid Waste Management in India

In India, SWM is the primary responsibility and duty of the municipal authorities. State legislation and the local acts that govern municipal authorities include special provisions for collection, transport, and disposal of waste. They assign the responsibility for provision of services to the chief executive of the municipal authority.

Most state legislation does not cover the necessary technical or organizational details of SWM. Laws talk about sweeping streets, providing receptacles in various parts of the city for storage of waste, and transporting waste to disposal sites in general terms, but they do not clarify how this cleaning shall or can be done. The municipal acts do not specify in clear terms which responsibilities belong to the citizens (for example, the responsibility not to litter or the accountability for storing waste at its source). Moreover, they do not mention specific collection systems (such as door-to-door collection of waste), do not mandate appropriate types of waste storage depots, do not require covered waste transport issues, and do not mention aspects of waste treatment or sanitary landfills. Thus, most state legislation, with the exception of that of Kerala, does not fulfill the requirements for an efficient SWM service.

Given the absence of appropriate legislation or of any monitoring mechanism on the performance of municipal authorities, the system of waste management has remained severely deficient and outdated. Inappropriate and unhygienic systems are used. At disposal sites, municipal authorities dump municipal waste, human excreta from slum settlements, industrial waste from small industrial establishments within the city, and biomedical waste without imposing any restrictions, thus provoking serious problems of health and environmental degradation.

A public interest litigation was filed in the Supreme Court in 1996 (Special Civil Application No. 888 of 1996) against the government of India, state governments, and municipal authorities for their failure to perform their duty of managing MSW adequately. The Supreme Court then appointed an expert committee to look into all aspects of SWM and to make recommendations to improve the situation. After consulting around 300 municipal authorities, as well as other stakeholders, the committee submitted a final report to the Supreme Court in March 1999. The report included detailed recommendations regarding the actions to be taken by class 1 cities, by the state governments, and by the central government to address all the issues of MSWM effectively.

On the basis of the report, the Supreme Court directed the government of India, state governments, and municipal authorities to take the necessary actions. The Ministry of Environment and Forests was directed to expeditiously issue rules regarding MSW management and handling. Such rules were already under development and had been under consideration for quite some time. Thus, in September 2000, the ministry issued the Municipal Solid Waste (Management and Handling) Rules 2000 under the Environment Protection Act 1986.

The Municipal Solid Waste (Management and Handling) Rules 2000

The Municipal Solid Waste (Management and Handling) Rules lay down the steps to be taken by all municipal authorities to ensure management of solid waste according to best practice. Municipal authorities must meet the deadlines laid down in Schedule I of the rules and must follow the compliance criteria and procedure laid down in Schedule II.

Hence, municipal authorities are responsible for implementing provisions of the 2000 rules. They must provide the infrastructure and services with regard to collection, storage, segregation, transport, treatment, and disposal of MSW. Municipal authorities are requested to obtain authorization (that is, permission or technical clearance) from the state pollution control board or committee to set up waste processing and disposal facilities, and they must deliver annual reports of compliance. The state pollution control boards are directed to process the application of municipal authorities and to issue authorization to the municipalities within 45 days of the application's submission. The CPCB is responsible for coordinating the implementation of the rules among the state boards. The municipalities were mandated to implement the rules by December 2003, with punishment for municipal authorities that failed to meet the standards prescribed; nevertheless, most municipalities did not meet the deadline.

The urban development departments of the respective state governments are responsible for enforcing the provisions of the rules in metropolitan cities. The district magistrates or deputy commissioners of the concerned districts are responsible for enforcing the provisions within the territorial limits of their jurisdictions.

The state pollution control boards are responsible for monitoring compliance with the standards on groundwater, ambient air, and leachate pollution. They must also monitor compliance with compost quality standards and incineration standards as specified in the rules.

The deadline for implementing Schedule I of the 2000 rules has already passed, and compliance is far from effective. Some cities and towns have not even started implementing measures that could lead to compliance with the rules (table 1.4). Enforcement and sanctioning mechanisms remain weak. Other cities and towns have moved somewhat forward, either of their own accord or because of pressure from the Supreme Court, their state government, or their state pollution control board.

Under Schedule II of the rules, municipal authorities have been further directed to set up and implement improved waste management practices and services for waste processing and disposal facilities. They can do so on their own or through an operator of a facility (as described in Schedules III and IV of the rules). Standards for waste

Table 1.4 The Four Steps of Schedule I of the 2000 Rules

Step	*Completion date*
1. Set up waste processing and disposal facilities.	December 2003 or earlier
2. Monitor the performance of processing and disposal facilities.	Once every 6 months
3. Improve existing landfill sites as per provisions of the rules.	December 2002 or earlier
4. Identify landfill sites for future use and make sites ready for operation.	December 2002 or earlier

Source: Ministry of Environment and Forests 2000.

processing and disposal facilities are defined in the rules, and municipal authorities are required to meet the specifications and standards specified in Schedules III and IV.

Collection of Solid Waste

To prohibit littering and to facilitate compliance, municipal authorities must take the following steps:

- Organize collection of MSW at household level by using methods such as door-to-door, house-to-house, or community bin service. Collection must be on a regular preinformed schedule or by acoustic announcement (without exceeding permissible noise levels).
- Give special consideration to devising waste collection in slums and squatter areas, as well as to commercial areas such as areas with hotels, restaurants, and office complexes.
- Segregate at the source all recyclable waste, as well as biomedical waste and industrial waste, to prevent special waste from being mixed with ordinary municipal solid waste.
- Collect separately all horticultural waste and construction or demolition waste or debris, and dispose of it following proper norms. Similarly, waste generated at dairies will be regulated in accordance with the state laws.
- Prohibit burning of waste.
- Do not permit stray animals at waste storage facilities.

Secondary Storage of Waste

With respect to secondary storage of waste, municipal authorities must do the following:

- Make available sufficient storage facilities in accordance to the quantities of waste generated.
- Provide covered storage facility so that waste is not exposed to open atmosphere.
- Ensure that storage facilities are attended daily and are emptied and cleaned regularly.
- Ensure that storage facilities or bins are of an appropriate design for ease in handling, transfer, and transport.
- Ensure that manual handling and multiple handling of waste are avoided or are done with proper safety and care.

Transport of Waste

The following rules apply to transport of waste:

- Ensure that vehicles used for transport of waste are covered.
- Ensure that waste is not visible to public or exposed to the open environment, thus preventing the scattering of waste.
- Attend to storage facilities daily for clearing of waste.
- Empty bins or containers before they start overflowing.
- Ensure that transport vehicles are designed so that multiple handling of waste is avoided before final disposal.

Waste Treatment

Waste treatment rules are as follows:

- Ensure that biodegradable waste is processed by composting, vermi-composting, anaerobic digestion, or any other appropriate biological process for stabilizing waste. Compost or any other end product must comply with the standards specified in Schedule IV.
- Ensure that mixed waste containing recoverable resources follows the route of recycling. Incineration with or without energy recovery may be used in special cases.

Waste Disposal

These rules apply to waste disposal:

- Restrict landfilling to nonbiodegradable and nonrecyclable waste.
- Ensure that landfilling meets the specifications defined in Schedule III.

Status of Compliance with the 2000 Rules

No consolidated official data are available about the status of compliance of MSW. However, figure 1.1 shows estimated percentages of compliance.

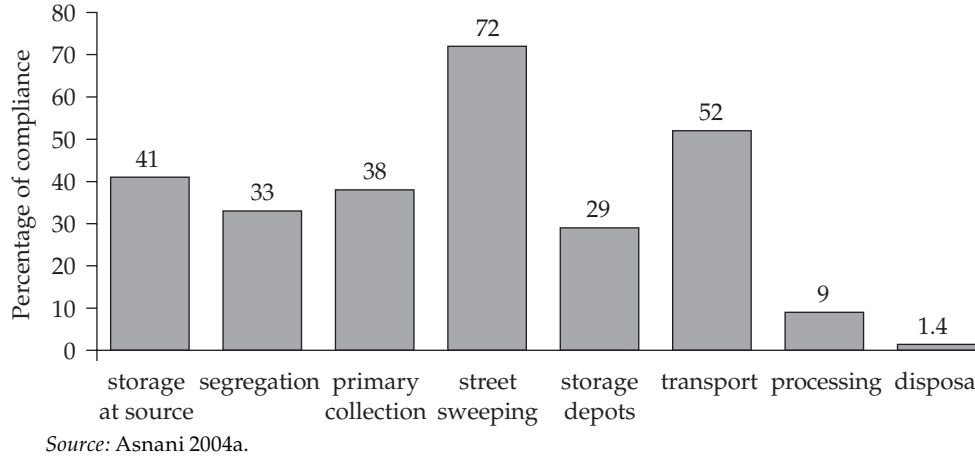
Municipal authorities report numerous reasons for noncompliance with the 2000 rules. Those reasons are listed in table 1.5.

Prevalent Deficiencies and Challenges in the SWM System in India

An expert committee appointed by the Supreme Court identified the following deficiencies in the SWM system in India.

- No storage of waste at source
- Partial segregation of recyclable waste
- No system of primary collection of waste at the doorstep
- Irregular street sweeping
- Inappropriate system of secondary storage of waste
- Irregular transport of waste in open vehicles
- No treatment of waste
- Inappropriate disposal of waste at open dumping grounds

Figure 1.1 Compliance with the 2000 Rules



Source: Asnani 2004a.

Table 1.5 Reasons for Noncompliance with the 2000 Rules

Area of compliance	*Reasons for noncompliance*
Storage of waste at source	• Lack of public awareness, motivation, and education • Lack of civic sense and bad habits of people to litter • Lack of cooperation from households, trade, and commerce • Lack of stringent panel provision • Lack of powers to levy spot fines • Lack of litter bins in the city • Long distance between community bins • Resistance to change in attitude
Segregation of recyclable waste	• Lack of wide publicity through electronic and print media • Lack of public awareness and motivation, resulting in poor response from citizens • Lack of citizens' understanding how to use separate bins for storage of recyclables • Lack of sufficient knowledge of benefits of segregation • Lack of cooperation and negative attitude of people • Lack of finances to create awareness • Difficulty of educating slum dwellers • Lack of effective legal remedy
Collection of waste from doorstep	• Lack of awareness and motivation • Unavailability of primary collection vehicles and equipment • Insufficient response from citizens • Lack of financial resources • Difficulty of motivating slum dwellers • Lack of personnel for door-to-door collection • Lack of suitable containers
Daily sweeping of streets	• Excessive leave and absenteeism of sanitary workers • Unavailability of workers on Sundays and public holidays • Kuchha (unpaved) roads • Lack of financial resources
Abolition of open waste storage depots and placement of containers	• Shortage of containers • Lack of financial resources • Lack of planning for waste storage depots • Inaccessible areas and narrow lanes that do not allow sufficient space for containers
Transportation of waste in covered vehicles	• Old vehicles that are difficult to replace
Processing of waste	• Lack of financial resources • Lack of technical know-how • Lack of skilled personnel • Unavailability of appropriate land • Lack of basic facilities to set up treatment plants • Lack of institutional capacity
Disposal of waste at the engineered landfill	• Lack of financial resources • Lack of technical personnel • Lack of technical know-how for scientific disposal of waste • Unavailability of appropriate land • Lack of institutional capacity

Source: Asnani 2004a.

The deficiencies are primarily caused by apathy of municipal authorities, lack of community involvement, lack of technical know-how, and inadequate financial resources. They constitute the main challenges that authorities must tackle to improve the system of waste management in the country.

Household Storage and Segregation of Waste

Storage of waste at the source of its generation is the first essential step toward appropriate SWM. Most urban areas of the country have yet to take this step.

Most households, shops, and establishments throw their waste just outside their premises, on streets, in drains, in open spaces, in water bodies, and in other inappropriate places. Because such waste contains high levels of biodegradable material, it attracts rodents and stray animals and thus contributes to the spread of filth and disease.

Waste is discharged into drains.

Disposal of waste is onto streets and into open places.

Partial Segregation of Recyclables

Segregation of recyclable waste at source is not seriously practiced by households, shops, and establishments in India. At least 15 to 20 percent of the country's total waste could be conveniently segregated at its source for recycling if the practice of segregation of waste at source were adopted.

Nevertheless, in all parts of the country, people by and large salvage reusable material—such as newspaper, glass bottles, empty tins, plastic bags, and old clothes—and then resell it. This sector is low profile but well established. Large numbers of waste buyers purchase recyclable waste from the doorstep and pass it on to a subdealer or a dealer with a good margin, who, in turn, passes on the material to the recycling industry in bulk.

Other people are known as *rag pickers*. Rag pickers are generally poor women and children who pick up discarded recyclables from the streets, bins, and dumpyards; segregate various components; and sell them to a dealer for a small price to earn a living. Those recyclables are often soiled with food waste, human excreta, and biomedical waste. Accordingly, the price of such waste is much lower than the dry and clean recyclable material that is picked up directly from households or shops. Furthermore, because rag pickers are very poor, they have little bargaining power to negotiate a higher price.

Paper is sold to a recycler.

Rag pickers work at the landfill.

A sizable amount of recyclable dry waste—such as wastepaper, plastic, broken glass, metal, and packaging material—is not picked up, because it is soiled substantially or is directly buried under a huge pile of waste in the bin or at the disposal site. Quite often, rag pickers focus their search and recovery on a few varieties of recyclables that have good returns. Other materials are discarded. Hence, much potentially recyclable waste from streets and bins ends up at the disposal site, along with other domestic waste and street sweepings. Rag pickers, who search disposal sites as well as streets, nevertheless, recover some of those materials; however, most of the waste gets buried.

Urban Indian cities generate 42 million metric tons of waste annually. Of that amount, around 4 million metric tons are retrieved for recycling. Another 4 million metric tons are disposed of in uncontrolled dumps—a problem that needs to be prevented.

The current practice of material recovery and recycling often leads to additional littering in streets when rag pickers are rummaging the waste bags and bins. A denial to rag pickers in the streets forces them to collect recyclables from landfill sites as well. This practice leads to even higher health threats and environmental pollution. In most cases, rag pickers are women and children from low-income groups, which compose the weakest group in the Indian society. They are often exploited by waste merchants because of their status. In the past 10 years, an increasing number of nongovernmental organizations (NGOs) have become active in improving the working and living conditions of rag pickers. Because the municipal waste service was until recently limited to waste collection from public bins, NGOs recognize the service gap and have started offering door-to-door collection services to households. Recognizing that recyclable waste should be collected at the source of its generation to maintain its value, NGOs and a few municipalities in India have tried to involve rag pickers in door-to-door collection. Several success stories show that such efforts have significantly improved the living conditions of hundreds of rag pickers.

Most of these efforts are done on a private or nongovernmental basis. Hence, they lack further dissemination and have limited positive effects for the whole sector. Waste recycling in India has many untapped potential opportunities that could benefit the entire Indian society.

Given the current situation, India needs to upgrade and reorganize its recycling system, to increase the effectiveness of its waste collection and recycling system,

and to improve the working conditions of rag pickers. The key stakeholders to lead this process are the municipal authorities, because they are ultimately responsible for waste management. Another major challenge is to obtain public participation and the involvement of the private sector. The Supreme Court's expert committee acknowledged this need in its report and recommended further action to intensify recycling, taking into account all stakeholders.

Construction and Demolition Waste

Construction and demolition waste that is generated during the course of repair, maintenance, and construction activities comprises bricks, stones, tiles, cement concrete, wood, and so forth. Such waste is generally not stored by the waste generator within its premises until disposal. By and large, this waste is deposited just outside the premises on the streets or in open spaces and may hinder traffic and adversely affect the aesthetics of the city.

Construction and demolition waste is deposited onto a street.

Industrial Waste

Many cities and towns have small and large industries within the city limits. Those industries produce hazardous and nonhazardous industrial waste, which the industries must dispose of following the standards laid down under hazardous waste management rules framed by the government of India and following directions given by CPCB and by state pollution control boards. In practice, however, very few sites are authorized for the disposal of industrial waste in the country; hence, compliance is weak. Some states do not have even a single facility for disposal of industrial waste. Industrial solid waste is, therefore, disposed of in an unscientific manner, often surreptitiously on open plots or on the roadside, thereby creating environmental pollution and subsoil contamination.

Biomedical Waste

Management of biomedical waste (BMW) is governed by the Bio-Medical Waste (Management and Handling) Rules 1998. Under the rules, the waste producer is responsible for managing the waste. Each generator of BMW is expected to store

BMW separately from general municipal waste and to keep different categories of BMW in color-coded bags, as described in table 1.6. The implementation of the 1998 rules has of late started to improve, with the establishment of common regional BMW treatment and disposal facilities in the country. However, in some states a large proportion of BMW generated by hospitals, nursing homes, and health care establishments is now disposed of on the streets or in open spaces around those medical establishments. Such BMW contains a variety of infectious and toxic substances. Without adequate facilities for the collection, transport, and disposal of BMW, this unhealthy practice is likely to continue.

Primary Collection

Generally, primary collection is the most essential component of SWM service and is grossly neglected. Collection systems in India are primitive and inefficient. Municipal authorities, by and large, do not provide the service of door-to-door collection of waste, nor do they contract for such services to be provided by the private sector. The principal reason for this deficiency in service is the mindset of the municipal authorities. Such authorities consider themselves responsible only for waste collection at street collection points and do not feel it is their job to provide doorstep collection service, even though such service is now mandated in the rules. The second reason is the lack of citizen involvement in the storage of waste at source, which would facilitate primary collection from the doorstep. Changing the habits of citizens, who are used to throwing waste on the streets and must instead learn to store it in domestic bins, will be a slow process.

In very few places does door-to-door collection exist. In such cases, it is provided by NGOs or the private sector with or without municipal initiative. The success of such efforts can be attributed to the concerted efforts of NGOs or, in some cases, a motivated municipal official or elected representative who is in a position to change the system. Imposing mandatory directions and taking punitive actions

Table 1.6 Color Coding and Type of Container for Disposal of Biomedical Waste

Color code[a]	*Type of container*[b]	*Waste category*[c]	*Treatment options*
Yellow	Plastic bag	1, 2, 3, and 6	Incineration or deep burial
Red	Plastic bag	3, 6, and 7	Autoclaving, microwaving, or chemical treatment
Blue, white, or translucent	Plastic bag or puncture proof container	4 and 7	Autoclaving, microwaving, chemical treatment, destruction, or shredding
Black	Plastic bag	5, 9, and 10	Disposal in secured landfill

Source: Ministry of Environment and Forests 1998.

a. Per Schedule I, the color code of waste categories with multiple treatment options is selected depending on treatment option chosen.

b. Waste collection bags for waste types needing incineration cannot be made of chlorinated plastics. Category 8 and liquid types of category 10 do not require containers. Category 3, if disinfected locally, also does not need to be put in a container.

c. Category types are as follows: 1 = human anatomical waste, 2 = animal waste, 3 = microbiology and biotechnology waste, 4 = waste sharps, 5 = discarded medicines and cytotoxic drugs, 6 = soiled waste, 7 = solid waste, 8 = liquid waste, 9 = incineration ash, and 10 = chemical waste.

have not been enough to bring about such a change. Any change has been possible only when serious efforts were made to educate the citizens through effective public awareness campaigns.

Citizens are generally expected to deposit their waste in the street bins provided by the city governments. Sometimes citizens must take their waste long distances to dispose of it. Street bins are poorly maintained and ill designed.

Often, citizens are allowed simply to throw the waste on the streets. The primary collection of waste is, therefore, done by picking up the waste deposited on the streets through a street-sweeping operation, which is not carried out regularly.

Street Sweeping

Without a system of primary collection of waste from the doorstep, street sweeping is the most common method adopted in India for primary collection of wastes deposited in the streets. However, only important roads and markets are swept daily. Some streets are swept on alternate days or twice a week, and some are swept occasionally or not at all. No planning is done to ensure that all streets are swept regularly.

Moreover, there is no uniform benchmark, or yardstick, prescribed by municipal authorities for street sweeping. In some places, sweepers are allotted work in terms of a given amount of road length, usually 250 meters to 1 kilometer. In other places, measurement is on the basis of square meters. In such places, a sweeper may be allotted 3,000 square meters or more. In still other places, allotment is made on the basis of a sweeper-to-population ratio: 1 sweeper per 250,500 or more people.

Each sweeper is given a "beat" (that is, an area demarcated for sweeping). The area allotted is swept in the first half of the day, and the street sweeper then carries the street sweepings to the designated waste storage depot. In the afternoon, either street sweepers generally are deployed to other areas for group sweeping or they return to the same place to repeat their sweeping. Their output in the afternoon is almost negligible given the lack of supervision and control. Hence, inadequate use of personnel is a problem.

Short-handled brooms cause fatigue and backache, resulting in loss of sweeper's productivity.

Inefficient handcarts require constant bending.

Some places have a two-tier system: some sweepers sweep only the streets and make small heaps, while another set of people pick up the waste in handcarts or tricycles. The lack of coordination between sweepers and waste collectors results in many heaps being left unattended, thus creating unsanitary conditions.

The street sweepers are not given appropriate tools to perform their duties effectively. They are given short-handled brooms, which necessitate constant bending and cause fatigue and loss of productivity. Municipal authorities, however, appear unconcerned about this matter, and sanitation workers—who are never keen for change, even if it is for their own good—do not bring the problem to the authorities' attention. The sweepers, approximately 50 percent of whom are women, feel comfortable with short-handled brooms on account of their traditional use. They do not appreciate the advantages of long-handled brooms and believe that such brooms could not be used conveniently. Moreover, they have not been educated in the benefits of long-handled brooms.

Meanwhile, the waste collectors who accompany the street sweepers are also given inefficient equipment. Their handcarts and tricycles are not adapted to the secondary collection system, often resulting in deposition of waste on the ground.

Box 1.1 summarizes the drawbacks of current street-sweeping practices.

Secondary Storage of Waste

Municipal authorities have designated several locations in cities and towns for the temporary storage of waste collected by street sweepers and for the deposition of the domestic or trade waste by the citizens. Those sites are intended to facilitate the bulk transport of waste from such depots. The waste depots are called dustbins, vats, dhallos, waste collection points, and so forth. Most of those sites are open and are located on the roadside. Some are constructed as cement or concrete bins, missionary bins, or large built structures.

Generally, such waste depot sites are not evenly distributed in cities and towns. In some wards, they are available in a large numbers and are very close to one another. In other areas, they are far apart, thus making it difficult and time consuming for the sanitation workers or sweepers to use them. Furthermore, they are often very poorly designed and are not synchronized with the primary collection system

Box 1.1 Summary of Drawbacks of the Current Street-Sweeping Practices

- Street sweeping is not carried out on Sundays and on public holidays in many cities and towns.
- All roads, streets, and lanes are not covered with daily street-sweeping operations.
- Citizens continue to throw waste on the streets throughout the day, even after cleaning of streets.
- There is a large variation in street-sweeping norms, which range between 250 meters per sweeper per day and 1 kilometer per sweeper per day.
- The time for cleaning of commercial streets is not synchronized.
- Sweeping tools are inadequate and inefficient.

Source: Authors.

Temporary storage bins frequently overflow.

This handcart is not synchronized with secondary storage.

used. Often, waste collected by handcarts or tricycles is left on the ground just outside the bin, thus blocking the passage to the bin and further hindering correct use of the bin. Bins frequently overflow because of their inadequate capacity, and often more waste is found outside the bin than in it. In addition, waste depots are not emptied on a regular basis. Serious complaints from neighborhood residents and resistance to new bins are a consequence.

Inappropriate secondary storage of waste leads to a "not in my backyard" syndrome. Fearing mismanagement of secondary waste facilities, citizens object to having a waste storage depot nearby and agitate over placement of any new container near their premises.

Some cities have improved their secondary waste storage by using mobile containers of various sizes, ranging from 1 cubic meter to 10 cubic meters. The containers are closely linked with the primary collection system of containerized handcarts and tricycles, and they facilitate a direct transfer of waste from the handcart or tricycle into the covered containers. This system creates more hygienic conditions and ensures efficient secondary storage of waste.

This open site is used for waste deposition.

Inappropriate secondary storage leads to deposition of waste outside the bin.

In small towns, waste is loaded manually in open tractors.

In large cities, waste is loaded manually in open trucks.

Transport of Waste in Open Vehicles

Waste in the cities and towns is not transported on a daily basis. Unfortunately, this service is performed very inefficiently and in an unhygienic manner. Open trucks and tractors used to transport waste are loaded manually. This time-consuming activity results in loss of labor productivity and increases the occupational health risk to workers.

Major drawbacks of the SWM transport system are summarized in box 1.2.

Waste is transported in open vehicles.

Box 1.2 Major Drawbacks of the SWM Transport System

- Trucks and tractors have open beds. During transport, waste spills from the truck, thereby causing nuisance.
- Practiced manual loading of waste without use of protective gears is dangerous to the health of workers.
- The transport system is not synchronized with the secondary storage system. Problems arise when a transport fleet is modernized, because waste at the secondary storage system is still dumped on the ground. If the secondary storage system is modernized without an adequate fleet of modern vehicles, similar problems arise.
- Multiple handling of waste results in low labor and equipment productivity.
- Overflowing secondary waste storage depots result from irregular and untimely transport of waste.
- Areas cannot be serviced properly because of an inadequate number of vehicles.
- Vehicles are poorly maintained because of inadequate workshop facilities and maintenance procedures. This problem leads to frequent breakdowns and trucks that are out of service for long periods.
- Spare parts are not readily available, because the procurement system is cumbersome and slow.
- Vehicle movement is not monitored in terms of quantity of waste carried, number of trips made, and optimum use of personnel.
- Unplanned routing of vehicles results in inefficient transport logistics.

Source: Authors.

Lack of Waste Treatment

Waste treatment is intended to reduce the amount of waste to be disposed of or to change its composition in a way that prevents adverse effects on humans or the environment.

In India, waste contains a large proportion of organic matter, ranging between 40 and 50 percent of total waste. This organic matter could potentially be treated and converted into stabilized degraded organic matter, often called *compost*. Compost is a product that can be used to improve soil quality by increasing its porosity and moisture retention and by supplying nutrients and organic matter for enhanced soil structure and agricultural yield. At the same time, diversion of organic waste from the overall waste stream reduces the burden on landfills so that less land is required for the disposal of waste.

The MSW generated in Indian cities is, by and large, not treated but is directly taken to the open dumpsites. Although India is known for its age-old technology of composting agricultural waste, composting of municipal organic waste is infrequent. In a few cities, however, initiatives exist for aerobically composting or vermicomposting of municipal organic waste. Some of the initiatives are managed by the private sector, and some are managed by community-based organizations or local authorities. Some show good results. However, many plants are not operated according to their installed capacity. Many plants face problems with compost marketing and find financial sustainability difficult.

Waste-to-energy technologies, though promising, do not yet have a track record in India (see box 1.3).

Inappropriate Disposal of Waste on Open Dumping Grounds

Waste disposal is a neglected practice in India. Waste is dumped in low-lying areas that are within or outside the cities and that are designated as dumping grounds or in unauthorized areas on the outskirts of the city. Sometimes waste is even dumped on the approach roads to rural areas, which do not have their own land for disposal of waste. Such practices result in extremely unsanitary conditions and create serious environmental degradation problems.

Box 1.3 Waste-to-Energy Technologies

Waste-to-energy technologies, such as anaerobic digestion, gasification, incineration, pyrolysis, and pelletization, are often pushed by vendors of waste treatment technologies. However, they have yet to be proven under Indian conditions. Waste-to-energy projects initiated in Delhi and recently in Lucknow have failed miserably. Those experiences have been a serious setback to the image and feasibility of such technologies in India.

Two waste-to-energy plants based on refuse-derived fuel were set up in Andhra Pradesh in 2003. Each of those plants produces 6.5 megawatts of power. However, the plants may be using predominately agricultural waste and not MSW. Thus, they cannot be considered MSW waste-to-energy plants. The matter needs further investigation.

Finally some small biomethanation (anaerobic digestion) plants are working successfully in Andhra Pradesh and in Maharashtra, where methane energy is produced from kitchen waste and green waste.

Source: Asnani 2006.

Mixed waste is dumped at open sites.

Because no segregation of waste at its source takes place, domestic waste of all types, infectious waste from medical facilities, and even hazardous industrial waste are deposited at dumpsites that are actually designated for domestic waste. The waste deposited at such sites is neither spread nor compacted. It is left uncovered to degrade under natural conditions. The sites generate leachate and thus pollute surrounding water bodies, contaminate the air with methane emissions and uncontrolled burning, and create serious health and environmental problems for the city as a whole and, more particularly, for the poor people living in the vicinity of the dumping ground.

Steps toward an Improved SWM System

MSWM refers to the entire process chain, comprising seven steps: (1) waste segregation and storage at source, (2) primary collection, (3) street sweeping, (4) secondary waste storage, (5) transport of waste, (6) treatment and recycling options for solid waste, and (7) final disposal. All seven steps are equally important and should be harmonized. Authorities need to consider specialized strategies for different waste generators (households, shops and commercial establishments, industries, hospitals, and so forth) and appropriate measures for the different levels in the SWM chain (household level, neighborhood level, regional level, and so forth). They must also coordinate with the different actors in the management of waste throughout the waste management levels.

It is important to note that municipal authorities have the overall responsibility for SWM and, therefore, need to collect useful information on quantity and quality of waste generated in their municipalities if they are to implement the 2000 rules successfully. Municipal authorities should also ascertain the physical and chemical composition of various categories of waste, such as that generated by households, shops and establishments, hotels and restaurants, vegetable and fruit markets, meat and fish markets, hospitals and nursing homes, and so forth. Doing so will facilitate the microplanning of waste management and will allow the authorities to implement a plan that complies with the 2000 rules.

Municipal authorities in each city must know the quantity of waste generated and its physical and chemical composition. Those quantities may vary seasonally. The quantity of waste in mass is expected to be higher during the monsoon season, when waste will be moister. However, weight will be less during the summer and even less during the winter. Quantifying waste generation according to season is an important precondition for infrastructure planning. Knowledge of physical and chemical composition helps authorities to determine the scope of retrieval of recyclable material and construction debris and to define appropriate technology for treating waste. It also allows them to determine the ultimate requirement of land for final disposal of inert material.

The seven steps described here aim at meeting the requirements of the national rules for municipal solid waste management. Details of each step are outlined further in individual chapters of the book.

Waste is segregated and stored at its source.

Step 1: Improve Waste Segregation and Storage at Source

It is important to address the solid waste issue from the generation of waste. Citizens, as the producers of waste, need to cooperate with SWM. No municipal effort can make a city clean unless its citizens cooperate and take an active part in waste management.

Citizens must be informed, educated, and motivated not to litter on the streets so they develop the habit of storing their waste at its source in at least two separate bins (one for biodegradable waste and one for recyclable waste). Citizens also need to be educated about risks to human health and the environment and taught to separate domestic hazardous waste and infectious waste from the other two types of waste.

Municipal authorities must, therefore, make concerted efforts to convince all classes of citizens to store their waste properly:

- The appropriate size of a bin for biodegradable waste is 10 to 15 liters.
- Another bin or a bag of similar size may be used for storing recyclables.
- Bins for shops and establishments should have the capacity to contain the waste that those establishments produce plus 50 percent spare capacity.
- Large establishments may keep larger bins that are coordinated with the municipal transport system.

Box 1.4 summarizes some best practices.

Box 1.4 Best Practices

Suryapet in Andhra Pradesh, North Dumdum and New Barrackpore in West Bengal, and Vejalpur in Gujarat are good examples of storage of waste at its source. Through an effective public awareness campaign, including public meetings and student rallies, citizens have been motivated to store the waste at its source in two separate bins. The system is working well.

Source: Authors.

Step 2: Improve Primary Collection

Step 2 aims at preventing litter on the streets. Waste that is stored and segregated at households or other establishments needs to be collected following a fixed schedule. Door-to-door collection also requires cooperation and participation of citizens, who must bring their waste to the doorstep when waste collectors arrive. It is important not to mix waste that was segregated by the households. Otherwise, efforts to segregate waste at source will have no effect.

Selection of Appropriate Collection Vehicles. Collection vehicles must meet the requirements of local conditions. Therefore, an assessment of the housing situation, street conditions, and geographic and topographic situation is always a prerequisite for efficient planning and decision making for primary collection equipment. In general, primary waste collection can be done with slow and smaller vehicles, which do not need to cover very long distances:

- Handcarts
- Tricycles and rickshaws
- Motorized rickshaws
- Tractors with trailers

Motorized vehicles are most suitable in areas with less dense housing patterns, because the collectors will need to cover longer distances (see box 1.5 for a case study). Those vehicles are also suitable for hilly areas. In hilly areas, waste collection routing needs to be planned so that the waste collectors start collecting at the highest level and proceed to lower levels while filling their vehicles with waste.

Box 1.5 Case Study: Door-to-Door Collection through Motorized Vehicles in Chennai

In Chennai, the private contractor ONYX covers three zones of the city with SWM services. ONYX caters to a population of approximately 20 million and covers an area of 87 square kilometers. The contractor employs 2,000 people. ONYX has 130 auto-rickshaws for door-to-door collection from narrow lanes.

Waste is collected at the doorstep with a motorized rickshaw.

Source: Authors.

Collection Frequency. In India, which has a hot and humid climate, organic biodegradable waste degrades easily, thereby producing odors and attracting vermin and disease vectors. Therefore, biodegradable waste needs to be collected every day. Dry waste (inorganic recyclables) can be collected less frequently; however, collection at least once per week is advisable.

Daily collection service is very important in India. Women responsible for household hygiene would not accept storage of waste in their home for more than 24 hours. When collection service is not provided on a daily basis, they discard waste on the streets. Shops and establishments also do not accept storing waste for more than 24 hours.

Options for Primary Collection. According to the 2000 rules, there are two options for primary collection: door-to-door collection at preset intervals or community bin collection (known as the *bring system*).

Door-to-Door Collection. There are different options for door-to-door collection. Those options are discussed briefly.

Door-to-door collection carried out along with street sweeping. With this option, street sweepers are given containerized handcarts or containerized tricycles. The vehicles have four to eight containers and a bell or a whistle. Depending on the density of the streets, a road length of between 350 and 750 meters is allotted to each sanitation worker for street sweeping. While sweeping the street, sweepers are also expected to do door-to-door collection of waste for the 150 to 250 houses situated on both sides of the street they are allotted to sweep. They ring the bell or use the whistle to announce their arrival, and citizens are expected to bring out their waste (see box 1.6 for a case study).

Door-to-door collection by resident welfare associations and nongovernmental organizations. Another option for door-to-door collection is to entrust the work to resident welfare associations (RWAs) or NGOs. Those organizations could be offered a reasonable subsidy (such as Rs 10 per house per month) to assist them in appointing and financing their own part-time sanitation workers for the door-to-door collection service. RWAs or NGOs can be invited to submit applications, and the agreement can be established through a memorandum of understanding.

A containerized handcart is used for primary collection at the doorstep.

Box 1.6. Case Study: Segregation, Door-to-Door Collection, and Street Sweeping in Suryapet, Andhra Pradesh

The municipal commissioner of Suryapet, Andhra Pradesh, along with elected representatives, led a successful door-to-door collection initiative. Staff members were given incentives to make the initiative work, but community participation was the most important component. The initiative ensured door-to-door collection of garbage and established monitoring mechanisms.

Households hand over segregated waste.

All households have been supplied with two dustbins for storing wet and dry garbage separately. All the roads and drains in the area are cleaned on a daily basis. One sanitary inspector, 1 health assistant, 7 public health j*awans* (sanitary supervisors), and 227 public health workers maintain the sanitation service.

Source: Authors.

The RWA or NGO can appoint one part-time sanitation worker per 200 households for door-to-door collection. This individual will work for four hours in the morning. Flexible hours can be fixed for shops and establishments. Sanitation workers can be given a containerized tricycle with a bell or whistle to facilitate collection of waste from the doorstep and should be paid at least minimum wage, as prescribed by the state government for part-time workers.

Ahmedabad, Hyderabad, Rajkot, Bangalore, Jaipur, and Chennai are cities where door-to-door collection services are carried out through RWA, NGO, and other private initiatives (see box 1.7 for a case study).

Door-to-door collection by private waste collectors. A third option for providing door-to-door collection is to contract with the private sector. Municipal authorities may prepare reasonably sized packages to make such contracts viable. The contracts could be only for door-to-door collection or could also include transport of waste.

Personalized door-to-door collection in high-income areas and compounds. High-income groups expect more personalized service and may not mind paying higher fees for door-to-door collection. In such areas, sanitation workers will need to visit and collect waste from each house in the area allotted to them. This system reduces the productivity of labor, so more workers will be needed to cover the same number of houses in a four-hour schedule. Hence, the cost of collection will be 30 to 40 percent higher. The higher cost justifies higher fees from such communities. The fees could be set at rates that would help to subsidize collection in poor communities.

Community Bin Collection: The Bring System. In the past, community bins have not been well accepted by citizens. Bins have not been emptied in time so they overflow, thereby causing an unhygienic situation. This situation is made worse because citizens tend to throw waste at the bins from a distance because they dislike coming too close. However, community bins are very effective for collection and still can be used in selected situations. For instance, bins can be placed in high-rise multistory buildings, housing compounds, or slum areas. Essential

Box 1.7 Case Study: Door-to-Door Collection through RWAs and NGOs in Ahmedabad

In Ahmedabad, a door-to-door collection initiative involving RWAs and NGOs met with success. The municipality took the lead in assessing the required human resources and machinery. It then decided to involve RWAs and NGOs. Under the memoranda of understanding signed with the RWAs and NGOs, the municipality provided subsidies of Rs 10 per household per month. The new service covers more than 855,000 households, or 95 percent of households in the city.

A tricycle provides door-to-door collection in Ahmedabad.

Ahmedabad has a population of 4 million, and its average rate of waste generation is 2,096 metric tons per day, including domestic, trade and institutional, and construction and demolition waste. The city had no system of primary door-to-door collection system, resulting in waste littered on the streets. Street sweeping was the principal method of primary collection. The city estimated that 3,900 sanitary workers would be required for ensuring door-to-door collection, so a resolution of the municipal corporation called for applications from RWAs and NGOs to volunteer for the work. They were offered a subsidy of Rs 2,000 per month per 200 households and one tricycle per 200 households, which would be replaced every three years. The entire city is now covered in door-to-door collection after less than six months of concerted effort.

Source: Authors.

for the acceptance of community bins is their frequent emptying and cleaning to avoid nuisance from litter, odor, and animals. Community bins must be designed to allow easy access for citizens, easy access for trucks, easy exchange or emptying, and easy cleaning of the area.

Ideally, bins will not be emptied but exchanged by a clean and empty bin with a truck. Optionally, those bins can be unloaded into a truck mechanically or manually, depending on the mechanization adopted in the city.

Table 1.7 provides a comparison of door-to-door collection and community bin collection.

Table 1.7 Comparison of Door-to-Door Collection and Community Bin Collection

Type of collection	*Advantages*	*Disadvantages*
Community bin collection	• Less cost intensive than door-to-door collection • 24-hour availability to households	• Problem of illegal waste disposal because households find it inconvenient to carry their waste to the community bin • Resistance from neighbors ("not in my backyard" syndrome) • Nuisance from animals and vermin roaming the waste
Door-to-door collection	• Convenience for households • Prevention of littering • Reduction of community bin • Segregated collection of waste	• Collection restricted to fixed collection times • Increased costs

Source: Ministry of Urban Development and Poverty Alleviation 2000.

Commercial Areas and Private Premises. Waste from commercial areas and private premises often has characteristics that are different from those of household waste. Therefore, it might be suitable to assess specialized collection options or treatment options for such waste. Table 1.8 gives an overview of typical commercial waste types and important aspects to be considered.

Step 3: Street Sweeping

In India, daily sweeping of streets and public places is essential because waste littering is still common and because it will take quite some time until Indian cities fully implement storage of waste at source and primary collection from the doorstep. Furthermore, dust and leaves accumulate rapidly on roads and pathways. Municipal authorities are expected under the respective municipal laws to undertake regular cleaning of streets and removal of rubbish. The yardstick of work may be prescribed by the municipal authority, depending on the local situation, type of roads, and amount of effort required by the sweeper. Solid waste authorities should prepare the following:

- A schedule of street cleaning that indicates which roads require daily cleaning and which ones need to be cleaned periodically.
- A list of such roads and streets, together with their length and width.
- A program for their cleaning, keeping in view the norms of work (yardsticks) prescribed (see box 1.8).
- A timetable for cleaning of open public spaces daily or periodically.

Box 1.8 Working Norms for Street Sweepers

The yardstick for cleaning open spaces should be prescribed on the basis of local conditions. However, CPHEEO estimates that a sweeper can cover 30,000 square feet of open space per day. Sweeping norms in running meters of road are as follows:

- High-density area—300 to 350 meters
- Medium-density area—500 to 600 meters
- Low-density area—650 to 750 meters

Source: Ministry of Urban Development and Poverty Alleviation 2000.

This street sweeper's containerized handcart is equipped with a handle at navel height plus a long-handled broom.

Table 1.8 Characteristics of Special Types of Waste

Type of waste	*Characteristic*
Waste from hotels or restaurants	• Hotel and restaurant waste has a similar composition to that of household waste but may contain more organic waste. • In general, hotels and restaurants either receive municipal collection service or must make their own arrangements for waste disposal. Their association may organize collection and transport of waste to the municipal treatment and disposal site. • If waste is segregated, the recyclable material has a high value and might be collected by a specialized waste collector. • Reuse and treatment options for the restaurant and kitchen waste should be assessed (such as animal feeding, composting).
Waste from fruit and vegetable markets	• Market waste contains a high fraction of biodegradable waste. Therefore, the waste might be of value for specialized waste treatment plants such as composting sites. • Options for private collection should be assessed because private operators might have interest in such waste. Daily collection is necessary to avoid animals and odor within the market premises. • Markets require large but easily accessible containers, which should be transported and emptied during nonpeak hours. • Waste from meat and fish markets requires closed containers and frequent collection services to avoid odor and attraction of vermin.
Waste from parks and gardens	• Park and garden waste mainly consists of biodegradable waste and litter. • The organic fraction might be treated directly in the park or garden and converted into compost. • Litter must be collected in litter bins in the park or garden. This waste could be collected on a daily basis. • If treatment of garden waste is not possible within the premises and if garden waste is generated in private places, such waste could be collected on a weekly basis by arranging a rotation schedule.
Construction and demolition debris	• Demolition debris is a big issue in Indian cities. Many vacant plots are misused and spoiled with illegal disposal of debris, causing considerable costs for the municipality and for private owners. • Because such debris is rather inert, it does not cause direct harm to people and the environment. Therefore, such waste could be collected separately and taken to landfill sites to be used as inert cover material. Another option is to use this material to fill low-lying areas in the city. This option will eliminate the need to take such waste to landfills and thereby save precious landfill space. • Demolition waste management needs special attention and monitoring. A closer cooperation with the construction sector might be necessary. Every likely generator may be required to deposit an approximate amount in advance at the prescribed rates with the municipal authority. • The municipal authority should prescribe the rate per metric ton for the collection, transport, and disposal of construction waste and debris and should announce such rates to the public. • In many countries, debris management is outsourced to private companies but closely monitored by municipal authorities. • Skip containers that are lifted on trucks are most suitable for debris collection and transport.

Source: Ministry of Urban Development and Poverty Alleviation 2000.

Table 1.9 Street-Sweeping Tools

Tool	*Design considerations*
Broom	• The design of the broom is important for both the efficiency and the occupational health of the worker. • Long, rounded handles are most suitable.
Metal tray and plate	• A metal tray and a plate facilitate the transfer of street waste into the handcart or tricycle and protect the worker from too much contact with waste.
Handcart or tricycle	• A handcart facilitates the movement of the sweeper. • Detachable containers allow easy emptying into the secondary waste storage bins. • The volume of each container should be such that it can be easily lifted. • The total capacity of the handcart should be such that it can carry the total quantity of waste to be picked up by the worker in three trips. • The handcart should have at least three wheels, and the handle should be at navel height so that the worker does not have to bend while pushing the cart.

Source: Ministry of Urban Development and Poverty Alleviation 2000.

Street-Sweeping Tools. Appropriate tools play an important role for improved efficiency. At present, most of the tools used by the sanitation workers are inefficient or inappropriate. Table 1.9 gives a brief overview of suitable tools.

Traditionally, the workforce resists any change, even if it is positive. Persuasion and awareness efforts will, therefore, be necessary to convince the workforce to adopt improved tools and equipments.

Working Conditions for Street Sweepers. Street sweeping is a daily task. Therefore, the allocation of work should provide rotating time off to facilitate working on weekends. Given public expectations and local habits in India, street sweeping should be organized for the early morning hours. Such an early schedule also protects workers from traffic and air pollution. For the rest of the workday, the sweeping crew might be assigned work in slums, informal settlements, areas that are very dense and need special attention, or places that are not covered in a daily schedule of street sweeping in absence of adequate staffing.

Street sweeping is generally carried out on two ends of the road or street, and a maximum of 0.75 meters of road width is swept on either side. The central part of the road is generally clean and litter free. If there is a central road divider, four sides have to be swept instead of two sides. Municipal authorities should take into consideration this workload rather than the width of the road when assigning the work. Municipalities may, therefore, plan the schedule of street sweeping depending on the density of area and importance of the road. They should ensure that slum dwellers and informal settlements are not marginalized or left out (see box 1.9 for a case study).

Step 4: Set Up Secondary Waste Storage Depots and Transfer Stations

Solid waste collected from the doorstep through the primary collection system has to be stored at a convenient place for its onward transport in a cost-effective manner.

Box 1.9 Case Study: Street Sweeping in Hyderabad

Hyderabad has a population of more than 4 million people. The city generates on an average 2,200 metric tons of waste per day, which is collected principally through sweeping of 3,823 kilometers of road length. The municipal corporation of Hyderabad employed only 2,500 public health workers. Of those, around 1,700 were deployed for street-sweeping operations. This staffing was wholly inadequate to keep the city clean. Given the size of the city, an estimated 7,500 or more workers were needed.

The municipality decided that, instead of recruiting additional personnel, outsourcing should be done. Street-sweeping contracts would apply a unique unit area method, and the practice of inviting competitive rates was eliminated. Instead, a fair and transparent system was introduced for the award of small fixed-cost contracts, which divided city roads into small units. Each unit comprised eight kilometers of road length. A yardstick of 500 meters of road length per sanitary worker was taken into consideration, with 1 supervisor per unit area and a team of 15 female workers for street sweeping and 3 male workers for carrying the street sweepings in handcarts to the secondary waste storage depot. The contracts were awarded after inviting application and then drawing lots.

Source: Authors.

In general, further waste handling should follow the principle of "Do not handle waste twice!"

Storage Depots. Municipal authorities need to dispense with open waste storage depots and to replace concrete cylindrical bins and missionary bins, which are inefficient and unhygienic, with neat, mobile covered containers. They should identify suitable locations, preferably from among the existing locations of waste storage depots in the city, where large containers ranging from three cubic meters to seven cubic meters could be placed for secondary storage of waste. The number of containers required will depend on the area of the city and its population.

A waste collector with a handcart should not be expected to walk more than 250 meters. Therefore, containers should be available within a radius of 250 meters. At least four containers per square kilometer need to be placed. In high-density areas, one container should be placed for every 5,000 to 10,000 residents, depending on the size of the container. A three cubic meter container will hold 1.25 to 1.50 metric tons of waste, just enough for a population of 5,000 whereas, a container of seven

Waste can be transferred directly from the handcart to the container at the waste storage depot.

cubic meter capacity can easily handle the waste of a population of 10,000 to 12,000. In highly spread-out areas, the municipalities may use their discretion in placing containers to facilitate an appropriate secondary storage system in a cost-effective manner. The containers could either be taken directly to the disposal site if the distance is shorter than 15 kilometers or might be taken to a transfer station if the distance is longer.

Because waste is segregated at its source, two bins are needed: one for biodegradable waste and the other for recyclables and waste collected by street sweepers. Appropriate waste storage depots should ensure easy access for primary waste collectors, easy further handling of containers, easy cleaning and prevention of water clogging, and coverage to protect from rain and animals.

Transfer Stations. In cities where the treatment and disposal site is more than 15 kilometers away from the city, transfer stations might be appropriate. Waste is transferred from small vehicles into larger container trucks so that waste can be transported more efficiently over long distances. It would be uneconomic to transport small quantities of waste to a long-distance haul. The following might be considered:

- The transfer station needs to be so designed that waste can directly be transferred into a large vehicle or container.
- Large vehicles or containers with a capacity of 20 to 30 cubic meters are typically used for long-distance waste transport to a treatment and disposal site.
- The design and capacity of transfer stations and storage equipment strongly depends on the waste quantity and on vehicles used for primary and secondary waste.

Municipal authorities should very carefully select the site of transfer station. One or more transfer stations in each city can facilitate optimum use of the fleet of small vehicles and can take optimum advantage of large hauling vehicles for bulk transport of waste. Transfer stations should be decentralized within the city, allocated to an enclosed area, and situated in the general direction of the main

A transfer station is appropriate when the treatment and disposal site is far from the city.

This transfer station has split levels for direct transfer of waste from a small vehicle to a large vehicle.

landfill site. The timings of the transfer station should match with the timings of waste transport from the city so that direct transfer of waste from a small vehicle to a large vehicle is possible. This arrangement can be facilitated by a split-level transfer station, where a small vehicle can go over a ramp and directly tip into a large vehicle. However, if direct transfer of waste from a small vehicle to a large vehicle is inconvenient, the municipal authority could also plan a transfer station at which waste is initially deposited in a large bunker and later moved using special equipment such as a grabbing machine. The contents could then be lifted into a large vehicle at any time during the day. Such an arrangement necessitates multiple handling but has the flexibility to allow the transfer of waste anytime during the day.

Step 5: Improve Transport of Waste

This step refers to the transport of large quantities of waste to treatment sites or the final disposal site. The transport of waste is the bottleneck of efficiency in most Indian cities. In many cases, the transport capacity is bound by lengthy loading times (manual loading) from storage areas. Additionally, long distances limit vehicle crews to one or two trips per day, which can be inefficient if the transport volume is small. The longer the distance to the landfill site, the more volume should be transported with each load. In case of long haul distances to the landfill site, transfer stations are found to be most efficient.

Vehicles should be selected according to capital costs, carrying capacity, life expectancy, loading speed, local spare part availability, speed, fuel consumption, and maintenance costs. Some general considerations for improvement could be followed:

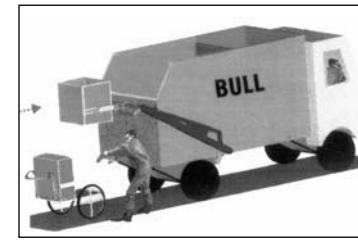
- Under the 2000 rules, the transport vehicle must be covered. In the beginning, therefore, municipal authorities will need to provide a cover for existing vehicles. Later, those vehicles should be replaced with a suitable covered vehicle to prevent waste from falling out.
- The transport of waste can be managed and monitored centrally or through a large decentralized arrangement. In either case, municipal officers should ensure the efficiency of the arrangement. Excessive decentralization may result in underuse of the fleet of vehicles and may prevent pooling of vehicles to tide over difficult situations expeditiously.
- Transport can be contracted out to private operators.
- The transport system must be harmonized with the secondary storage system of waste to prevent manual and multiple handling of waste.
- Transport capacity must be sufficient to ensure a frequent evacuation of secondary waste storage containers. Otherwise containers will overflow.
- A two-shift working system capitalizes the collection fleet and reduces the requirement for new vehicles.
- Work at night will increase efficiency as trucks will not be slowed down by daily traffic. This consideration is particularly relevant in city centers and commercial areas.
- In small cities that lack adequate maintenance facilities for hydraulic vehicles, combined tractor-trolley vehicles or tractors with lifting devices may be more suitable.

In small towns, containers can be transported by tractors equipped with a container-lifting device.

In large cities, containers can be transported by a hydraulic vehicle.

Technical Considerations. To prevent manual handling of waste and loss of time, municipal authorities should ensure that secondary storage containers are harmonized with the transport vehicles. The dumper placer system has proved to be very suitable in the Indian context. For long-distance transport, it is advisable to set up a transfer station and to use large hauling vehicles or containers into which waste can be tipped directly from smaller vehicles or containers. Where small containers are used (for example, for apartment blocks), the trucks need to be equipped with a suitable loading facility to allow those containers to be emptied into the truck.

Both containers and trucks require frequent maintenance because they are exposed to corrosive material and heavy loads. In particular, hydraulic systems require the attention of a skilled staff. Therefore, the setup of an efficient waste transport system requires a professional maintenance staff as well.



Waste is directly transferred from a community bin to the vehicle.

When planning proper maintenance of vehicles, municipal authorities should consider the following:

- Proper maintenance of fleet of vehicles is necessary to ensure that transport of waste is carried out without interruption.
- All municipal authorities must have adequate workshop facilities for maintenance of their fleets of vehicles, including containers and handcarts, as well as trucks.
- The workshop, public or private, should have adequate technical personnel, spare staff members, and a preventive maintenance schedule to ensure that at least 80 percent of the vehicles remain on the road each day.
- Waste transport vehicles have a useful life of 8 to 10 years; therefore, financial planning is necessary to ensure timely replacement of vehicles.

Step 6: Determine and Establish Treatment and Recycling Options for Solid Waste

This sixth essential step was made mandatory under the 2000 rules. The municipal authority must treat the organic fraction of waste before disposal. Municipal authorities are expected to set up a plan for composting waste or to adopt waste-to-energy technology as may be appropriate. Currently, private entrepreneurs are advocating several technologies for the processing and treatment of organic MSW. Some of the technologies have been used in India in the past, such as microbial composting and vermicomposting, whereas some are based on applications used in foreign countries that have yet to be tried in India or that have failed in India. Such applications include incineration for power generation.

Quite often, municipal authorities fail to assess the suitability of new technology to Indian conditions. They may be attracted to technology that is successfully used in industrial countries without evaluating its applicability to India. As a result, they may meet failure later. It is important to avoid this mistake and to properly address the issue of suitability to local conditions, including local technical knowledge, operation capacity and cost of maintenance. Municipal authorities should also consider seeking expert opinion from outside the municipality. The criteria that are in table 1.10 could be adopted when selecting appropriate waste processing and disposal technologies.

Table 1.10 Criteria for Selection of Appropriate Technology or Combination of Technologies

Technical criteria	*Financial criteria*	*Managerial criteria*
• Experience with technology under Indian conditions (references) • Scale of operation • Required land, water, and power • Locally available spare parts • Process aesthetics • Environmental impact	• Investment cost • Operation cost • Financing mechanisms • Market for end product (demand, price)	• Labor requirement • Skills for operation and maintenance • Skills for monitoring and management

Source: Ministry of Urban Development and Poverty Alleviation 2005b.

Waste Recycling. Waste recycling in India has great untapped potential that can benefit Indian society as a whole. Throughout the country, there is a need to upgrade and reorganize the recycling system, to increase effectiveness of the waste collection and recycling system, and to improve the working conditions for rag pickers. The Supreme Court's expert committee acknowledged this potential in its report and recommended further action toward intensified recycling that takes into consideration all stakeholders. Schedule II of the 2000 rules lays down mandatory directions for waste segregation and processing within municipal management services. Hence, municipalities need to select appropriate processing technologies in the recycling sector.

Treatment of Organic Waste. Household waste can contain 40 or 50 percent organic waste. Waste from urban fruit and vegetable markets contain even higher amounts. Because organic waste causes major hygienic and environmental problems in cities and at landfills, the 2000 rules mandate improved management and treatment of this fraction before final disposal. Several treatment options for organic waste are available. Chapter 6 provides in-depth information on recycling and reuse options.

Composting. In the 2000 rules, *composting* is defined as a controlled process involving microbial decomposition of organic matter under aerobic conditions. Biodegradable waste is converted to a soil-like substance (compost), which is a valuable soil amendment and fertilizer. India has a well-established composting community with a wealth of experience in composting. However, only a few municipalities have adopted composting as a treatment option in their SWM strategy. Many composting initiatives are not formally linked to the official system and, therefore, struggle with organizational, financial, and institutional problems. Sustainable composting is possible only with the financial or organizational support of municipal authorities.

Composting schemes vary in terms of scope, technology, and management. The most important schemes for India are listed in table 1.11.

Anaerobic digestion. Anaerobic digestion is a process that produces biogas from decomposed waste. The biogas can be used to power electricity generators or to produce heat. The anaerobic digestion process reduces the volume of organic matter from the waste stream, therefore reducing the amount of waste that needs to be put in a landfill or incinerated.

Table 1.11 Composting Schemes

Scope	*Technology*	*Management*
• Backyard composting • Neighborhood composting • Market waste composting • Centralized composting	• Box composting • Window composting • Vermicomposting (using worms) • Pit composting • Co-composting (combination with other types of waste)	• Individual composting • Community composting • Municipal composting • Private composting (of, for example, market waste)

Source: Ministry of Urban Development and Poverty Alleviation 2005b.

Incineration and other technologies. Indian waste has a low calorific value—between 700 and 1,000 kilocalories. Therefore, it is not suitable for incineration. Any technology for incineration requires a high calorific value input. Municipal authorities should, therefore, be very careful in assessing this option for disposal of waste. A large incineration plant set up in Delhi in 1986 failed and had to be closed down. However, two power plants using refuse-derived fuel are in operation in Andhra Pradesh at Hyderabad and Vijayawada. Both produce 6.5 megawatts of power, but those plants may be using more agro waste than MSW. The technology should, therefore, be carefully evaluated in the Indian situation. While considering this technological option, municipal authorities should look at the calorific value of the waste and keep in mind the likely reduction in the calorific value on account of segregation of recyclable waste (which has a high calorific value) at source.

Treatment of Inorganic Waste. The inorganic fraction of municipal household waste can be divided into recyclable materials and nonrecyclable materials. The earlier recyclable materials are segregated from the solid waste stream, the higher their value and the easier the further processing. The appropriate treatment option for inorganic waste depends on its physical and chemical characteristics as well as on its reuse potential. In India, the predominant treatment option for inorganic waste is recycling through the informal sector. This method has the potential to salvage nearly 20 percent of such waste and for reuse and recycling. Experiences with incineration (waste-to-energy approaches) are less promising. The recycling sector is well established in India; however, much is left to do regarding working conditions and environmental protection. This aspect will be discussed in detail in chapter 6.

Step 7: Improve Final Disposal of Waste by Constructing Engineered Landfills

Open dumping of waste can cause irreparable damage to the environment by polluting land, water, and air; adversely affecting human health; and lowering people's quality of life. The 2000 rules, therefore, prohibit open dumps and require municipal authorities to safely dispose of solid waste in engineered landfills. The rules further mandate treatment of the organic fraction of solid waste before final disposal in the landfill sites. Thus, only rejects and degraded waste can be placed in landfills. All cities and towns in India are, therefore, under an obligation to stop crude dumping of waste at open dumping grounds and to instead identify suitable lands for the construction of engineered landfills following the standard prescribed in Schedule III of the rules. Schedule III provides guidelines for the basic landfill requirements for selection and design. The following sections outline important guidelines.

Site Selection. The guidelines include the following provisions regarding site selection:

- In areas falling under the jurisdiction of "development authorities," it is the responsibility of those authorities to identify the landfill sites and to hand over the sites to the concerned municipal authority for development, opera-

tion, and maintenance. Elsewhere, this responsibility lies with the concerned municipal authority.

- Selection of landfill sites must be based on examination of environmental issues. The Department of Urban Development of the State or the Union territory must coordinate with the concerned organizations to obtain the necessary approvals and clearances.
- Landfill sites must be planned and designed with proper documentation of a phased construction plan as well as a closure plan.
- Landfill sites must be selected to make use of a nearby waste processing facility. Otherwise, a waste processing facility must be planned as an integral part of the landfill site.
- Existing landfill sites that will continue to be used for more than five years must be improved in accordance with the specifications that are given in Schedule III.
- Biomedical waste must be disposed of in accordance with the Bio-Medical Waste (Management and Handling) Rules 1998, and hazardous waste must be managed in accordance with the Hazardous Wastes (Management and Handling) Rules 1989, as amended.
- Landfill sites must be large enough to last for 20 to 25 years.
- Landfill sites must be away from habitation clusters, forest areas, water bodies, monuments, national parks, and wetlands, as well as places of important cultural, historical, or religious interest.
- A buffer zone of no development must be maintained around the landfill site and must be incorporated in the town planning department's land-use plans.
- Landfill sites shall be away from airports, including airbases. Approval of airport or airbase authorities must be obtained before setting up a landfill site if the site is to be within 20 kilometers of an airport or airbase.

In addition to those rules, the state pollution control boards are required to prescribe the criteria for site selection in terms of distance to be maintained from habitation, water bodies, highways, railways, and so forth. Municipal authorities should also adhere to those criteria.

Table 1.12 shows the basic requirements for selection of landfill sites.

Table 1.12 Basic Requirements for Selection of Landfill Sites

Place	*Minimum siting distance*
Habitation	500 meters
Water bodies (rivers, lakes)	200 meters
Canals, drainage systems	30 meters
Highways, railways	300 meters from center line
Coastal regulation zoning	No landfill permitted
Flood-prone areas	No landfill permitted
Airports	20 kilometers
Earthquake-prone areas	500 meters from fault-line fracture

Source: Ministry of Environment and Forests 2000 (Schedule IV).

Facilities at the Site. The guidelines include several provisions regarding facilities:

- Landfill sites must be fenced or hedged and must be provided with a proper gate to monitor incoming vehicles or other modes of transport.
- Landfill sites must be well protected to prevent entry of unauthorized persons and stray animals.
- Approach and other internal roads for free movement of vehicles and other machinery must exist at the landfill site.
- Landfill sites must have a waste inspection facility to monitor waste brought to the landfill, an office facility for recordkeeping, and a shelter for equipment and machinery, including pollution-monitoring equipment.
- A weigh bridge to measure the quantity of waste brought to the landfill, fire protection equipment, and other facilities should be provided as required.
- Utilities such as drinking water and lighting arrangements for easy landfill operations when carried out in night hours must be provided. If possible, bathing facilities for workers should be provided.
- Safety provisions, such as health inspection for landfill workers, must be periodically made.

Specifications for Landfilling. The rules lay down detailed specifications for landfilling, which should be strictly adhered to. Waste subjected to landfilling is expected to be compacted in thin layers and covered immediately or at the end of each workday with at least 10 centimeters of soil. After completion of landfill, a final cover must be designed to minimize infiltration and erosion. The final cover must have a barrier soil layer followed by a drainage layer. On top of the drainage layer, a vegetative layer is needed to support natural plant growth and to minimize erosion. Moreover, directions have been given for pollution prevention and water-quality monitoring, landfill closure, and later care. The municipal authorities should follow the rules carefully when constructing an engineered landfill.

Rule of Thumb for Requirement of Land. Municipal authorities are expected to identify a suitable parcel of land that meets the requirement as prescribed by the 2000 rules and the respective state pollution control boards. Small cities that have limited land may not be able to construct engineered landfills that are very deep or high. In such cases, authorities should consider an average landfilling of about four meters. Two acres of land is advisable for a population of 10,000. Eight hectares or 20 acres land of land will service a population of 100,000 population. Of this land, 25 percent may be used for composting and the rest for landfilling. The landfill should be functional for 20 to 25 years.

In the case of large cities or for regional facilities, it may be possible to construct a landfill that is deep and high. The landfilling could be of 12 to 15 meters. In this case, the land requirement could be substantially reduced in proportion to the height that could be achieved at the landfill. In such landfills, 8 to 10 acres of land may be adequate for a population of 100,000.

References and Suggested Readings

Akolkar, A. B. 2005. *Status of Solid Waste Management in India: Implementation Status of Municipal Solid Wastes, Management, and Handling Rules 2000.* New Delhi: Central Pollution Control Board.

Asnani, P. U. 2004a. "Status of Compliance of Municipal Solid Waste (Management and Handling) Rules 2000 in 127 Class 1 Cities in India as on 1-4-04." Paper presented at the National Training Programme on Design, Construction, and Operation of Sanitary Landfills, jointly organized by the Government of India, the Central Pollution Control Board, the United States–Asia Environmental Program, and the Water and Sanitation Programme of the World Bank, at Panaji, Goa, India, May 24–28.

———. 2004b. *United States–Asia Environmental Partnership Report*. Ahmedabad, India: United States Agency for International Development, Center for Environmental Planning and Technology.

———. 2006. "Solid Waste Management." In *India Infrastructure Report 2006: Urban Infrastructure*, ed. Anupam Rastogi, 160–89. New Delhi: Oxford University Press. http://www.3inetwork.org/reports/IIR2006/Solid_Waste.pdf.

Bartone, Carl R. 2000. "Strategies for Improving Municipal Solid Waste Management: Lessons from World Bank Lending." Paper presented at the International Workshop for Planning of Sustainable and Integrated Solid Waste Management, Manila, September 18–22.

Bartone, Carl R., Janis Bernstein, Josef Leitmann, and Jochen Eigen. 1994. "Toward Environmental Strategies for Cities: Policy Considerations for Urban Environmental Management in Developing Countries." Urban Management Programme Policy Paper 18, World Bank, Washington, DC. http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000009265_3970128113220.

Cointreau, Sandra. 1982. "Environmental Management of Urban Solid Wastes in Developing Countries: A Project Guide." Urban Development Technical Paper 5, World Bank, Washington, DC. http://www.worldbank.org/html/fpd/urban/uswm/techpaper5.pdf.

———. 2001. "Declaration of Principles for Sustainable and Integrated Solid Waste Management (SISWM)." http://siteresources.worldbank.org/INTUSWM/Resources/siswm.pdf.

———. 2003. "Environment Network: Economic Instruments for Solid Waste Management—Global Review and Applications for Latin America and the Caribbean." Regional Policy Dialogue Study, Inter-American Development Bank, Washington, DC. http://www.iadb.org/int/drp/ing/Red7/Docs/EconomicInstrumentsSolidWaste01-04eng.pdf.

CPCB (Central Pollution Control Board). 1995. "Management of Municipal Solid Wastes—Status and Options." CUPS/41/1994–95, CPCB, Ministry of Environment and Forests, New Delhi.

———. 1999. "Status of Municipal Solid Waste Generation, Collection Treatment, and Disposal in Class-I Cities." CUPS/46/1998–1999, CPCB, Ministry of Environment and Forests, New Delhi, CPCB, Ministry of Environment and Forests, New Delhi.

———. 2000a. "Status of Municipal Solid Waste Generation, Collection Treatment, and Disposal in Class-I Cities." CUPS/48/1999–2000, CPCB, Ministry of Environment and Forests, New Delhi.

———. 2000b. "Status of Solid Waste Generation Collection, Treatment, and Disposal in Class-II Towns." CUPS/50/1999–2000, CPCB, Ministry of Environment and Forests, New Delhi.

Dente, Bruno, Paolo Fareri, and Josee Ligteringen, J. 1998. *The Waste and the Backyard—The Creation of Waste Facilities: Success Stories in Six European Countries*. Dordrecht, Netherlands: Kluwer Academic.

Diaz, Luis F., George M. Savage, Linda L. Eggerth, and Clarence G. Golueke. 1996. *Solid Waste Management for Economically Developing Countries*. Copenhagen: ISWA.

Globalis. 2005. "Urban Growth Rate." http://globalis.gvu.unu.edu/.

Gopalan, Prasad, and Bartone, Carl. 1997. "Assessment of Investments in Solid Waste Management: Strategies for Urban Environmental Improvement." World Bank, Washington, DC.

Government of India. 2003. *Report of the Technology Advisory Group on Solid Waste Management*. New Delhi: Government of India Publications.

Hanrahan, David, Sanjay Srivastava, and A. Sita Ramakrishna. 2006. "Improving Management of Municipal Solid Waste in India: Overview and Challenges." Environment Unit, South Asia Region, World Bank, Washington, DC.

Hoornweg, Daniel, with Laura Thomas. 1999. "What a Waste: Solid Waste Management in Asia." Urban and Local Government Working Paper 1, World Bank, Washington, DC. http://web.mit.edu/urbanupgrading/urbanenvironment/resources/references/pdfs/WhatAWasteAsia.pdf.

Johannessen, Lars Mikkel, with Gabriela Boyer. 1999. "Observations of Solid Waste Landfills in Developing Countries: Africa, Asia, and Latin America." Urban and Local Government Working Paper 3, World Bank, Washington, DC. http://web.mit.edu/urbanupgrading/urbanenvironment/resources/references/pdfs/Observations.pdf.

Kobus, Dariusz. 2003. *Practical Guidebook on Strategic Planning in Municipal Waste Management*. Gütersloh, Germany: Bertelsmann Stiftung. http://www.bancomundial.org.ar/lfg/gas_access_009.htm.

Leitmann, Josef. 1994. "Rapid Urban Environmental Assessment: Lessons from Cities in the Developing World." Urban Management Programme Policy Paper 14, World Bank, Washington, DC. http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000009265_3970128112130

———. 2000. "Integrating the Environment in Urban Development: Singapore as a Model of Good Practice." Urban and Local Government Working Paper 7, World Bank, Washington, DC. http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2001/05/11/000094946_01050204303261/Rendered/PDF/multi0page.pdf.

Ministry of Environment and Forests. 1998. *Bio-Medical Waste (Management and Handling) Rules*. New Delhi: Ministry of Environment and Forests.

———. 1999. *Recycled Plastics Manufacture and Usage Rules*. New Delhi: Ministry of Environment and Forests.

———. 2000. *The Municipal Solid Waste (Management and Handling) Rules 2000*. New Delhi: Ministry of Environment and Forests.

Ministry of Urban Development and Poverty Alleviation. 2000. *Manual on Solid Waste Management*. New Delhi: Government of India Publications.

———. 2005a. "Management of Solid Waste in Indian Cities." Ministry of Urban Development and Poverty Alleviation, New Delhi.

———. 2005b. "Report of Technology Advisory Group on Solid Waste Management." Ministry of Urban Development and Poverty Alleviation, New Delhi.

NEERI (National Environmental Engineering Research Institute). 1995. "Strategy Paper on SWM in India." NEERI, Nagpur, India.

———. 1996. "Characterization and Quantification of Solid Waste in 44 Indian Cities and Standardization of the Procedure." BIS 10158–1982, NEERI, Nagpur, India.

———. 2005. "Study on Composition and Per Capita Generation of Waste." Survey of solid waste management in 59 Cities (35 metro cities and 24 state capitals) conducted in 2004 and 2005. NEERI, Nagpur, India.

Obeng, Letitia, and Sandra Cointreau-Levine, eds. 1997. "Urban Waste Management: Guidelines, Tools and Practices in Sub-Saharan Africa." AFTI Working Paper, World Bank, Washington,DC.http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTURBANDEVELOPMENT/EXTUSWM/0,,contentMDK:20239437~menuPK:463861~pagePK:210058~piPK:210062~theSitePK:463841,00.html.

PAHO (Pan American Health Organization). 1994. "Methodological Guidelines for Sectoral Analysis in Solid Waste: Preliminary Version." PIAS Technical Paper 13, PAHO, Washington, DC.

Sakurai, Kunitoshi. 1990. *Improvement of Solid Waste Management in Developing Countries*. Tokyo: Institute for International Cooperation, Japan International Cooperation Agency.

Singhal, Shaleen, and Suneel Pandey. 2001. "Solid Waste Management in India: Status and Future Directions" *TERI Information Monitor on Environmental Science* 6(1):1–4.

Schubeler, Peter, Karl Wehrle, and Jürg Christen. 1996. "Conceptual Framework for Municipal Solid Waste Management in Low-Income Countries." Urban Management Programme Working Paper 9, World Bank, Washington, DC. http://www.worldbank.org/html/fpd/urban/uswm/conceptualframework.pdf.

Solid Waste Management Thematic Group.2005. Materials from the basic training session "Solid Waste Primers and Lessons Learned from Bank Projects,"Washington, DC, March 7. http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTURBANDEVELOPMENT/EXTUSWM/0,,contentMDK:20446365~pagePK:210058~piPK:210062~theSitePK:463841,00.html.

Supreme Court. 1999. "Report of the Supreme Court Appointed Committee on Solid Waste Management in Class I Cities in India." Supreme Court of India, New Delhi.

Tchobanoglous, George, and Frank Kreith. 2002. *Handbook of Solid Waste Management*. New York: McGraw-Hill.

WHO (World Health Organization). 1993. *Urban Solid Waste Management*. 1991–93 ed. Firenze, Italy: Instituto per i Rapporti Internazionali di Sanita.

———. 1995. "Solid Waste and Health." Briefing Pamphlet 5, European Series, Regional Office for Europe, WHO, Copenhagen.

World Bank. 2005. "Waste Management in China: Issues and Recommendations." Urban Development Working Paper 9. East Asia Infrastructure Department, World Bank, Washington, DC. http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/EXTEAPREGTOPURBDEV/0,,contentMDK:20535612~pagePK:34004173~piPK:34003707~theSitePK:573913,00.html.

———. 2007a. "Solid Waste Management (SWM)." http://web.worldbank.org/WBSITE/EXTERNAL/WBI/WBIPROGRAMS/ENRLP0,,contentMDK:21029786~pagePK:64156158~piPK:64152884~theSitePK:460957,00.html.

———. 2007b. "Urban Solid Waste Management." http://www.worldbank.org/solidwaste.

2

Financing for Municipal Solid Waste Services

Municipal authorities in India are autonomous governments that provide essential services to the citizens at the local level. This institutional arrangement came into being during the 18th-century British regime. Over the past three centuries, state governments have established urban local bodies (ULBs) to provide basic services: 4,378 cities and towns in India have municipal authorities to provide basic essential services. Local bodies were recognized by the 74th constitutional amendment in 1992, which clearly defined their roles and responsibilities. They need to perform certain mandatory duties and are required to raise sufficient financial resources to meet their obligations.

Among those mandatory duties is a minimum level of solid waste management (SWM) service. Because SWM is an obligatory duty of municipal authorities, they cannot escape the responsibility of providing those basic services on the grounds of paucity of funds, but must find or raise funds to provide for SWM. This chapter describes the traditional financial resources of municipal authorities in India and highlights the situation of levy and recovery of taxes and charges resulting in the poor financial health of ULBs.

The chapter also provides suggestions for improving the financial discipline of ULBs and elaborates on the methods of assessing funding requirements for various SWM services. It also advises on the strategy of financing through user fees or taxes to meet the cost of SWM services and suggests ways of minimizing SWM service costs by enhancing community, nongovernmental organization (NGO), and private sector participation.

Existing Financial Situation of the Municipal Authorities

The state laws governing municipal authorities establish their powers to levy taxes, charges, fees, and the like for raising money to meet their statutory obligations. Municipalities, of course, need adequate and recurrent cash flows to provide a service. Without recurrent revenues, service provision must rely on transfers from another level of government or grants, making the service difficult to sustain.

Sources of Income

Municipal authorities levy taxes, charges, and fees such as those listed next to gain revenues and to improve their financial situation. Some municipalities also levy monthly user fees or charges for water, drainage, and sanitation to meet the

necessary operating and maintenance cost of the service. By and large, however, municipal authorities suffer a major deficit of funds to meet their obligations. Many municipalities do not generate sufficient funds even to pay their staff members' salaries.

The following are principal sources of municipal authorities' income:

- Property and house taxes
- Octroi duty (in some states only)
- Water tax
- Sewerage, drainage, and conservancy tax
- City cleaning tax
- Fees for passing building plans
- Levies on advertisement through hoardings, signboards, and so forth
- Rents from municipal properties
- Fees from licenses for various trades
- Parking fees

Levy and Recovery of Taxes and Charges

Despite powers given to ULBs to impose taxes, most municipal authorities do not levy sufficient taxes. The tax base is generally very weak. The basic valuation from which the level of taxes is calculated is faulty or is deliberately kept low to reduce the burden on the taxpayers. Elected representatives shy away from imposing new taxes or increasing the tax rates for fear of public outcry or losing their constituency. They do not appreciate that if they fail to provide services for want of funds, public outcry or distrust could be worse. Mostly, elected officials cannot muster the courage to convince citizens that "there's no such thing as a free lunch."

The situation for tax recovery is also very poor. First, many taxable properties are not registered. Certain property holders somehow manage to escape the tax net. Those who are assessed are quite often underassessed and do not pay their taxes regularly. Second, the mechanism of tax recovery is poor. The rates of tax recovery generally range between 30 and 50 percent. In this situation, the financial health of ULBs in India is poor, and they are unable to fulfill their obligations. ULBs are always trying to put out fires rather than planning ahead to meet challenges.

Dependence on Government Grants

Most municipal authorities in the country are not in a position to meet their financial needs from the internal financial resources of the area. They therefore fall back on the state government for grants. The states give the municipalities grants for paying staff salaries as well as for carrying out development work. This dependence on state government grants is not sustainable in the long term, and municipalities need to find ways to fund services from their own resources.

Following are the main sources of grants that municipalities can obtain:

- State Finance Commission grants
- 12th Finance Commission grants
- Jawaharlal Nehru National Urban Renewal Mission (JNNURM) grants
- Urban Infrastructure Development for Small and Medium Towns (UIDS & MT) scheme grants

- Share from stamp duty on transfers of property
- Share from entertainment tax
- Share from education tax in the form of a grant from the provincial or national government

Allocation of Inadequate Funds for SWM

Municipal decision makers do not give adequate priority to SWM. Financial allocations go for staff salaries as the first priority, and what is left is spent on visible infrastructure projects. Very little is allotted to improving SWM services, varying between 1 percent and 30 percent of the total municipal budget depending on the size of the municipality (Gujarat Urban Development Company 2005–06).

Most of the budget for SWM is consumed in salaries of sanitation workers and transport of waste. Very little or none is set apart for actual treatment and disposal of waste. The percentage of expenditures for various solid waste services is as follows (Supreme Court 1999):

- 70 to 75 percent on street sweeping
- 25 to 30 percent on collection
- 0 to 5 percent on disposal

Failure to Levy SWM Tax or User Fees

Most of the municipal authorities allocate general municipal funds to cover the costs of SWM services. They most often do not levy any sanitation or city cleaning tax, nor do they impose user fees for waste collection service or for any other SWM service. Very few cities have mustered courage to levy user fees for door-to-door collection.

Strategies for Improving the Financial Situation

The municipal authorities need to take a careful look at their finances and implement a transparent financial and accounting system that will allow them to impose expenditure discipline and make judicious use of limited funds available. The following measures could help improve the financial health of municipal authorities:

1. Identify priority areas.
   - Prioritize the services that the municipal authority has to provide.
   - Put SWM service in the top priority list because it is an essential service and obligatory for the municipal authorities to perform.
   - Put all nonobligatory functions in a separate category of duties that may be performed only after providing adequate funds for satisfactory performance of all essential services.
   - Ban wasteful expenditures.
2. Define priorities for obligatory services.
   - Decide the minimum level of service the municipal authority would like to provide in each category of service in a given time frame.
   - Estimate the funds required to provide that level of service.

- Set the priority of the essential services among themselves, giving due priority to SWM services.
- Allocate funds for each service.
- Decide the critical area in each service and use the funds to optimize the benefits to society.
- Defer expenditures that can wait.

3. Improve tax collection efficiency.[1]
   - Critically look into the existing mechanisms and efficiency of tax collection and collection of charges, fees, and other income sources prescribed by the municipal authorities.
   - Identify the leaks or lapses in the system.
   - Plug the leaks and maximize the efficiency of collection of taxes, charges, and fees.
   - Get professional or private sector help in this area wherever required.
   - Use the additional funds generated through this effort for the essential services.
   - Streamline procedural steps for debt collection from nonpayers.
4. Review the existing rates and charges.
   - Compare existing rates of taxes and charges to the current cost of services.
   - Make sure that citizens are reasonably taxed for the services they receive. Rates that are too low may be suitably increased to reduce the gap between income and expenditure.
   - Rationalize the property tax structure, preferably on the basis of carpet area or plinth area rather than on the basis of rents.
   - Introduce the element of cost recovery for specialized services rendered, particularly in the case of doorstep services or nondomestic waste collection services.
5. Encourage NGO and private sector participation.
   - List all the SWM activities performed by the municipal authority.
   - Identify the areas where NGO or private sector participation or contracting out of services is desirable.
   - Change policy: instead of being a provider, become an enabler of the service.
   - Determine which services can be covered by the private sector, an NGO, or a cooperative for direct payment from users to reduce the burden on the municipal authority.
   - In such areas, carefully monitor the performance of the NGO or private sector provider to ensure required levels of service are met.
6. Review establishment costs.
   - Critically review overhead costs and the job requirements of officers and staff.
   - Set work norms carefully.
   - Review human resource needs.
   - Reduce surplus staff members, if any, or redeploy them where needed.
   - Economize in expenditure in all activities of the municipal authority.

All the efforts from 1 to 6 will improve financial discipline and put the municipal authority in a more comfortable position to plan expenditures for essential items of work. The improved fiscal efficiency of a municipal authority may even make it eligible for funding by financial institutions. A municipal authority should have a contingency fund for planned and timely replacement of vehicles and equipment.

Costing and Budgeting of SWM Services

Solid waste management constitutes from 10 to 50 percent of municipal budget expenditure, depending on the income sources of the municipal authorities. The main expenditure categories under SWM are salaries and allowances, consumables, vehicle repair and maintenance, contingencies, and other.

As much as 30 to 50 percent of municipal personnel in a local body are engaged in SWM activities. Most of this staff is engaged in street sweeping. A recent survey by the National Institute of Urban Affairs shows "salaries of sanitation workers" for SWM in class I cities constitute as much as 75 percent of total SWM expenditure (Asnani 2006: 180). This amount is even higher in class II cities.

Each city or town should have a full-cost accounting system that shows the exact cost of SWM service and takes into account all hidden costs. Furthermore, it must take into account past and future outlays, overheads, and operating cost. Depreciation and amortization should also be shown so that the cost of service and financial liability is known. The full-cost accounting should reflect not only what has been spent on SWM but also what is committed to be paid regardless of when the money is spent. For example, payment can be made before or after the operating life of the landfill facility.

All this information is necessary for making informed decisions on what service needs special attention to reduce cost. It also clarifies what strategies need to be adopted for private sector participation, public-private partnership, or NGO participation in SWM service in lieu of departmental service. Furthermore, knowing the actual cost involved in SWM services will help make communication with the public transparent when authorities must advocate for financing through user fees.

Municipal authorities must work out the operating, maintenance, and capital costs required for each component of SWM service. The costing should take into account personnel costs for primary collection, secondary storage, transport, and disposal of waste. It should also take into consideration the cost of tools and equipment, the debt-servicing charges, and operating and maintenance costs. Careful assessment of operating and maintenance costs is essential. SWM collection equipment has a relatively short life, so such costs are substantial. All hidden costs of supervision and administrative expenses not directly booked under SWM budget heads must also be taken into consideration to ascertain the true cost of service. Individual costing for each component is critical because each component could be contracted out, and this information will assist in preparing the tender documents.

Budgeting for SWM should be done every year, taking into account needs for operation and maintenance of SWM services as well as investment costs for procuring tools, equipment, and construction of treatment and landfill facilities. Projected increases in population and quantity of waste generation also should be taken into account when determining the financial requirements of municipal authorities, and provision should be made to account for all expenditures.

Generally, municipalities prepare their budgets using an incremental approach that is based on the previous year's budget. Annual budgeting should include the projections and SWM works to be undertaken in the next financial year. Municipal authorities need to take into consideration whole-project costs when preparing their budgets and then breaking up the project costs into costs for yearly activities. Annual budgets should be prepared after detailed costing for all seven steps described in chapter 1. Costing should include tax recovery, debt payment, and contingencies.

Many municipalities are not aware of the norms or criteria for providing SWM service and find working out the costs difficult. The following elements can serve

as yardsticks to help municipal authorities work out what funds are needed to provide efficient service.

Door-to-Door Collection

On the basis of population and the number of households, shops, and establishments in a city, a ULB can easily determine the personnel, tools, and equipment needed to service the city on a day-to-day basis. For example, in the cities of Ahmedabad and North Dum Dum, one part-time sanitation worker services, on average, 200 houses or shops in four hours. Using an average household size of five people, the part-time worker serves a population of 1,000 each day (Ahmedabad Municipal Corporation 2006; North Dum Dum Municipality, West Bengal 2006). Experience in several cities where door-to-door collection has been successfully implemented shows that the same yardstick can be recommended for all cities irrespective of their population. The work distribution could vary with the density of population as explained in chapter 4.

The sanitation worker for door-to-door waste collection should, if possible, be contracted by a resident welfare association, local association, or NGO or by the private sector, thereby relieving the municipal authority of employment liability. The wages of part-time sanitation workers and supervisors can be calculated using the Minimum Wages Act, which will reduce the cost by at least 50 percent compared with the cost the municipal authority would have incurred by making appointments that were based on its normal wages. The minimum wage in 2005 and 2006 was between Rs 80 and Rs 100 per day, whereas a regular employee in municipal services earned between Rs 150 and Rs 200 per day. The city of Hyderabad, for example, pays more than Rs 6,000 per month to a full-time sanitation worker. The part-time cost would thus be Rs 3,000 per month, but under the Minimum Wages Act, the worker would be entitled to about Rs 1,800 per month for part-time work without any additional liability for pensions, provident fund contributions, uniforms, and so forth. Under this arrangement, the municipal authority stands to save more than 50 percent in wages as well as future liabilities. Municipal authorities should keep a track of changes to the minimum wage and revise the rates accordingly to comply with the provisions of Minimum Wages Act.

Each sanitation worker needs a containerized handcart or containerized tricycle for door-to-door collection of waste, or a grant to acquire one. The handcart or tricycle has a useful life of three to five years. The cost of handcarts or tricycles may be computed as follows at 2006 prevailing market rates:

- Handcart: Rs 5,000 to Rs 7,000
- Tricycle: Rs 8,000 to Rs 12,000 (including containers)
- Annual replacement cost of containers: Rs 1,000 to Rs 1,500 per handcart or tricycle

One part-time supervisor per 25 sanitation workers may be necessary to ensure efficient service delivery (Ministry of Urban Development and Poverty Alleviation 2000). A part-time supervisor may cost Rs 3,500 to Rs 4,500 per month as of 2007.

Street Sweeping

Street sweeping is generally done by the municipal authority, although in some cases it is privatized, such as in parts of cities like Hyderabad, Rajkot, and Surat.

Yardsticks for measuring street sweeping vary from municipality to municipality and from state to state. They include allotment on the basis of population (for example, 2 to 4 sweepers per 1,000 population) and allotment on the basis of area (for example, 1 sweeper per 500 meters to 1 kilometer of road length).

A uniform standard needs to be agreed on and followed to ensure adequate output from sanitation workers and to prevent their exploitation. The *Manual on Solid Waste Management* (Ministry of Urban Development and Poverty Alleviation 2000) recommends that one person be deployed for street sweeping according to the following standards:

- High-density area: 300 to 350 meters of road length
- Medium-density area: 500 to 600 meters of road length
- Low-density area: 650 to 750 meters of road length

This standard should be followed. Any shortfall may be made up by outsourcing of part-time workers for four hours through a contracting mechanism involving NGOs or the private sector. This mechanism will again save the municipal authority at least 50 percent of the cost.

The street sweepers must also be given individual containerized handcarts or tricycles, as may be convenient, and equipment cost should be taken into account according to the previous indications.

Secondary Storage

Secondary storage can be handled by providing metallic containers of 3.0 to 7.5 cubic meters at four containers per square kilometer of city area or one container per 5,000 to 7,500 population. These containers ensure that sanitation workers do not have to walk a distance exceeding 250 meters. That distance can be doubled or more where tricycles are used exclusively, as recommended in the *Manual on Solid Waste Management* (Ministry of Urban Development and Poverty Alleviation 2000), the expert committee of the Supreme Court (Supreme Court 1999), and World Bank observations in other urban areas.

Procurement of containers could be planned on the basis of the yardstick given. A minimum 150 percent storage capacity should be created to avoid overflow of any container before its scheduled time of lifting.

A pair of containers can be kept at each site to ensure segregated storage of organic matter collected from households and sweepings collected by street sweepers. The container for domestic waste could be green, and the one meant for street sweepings black. The cost of containers will depend on the weight of the steel used. Normally a container of 3.0 cubic meters will cost Rs 19,000 to Rs 20,000 and one of 7.5 cubic meters will cost approximately Rs 45,000 (Ahmedabad Municipal Corporation 2006).

Transport

For transport of waste, municipal authorities need to decide the type of vehicles to be procured and the system of transportation to be adopted. If they use a containerized system, the vehicles needed may be calculated according to the number of containers that will become full each day and the number of containers each container-lifting device will be able to take to the transfer station, treatment plant,

or disposal site. Normally, one vehicle will be able to lift seven or eight containers if the distances to be traveled are within 5 kilometers. The number of trips may be reduced to five or six if the distance is between 5 and 10 kilometers, and it may be further reduced depending on the distance to be traveled. In addition, 25 to 30 percent additional spare vehicles will be needed to maintain reliability of service during breakdowns and during preventive maintenance of vehicles. The vehicles should, if possible, be used in two shifts to ensure optimum use of investment made.

Small towns can use tractors with container-lifting devices. They can use containers of up to 4 cubic meters of capacity, which will make optimum use of the tractors. A tractor with a container-lifting device costs about Rs 525,000, and the 4 cubic meter container will cost about Rs 35,000. Large cities can use dumper placers, which may cost Rs 850,000 mounted on a light commercial vehicle or Rs 1 million mounted on a heavy commercial vehicle.

Although cities such as Bangalore, Chennai, and Namakkal are pursuing the strategy of direct transfer of waste from tricycles or handcarts into the transport vehicle, thereby eliminating the need to place containers for secondary storage in various parts of the city, the need for vehicles will increase. In such cases, the vehicles required must be calculated on the basis of the number of spots the vehicle can cover to pick up waste directly from the waste collectors. Costs of some vehicles and equipment are listed in table 2.1.

Processing of Waste

Privatization of the waste processing system should be considered to eliminate any financial burden on the municipal authority. However, if the municipality needs to finance the system, it should obtain cost estimates prepared by experienced mechanical engineers. The rule of thumb cost estimates shown in table 2.2 are given

Table 2.1 Vehicle and Equipment Costs, 2006

Equipment or vehicle	*Approximate cost per unit*[a]
3.0 cubic meter garbage container	Rs 20,000
Twin-container dumper placer	Rs 8.5 lakhs[b] on light commercial vehicle Rs 10 lakhs on heavy commercial vehicle
Tractor with lifting device	Rs 3.75 lakhs plus Rs 1.5 lakhs (Rs 5.25 lakhs)
1.1 cubic meter garbage container:	
Galvanized	Rs 19,000
Mild steel	Rs 9,000
14 cubic meter refuse collector	Rs 18 lakhs to Rs 19 lakhs with chassis
2 cubic meter ride-on road sweeper	Rs 15 lakhs
Truck-mounted road sweeper	Rs 30 lakhs to Rs 45 lakhs
Tractor-attached road sweeper	Rs 11 lakhs without tractor
Large hauling vehicle:	
30 cubic meter capacity with truck	Rs 20 lakhs
20 cubic meter capacity with truck	Rs 14 lakhs

Source: Based on cost estimates of the central workshop of the Ahmedabad Municipal Corporation.
a. Exchange rate in November 2006: US$1 = 45 rupees (Rs).
b. 1 lakh equals 100,000 Rs.

by Karnataka Compost Development Corporation, a well-established government of Karnataka undertaking at Bangalore, has developed some general rules for cost estimates (table 2.2). If the ULB is to make the investment, it should insist on revenue sharing with the private operator of the facility.

Table 2.2 Cost Estimates for Establishing a Composting Plant, 2005–06

	Population[a]		
Infrastructure required	*Under 50,000*[b]	*Up to 100,000*	*Up to 200,000*
Disposal site, including landfill area (acres)[c]	20 + 15	25 + 20	30 + 25
Compound wall or barbed-wire fencing	Cost depends on materials used.		
Internal and peripheral roads	Rs 2.00 lakhs[d]	Rs 3.00 lakhs	Rs 5.00 lakhs
Green belt along the boundary	Rs 0.50 lakhs	Rs 0.75 lakhs	Rs 1.50 lakhs
Weigh bridge	Rs 5.00 lakhs	Rs 5.00 lakhs	Rs 7.50 lakhs
Control room as office and laboratory	Rs 3.00 lakhs	Rs 4.00 lakhs	Rs 5.00 lakhs
Concrete yard with drains:			
Area (cubic meters)	6,000	12,000	18,000
Cost	Rs 45.00 lakhs	Rs 80.00 lakhs	Rs 120.00 lakhs
Shed for processing machinery with space for storing and bagging	Rs 15.00 lakhs	Rs 25.00 lakhs	Rs 40.00 lakhs
Processing machinery (such as rotary screens with conveyor belts)	Rs 30.00 lakhs	Rs 50.00 lakhs	Rs 80.00 lakhs
Processing equipment	Rs 10.00 lakhs (1 tractor with accessories)	Rs 25.00 lakhs (1 medium payloader and 1 tractor with accessories)	Rs 65.00 lakhs (1 heavy-duty payloader, 2 medium payloaders, and 1 tipper)
Vehicle shed	Rs 0.50 lakh	Rs 0.50 lakh	Rs 1.00 lakh
Leachate tank			
Capacity (liters)	20,000	35,000	50,000
Cost	Rs 0.50 lakh	Rs 1.00 lakh	Rs 2.00 lakhs
Water supply (excluding bore well cost) and lighting	Rs 1.00 lakh	Rs 1.50 lakhs	Rs 2.00 lakhs
Generator with panel board			
Capacity (horsepower)	25	50	100
Cost	Rs 6.00 lakhs	Rs 7.50 lakhs	Rs 8.50 lakhs
Total	Rs 118 lakhs	Rs 203.25 lakhs	Rs 337.5 lakhs

Source: Karnataka Compost Development Corporation 2006.

Note: The estimates given are for treating unsegregated municipal solid waste. A reduction can be expected up to 30 to 40 percent if the waste is segregated.

a. Although 25 tons per day of waste is expected to be generated for a population of 50,000, provision is made to treat garbage up to 50 tons per day (that is, up to 100,000 population). Similarly, for a population up to 100,000 and 200,000, provision is made to treat up to 100 tons per day and 200 tons per day, respectively.

b. Vermicomposting is recommended for towns having a population under 50,000.

c. Value of site is not included.

d. 1 lakh equals 100,000 rupees.

Disposal of Waste

An engineered landfill is now a must for all municipal authorities, and they need to invest in one either by participating in a regional facility or by involving the private sector to set up the facility and paying tipping fees for the disposal of waste as may be mutually agreed on.

The cost of a large engineered landfill works out to be in a range of Rs 100 to Rs 150 per cubic meter of waste deposited (box 2.1). This figure includes the cost of construction of an engineered landfill cell, which may last for five to seven years, the weigh bridge, office accommodation at the landfill, and the like.

The cost of small landfills, however, could be higher, because they lack the economies of scale. A rule-of-thumb cost estimate has been worked out for various sizes of cities and can be referenced by municipal authorities when considering allocation of funds.

To economize in construction as well as operation and maintenance (O&M) of the landfill, each municipal authority should plan for a regional landfill facility. The unit cost of a landfill varies substantially between small and large sites, and O&M cost becomes very high in case of small landfills and decreases dramatically when a large quantity of waste is handled at a regional facility. The cost varies between Rs 200 and Rs 1,100 per metric ton for O&M of the landfill, depending on the size of the site. Hence, a regional large-scale facility is most cost-effective (Solid Waste Management Cell, All India Institute of Local Self-Government 2004). See chapter 5 for further details.

Strategies to Minimize the Cost of SWM Service

Having established the cost of service, the municipal authority needs to adopt a strategy for minimizing the cost. Looking at the efficiency of service and its cost-effectiveness is the first step. Wherever the services are inefficient and cost is higher than expected, municipalities need to consider whether the private sector or NGOs could provide the service more cost-effectively.

Redeploy Surplus Staff Members

Many municipalities have surplus staff members, and output is very low. They need to redeploy the surplus staff members according to the yardstick previously provided to reduce the cost of SWM service.

Involve Private Sector

The municipal authority, to the extent possible, can explore the possibilities of community, NGO, or private sector participation for reducing the cost of service.

Box 2.1 The Surat Landfill

The Surat landfill cost Rs 105 per cubic metric ton for the construction of the cell alone, whereas in Ahmedabad the total cost of the cell, including weigh bridge, office accommodation, and so on, is expected to be about Rs 150 per cubic metric ton. This cost may be kept in mind as an indicative figure for an engineered landfill with a cell capacity of 100,000 cubic meters.

Source: Officials from the Surat Municipal Corporation and Ahmedabad Urban Development Authority.

Table 2.3 Example of Cost Savings

City	*Number of contracts*	*Cost savings (%)*
Hyderabad	161	65
Bangalore	61	50

Source: Asnani 2006.

Experience has shown that a 50 percent cost saving takes place when service is appropriately privatized (table 2.3). Nevertheless, improper contracting schemes without proper monitoring and enforcement mechanisms can be prejudicial for the system (for more information about privatization and contracting mechanisms, see chapter 3).

Raising Financial Resources for SWM

Levy SWM Tax

The municipal authorities need to seriously consider introducing a sanitation or SWM tax to meet the cost of service. A small amount of tax linked with property tax can be levied for SWM service to meet capital costs. See box 2.2 for a case study.

Box 2.2 SWM Tax in the United Kingdom

In the United Kingdom, waste management is financed through the council tax, which is raised by local authorities to pay for local services, such as providing police and security, providing support to the elderly and vulnerable, maintaining parks and open spaces, cleaning streets, and collecting and disposing of waste. The tax is based on the property value and is set in an amount to cover the budgeted expenses for the year. Waste management authorities also receive money from a central grant. Waste collection authorities do not receive any financial compensation from the Packaging Waste Recovery Notes system.

The introduction of direct user charges is obstructed by the Environmental Protection Act 1990, which states that "no charges shall be made for the collection of household waste" that is the responsibility of local waste collection authorities. But the collection authority may specify "the kind and number of receptacles" in which the residents store the waste for collection. Accordingly, it is becoming common to charge for the waste amount that exceeds the volume of the storage receptacle and lies next to the bin.

Because by law waste reduction and enhanced recycling cannot be encouraged by financial incentives, different alternatives have been put into practice:

- Revenues for materials generated from recyclables brought to civic amenity sites can be channeled back into the community for various projects.
- Residents who do not use the recycling facilities provided by local authorities can be fined.
- Waste authorities can assign credits to the waste collection authorities if they have diverted recyclables from the waste stream. Similarly, the waste collection authorities can assign such credits to third parties (waste generators or recycling initiatives), which have helped them divert recyclables from the waste stream, thus reducing waste collection costs.

Source: Becker 2007.

Box 2.3 User Fees and Polluter-Pays Principle in Switzerland

The Swiss environmental protection law stipulates that the producers of waste should bear the cost of solid waste disposal. In 2003, 70 percent of the Swiss population paid for waste collection and disposal following the polluter-pays principle. Because the provinces are autonomous in setting the tariff, many different models are used:

- Unit-based pricing system charging for each bag
- Unit-based pricing system charging for each bag in combination with a flat fee
- Weight-based system in combination with the bag-based system

This pay-per-bag scheme applies to residual waste designated for incineration. Waste bags for this residual waste can be purchased at large retail stores and are available in different sizes (for example, 17, 35, 60, and 110 liters in Zurich). The prices vary according to bag size (for Zurich they are €0.60, €1.20, €2.06, and €3.80, respectively, which translates into a unit price of about €0.035 per liter). Only these waste bags are picked up at the curbside on a fixed weekday. To cover infrastructure cost, local authorities can also levy a flat fee using one of the following bases:

- Per adult with residency in the particular community
- Per dwelling, whether a house or an apartment
- Per electricity meter (in general, every house or apartment has its own meter)
- Per dwelling, but charging different fees for a house or an apartment
- Per dwelling, but charging a lower fee for a single person and a higher fee for multiperson households (two or more adults)
- Per dwelling, but charging a lower fee for dwellings with up to two and one-half bedrooms and a higher fee for dwellings with three bedrooms or more
- According to the number of bedrooms in a dwelling

The charge is adapted by local authorities according to the level of expenses that should be covered by it.

Flat fee charges are usually collected once a year with a bill sent by the local authority. If the charge is levied per capita, the bill can be included in the yearly tax bill. When the determining unit is the electric meter, the charge is usually collected by the local utility provider (electricity and water) through the yearly or quarterly electricity bill.

The flat fee does not take into account the ability to pay or the income level of fee payers when charging per person or per room. If one assumes that higher-income households are more likely to live in houses or larger apartments, fees that differentiate between type and number of rooms in dwelling have a very crude equitable component. The fee structure privileges households with children, because only adults count.

Similar to the property tax and contrary to the polluter-pays charge, the flat charge is less susceptible to illegal dumping, but it also does not encourage environmentally friendly changes in waste generation, handling, or behavior.

An extensive recycling system enables households to reduce the waste amount disposed of in official waste bags. The recycling system is financed through the following:

- An advance recycling contribution, which is a voluntary contribution on every recyclable unit made by the producers to organizations that organize the collection and recycling (applied for bottles, aluminum cans and packaging, and steel and tin cans)
- An "advance disposal fee" that the producer is legally required to pay on glass packaging and batteries and that is included in the retail price
- Taxes or a flat fee component of a two-tier unit-based pricing system (applied for metals, paper, and cardboard)
- Revenues from sales of recyclable materials (applied for textiles)

The recyclable materials may be picked up at the curbside, brought to containers at a community collection point, or returned to collection points at retail markets.

Source: Becker 2007.

Levy User Fees

User charges can be an equitable means of funding SWM services if properly administered. They are an excellent means of cost recovery. User charges may be used as an incentive to reduce waste generation and encourage recycling, so that those who pollute more pay more (the *polluter pays principle*) (see box 2.3). Increased public awareness of solid waste issues and public involvement in the decision-making process may provide the opportunity to adjust user charges to reflect real costs of providing solid waste services.

It is essential that citizens know the cost of service and be motivated to share the cost in the form of user fees or user charges to sustain the service. Initially, a small charge can be levied to meet the O&M cost of primary collection of waste from the doorstep. If good-quality service is provided regularly, people will be willing to pay the user fees without much hesitation. Monthly user fee rates can be prescribed for various categories of waste generators, such as poor households, wealthier households, shops and offices, and large commercial establishments. Different rates can be prescribed for the generators as well as the amount to be directly recovered by the service provider.

In the SWM strategy in Kerala, rates of Rs 30 per month for households and Rs 50 to Rs 75 per month for shops and establishments were fixed. These rates would meet the entire cost of O&M for collection, transport, and disposal of waste if appropriate collection of user charges could be achieved. Similar rates prevail in other cities, varying with the socioeconomic profiles within the cities. See table 2.4 for some examples of user charges.

Revenue from Recovery and Treatment of Waste

Waste recycling, composting, and waste-to-energy operations may generate operating revenues or at least reduce the cost of waste treatment. Such programs provide direct paybacks in terms of tangible financial benefits associated with recovered materials and conserved energy as well as additional benefits from the avoided costs of landfilling. Furthermore, these programs help increase the life span of the landfill facility.

Private Sector Financing for Waste Treatment and Recovery

Because municipal authorities lack sound financial health, the private sector is being invited to invest in waste treatment. The role of the private sector in financing resource recovery (composting, waste-to-energy) facilities is growing in India. Many composting facilities as well as two large power plants have been set up in

Table 2.4 Examples of User Charges

City or state	*Monthly user fee*
North Dum Dum	Rs 10 per household
New Barrackpore	Rs 5 per household
Gandhinagar	Rs 15 to Rs 25 per household
Shimla	Rs 35 to Rs 225 per household or shop
Kerala state (Kudumbshree scheme)	Rs 30 per household

Source: Asnani 2006.

the country with private sector involvement. Although private sector funding is a potential source, it is feasible only if potential profit exists.

Need of Financial Support from Higher Tiers of Government

The income and expenditure profile of ULBs clearly indicates that the requirement of funds for SWM cannot be met fully by internal resources. ULBs need substantial financial support from the government of India and state governments, without which modernization of SWM practices will remain only a dream.

The 12th Finance Commission Grants and JNNURM Fund. Municipal authorities can access the funds made available under the 12th Finance Commission grants to all the states and JNNURM funds made available to 63 selected megacities, state capitals, and a few historical cities. Other cities can access the fund under the UIDS & MT scheme of the government of India.

The government of India has already earmarked Rs 2,500 crores[2] (more than US$650 million) exclusively for SWM. The funds have been allotted to various states. The government has also earmarked Rs 100,000 crores (approximately US$20 billion) over a period of seven years for development of urban infrastructure in 63 cities under JNNURM schemes. In addition, the government of India has allocated funds under UIDS & MT schemes for small towns. The 12th Finance Commission has allotted Rs 5,000 crores (approximately US$1 billion) for supplementing the resources of the ULBs for improving urban infrastructure. The funds allocated under the 12th Finance Commission scheme are a 100 percent grant; those under JNNURM have a grant component of 37 to 80 percent, and the grant component under UIDS & MT is 70 percent or more. Details of allocations by state under the 12th Finance Commission are shown in table 2.5.

Of the amount of Rs 5,000 crores allotted by the 12th Finance Commission for 423 class I cities, the government of India has earmarked 50 percent for improving SWM services (Rs 2,500 crores)—the first time it has made a sizable allocation for improving SWM. This amount is to be spent in five years, between 2005 and 2010. The government of India has also created an urban renewal fund from which funds will be available to states for improving their SWM. If the state governments and ULBs come forward with matching funds, they should be able to address the most difficult problems of SWM in urban areas effectively.

Megacity Scheme. The centrally sponsored Scheme of Infrastructure Development in Megacities has been in operation from 1993/94. The scheme applies to Mumbai, Calcutta, Chennai, Bangalore, Hyderabad, and Ahmedabad. The primary objective of the scheme is to undertake infrastructure development projects of citywide significance covering components such as water, sewerage, and roads, including SWM.

The central and state governments share funding, with each contributing 25 percent. The other 50 percent is to be met by institutional financing and market funds. Funds flow from the central and state governments to the nodal agency as a grant. However, the amounts flowing from the nodal agency to the implementing agencies for projects are a mix of loans and grants such that 75 percent of the central and state shares are recovered into a revolving fund at the level of the Megacity Scheme nodal agency. The objective is to create and maintain a special fund for the development of infrastructure assets on a sustained basis.

Table 2.5 Allocation of Funds under the 12th Finance Commission

	Panchayats		*Municipalities*	
State	*Percent*	*Rs crore*	*Percent*	*Rs crore*
Andhra Pradesh	7.935	1,587	7.480	374
Arunachal Pradesh	0.340	68	0.060	3
Assam	2.630	526	1.100	55
Bihar	8.120	1,624	2.840	142
Chandigarh	3.075	615	1.760	88
Goa	0.090	18	0.240	12
Gujarat	4.655	931	8.280	414
Haryana	1.940	388	1.820	91
Himachal Pradesh	0.735	147	0.160	8
Jammu and Kashmir	1.405	281	0.760	38
Jharkhand	2.410	482	1.960	98
Karnataka	4.440	888	6.460	323
Kerala	4.925	985	2.980	149
Madhya Pradesh	8.315	1,663	7.220	361
Maharashtra	9.915	1,983	15.820	791
Manipur	0.230	46	0.180	9
Meghalaya	0.250	50	0.160	8
Mizoram	0.100	20	0.200	10
Nagaland	0.200	40	0.120	6
Orissa	4.015	803	2.080	104
Punjab	1.620	324	3.420	171
Rajasthan	6.150	1,230	4.400	220
Sikkim	0.065	13	0.020	1
Tamil Nadu	4.350	870	11.440	572
Tripura	0.285	57	0.160	8
Uttar Pradesh	14.640	2,928	10.340	517
Uttranchhal	0.810	162	0.680	34
West Bengal	6.355	1,271	7.860	393
Total	100.000	20,000	100.000	5,000

Source: Authors.
Note: 1 crore equals Rs 10 million.

Government of India Subsidy for Compost Plant and Waste-to-Energy Projects. The Ministry of Agriculture (MOA) and the Ministry of Environment and Forests (MOEF) have been actively promoting waste composting, while the Ministry of New and Renewable Energy has designed schemes to promote waste-to-energy projects. Furthermore, the MOEF sanctioned a project to the Central Road Research Institute for conducting research for effective use of municipal solid waste in road construction.

Ongoing Government of India Schemes to Promote Municipal Solid Waste Composting. The MOA and the MOEF have two separate schemes to promote municipal solid waste composting. Both schemes provide only subsidies and do not follow through on implementation and performance monitoring. As a result, the effect of these schemes is not known at the central government level.

The MOA introduced a centrally sponsored plan for balanced and integrated use of fertilizers in 1992 (Eighth Five-Year Plan, 1992–97), under which support is given to local bodies and the private sector (included recently) for setting up composting

plants for converting municipal solid waste into compost. This grant is available for up to one-third of the project's cost, subject to a maximum of Rs 5 million per project. The grant is provided for buildings, plant, and machinery only. The allowable treatment capacity of the plant is 50 to 100 tons per day. According to the MOA, 38 projects were taken up under this scheme. The total central assistance proposed during the Ninth Five-Year Plan (1997–2002) procedure for release of central grants through state governments was Rs 180 million, and the budget provision during 2002/03 was Rs 50 million. Very little is allocated from these grants.

The MOEF provides financial subsidies of up to 50 percent of the capital costs to set up pilot demonstration plants on municipal solid waste composting. The ministry also extends limited financial assistance for waste characterization and feasibility studies. The scheme was first introduced in 1992. Subsequently the MOEF had sanctioned three pilot projects for qualitative and quantitative assessment of the solid waste in the cities of Hyderabad, Shimla, and Ghaziabad.

Recently, a few more demonstration projects have been sanctioned, and they are being implemented in North Dum Dum and New Barrackpore municipalities in West Bengal, Chandigarh, Kozikode in Kerala, and Udumalpet in Tamil Nadu. Three more projects in Kohima, Suryapet, and Mandi are also likely to be sanctioned shortly.

Support from the Central Government for Waste-to-Energy Projects. The national program on energy recovery from urban and industrial waste was launched by the Ministry of Non-Conventional Energy Sources during 1995, with the approval of the Commission for Additional Sources of Energy. Recently, the Ministry of New and Renewable Energy has announced an accelerated program on energy recovery from urban waste during 2005/06, which will provide financial assistance for setting up projects for recovery of energy from urban waste (see the incentives described in table 2.6). The financial assistance for any single project is limited to Rs 80 million.

Financial assistance of 20 percent higher than those specified for various categories of projects will be provided for projects in the North Eastern Region and

Table 2.6 Incentives under the National Program on Energy Recovery

Program	*Incentive*
Project for power generation from municipal solid waste involving refuse-derived fuel	Rs 1.5 crores per megawatt
Power project based on high-rate biomethanation technology	Rs 2 crores per megawatt
Demonstration project for power generation from municipal solid waste based on gasification-pyrolysis and plasma arc technology	Rs 3 crores per megawatt
Biomethanation technology for power generation from cattle dung, vegetable market waste, and slaughterhouse waste above 250 kilowatt capacity	50% of project cost; maximum of Rs 3 crores per megawatt
Biogas generation for thermal application	Up to Rs 1 crore per megawatt equivalent
Project development assistance	Up to Rs 10 lakhs per project
Training course, seminar, workshop	Rs 3 lakhs per event

Source: Authors.
Note: 1 lakh equals 100,000 rupees; 1 crore equals Rs 10 million.

special-category states: Himachal Pradesh, Jammu and Kashmir, Sikkim, and Uttranchhal. The Supreme Court of India has, however, ordered the government of India not to sanction any subsidies for projects based on municipal solid waste until further decree of the Supreme Court. Therefore, government of India subsidies for waste-to-energy projects are on hold at the moment.

Support from State Governments. Some state governments—Uttar Pradesh, Madhya Pradesh, Tamil Nadu, Andhra Pradesh, Maharashtra, Haryana, Karnataka, Gujarat, and Rajasthan—have announced policy measures pertaining to allotment of land; supply of garbage; and facilities for evacuation, sale, and purchase of power to encourage the setting up of waste-to-energy projects. Land for the facilities is provided by the ULB at a nominal rent. The tariff for power purchase generally agreed upon according to the general guidelines issued by the Ministry of Non-Conventional Energy Sources is left to regulatory authority. However, in the wake of deregulation of the power sector and in the absence of clear policy directions, delays often occur in finalization of actual contract terms with the entrepreneur, especially with regard to the power tariff.

Incentives for SWM Infrastructure Financing

In addition to financial and technical support from central and state governments, the following incentives are available for financing solid waste infrastructure in urban areas.

Tax Exemption of Certain Bonds Issued by Local Authorities. According to section 10(15) of the Income Tax Act, in recognition of the need for mobilizing resources for urban infrastructure projects, the central government has accorded a tax-free status to the interest on certain bonds issued by local authorities each year. These bonds are specified by notice in the *Official Gazette*.

Tax Holiday for the Project Entity for Solid Waste Management. As announced in the Union Budget 2001/02, an undertaking or enterprise that is engaged in SWM projects is allowed a deduction under section 80IA of the act of profits and gains related to such projects. The deduction equals 100 percent of such profits for 10 consecutive assessment years in the first 20 years of the project.

To qualify for tax holiday under this provision, the enterprise must satisfy the following conditions:

- A company or a consortium of companies registered in India owns the enterprise carrying on the infrastructure business, including solid waste management.
- The enterprise has entered into an agreement for developing, maintaining, and operating an infrastructure facility.
- The agreement is with one of the following: the central government, the state government, the local authority, any other statutory body, or such other entity or body as may be notified to the central government.
- The infrastructure facility shall be transferred to the government or local authority within a period stipulated in the agreement.
- The enterprise starts operating and maintaining the infrastructure facility on or after April 1, 1995.

Tax Exemption for Income of Infrastructure Capital Funds and Companies. Section 10(23G) of the Income Tax Act provides that any income of an infrastructure capital fund or an infrastructure capital company that takes the form of interest, most types of dividends, and long-term capital gains is not included in the calculation of total income for tax purposes. The income must derive from an investment made by way of equity or long-term finance in an approved enterprise that is wholly engaged in the business of (a) developing; (b) maintaining and operating; or (c) developing, maintaining, and operating an infrastructure facility.

Moreover, to provide impetus for infrastructure development, the scope of the term *infrastructure facility*, as defined in subsection (12) of section 80IA, has been enlarged to include solid waste management and water treatment. As a consequence, income derived by an infrastructure capital fund or infrastructure capital company from investments in any enterprise wholly engaged in the development of these infrastructure facilities would be exempt from tax. However, this income is subject to presumptive tax under section 115JB on book profit.

Furthermore, the criteria for companies that can take advantage of the benefits under section 10(23G) of the Income Tax Act has been broadened from those maintaining, operating, and developing (that is, all activities were to be performed by one company) to allow those companies to be doing any of the following: developing, operating, maintaining, and providing long-term funds and project development support.

Inclusion as Eligible Investments of Charitable Funds. Section 11(5)(ix) of the Income Tax Act provides for inclusion as eligible investments of charitable funds (a) any deposits with a public company or (b) any investments in any bonds issued by such a company, provided that the company was formed or registered in India with an objective of carrying on a business of providing long-term finance for urban infrastructure. This provision enables sponsors of urban infrastructure projects to have access to investable surpluses of charitable trust funds.

Availability of Funds by Sale of Carbon Credits. Greenhouse gas (GHG) emissions are causing climate change. Major initiatives have, therefore, been taken internationally to mitigate GHG emissions. The Rio Earth Summit of 1992 focused attention on this issue, and it was further strengthened at Kyoto in 1997, where the nations of the world agreed that industrial countries would reduce their aggregate emissions to 5.2 percent below 1990 levels between 2008 and 2012. Because reduction of emissions levels necessitates that industrial nations incur huge expenditures, they are allowed to reduce emissions in any part of the world and use carbon credits to count toward their effort to reduce GHG emissions globally. Three mechanisms are available to supplement national actions to achieve measurable and cost-effective GHG reduction:

- Clean development mechanism
- International emission trading
- Joint implementation

Under these mechanisms, cities can use waste treatment and disposal projects to take advantage of the carbon finance benefits by selling certified emis-

sions reduction credits at the prevailing market price to the industrial countries through a well-established mechanism involving consultants specializing in this matter. The government of India's MOEF has a nodal officer to handle these issues.

Anaerobic degradation in landfills generates biogas that contains nearly 50 percent methane, and 1 ton of methane is equivalent to 21 tons of carbon dioxide. Hence, capturing landfill gas can produce quite a good amount of certified emissions reduction credits for which municipal authorities can receive money. These funds can pay for the system's installation and the operations carried out. Smaller cities can pool resources and make a combined case for qualifying for carbon credits. The prevailing rates per ton of carbon equivalent are US$6 to US$9. The municipal authorities have only to establish that they have reduced the emission levels by appropriately managing the landfill, compost plant, or waste-to-energy plant.

Sectoral Lending by Financial Institutions. Municipal authorities can also take advantage of funding from financial institutions for SWM. Such institutions include the following:

- Housing and Urban Development Corporation
- Industrial Credit and Investment Corporation of India
- Infrastructure Development Finance Company
- Infrastructure Leasing and Financial Services
- National Bank for Agriculture and Rural Development
- Indian Renewable Energy Development Agency
- Industrial Development Bank of India
- Industrial Finance Corporation of India
- Commercial banks, suppliers, creditors, and private venture capital funds

Bilateral and Multilateral Donors. Even though there is no dedicated SWM program, technical assistance for such projects may be obtained under programs such as water and sanitation. A number of donor agencies provide support in related areas, such as microfinance, poverty, health, and energy-related programs.

Tax Financing. Traditionally, funding for solid waste systems comes from the general fund. Most ULBs use a percentage of property tax to support the SWM system. This tax is easy to administer because no separate billing or collection system is needed. The disadvantage, however, is that in most Indian cities, assessment and collection of property tax is poor, and this poor base provides very little income.

Carbon Finance

Carbon finance provides an opportunity for an extra source of revenue for SWM projects in developing countries. The main idea behind it is that industrial countries will pay for projects in developing countries that contribute to the reduction of GHG emissions. Therefore, carbon finance can be used with any technology that leads to the reduction or avoidance of carbon emissions. Given that solid

waste is a significant source of pollution—in particular emissions of methane gas by anaerobic degradation—carbon finance represents a good opportunity for solid waste projects in developing countries and gives incentives to operators to focus on good design and environmental awareness to obtain this source of revenue.

Countries that signed the Kyoto Protocol have committed to reducing their GHG emissions by certain targets. However, if countries maintain or increase emissions, they will have to engage in emissions trading. For this reason, the Kyoto Protocol created market mechanisms for emissions trading to help countries achieve their commitments on reducing GHG emissions. According to the European Union, an estimated annual 430 million tons of carbon dioxide must be reduced worldwide to meet the Kyoto Protocol's emission reduction targets. These mechanisms to trade emissions allow countries with excess emissions units to sell them to other countries that are unable to meet their commitments. Among the mechanisms created, the clean development mechanism (CDM) allows the creation of carbon funds through which governments and companies in rich countries contribute money to purchase project-based GHG emissions reductions in developing countries. Industrial countries pay for projects that cut or avoid emissions in poorer nations, and poorer nations benefit from revenues and advanced technology.[3]

See box 2.4 for some definitions.

Box 2.4 Basic "Carbon Finance" Concepts

Baseline: Carbon emissions associated with a given scenario without carbon finance. Typically, this is the "business as usual" case, or what can reasonably be expected as common practice in the country concerned.

Project: A clean development mechanism (CDM) project is one where the baseline scenario is compared with additional scenarios, including those with carbon finance, where additional revenues or lower risk from sale of carbon can make the project more attractive than the baseline. The lower emissions associated with a CDM project compared with baseline emissions without the carbon project give rise to emissions reductions.

Additionality: Emissions reductions are considered for "credits" if they can demonstrate their "additionality." According to the CDM Modalities of Marrakesh Accords, CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity.

Contract: An emissions reduction purchase agreement is signed between a carbon fund (for example, the World Bank Carbon Fund) and a private or public project entity for payment of a negotiated amount against delivery of an agreed number of emissions reduction tons before 2012. The World Bank is now signing contracts that extend through 2015, offering a lower price but assuming some of the risks of what will happen after 2012.

Monitoring and Independent Verification: All carbon projects must be independently verified by a third party. Carbon payments are made annually upon verification reports ("delivery" of carbon).

Sources: Capoor 2005; UNEP Finance Initiative Web site (http://www.unepfi.org); interviews with the World Bank's Carbon Assist Team.

Carbon Credits

Projects in developing countries that reduce emissions and contribute to the sustainable development of the country qualify under the CDM and can earn certified emission reductions (CERs). On the basis of the reductions of emissions achieved, projects will earn CERs that can be sold to the carbon fund. The price of CERs is a function of market demand and supply. For example, the 2006 price paid was, on average, US$7 per ton of carbon dioxide emission reduction or US$147 per ton of avoided methane. One ton of carbon dioxide equivalent is 1 ton of CER. Given that methane is a gas 21 times more potent as a GHG than carbon dioxide, 1 ton of avoided methane emissions is worth 21 tons of carbon dioxide equivalent, or 21 CERs.

The projects that certify their emissions reductions can obtain CERs and sell them to the carbon fund. According to CDM rules, project proponents can choose between two options for the crediting period to earn CERs:

- A 10-year crediting period, with no option of renewal
- A 7-year crediting period, with the option of two renewals

Projects can earn carbon credits up to a maximum of 21 years. Currently, carbon finance buys credits until 2012. Therefore, the sooner projects can be identified, the more years of revenue they can earn.

Solid Waste and Carbon Finance

Because municipal solid waste is a significant source of methane emissions, solid waste projects can take advantage of the carbon finance mechanism. As already mentioned, methane is a gas 21 times more potent as a GHG than carbon dioxide; it is produced when organic waste decomposes under anaerobic conditions. Landfills in particular are one of the greatest sources of methane emissions.

Projects that qualify for carbon credits not only bring the benefit of additional revenue to the project, but also contribute to increasing the life of the landfill, generating new sources of energy, creating additional jobs, and improving environmental conditions. In many cases, solid waste projects applying for carbon funds increase their internal rate of return by more than 5 percent.

To register under the CDM, the project has to meet the following criteria:

- The project leads to measurable reductions in GHG.
- It represents an additional activity, meaning that it does not represent the common practice or normal course of action.
- It contributes to the sustainable development of the country.

Additionally, the project needs to be approved by the designated national authority, and a Project Design Document must be developed, including a baseline methodology and a monitoring plan.[4] The transaction cost for registering a project ranges from US$50,000 to US$250,000, depending on project size and type. Registering a project takes approximately one to three years. Registration ends when an emission reduction purchase agreement is signed. The future of CDM after 2012 is unclear because no decisions have been made on what will happen after the first Kyoto Protocol commitment period (2008–12).

The following SWM projects can include carbon finance components to reduce methane emissions:

- Landfill gas recovery
- Composting
- Incineration and anaerobic digestion
- Recycling

Landfill Gas Recovery. Landfills produce gases created by the anaerobic degradation of organic materials. Instead of letting these gases pollute the environment, landfill operators can recover these gases, treat them, and use them as sources of energy. In many countries, environmental regulations already require landfill operators to recover and treat landfill gases to protect the environment. Recovering landfill gases produces many benefits, such as reducing odors from landfills, generating new jobs, and producing profits from the sale or use of energy. Moreover, for developing countries, carbon finance can provide additional revenues to landfill projects that recover landfill gases. See box 2.5 for a case study.

The amount of credits that can be earned from landfill gas recovery projects depends on several factors, such as amount of waste, organic fraction of the waste, landfill technology, moisture, age of landfill site, and efficiency of the landfill gas collection system. The approximate landfill gas potential is as follows:

- One million tons of waste "in place" generate 6 million cubic meters of landfill gas per year.
- In 1 cubic meter of landfill gas, there are about 357 grams of methane.
- Therefore, 1 million tons of waste generate about 2,140 tons of methane per year.
- Of the 2,140 tons of generated methane, 1,500 tons of methane can be recovered (assuming 70 percent collection efficiency) and destroyed.

Box 2.5 The Olavarría Landfill Gas Recovery Project

In 1999, the municipality of Olavarría in Argentina commissioned a sanitary landfill to dispose of the town's solid waste. Five years later, to help improve overall SWM practices and to address remaining environmental problems associated with waste disposal, such as odor and contamination of groundwater, the municipality embarked on a new project to recover the gases emitted by the landfill. These gases are among those that contribute to climate change and global warming.

The Olavarría Landfill Gas Recovery Project will capture and destroy the landfill gases through flaring. The resulting reductions in landfill gas emissions will be monitored, verified, certified, and sold as verified greenhouse gas emission reductions to the Community Development Carbon Fund. The fund has agreed to purchase a total of 131,000 tons of carbon dioxide emissions reductions equivalent. This partnership of four governments and 12 companies managed by the World Bank is designed to provide communities in developing countries—in particular, the least developed countries—with an opportunity to benefit from new investments in renewable energy and clean technology that aim at reducing greenhouse gas emissions and mitigating the effects of climate change while measurably improving the welfare of the communities involved.

Source: Project documents, World Bank.

- The 1,500 tons of methane destroyed translate into roughly 31,500 CERs per year.
- Assuming 1 ton of avoided methane pays US$147, the carbon fund will provide US$220,500 (US$147 times 1,500) a year for the project.

Composting. Composting projects can apply for carbon finance because these processes applied to solid waste reduce the production of methane by diverting high organic waste from being dumped at the landfills. By preventing organic waste from getting into the landfill, composting projects reduce landfill gas methane emissions, and this reduction can be claimed as emissions reductions and sold to the carbon fund. In developing countries, where a great part of the waste consists of organic substances, finding ways to treat organic waste is an attractive option for protecting the environment and increasing the life of landfills. Composting results in an economic and rapid solution that can be easily implemented and can result in carbon credits. See box 2.6 for a case study.

Incineration and Anaerobic Digestion. Incineration and anaerobic digestion are other methods that prevent the formation of methane by reducing the amount of waste disposed of in landfills. Incinerators and anaerobic digesters can also recover some of the energy to be used as electricity or heating. Although these technologies have many advantages and can be eligible for carbon finance, incineration and anaerobic digestion plants are capital intensive and require well-trained operators, resulting in an extremely expensive waste management option. In developing countries, this option should be carefully weighed against other less expensive options.

Recycling. Recycling programs also reduce the waste that ends up in landfills, thereby preventing the production of methane. Recycling not only reduces the need for a sanitary landfill but also recovers raw materials that can be used for production.

Box 2.6 Santiago: Composting for Better Waste Management

In Chile, well-received economic growth has also meant large increases in urban waste volumes. In metropolitan Santiago, the challenge is to develop a sustainable system to manage these increases. One solution is the development of the Santiago Composting Project, which will build and operate a composting facility to treat urban biodegradable waste and nontoxic wastewater sludge. The plant will use at least 20 percent of the organic waste generated in metropolitan Santiago, treating approximately 216,000 metric tons of waste per year that would otherwise be disposed of in a sanitary landfill. In addition to alleviating landfill pressures, this project generates revenues through the production of compost and through the sale of emissions reductions resulting from the project's mitigation of nearly 326,000 tons of carbon dioxide equivalents per year. The project is the first of its type in Latin America and demonstrates that thinking "outside the box" can lead to waste management that is not only sustainable but also profitable. As with many of the more innovative CDM projects, the project is requiring considerable time to develop an agreed-upon methodology and to obtain local environmental approvals.

Source: World Bank 2006.

Lessons Learned

A number of lessons can be learned from the discussion in this chapter:

- Municipal authorities need to increase their financial resources to meet their statutory obligations instead of solely depending on government grants.
- Before considering raising tax rates, municipal authorities should plug inefficiencies and leaks in their revenue collection and economize in costs by avoiding wasteful expenditures and postponing expenditures for nonessential items.
- Municipal authorities need to levy user fees to recover full or partial costs of SWM service, more particularly for the door-to-door collection of waste when that service is provided.
- Municipal authorities should consider involving the private sector in SWM services to provide efficient services cost-effectively.
- Municipal authorities need to clearly understand how much is spent for the various components of SWM services.
- Given the knowledge of expenditures by various components of SWM services, the next step is to develop and implement strategies to minimize the cost of SWM services.
- Various ways to raise financing exist, either by making use of user charges or funding opportunities from national or international programs.
- Many means for obtaining financial support exist under various government of India schemes.

Notes

1. These efforts could increase substantially the revenues of the municipal authorities without any increase in the rates or charges.
2. One crore equals Rs 10 million.
3. For more information, check United Nations Framework Convention on Climate Change at http://unfccc.int/.
4. For the Project Design Document database and more information on registering a project, go to http://cdm.unfccc.int/Projects/.

References and Suggested Readings

Ahmedabad Municipal Corporation. 2005–06. Contract documents prepared on the basis of market surveys. Ahmedabad, India.

———. 2006. *Model SWM System*. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests, Government of India.

Asnani, P. U. 2006. "Solid Waste Management." In *India Infrastructure Report 2006: Urban Infrastructure,* ed. Anupam Rastogi, 160–89. New Delhi: Oxford University Press. http://www.3inetwork.org/reports/IIR2006/Solid_Waste.pdf.

Becker, Birgit. 2007. "Covering Costs of Solid Waste and Faecal Sludge Management in Developing Countries: The Case of User-Fees as a Financing Mechanism." Department of Water and Sanitation in Developing Countries, Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland.

Capoor, Karan. 2005. "Carbon Finance and Infrastructure: Africa Region Experience." Presentation prepared for Urban Week, World Bank, Washington, DC, March 5.

CPCB (Central Pollution Control Board). 2000. "Status of Municipal Solid Waste Generation, Collection Treatment, and Disposal in Class-I Cities." CUPS/48/1999–2000, CPCB, Ministry of Environment and Forests, New Delhi.

Florida Department of Environmental Protection. 1997. *Municipal Solid Waste Management Full Cost Accounting Workbook for Local Governments in Florida*. Vienna, VA: TetraTech EM. http://www.dep.state.fl.us/waste/quick_topics/publications/shw/fca/fcawkbk.pdf.

Gujarat Urban Development Company. 2005–06. Projects prepared by the Gujarat Urban Development Company.

Infrastructure Development Finance Company. 2003. *Clean Development Mechanism Project Design Document: Municipal Solid Waste Treatment cum Energy Generation Project, Lucknow, India*. Submitted to Prototype Carbon Fund. Chennai, India. http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_415553625.

Karnataka Compost Development Corporation. 2006. "Cost Estimates for State of Gujarat." Karnataka Compost Development Corporation, Bangalore, India.

Lecocq, Franck, and Capoor, Karan. 2003. *State and Trends of the Carbon Market 2003*. Washington, DC: World Bank.

McMaster, James. 1991. *Urban Financial Management: A Training Manual*. Washington, DC: World Bank. http://www-wds.worldbank.org/external/default/WDS/ContentServer/WDSP/IB/2000/01/15/000178830_98101901474625/Rendered/PDF/multi_page.pdf.

Ministry of Urban Development and Poverty Alleviation. 2000. *Manual on Solid Waste Management*. New Delhi: Government of India Publications.

———. 2006. "Report of the Technology Advisory Group on Appropriate Technology, Research, and Development on SWM: Financial Aspects and Training and Capacity Building of Municipal Authorities." Ministry of Urban Development and Poverty Alleviation, New Delhi.

North Dum Dum Municipality, West Bengal. 2006. *North Dumdum Model Study*. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests, Government of India.

Sinha, Chandra Shekhar. 2003. "Carbon Finance at the World Bank." Workshop on Carbon Credits from Flare Reduction Activities, London, July 1. http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTOGMC/EXTGGFR/ 0,,contentMDK:20316443~menuPK:2859473~pagePK:64168445~piPK:64168309~theSitePK:578069,00.html.

Solid Waste Management Cell, All India Institute of Local Self-Government. 2004. "Action Plan for Implementation of MSW Rules 2000 in Maharashtra." All India Institute Local Self-Government, Mumbai.

Supreme Court. 1999. "Report of the Supreme Court Appointed Committee on Solid Waste Management in Class I Cities in India." Supreme Court of India, New Delhi.

USEPA (United States Environmental Protection Agency). 1997. *Full Cost Accounting for Municipal Solid Waste Management: A Handbook*. EPA 530-R-95-041. Washington, DC: USEPA. http://www.epa.gov/epaoswer/non-hw/muncpl/fullcost/docs/fca-hanb.pdf.

World Bank. 2004. "CDM Umbrella Guidelines for MSW in China." World Bank, Washington, DC.

———. 2006. "Santiago: Composting for Better Waste Management." *Carbon Copy* 2: 2. http://siteresources.worldbank.org/INTLACREGTOPURBDEV/Resources/CarbonCopyJuly2006.pdf.

World Bank Carbon Finance Unit. n.d. "Catalyzing Markets for Climate Protection and Sustainable Development." http://www.carbonfinance.org.

3

Private Sector Participation

Solid waste management (SWM) is a mandatory duty of all municipal authorities in the country. They spend a significant proportion of their total budget on it, yet service is very poorly performed, with treatment and disposal getting the least attention.

The many attempts to reform the public authorities in order to improve the reliability and efficiency of services have shown limited or no effect. The pathetic situation makes it necessary for the municipal authorities to seriously consider solutions that are "outside the box" to improve services. One option is to involve the private sector more extensively in providing services, with the municipal authority moving from being a service provider to being a regulator and service facilitator. Experience in many countries shows that, in certain circumstances, involving the private sector can significantly improve SWM service quality. Thus, private sector participation should be considered in India.

This chapter discusses the advantages and disadvantages of private sector participation, the various contract options available, and the key requirements for privatizing different services. It describes the process of project preparation, bid solicitation and evaluation, and award of contracts and provides guidelines for monitoring contracts for various SWM services. This chapter also includes national and international case studies and experiences with private sector involvement in SWM.

Reasons for Involving the Private Sector

According to India's constitution, SWM falls within the purview of the state government. The activities are local ones and are entrusted to urban local bodies (ULBs) through state legislation. Because these activities are nonexclusive, nonrival, and essential, the responsibility for providing them lies within the public domain. ULBs accordingly undertake the task of SWM service delivery.

However, many municipal authorities in India provide SWM services very inefficiently. Old and inappropriate vehicles and tools for collection, inadequate transport, and inefficient disposal not only cause unhygienic working conditions and slow down the process but also severely affect the environment. Productivity is very low, resulting in a high unit cost of service. Collection coverage rates are only 50 to 70 percent. The collected waste is disposed of at open dumping grounds within or outside cities, causing health hazards and environmental degradation.

The poor performance of municipal authorities led to the filing of public interest litigation in the Supreme Court of India. The Supreme Court constituted an expert committee to look into all aspects of SWM and directed all municipal authorities to follow the committee's recommendations. The Ministry of Environment and Forests

directed all municipal authorities in the country to take seven essential steps to provide SWM services in an efficient and environmentally acceptable manner. None of the 4,378 municipal authorities in the country has yet implemented all seven steps within the set time frame (see chapter 1).

This unsatisfactory situation makes it necessary for the municipal authorities to seriously consider new concepts and approaches for improving services. Private sector participation is an interesting option for boosting performance, whereby the municipal authorities change their role from service provider to regulator and service facilitator. Different forms of collaboration with the private sector can be envisaged, involving different types of agreements and preconditions of partnership. Enabling improvements through the participation of the private sector depends on the political will for change; clear agreements and contracts; the public authority's ability to regulate the service, monitor performance, and enforce the terms of agreement; financial capacities; and mutual trust between all partners.

Opportunities and Challenges in Private Sector Involvement

The overall objective of involving the private sector is to achieve an improvement in SWM service and to extend coverage to the yet unserved. Delegating tasks and responsibilities to the private sector, however, also entails new challenges for all. All critical factors must be taken into account to prevent misuse or failure of private sector participation. The advantages and disadvantages of involving the private sector strongly depend on the manner in which the tasks and service are contracted out and on the way the daily operational procedures of collaboration between public and private sector are handled and ensured.

Opportunities

Some examples of characteristics of the private sector that offer possible opportunities follow:

- Flexibility:
  - The private sector can easily hire qualified staff members and pay the salaries those experts demand.
  - Salaries and bonuses can be based on staff performance, thus also providing incentives for efficiency and good work.
  - Employment is easily terminated when performance is unsatisfactory.
  - More effective administration with fewer bureaucratic delays will result.
  - Responsibilities will be more clearly defined, with no interdepartmental overlaps and no cross-departmental coordination needs.
  - A faster and simpler decision-making process can be implemented.
- Increased efficiency:
  - New equipment or spare parts for equipment maintenance can be easily acquired.
  - The private sector has ready access to technology and expertise.
  - The private sector has easy access to financial resources for new investments.
  - Adapting technology to context and situation will be easier, thus increasing equipment performance.
  - Full cost accounting and incentives for the lowest possible unit cost can be implemented.

- Contestability:
  - Performance monitoring is necessary.
  - The focus should be on customer satisfaction.
  - The service provider must be accountable to the beneficiaries for services rendered.
  - Incentives for good performance and efficiency can be offered through competition.
  - Less political interference will occur with private sector involvement.

Challenges

Private sector participation in SWM can be a very attractive option. However, if certain conditions cannot be met, the partnership between the public and private entities may face severe risks. It is crucial that the following conditions and the risks they pose be carefully considered and steps taken to avoid them.

- No competition:
  - If not enough private sector companies are interested in providing the service, choice and performance incentives will be minimized.
  - Lack of sufficient capacities and skills to ensure satisfactory performance could reduce competition.
  - A very strong private sector and weak municipal capacities could result in an unbalanced partnership.
  - Long-term contracts with the private sector (creating a monopoly) could lead to loss of control by the municipality, which would eliminate one means of enforcing performance standards.
- Uncertain safety and social benefits for workers:
  - The private sector may not provide workers social security benefits, pensions, sick leave, social insurance, regular medical examinations, vaccinations, and so on.
  - The private sector may not ensure use of safety and protective equipment.
  - The private sector may pay wages for unskilled labor that are minimal or even below minimum wage.
- No financial mechanism to ensure timely, regular payment for services:
  - Municipal financial means may be inadequate to maintain regular payments to the private sector.
  - Municipal bureaucratic and administrative deficiencies may severely delay payments to the private sector, thus endangering cash flow and the sustainability of the service.
- Corruption:
  - Suspicion of corruption could discourage enterprises from bidding because they do not believe that the most competitive and competent bid will win the tender.
  - Lower standards of operation and service would prevail if monitoring inspectors were bribed.
  - Lack of transparency could result in lack of trust between the public (civil society), municipal officials, and the private sector.
- Unclear or unstable policy toward private sector participation:
  - Fear of reversal of policy and termination of contracts with political change could discourage private sector involvement.

Many of these risks can be avoided with improved tendering procedures and appropriate contracting and negotiations.

Legal Environment for Private Sector Participation

In India, labor laws protect the interests of workers and regulate the contracting of services. The Contract Labor (Regulation and Abolition) Act 1970 (CLA) provides that contracting out of services can be prohibited if the services are already provided departmentally by any municipal authority. Under section 10(1) of the CLA, the state government may prohibit the employment of contract labor in any process, operation, or work in any establishment (defined to include any office of department of a local authority). The municipal authorities therefore must take into account the provisions of this act and the Supreme Court's interpretation of it. A state government can prohibit activities such as street sweeping and garbage collection at the request of labor unions if the government is satisfied that the contract adversely affects the interests of existing labor. Therefore, municipal authorities should carefully consider the options for private sector participation.

If the ULB chooses to employ contract labor, it is still a principal employer, and the onus of carrying out the duties prescribed under the CLA rests with it. If service is delivered using private sector participation, the local body, as a principal employer, must ensure that the private firm meets its responsibilities under the CLA. It must also identify the private firm as a principal employer in the project document. The challenge is to integrate the services of the private sector and link them to the services provided by the public sector. For example, the state government of Tamil Nadu has exempted the Chennai Municipal Corporation from the purview of the CLA through Order 40 MS 99, dated July 8, 1999, allowing the municipal corporation to engage contract labor for sweeping and scavenging activities.

In the current legal situation, the municipal authorities may involve the private sector in the following SWM tasks:

- Door-to-door collection of waste, because municipal authorities do not provide this service
- Street sweeping in unserved areas, without disturbing or retrenching existing street sweepers
- Provision of large containers for secondary waste storage in various parts of the city
- Construction, operation, and maintenance of transfer stations
- Extension of coverage and increased transportation of waste without replacing existing workers
- Provision of the vehicle fleet and equipment for transporting waste
- Construction of treatment facilities (composting, waste-to-energy conversion, sanitary landfill, and so on)
- Operation and maintenance of treatment facilities

Private Sector Involvement in SWM

Many municipal authorities are not yet comfortable with private sector participation because they are unclear about their authority to engage in it. They have some doubts and some reservations about the benefits of private sector participation.

Steps toward Developing State Policy and Reviewing Legislation

Before preparations for involving the private sector start, it is advisable to review existing contract law and practice. In places where government has little experience entering into service contracts, a variety of unforeseen difficulties can arise. New arrangements and mechanisms may be needed. Some issues that should be considered follow:

- *Licensing.* If plans are developed to license enterprises to collect, transport, recycle, or dispose of waste, it may be necessary to add enabling clauses in legislation.
- *Special wastes.* Particular regulations may exist regarding the handling of special wastes (such as wastewater sludge, hazardous industrial waste, and hazardous medical waste). The definitions of such wastes in contracts should be the same as the definitions used in legislation.
- *Collection of fees.* Legislation must allow the fee collection method proposed for a SWM service. For example, legislation may need to be adjusted if fees are to be collected by the private sector service provider or in conjunction with another service (such as water supply or electricity).
- *Participation of small enterprises.* Contract requirements and laws are often designed for contracts with large companies and are not suited for small, labor-intensive tasks that small enterprises could carry out. If so, legislative revisions may be necessary.
- *Bonds.* Requirements for bonds may not be appropriate for certain types of contracts, and insistence on bank accounts, a certain tax status, and experience may also, for some purposes, be unnecessary barriers.
- *Restrictions on contract duration.* If regulations limit the length of contracts to periods that are unsuitable for waste management, they will need to be changed.
- *Cross-boundary arrangements.* For the sake of financial efficiency or environmental protection, or because of public opposition, it may be necessary to transport waste for disposal in a neighboring administrative area. In such cases, the law must contain provisions for honoring such agreements and for compensating the host region.
- *Taxes and customs duties.* Private enterprises that provide public services such as SWM may be given special tax privileges in order to encourage them to become involved in these and other public services.
- *Charges and social security payments.* Some contractors have been surprised by unexpected demands for payments. In one case, contractors learned, after starting service, that they were required to pay a significant stamp duty on checks they received and that they were also responsible for considerable social security payments, the magnitude of which was subject to negotiation and therefore apparently unpredictable. In some cases, the bidders were not aware of these costs during the tendering process and so did not make allowance for them when calculating their bid prices. A full investigation of the law related to such charges is therefore advisable during the preparation of the solicitation.
- *Transfer of vehicles and personnel.* Changes to legislation may be required to allow the local government to sell or lease its vehicles to a private enterprise and to enable it to change the status of government employees who will be transferred to contractors.

- *Labor laws.* SWM may be considered a permanent occupation (because it is not meeting a temporary need), so labor laws may oblige contractors to take on laborers as permanent employees.
- *Establishing monitoring and enforcement capacity.* Enabling legislation may be needed to allow local governments to establish an agency to monitor the performance of private sector service providers and to enforce fines or other sanctions.
- *Environmental standards.* Tender documents and contracts will need to refer to current environmental standards (and anticipated revisions) when specifying the performance required of the contractor. In exceptional cases, it may be justifiable to impose a standard that is higher than existing requirements.
- *Opportunities for foreign companies.* Although the long-term aim must be to develop indigenous capacity, there may be short- and medium-term advantages in encouraging international companies to participate. If so, it may be worthwhile to review regulations regarding the opportunities open to foreign firms, requirements to register locally and form joint ventures with local companies, and restrictions on repatriation of funds.
- *Registration.* Agencies and ministries responsible for registration should be identified. The formation of a locally registered enterprise may be subject to some requirements that appear unnecessary, and the process of registration may involve long delays and numerous requests for informal payments.
- *Limitations on market share.* To prevent monopolies, lawmakers may need to enact legislation that limits the number of contracts that one enterprise or family can have. It may also be appropriate to review legislation that prohibits cartels.
- *Transparency and availability of information.* Solid waste disposal can generate intense public opposition. Such opposition can be fueled by secrecy. Therefore, consideration should be given to ways to make information related to financial and environmental issues available to the public.

A clear state policy and legal framework are needed to facilitate private sector participation in SWM service. The state government should declare a state policy facilitating such participation. The state policy may advise the cities on many questions:

- What type of SWM services may be considered for private sector participation?
- How may contracts be packaged to get the right people to bid?
- What is the best way to ensure fair competition among bidders on a contract?
- What size of contract will be attractive for the private operator but avoid the creation of a monopoly?
- How may bids be evaluated in a transparent manner?
- What is the best payment structure to make the contract sustainable—levy of user fees, charges, or taxes?
- Who should have the power to award the contract?
- What should be the institutional arrangement at the ULB level for monitoring the contract?
- How can municipal or government land be leased to a private sector for setting up treatment and disposal facilities?
- What is the best way to subsidize community-based organizations (CBOs), resident welfare associations (RWAs), nongovernmental organizations (NGOs),

and the private sector in providing services with or without a cost-sharing basis with the beneficiaries?
- What is the best way to ensure that long-term contracts are binding for both sides beyond terms of office and to ensure fairness to both sides through adjustment clauses?
- How can hardships arising out of unforeseen situations be mitigated during the contract period?

The policy should encourage municipal authorities to involve the private sector in providing various types of SWM services and to levy user fees or user charges to compensate the private sector for the services rendered. There should be a clear policy on the allocation of government land to municipal authorities for the construction of treatment and disposal facilities and an option to allocate these lands on a long-term lease to the private sector to set up such facilities and others like them.

Recently the states of Rajasthan and Karnataka declared state policies on SWM; the states of Gujarat, West Bengal, and Kerala created high-powered state missions to facilitate the expeditious implementation of municipal solid waste rules.

Contractual Issues

"A contract, like a human being, stands on two legs. One leg is the precise definition of the work that is to be done and the action to be taken in the event of poor performance. The other leg is the attitude of both parties and of the judiciary toward the contract—it should be regarded as binding on both sides, in terms of obligations as well as rights."

—Adrian Coad (2005, 93)

The design of the contractual agreement depends on the type of work or service delivered and on mutual cooperation between the public and private sectors. In general, both the public and the private stakeholder should consider a contract philosophy based on partnership, cooperation for improved performance, and clear responsibilities. Because a contract cannot consider all risks and shortcomings, it must allow a certain flexibility within tasks so responsibilities can be adjusted to the actual situation.

Contracts should be of reasonable size. They should not be very large, creating a monopoly of one or two parties, and they should not be very small, making the contracts unviable because of the lack of economies of scale. Bigger cities might split service areas into several zones and award contracts for each zone, to promote healthy competition among the contractors.

When the contract packages are prepared, cost estimation must be done to assess the price offered by the bidders. The municipal authority must know beforehand the current costs of comparable service in the region. This estimation could be done by collecting information from neighboring cities. The market cost should be compared with the current cost of provision of public service to ascertain the extent to which the added efficiency of the private sector could reduce costs for the municipal authority. The authority can then evaluate the bids realistically and negotiate the rates as needed.

Contract Period. To attract private sector participation and cut service costs, municipal authorities must establish appropriate contract periods. If contracts with the private sector are to be effective and bankable, their duration and compensation

must be sufficient. They should be for a period that is long enough to enable the contractor to repay loans taken to purchase the equipment or refinance the facilities for the work.

Start of Operations. The starting date of operations must be clearly specified in the contract, taking into account the complexity of the operation and the need to mobilize human resources and machinery. Adequate preparation time should be provided to the contractor. Special consideration should be given when certain tools and equipment are to be manufactured or imported. In case of large contracts for waste collection, the work should start in phases and scale up over a reasonable period of time for smooth operations. Putting undue pressure on the contractor to start early quite often leads to improper starting procedures and puts the project in disrepute.

Extension of Contract. Giving or extending the contract for only a short duration poses larger risks to contractors, resulting in higher quotations. If possible, the contract should be for a long duration so that rates will be competitive or should include an extension provision for a duration appropriate for covering depreciation or for cost recovery. If the contractor is doing well and the rates are reasonable, the contract could provide for extension for a longer period. Longer periods of contract bring economy in operation.

Guarantees of Performance. The "guarantee" is an essential ingredient of a contract. It ensures that contractors perform their obligation to the satisfaction of the contracting authority, and if they fail to do so, it provides compensation to the contracting authority for the deficiency in service. Performance guarantees are essential to ensure the fulfillment of contractual obligations.

Terms of Payment. The most commonly used payment methods are lump sum and unit price. In the lump-sum method, the contractor has no risk of losing money on account of fluctuations in the quantities of waste collected. In the unit price method, payment is adjusted when the amount of waste collected, transferred, or disposed of changes. The contractor gets a fair deal, and risk is reduced.

Payments based on unit prices and measurements reflect the extent of work carried out. With the unit price method, it is necessary to verify the measurement procedure from time to time and adequately supervise measurement because of the strong possibility or temptation for the contractor to manipulate the procedure to get more payments. An assessment that does not include a weigh bridge based on vehicle volume is not an appropriate base for payment to the contractor. The potential for misuse and fraud must be avoided in this type of contract. The concept of a "tipping fee" payable by the contracting agencies is being accepted (as with the integrated treatment landfill at Bangalore and the collection and transport concessions at the Municipal Corporation of Delhi, among others).

In waste collection contracts, generally a large workforce is engaged, and these workers are paid on a monthly basis. Therefore, the contractor needs to be paid on a regular basis to ensure cash flow. Delays in payment can cause labor unrest and adversely affect services. A provision should be made for the contracting author-

ity to pay penal interest if payments are delayed beyond the reasonable time prescribed.

Incentive clauses are beneficial if the performance of employees can make a marked difference in the level of service. However, they may not be relevant if there is very little scope for improvement, as where systems are well established. In cases where incentives are built into the contract, they should be very clearly defined in the form of milestones or targets to achieve. The incentives should be designed so that while they entitle the contractor to additional payment, they also result in overall economy in expenditure of improved efficiency in service—so that citizens are not made to pay additional costs.

Every contract should have a clause that clearly defines the grounds for penalty, the amount of the penalty, and the mechanism for enforcing the penalty. This clause must be used judiciously to safeguard the interests of both the parties. The contract should define a fair procedure that prevents the contracting authority from abusing its power and the contractor from escaping its responsibility.

Price Adjustments. All long-term contracts should include a price adjustment procedure to cover the risk of drastic inflation, an increase in the cost of fuel, and other cost factors. The contractor therefore quotes a higher price to cover such risks. In the case of unforeseen rises in the costs of certain components, the contractor may even cease to operate if it faces heavy losses. It is, therefore, desirable to provide in the contract for price adjustments that are based on certain well-defined parameters.

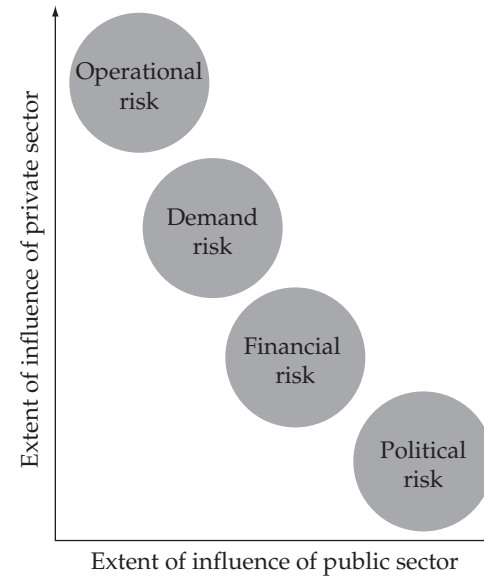
The Role of Performance Indicators. It is common to define performance indicators that help the public authority monitor the contractor's performance. However, it is crucial to limit the performance indicators to the most important aspects and to make them realistic. The efforts required for documenting and reporting performance should not jeopardize the day-to-day operation of the private contractor.

Allocation of Risks. The project must be defined appropriately to resolve all issues and to allocate risks equitably to the party best able to manage them. Lack of clarity or excessive transfer of risks to the private sector may lead to lack of participation. Hence, contracting agencies need to invest in requisite technical, market, and financial viability studies to reduce project risks and attract bidders to the project. One example comes from North Dum Dum in West Bengal. There the contractor is at risk if citizens fail to pay the fees and municipalities do not underwrite or assist in cost recovery. Private sector participation in SWM is expected to improve the services and reduce certain risks. The private sector is perceived to provide better technical and managerial expertise, more customer-oriented service, fewer project delays, and much-needed investment.

The contracting authority generally takes the responsibility to pay the contractor on time, but more often than not payment is delayed. The contractor therefore undertakes the risk of payment being delayed or suspended. Lack of funds in the municipal authority and corrupt practices generally lead to delayed payments. The contract documents need to be very fair and cover the risks of both sides. It is essential that both sides share the risks to keep both sides accountable. The risks could

Figure 3.1 Risks and Potential Influence of Partners in Private Sector Participation

Risk category	*Examples*
Operational risk	Delay in construction
	Cost overrun
	Quality and performance failures
	Increasing operation costs
Demand risk	Change in demand
	Cost increase for resources
	Change of tariffs
Financial risk	Delayed or canceled payment
	Fluctuation of foreign exchange rates
	Fluctuation of interest rates
Country risk or political risk	Expropriation, breach of contract, or war
	Cancellation of credits
	No refund of profits



Source: SECO 2005.

be operational, related to demand, financial, or political (figure 3.1). All those risks should be evaluated when generating contract documents, and they should be distributed fairly.

Type of Contractual Agreements

Table 3.1 gives an overview of existing contracting options relevant to the SWM sector. The models presented must be seen as ideal types. Reality might require a combination of two models to cover all aspects of collaboration.

Service Contracts. Service contacts are generally used for waste collection, transport, and transfer and for operation of treatment and disposal facilities. Two types—one for short terms requiring low investment or no investment and one for longer terms—can be distinguished. A specific service (discrete and clearly defined) is contracted out by the public agency to a private operator in accordance with a competitive procurement procedure.

If the contract requires the contractor to deploy his labor force only for primary collection, street sweeping, or waste transport, the contract period could be short—perhaps one to three years—because the contractor does not have to make any investment. If the contractor is expected to use its own equipment or vehicles of a special type that generally are not used in daily life, the term of the contract should

Table 3.1 Assigned Responsibilities for Each Option for Private Sector Participation

Option	*General characteristics*	*Aim of having private sector participation*	*Operations and maintenance*	*Capital investment and asset ownership*	*Responsibility and risk*	*Contract duration*
Service contract	The private partner provides a clearly defined service to the public partner.	To increase efficiency of particular public services	Public and private	Public	Public	1–2 years or 5-8 years
Management contract	The private partner is responsible for core activities such as operating and maintaining the system.	To increase efficiency of service with improved management structures	Private	Public	Public	3–5 years
DBO	The private contractor is responsible for designing, constructing, and operating infrastructure.	To have better commitment because of full responsibility	Private	Public	Shared	5–8 years
Lease	The private partner is fully responsible for operation and maintenance; the public partner is responsible for new investments.	To obtain benefits of a management contract but with improved investment planning and financial management	Shared	Public	Public	8–15 years
BOO	The private partner builds a facility that is based on a defined design and owns and operates it. The private partner charges a tipping fee to recover its cost.	To transfer the responsibility of investment and management in a cost-effective manner with all risks on the private partner	Private	Private	Private	15–30 years

Table 3.1 Continued

Option	*General characteristics*	*Aim of having private sector participation*	*Operations and maintenance*	*Capital investment and asset ownership*	*Responsibility and risk*	*Contract duration*
BOOT	Same as BOO with an additional clause for later transfer of the asset to the public partner.	To obtain private sector investment with operating and management risks on the private partner and eventual asset transfer to the public	Private	Private	Private	15–30 years
BOT	The private partner is responsible for constructing, financing, and operating the facility during the contract period. After the contract period, the facility is transferred to the public.	To transfer all risks to the private partner	Private	Private	Private	20–30 years
Concession (including fee collection)	The private partner is fully responsible for operation, maintenance, and investment.	To create competition in the market	Private	Private	Private	25–30 years

Sources: Cointreau-Levine 1994; International Consortium, GTZ-ERM-GKW 2004; World Bank 2004.
Note: DBO = design, build, operate; BOOT = build, own, operate, and transfer; BOO= build, own, operate; BOT = build, operate, and transfer.

be longer, in keeping with the useful life of the equipment or vehicle deployed. In such cases, the contracts should be for a period of three to eight years, depending on the equipment and vehicles deployed. The longer period makes it possible for the contractor to take full depreciation of the vehicles deployed and proves cost-effective compared with short-term contracts, which cover investments that do not ensure full cost recovery of the equipment or vehicles used. Short-term contracts that require investments by the contractor are not attractive because the contractor risks losing its investment if the contract is not extended for a reasonable period of time in future. In such cases, contractors quote very high rates to cover the risk.

Payment is usually made on fee per task basis in contracts that require small investments that are not recoverable in case of early termination. Here the contractor is paid on the basis of houses covered, road length swept, quantity of waste collected, quantity of waste transported, or trips made or is paid a lump-sum amount for the services rendered per month or per year.

Management Contracts. Under management contracts, the private company takes over the management and operation of a defined department or entity with its staff, facilities, and machinery. The private company brings in its own personnel for key management positions; however, it is unlikely to make major capital expenditures. Management contracts are more frequently used in the drinking water and wastewater sector but less often for SWM because of its more complex asset structure. Payment of the contractor typically is based on a fixed fee, and a performance fee is paid by the public authority.

International experience shows that two key elements are required for successful management contracting. First, the contractor must be given enough autonomy to implement commercial reforms. Second, the contract must contain effective incentives for good performance, including penalties for failure to meet agreed performance goals.

Design, Build, and Operate. Under a design, build, and operate (DBO) contract, the contractor bears the responsibility for the project, including design, building, and operation. The financing is provided by the contracting authority. The payment is made step by step with the stages of construction. The contracting authority remains the owner of the assets created. This contract has the benefit of fixing the accountability on one party only for the successful execution of the project. When awarding such contracts, authorities must ensure that the contractor has the desired capability to design, build, and operate the facility or has formed a consortium of companies that collectively have those capabilities.

The DBO approach appears most suitable where financing is done by the contracting authority and the systems are designed, constructed, and operated by professional agencies. DBO contracts minimize critical interface and makes the contractor responsible for successful implementation of the facility.

Build, Operate, and Transfer. Build, operate, and transfer (BOT) arrangements are more common in waste treatment (composting, waste-to-energy conversion, and so on) and disposal (sanitary landfill) facilities. In a BOT arrangement, the private sector is responsible for constructing, financing, and operating the facility during the contracting period. After the completion of the contracting period, the facility and assets are transferred to the public entity.

In BOT contracts, the obligation of the contractor to operate the designed and constructed facility terminates when the facility is transferred to the public authority. Here, the contractor undergoes a much larger risk because it receives no payment in parallel with the construction but must recover the investments made by levying charges for the services rendered during the period of the contract. The contractor thus runs a risk of nonpayment or closure of the facility for unforeseen reasons. It also suffers on account of fluctuations in the interest rates.

Build, Own, Operate, and Transfer. In a build, own, operate, and transfer (BOOT) arrangement the contractor is expected to build the facility at its own cost and operate the facility for a long term. The contractor recovers its cost during the agreement period and then transfers the assets, in working condition, to the municipal authorities at the end of the agreement—with or without any compensation, as agreed between the parties. The municipal authorities prefer BOOT contracts because they get the assets free at the end of the agreement.

The terms *BOT* and *BOOT* are often used interchangeably; however, there is a difference. In a BOT arrangement, ownership of the facility goes directly to the authority once construction is completed. The private entity can then operate the facility until transfer; however, it does not have ownership. In a BOOT arrangement, the private entity retains ownership after construction until the transfer is completed.

Build, Own, and Operate. The build, own, and operate (BOO) type of contract is very similar to the BOOT arrangement, except the private entity is not obliged to transfer the facilities as an asset to the public entity. In a BOO arrangement, the private sector is responsible for design, construction, operation, services, and financing of the investment. Contract documents must balance sharing and tariff adjustments to avoid unreasonable high-price offers and refusal of contracts.

In BOO contracts, the private entity builds the facility at its own cost, owns it, and operates it for an indefinite period or for a long term agreed to by the parties. There is no provision for termination of contract or transfer of assets, except in cases where land or garbage is given by the municipal authority free or at a token charge and the party fails to perform its obligation to treat or dispose of the waste in a scientific manner. If the contract is terminated, the private operator is obliged to vacate the site but is not obliged to transfer the assets. Such types of contracts must be very carefully designed to safeguard the interests of both sides. There should be an appropriate mechanism to monitor performance, costs, and prices during the provision of services.

These contracts are for a long period and might create a monopoly. The rates payable continue to bind the beneficiary to the terms of the contract although the cost of the service may go down because of technological advances over a period of time or on account of larger competition in the market.

Concession. Under a concession arrangement, the private operator manages the infrastructure facility, operates it at commercial risk, and invests in creating a new facility or rehabilitating an existing facility. A typical contract has a fixed term and involves selling the assets back to the municipality at the end of the term.

Concession contracts generally run from 25 to 30 years, making it possible for the private party to recover the capital expenditure invested.

Lease. A lease contract entitles a private company to operate a service with assets owned by the public sector. The private partner is responsible for collecting fees to cover the operation and maintenance costs. The profits are shared with the public sector because it is responsible for new investments. Such a contract might be suitable for the operation of waste treatment facilities.

Existing Private Sector Participation in SWM in India

Recently, cities have taken the lead in involving the private sector in various areas of SWM service. Some examples and experiences are given in this section.

Door-to-Door Waste Collection and Transport

Many cities have involved the private sector in door-to-door waste collection and transport. Many cities have given contracts for door-to-door collection only (as in Ahmedabad in Gujarat and in North Dum Dum and New Barrackpore in West Bengal) (boxes 3.1 and 3.2), whereas some cities have combined door-to-door waste collection and transport in one contract (as in Bangalore, Surat, and Jaipur) (box 3.3). Some contracts involve partnerships and contracts with RWAs, NGOs, and private companies, whereas others involve only private enterprises.

The type of contract selected for transport of waste will depend on the proposed extent of investment and equipment that the contractor will provide. The typical private sector actors in waste transport contracts range from individuals and proprietorship or partnership firms (as in the service contracts with Bangalore Mahanagara Palike) to companies and consortia (as in the concession contracts with the Delhi Municipal Corporation and the Corporation of Chennai). The duration

Box 3.1 Service Agreement between Ahmedabad Municipal Corporation and RWAs and NGOs

The city of Ahmedabad has awarded contracts for door-to-door collection at a predetermined rate per house per month. To avoid exploitation of labor, the city does not ask for competitive bids. Each part-time sanitation worker covers a unit of 200 houses, and the RWA or NGO or contractor is paid Rs 2,000 per month per part-time worker, 90 percent of which is paid to the sanitation worker. These fixed-amount contracts are awarded in order of preference to RWAs of the respective area and, in their absence, to associations of backward classes, women, NGOs, and so on, as has been prescribed by the Ahmedabad Municipal Corporation. Contracts for 3,900 units have been awarded, covering a population of 3.9 million people.

With the introduction of the system of door-to-door collection through RWAs and NGOs, community mobilization has become possible. Citizens have been storing the waste at source in their domestic bins and handing it over to municipal sanitation workers once a day, so littering on the streets has been minimized. The cost of primary collection has remained very low, because the RWAs and NGOs have taken up the work at a minimal cost, paying a reasonable amount above the minimum wage rate to the sanitation workers. The Ahmedabad Municipal Corporation is relieved of the effort of recruiting more than 4,000 more people.

Currently, the Ahmedabad Municipal Corporation is paying the fees to the RWAs and NGOs; eventually this cost can be passed on the citizens in the form of a user fee. Citizens would not hesitate to pay once they have formed the habit of storing the waste at source and handing it over to a sanitation worker.

Source: Authors.

Box 3.2 Case Study: North Dum Dum and New Barrackpore

In the state of West Bengal, the North Dum Dum and New Barrackpore municipalities have taken up a model SWM project and have introduced private sanitation workers for door-to-door collection of waste. A monthly fee of Rs 10 in North Dum Dum and Rs 5 in New Barrackpore is prescribed; the responsibility for collecting this fee is entrusted to the waste collector or supervisor. The waste collectors provide service on all days of the year including Sundays and public holidays. They collect the organic waste every morning and recyclable components once a week. In both cities, the efficiency rate for user fee collection is more than 95 percent. In North Dum Dum, out of Rs 10 collected by the private contractor, Rs 8 is paid to the sanitation worker, Rs 1 to the supervisor, and Rs 1 to the municipality. The municipality uses its share toward repair and maintenance of the tricycle that the municipality provides the waste collector. In New Barrackpore, the entire amount of Rs 5 per house per month goes to the waste collector.

The municipality is responsible for general supervision. In this arrangement, there is no financial burden on the municipality, and the entire contract is self-sustaining.

Source: Authors.

Box 3.3 Service Agreement between Bangalore Mahanagara Palike and Contractors for Waste Collection and Transport in Bangalore

Bangalore Mahanagara Palike entered into service agreements with local contractors in June 2003 for collection and transport of municipal solid waste in 182 health wards in the city of Bangalore.

The term of the agreement is two years. The project was structured in 61-day packages and 12-night packages. Each package covers a certain number of health wards, varying between two and seven, and is based on geographic distribution. A single contractor could bid for a maximum of four packages. The contractors were selected in a single-stage bidding process. The contractor is expected to arrange door-to-door collection in containerized handcarts and tricycles and to arrange for direct transport of waste to the disposal site by deploying its own collection vehicles.

The contracts have been operational since June 2003. Some of the highlights of the current contract system are as follows:

- The contracts cover door-to-door collection of waste through pushcarts.
- Emphasis is on source segregation of waste (wet and dry).
- Garbage must be cleared once a day.
- The contracts provide for separate collection and transport of debris.
- The contracts provide for identification of dumpsites and facilities, along with disposal areas for municipal solid waste.
- Dry waste is collected separately.
- Citizen participation is included in the monitoring and feedback program.
- Work norms for cleaning and garbage collection activities have been clearly defined.
- A minimum wage of Rs 1,800 per month is paid to the contract workers.

The contractual arrangements have been working quite satisfactorily for more than five years because coordination of service is strong. Only one contractor is used for both collection and transport. The contracts have resulted in a cost saving of nearly 50 percent as compared with the departmental cost.

The door-to-door system of waste collection has become a norm rather than a novelty for Bangalore. However, the choice of either handing waste over to the door-to-door system operator or dumping waste into a nearby litter bin (in some localities) still lies with the citizen. The result is that both systems are functioning in parallel, and waste is collected in pushcarts from the houses and also from the litter bins.

Box 3.3 Continued

The city of Bangalore has encountered some limitations to the program. The risk of managing the project facilities and the quality of work is allocated to the contractor. However, no penalties or monitoring systems are in place. As a step toward citizen engagement in monitoring field performance, provision has been made in the new garbage contracts for citizen endorsement of the work done. In accordance with the norms specified and the conditions of the contract for cleaning, collecting, and transporting garbage and debris, independent monitoring committees need to be constituted. These committees would assess performance and approve the monthly payment of bills.

Source: Authors.

of contracts typically ranges from two to nine years. The nature of the services required usually determines the profile of the service providers. Individuals and proprietorship and partnership firms tend to have lesser financial capabilities and are not able to take on investment-intensive contracts.

Street Sweeping

Municipalities face stiff resistance to private street sweepers from staff members employed under public regulations; therefore, street-sweeping contracts involving private enterprises are very few. However such contracts have been established successfully in Hyderabad (box 3.4), Chennai, and Rajkot while ensuring that existing staff members are not affected.

Generally such contracts should not be awarded unless the city has large unserved areas and inadequate staff members to cover the unserved areas, because this type of contract could be stiffly resisted by existing laborers, who are under the perceived threat of losing their jobs. However, such resistance can be overcome by ensuring the labor force of their security of service. Here the principal advantage to the municipal authority is to get labor at a much lower rate than the municipal rates. Well-prepared contracts can lead to better quality of services at a reasonable cost. The norms of work could be prescribed and the minimum wages could be ensured in such contracts to prevent exploitation of labor by the private operators.

Treatment

Various treatment facilities in a few cities in India have been established through private sector participation. The most common facilities implemented are composting plants, because composting represents a quite low-cost and technically simple process. Pelletization of waste is another alternative that some ULBs have considered in the recent past; such plants are operating in Hyderabad and Vijayawada. Small biomethanation plants have been set up through private sector participation in Vijayawada and eight other towns in Maharashtra. This recent development is proving successful, although another initiative (the large plant in Lucknow) failed and has now been shut down.

Contracts related to the construction of compost plants, waste-to-energy plants, and engineered landfills require relatively large investments and skilled labor. A precondition for developing a contract is that the location for construction and operation must fulfill technical and legal requirements. Furthermore, the necessary environmental clearances from the State Pollution Control Board should be obtained.

Box 3.4 Service Agreement for Street Sweeping in Hyderabad

The Municipal Corporation of Hyderabad has awarded 161 contracts for street sweeping, adopting a unit area allocation method. Three-fourths of the city is divided into 161 units of 8-kilometer road lengths. The number of workers to be deployed for cleaning 8 kilometers of road length is worked out, taking into consideration the minimum wages payable in the state, the cost of tools used, and a reasonable profit margin for the contractor. Applications are invited from those interested to take the contract, and lots are drawn for award of contracts. Each unit is contracted out to a team of 19 people, comprising 16 women and 3 men, for sweeping the streets and transferring the sweepings to a municipal waste storage depot nearby. Each female worker is expected to sweep 500 meters of road length and make small heaps. The male workers are expected to pick up those heaps in handcarts and take the waste to the waste storage depot nearby. This arrangement has been working satisfactorily for more than seven years. The Municipal Corporation is realizing savings of approximately 50 to 60 percent of their costs.

With the introduction of the unit area method in the street-sweeping operations and the outsourcing of the service, the Municipal Corporation of Hyderabad has added to the efficiency of street sweeping at a relatively very low cost. By outsourcing the work, it is saving about 50 to 60 percent of the cost that it used its own labor force. In addition, it is free from liability for pensions and several other postretirement benefits that would have added to the cost substantially.

A word of caution should be mentioned. The norms of work should be prescribed and the minimum wages should be ensured in such contracts to prevent exploitation of labor by the private operators. Delays in payment can cause laborers unrest and can adversely affect services. A provision should be made for the contracting authority to pay penal interest if payments are delayed beyond the reasonable time prescribed. Labor laws applicable in the state must be followed carefully by labor contractors; otherwise, the principal employee liability may devolve to the municipal authority.

Citizen committees need to be involved for monitoring the performance of the private workers.

Source: Authors.

Disposal

Even though the Municipal Solid Waste (Management and Handling) Rules 2000 are in force, India has only a few landfills constructed so far, and crude dumping is still the prevalent practice. Private sector participation has recently been introduced in landfill construction and operation in a very few cities, but many cities are actively considering it. A contract was awarded in Bangalore for construction of a landfill, including a compost plant. This arrangement was made on the basis of a BOO contract. The landfill and compost plant have become operational after lots of delays in clearances from the regulatory authority.

Sanitary landfills involve long-term risks and liabilities for aftercare: leachate treatment, rehabilitation, and monitoring. The contract should clearly specify the responsibility to conduct and finance these tasks. (See box 3.5 for a case study.)

Facilitation of Private Sector Participation in India

More private sector participation in India will be possible only if certain issues are addressed. Labor redundancy is a major obstacle to privatization. Private sector participation could also be greatly facilitated if procedures were set out for establishing equitable contracts and transparent procedures for awarding contracts.

Box 3.5 Concession Agreement between Corporation of Chennai and CGEA Asia Holdings Pte Ltd., Singapore

For collection and disposal activities in select zones in Chennai, the Corporation of Chennai has entered into a concession agreement with CGEA Asia Holdings Pte Ltd, Singapore.

After an international competitive bidding process, Tamil Nadu Industrial Development Corporation Limited selected CGEA on behalf of the Corporation of Chennai. The scope of work of CGEA, as per the initial action plan, includes collection of waste from mobile garbage bins and deployment of rear-lift compacting trucks to deliver the waste to the two transfer stations, one each in zone 8 and zone 10.

The work includes deploying light vehicles such as three-wheelers or small four-wheelers on narrow streets and having collectors pass daily on foot in nonmotorable lanes; waste is collected in small-capacity mobile garbage bins. In addition, CGEA collects segregated construction debris and garden waste using specialized vehicles and equipment in addition to manual handling. Street sweeping is carried out manually as well as mechanically. The transfer stations and two vehicle workshops owned by the Corporation of Chennai are managed by CGEA. The waste is sent from transfer stations and from some select areas directly to the disposal area.

Source: Authors.

Preparing and Awarding a Contract

Contracts can be processed through different preparation, selection, and awarding methods depending on the nature of the project, the financing instrument used, and the policy and procedures the contract needs to follow. For example, when a project is complex and the cost is high, an international competitive bidding might be appropriate; when a project is simple and cost is low, a local competitive bidding might be acceptable. It is important that the local authorities undertake a contracting process following local and national contracting rules. And if the project is financed by an international organization, related procedures should be followed.

Addressing Labor Redundancy

Adding more human resources for providing service only adds to the burden of the municipal authority and makes the existing staff redundant. Efforts should be made to deploy the existing staff adequately and bring in private sector entities for the work that the existing laborers do not perform or are not expected to perform.

The concern about labor redundancy must be addressed. This could be done in the following ways:

- Freezing the hiring of new staff members for additional work to be done
- Not filling the vacancies that may be created on account of retirements, resignations, death, incapacity, and so on
- Offering better opportunities or similar work opportunities in other positions within the organization
- Introducing private sector participation step by step in selected areas to fill the gaps created by carving out the geographic areas that can be privatized by redeployment of existing labor in other parts of the city
- Entering an agreement with the private sector to take on public sector employees in the number required to meet its obligations, thus protecting the interest of the labor force

Establishing Equitable Contracts

Private sector participation will not work unless the contracts established treat all parties fairly. Table 3.2 gives an example of the requirement in an equitable contract.

Establishing Transparent Procedures for Awarding Contracts

The municipal authority should lay down a clear procedure for involving the private sector in SWM services. It should include these elements:

- A method for deciding technical and financial prequalification of tenders, to facilitate adequate competition
- A transparent method of invitation of bid through wide publicity
- A method for evaluating bids in a transparent manner
- A method for awarding contracts

International Case Studies

The following case studies are summarized from *Private Sector Involvement in Solid Waste Management* (Coad 2005), in which the full cases are described. In many cases, the cities are not mentioned here.

Peru: Involvement of Microenterprises

The NGO Alternativa founded several microenterprises for solid waste collection. The NGO signed an agreement with the municipality to establish, shape, and support the microenterprises that the municipality would control. The microenterprises created limited liability companies, and members are both partners and workers. SWM service contracts are signed by the companies and the municipality. The contract payment takes into account the operation and management expenses of the private company as well as the loan repayment. The contract duration was rather short: 12 months. The method of work was agreed with the municipality and discussed with residents. Customers soon appreciated the good service, which resulted in an improved fee collection rate. One persistent problem is the lack of cooperation between microenterprises and the municipal waste transport service. The collected waste often remains too long at transfer points, which leads to complaints from neighbors. The NGO reacted by trying to establish a private waste transport company that could serve several collection enterprises.

This case study indicates that women remain in SWM enterprises longer, whereas most men consider their job in SWM temporary. Many men prefer to leave immediately on finding a job or occupation considered more prestigious than garbage collection. Women, however, see their jobs as their only source of income and, therefore, perform their work with more responsibility and continuity.

Drawbacks and Limitations. Delays in payment by municipalities are a major problem. Also, the time allowed for bid preparation (seven weeks) was too short to allow foreign firms to bid. One U.S. firm had even visited the municipal authorities to express interest. International firms need more time for travel, communication, familiarization with local aspects, and planning.

Table 3.2 Requirements for an Equitable Contract

Contents	*Requirements*
Recitals	Recitals should include the development history, the internal approval process, and any other supporting documents to the contract.
Definitions and interpretations	All key items should be defined.
Project structure and term	The type of contract being entered into should be defined, as well as the tenure of the agreement. This clause should also include the award and acceptance of the project. Ownership issues regarding project assets should also be addressed.
Site	For development of project facilities, the exact site details and details of handover should be mentioned. For collection, transport, or sweeping, the zones to be covered under the contract should be set out.
Obligations of party 1	Responsibilities of the parties, both general and specific, should be addressed.
Obligations of party 2	
Payments, consideration, and other commercial terms	The consideration paid and the method of payment should be clearly set out, along with the escalation clause, if any. Penalty mechanisms for suboptimal service delivery should also be addressed.
Obligations of other stakeholders and scope of work	The scope of work of an independent consultant (if any) should be covered. Method of payment of consultant fees should also be addressed. Monitoring mechanisms should be detailed.
Force majeure and change of law	The contract should set out force majeure events, which are events caused by acts of God and events caused by political and nonpolitical reasons. It should set out the procedure to be followed in such circumstances. The contract should also address the procedure to be followed if a change of law affecting the project comes into force and define the obligations of the parties in that case.
Events of default and termination	The contract should clearly state what constitutes a default on the part of either party, the penalty for default, and the conditions under which the agreement may be terminated. Objective output parameters should be clearly set out, including the monitoring mechanism to check them.
Handover procedures	For development and transfer of any project facilities to the contracting agency (such as landfills or a composting plant), the handover procedure should be clearly set out. The ownership issues of the project assets should be clearly described.
Dispute resolution	This section should address the procedure for dispute resolution, the authority for it, and under what circumstances the procedure holds good.
Representations and warranties	This section should set out the representations and warranties of either party and the procedure to be followed in case of any change.
Miscellaneous	Any other clauses pertinent to the project, such as interest offset, waivers, governing law and jurisdiction, amendments, and notices, should be included.
Schedules to the agreement	This section should include documents that are relevant to the contract and that will make it more precise.

Source: Infrastructure Development Corporation (Karnataka) Limited 2005.

Egypt: Integrating the Informal Sector with International Contractors

The informal sector in Egypt traditionally played a leading role in waste collection, particularly door-to-door collection and recycling. Waste collectors collected waste outside apartment doors in tall buildings, and households appreciated this service, paying an extra fee. The municipality recently decided to contract SWM out to a number of international companies that won the bids for different areas in the city. Although one contractor failed on a massive scale owing to operational problems and unofficial competition with the informal sector for waste, another contractor managed to cooperate with the informal sector. After intense and long negotiations, informal waste collectors were hired under a subcontract to continue waste collection from apartments and were allowed to sort out recyclables at transfer points. There has been an unexpected reduction in the amount of waste taken to the landfill because of that sorting, which benefits both the contractor and the subcontractors. The continuous good service satisfied the customers, who were willing to pay the fees. Furthermore, the monitoring department was more lenient in enforcing penalties on the contractor because of the contractor's contribution to solving a social problem in integrating the waste collectors into the new system.

Drawbacks and Limitations. Developing economies face the challenge, but also the opportunity, of building on rather than replacing their existing informal recycling systems. Measures need to be taken to protect livelihoods while working to improve both the efficiency and the living and working conditions of those involved.

Germany: Joint Venture Model

Various public-private partnership models exist in Germany. One common model is the joint venture for SWM, in which a municipal or district administration joins forces with a private enterprise under private law. The selection of the private partner was preceded by monthlong talks between the administration and potential partners. The administration initially held 51 percent of the shares in order to maintain the influence required, but later it reduced the shares as the joint venture proved to work in line with its goals. The joint venture considers itself essentially a planning, controlling, and organizational entity that can subcontract other private companies for SWM services. On behalf of the district administration and municipality, the joint venture collects waste management charges from all private households and other generators that receive the public service. Because the joint venture is an entity, the revenues remain with the company and are used solely to cover the cost and make new investments.

Mauritius: Landfill Privatization

In Mauritius, under a World Bank project, a sanitary landfill was designed by one contractor, constructed by another contractor, and operated by a third. During the transition period between the construction and the operation phases, many disputes arose over the adequacy of construction, with the operating contractor refusing to take full responsibility for managing the works it had taken over. If, in the long term, there were adverse environmental consequences (such as groundwater

pollution), a legal battle would undoubtedly arise between the design engineer, construction contractor, and operation contractor over which entity was responsible. The lesson learned was clear: when a new sanitary landfill is to be constructed and operated by the private sector, responsibility for all stages should rest with one company.

References and Suggested Readings

Ali, Mansoor. 1997. "Micro-enterprise Development for Primary Collection of Solid Waste." Water, Engineering, and Development Centre, Loughborough University, Leicestershire, U.K. http://www.gdrc.org/uem/waste/swm-confpaper.html.

Arroyo-Moreno, Jorge, Francisco Rivas-Rios, and Inge Lardinois. 1999. *Solid Waste Management in Latin America: The Role of Micro- and Small Enterprises and Cooperatives*. Gouda, Netherlands: WASTE.

Bartone, Carl R. 2001. "The Role of the Private Sector in Municipal Solid Waste Service Delivery in Developing Countries: Keys to Success." In *The Challenge of Urban Government: Policies and Practice*s, ed. Mila Freire and Richard E. Stren, 215–23. Washington, DC: World Bank.

Bartone, Carl R., Luiz Leite, Thelma Triche, and Roland Schertenleib. 1991. "Private Sector Participation in Municipal Solid Waste Service: Experiences in Latin America." *Waste Management and Research* 9 (6): 495–509.

Coad, Adrian. 2005. *Private Sector Involvement in Solid Waste Management*. Eschborn, Germany: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). http://www.cwgnet.net.

Cointreau-Levine, Sandra. 1994. "Private Sector Participation in Municipal Solid Waste Services in Developing Countries (Vol. 1)." Urban Management Programme Discussion Paper 13, World Bank, Washington, DC. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/1994/04/01/000009265_3970128111924/Rendered/PDF/multi_page.pdf.

Cointreau-Levine, Sandra, and Adrian Coad. 2000. *Guidance Pack: Private Sector Participation in Municipal Solid Waste Management*. St. Gallen, Switzerland: Swiss Centre for Development Cooperation in Technology and Management. http://rru.worldbank.org/Documents/Toolkits/waste_fulltoolkit.pdf.

Commonwealth Secretariat. 2004. "Effective Partnerships in Areas of Human Development, Water, Sanitation, and Waste Management." Commonwealth Consultative Group on Environment, London, United Kingdom. http://www.thecommonwealth.org/shared_asp_files/uploadedfiles/{E44377F4-04E8-4560-B9D1-D863225DECC7}_CCGE(04)1_Effective%20Partnerships.pdf.

DANIDA (Danish International Development Agency). 2000. "What Can the Public-Private Sector Do to Improve Environmental Services?" In *DANIDA Workshop Papers: Improving the Urban Environment and Reducing Poverty*. Copenhagen: DANIDA. http://web.mit.edu/urbanupgrading/urbanenvironment/issues/public-private-sector.html.

Haan, Hans Christiaan, Adrian Coad, and Inge Lardinois. 1998. *Municipal Solid Waste Management: Involving Micro- and Small Enterprises: Guidelines for Municipal Managers*. Turin, Italy: International Labour Organization.

Infrastructure Development Corporation (Karnataka) Limited. 2005. "Review of Contractual Arrangements in SWM Final Report." Infrastructure Development Corporation (Karnataka) Limited, Bangalore, India.

International Consortium, GTZ-ERM-GKW. 2004. "Training Modules for ISWM Private Sector Waste Management Services Participation." Tunis: International Consortium, GTZ-ERM-GKW.

Lardinois, Inge, ed. 1996. "Solid Waste Micro and Small Enterprises and Cooperatives in Latin-America." Gouda, Netherlands: Urban Waste Expertise Programme, WASTE. http://www.gdrc.org/uem/waste/swm-waste.html.

Ministry of Urban Development and Poverty Alleviation. 2000. *Manual on Solid Waste Management*. New Delhi: Government of India Publications.

———. 2005. "Report of the Technology Advisory Group on Solid Waste Management." Ministry of Urban Development and Poverty Alleviation, New Delhi.

Ortiz, Alexandra, and Carolina Piedrafita. 2006. "Providing and Expanding Water Provision and Solid Waste Collection Services in Peri-urban and Rural Areas: The Role of Small-Scale Providers." Public-Private Infrastructure Advisory Facility, World Bank, Washington, DC. http://siteresources.worldbank.org/INTUSWM/Resources/sw_periurban.pdf.

Rotman, Allan. 2005. "Sample Bidding Document: Design-Build-Operate Solid Waste Facility." World Bank, Washington, DC. http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/PROCUREMENT/ 0,,contentMDK:20619680~menuPK:84284~pagePK:84269~piPK:60001558~theSitePK:84266,00.html.

SECO (State Secretariat for Economic Affairs). 2005. "Public–Private Partnerships in Infrastructure Services: An Instrument for Poverty Reduction and Economic Development," SECO, Berne, Switzerland.

World Bank. 2004. "Private Sector Participation Guidelines, Tool PSP 2.1." Mediterranean Environmental Technical Assistance Program, Regional Solid Waste Management Project, World Bank, Washington, DC.

4

Institutional Aspects of Solid Waste Management

The subject of solid waste management (SWM) has remained neglected in India for the past several decades, resulting in highly inadequate and inefficient SWM services. Improvement of SWM requires promotion of an institutional framework that is transparent and has very well-defined roles and responsibilities for the different actors. Authorities and service providers should be accountable to the public in accordance with principles for good governance. Moreover, the professionalization of the SWM sector and its workers is essential to improve the provision of such an important service that affects the health, environment, and quality of life of urban populations.

This chapter describes the condition of current SWM institutions in India and provides a set of guidelines to strengthen the institutional capacity to perform SWM more efficiently.

Institutions for an SWM System

Solid Waste Management System

In most cases, SWM is a responsibility of the local authorities. Municipalities are therefore responsible for collection, sweeping, storage, transfer, treatment, and final disposal of waste. In many cases, however, the provision of this service is not efficient, and the providers are not accountable to the residents and business establishments they serve. Another typical problem is that SWM services come under municipal departments without the expertise to handle them, such as public health departments. To improve the service, SWM needs to be professionalized, and solid waste departments should be managed by those trained to handle these systems. Local authorities need to understand how solid waste affects environment, health, and quality of life and to take appropriate actions toward improving the system.

Although in most cases the responsibility for SWM systems remains within the municipal government, specific tasks can be delegated to others, including the private sector, nongovernmental organizations (NGOs), community-based organizations (CBOs), and even the informal sector. Whether or not those tasks are delegated, local authorities are ultimately accountable and should retain control for the functioning of the system, specifically the following roles and functions:

- Spending taxpayers' money in relation to the performance of actors in the SWM system
- Control and protection of environmental and health factors affecting the city and its population

SWM systems are complex, and many actors are involved in the processes. Therefore, a clear and well-defined institutional framework, in which the roles and

responsibilities for each task are properly assigned, is very important. Authorities should always facilitate the processes and build the proper institutions to handle SWM.

Decentralization and Delegation of Functions in the SWM System

Moving the decision making closer to the executing actors and beneficiaries allows certain functions to be handled more efficiently. In the case of SWM, understanding which decisions are better handled at each level of management is important. Some decisions should be taken by the top level of management (such as planning and monitoring) and others by the middle and lower levels of management (such as day-to-day activities related to providing service). A medium or large city will obtain greater efficiency by dividing the municipality into zones or wards for service provision and by delegating some decision-making powers. This mechanism will allow the zone or ward to allocate some of the available resources according to the particular needs of a zone or ward. The powers delegated to the zones or wards will ensure more effective supervision of the workforce engaged in tasks like sweeping streets, door-to-door collection, and secondary storage of waste as well as more effective handling of complaints from the public. For example, zonal or ward officers can take care of street sweeping, door-to-door collection, and secondary storage of waste while the municipality takes care of transportation, treatment, and disposal.

When functions are decentralized, administrative and financial powers to perform the tasks must also be decentralized. The municipality should give all the necessary resources and decision-making powers to local authorities, while making these authorities accountable for the roles they are performing.

In India, the 74th amendment of the constitution of India has made decentralization of administration obligatory in cities with a population above 300,000. The amendment requires that ward committees perform the municipal functions delegated to them.

Service Provision by Other Actors

Although the government is ultimately responsible for service provision, some of the functions can be transferred to the private sector, NGOs, or CBOs for more efficient service.

NGOs and the private sector can participate in many areas of SWM, such as providing door-to-door collection of domestic, commercial, and hospital waste; creating public awareness; and increasing public and community participation. The private sector may participate in setting up and operating composting plants and other treatment and disposal facilities. Contractual arrangements with the private sector can also provide for transport of waste, rent or lease of vehicles, or repair and maintenance of vehicles.

SWM services are highly labor intensive, and the higher wage structure of government and municipal employees makes such services more expensive with the passage of time. Moreover, the efficiency of the labor force employed in the urban local bodies (ULBs) is far from satisfactory. The high wage structure and inefficient workforce cause a steep rise in the cost of service; yet the public generally is dissatisfied with the level of service provided by the ULBs. Considering the involvement of other actors might alleviate the burdens on the public sector of managing the service.

When considering private sector participation, municipal authorities need to keep in mind the provisions of the government of India's Contract Labour (Regulation and Abolition) Act 1970, under which the government can prohibit the contracting out of services that are already being provided by the municipal authorities. Therefore, private sector participation should only be considered when the law allows private participation.

When most functions are delegated to the private or nongovernmental sectors, the municipal government must monitor service provision and encourage good services even in areas that might not be profitable or easy to access for the private sector or NGOs. Good service can be encouraged by providing the right incentives and enforcement mechanisms. For this purpose, an adequate legislative and regulatory framework, with appropriate compliance and enforcement mechanisms, is necessary to ensure adequate performance by private enterprises. Moreover, a supportive and consistent legislative and regulatory infrastructure—such as rules of liability, insurance coverage, bankruptcy protection, and public contract law—forms an indispensable foundation for the development of mixed public and private sector systems.

Institutional Setup in India

In India, the law sets out in a very specific manner how solid waste should be managed. Solid waste management is a state function; however, the central government has powers to enact laws and frame rules for environmental protection. Accordingly, the government of India has enacted Environment Protection Act 1986 (EPA) and under the provisions of this act has framed rules for managing and handling municipal solid waste, biomedical waste, hazardous waste, and so on.

Management of municipal solid waste is covered in all state laws pertaining to municipal governance, but all the issues relating to SWM are not adequately addressed in state laws. The government of India has, therefore, framed uniform rules, the Municipal Solid Waste (Management and Handling) Rules 2000, pursuant to the EPA and has made it mandatory for all municipal authorities in the country to implement those rules within the prescribed time frame. (Chapter 1 addresses those rules in more detail.)

Central Government Level

Because the subject of SWM is left to the states and passed on to the ULBs by state governments, the central government has a very limited role. The role of central government is principally to frame laws and rules, which it does through the Ministry of Environment and Forests, and to provide guidelines, technical assistance, financial support, and so forth, which it accomplishes through other ministries such as the Ministry of Urban Development and Poverty Alleviation.

The Ministry of Urban Development and Poverty Alleviation has already issued a national manual on solid waste management (Ministry of Urban Development and Poverty Alleviation 2000); constituted a technology advisory group; and published a report on appropriate technologies, financial aspects, and needs for training and capacity building. It has also facilitated allocations of 12th Finance Commission grants to the extent of Rs 25 billion to ULBs for improving SWM. This ministry has also been supporting training and capacity-building programs for municipal authorities.

The Central Pollution Control Board (CPCB) is the apex regulatory body in environmental matters. Its principal role is to monitor the implementation of the rules. However, the CPCB has taken several proactive measures by issuing guidelines and manuals and has also supported several training programs and pilot projects.

The Ministry of Agriculture and the Ministry of New and Renewable Energy are also playing an active role in promoting and providing financial support for composting of municipal solid waste and waste-to-energy projects, respectively.

State Government Level

The state governments are primarily responsible for appropriate SWM in the state. The state urban development department, which is responsible for looking after urban affairs through municipal corporations and state municipalities, plays a decisive role in directing the municipal authorities in implementing the rules and in giving them financial and technical support to facilitate implementation.

The state environment department usually plays a role in monitoring the implementation through the urban development department and the state pollution control board. State pollution control boards (PCBs) are primarily responsible for monitoring the implementation of the Municipal Solid Waste (Management and Handling) Rules 2000 and for taking actions against defaulters. The state PCBs are also responsible for authorizing the municipal authorities or operators of the facilities to set up treatment and disposal facilities in the respective states. In addition to regulating local authorities, some state PCBs take a proactive role in guiding the local authorities in implementation of the rules.

Urban Local Body Level

The 74th amendment of the Indian constitution creates three tiers of ULBs:

- Municipal corporations
- Municipalities
- Transition areas, such as *nagar panchayats* and town *panchayats*

The country has 4,378 municipal authorities. These authorities are responsible—under the respective state laws and the Municipal Solid Waste (Management and Handling) Rules 2000—for managing municipal solid waste in an appropriate manner (table 4.1). They are expected to follow the directions given in applicable state laws and the 2000 rules, and they must adhere to the time frame prescribed.

Urban Local Bodies: A Key Player in India

In most Indian cities, health officers (usually medical professionals) are placed in charge of the SWM departments. They generally lack the technical background and knowledge of engineering and environmental aspects of SWM and, therefore, generally focus more attention on preventive health services and food sanitation, giving little attention to waste management and the treatment and final disposal of waste. Most often, the responsibility of managing solid waste is passed on to sanitary inspectors and supervisors. In only a few large cities are engineers in charge of SWM systems, but they are not necessarily environmental engineers with experience in such systems. Sanitary inspectors have limited technical capabilities with very specific knowledge on traditional ways of collecting the waste: sweeping streets, taking waste to open waste storage depots, and transporting waste in open

trucks for disposal. They lack the technical knowledge to provide more efficient service and have no knowledge regarding treatment and disposal of waste. Many small municipalities do not have even a qualified sanitary inspector to take care of SWM service and to supervise sanitation workers (box 4.1).

Table 4.1 SWM Institutions and Functions

Responsible institution	*Roles and responsibilities in SWM*
Central government	Make laws and rules; frame policies; prepare guidelines, manuals, and technical assistance; provide financial support; monitor implementation of laws and rules.
State government	Make state-level laws and rules; frame policies; prepare guidelines, manuals, and technical assistance; provide financial support; monitor implementation of laws and rules.
Municipal authorities and state government	Plan for SWM treatment facilities.
Municipal authorities	Collect, transport, treat, and dispose of waste.
Municipal authorities with the approval of state governments	Frame bylaws; levy and collect fees.
Municipal authorities and state and central governments	Finance SWM systems.

Source: Authors' compilation.

Box 4.1 Sanitation Workers in India

In most municipal authorities, large numbers of sanitation workers are appointed to sweep streets and take the waste to the waste storage depots. They follow an age-old practice of making small heaps on the roadside and leaving the heaps for another set of colleagues to pick up, or they themselves pick up the waste in their handcarts and take it to the waste storage depots.

Most sanitation workers are deployed without proper fixation of norms. In some states, four workers are appointed per 1,000 population; in other states, one worker is assigned per 500 meters of road length. At some places, the workers are given 30,000 square feet of area to be swept; at other places, a larger area is given that they cannot cope with. These sanitation workers generally perform their duties in two sessions: four to five hours in the morning and three to four hours in the afternoon.

A second category of sanitation workers is deployed by the municipality for transport of waste. These workers load waste manually into open trucks or tractor trolleys and take the waste to the disposal site. Generally, six sanitation workers are deployed for loading a truck, and two to four workers are deployed for loading a tractor trolley.

Both categories work under unhealthy conditions with no or limited protective gear, resulting in injury to health. Sanitary workers are generally illiterate and poor. They do not have any exposure to modern systems and generally resist any changes or improvements in the system for fear of losing their employment.

Most sanitary workers perform their duties for two to three hours in the morning with some effectiveness, but thereafter the performance deteriorates. Most sweepers generally do not do any substantial work in the afternoons. Workforce efficiency is well below 50 percent. Workers are not motivated to perform better, and their problems are not properly addressed by management. The few qualified sanitary inspectors generally supervise the work of street cleaning with the help of sanitary workers.

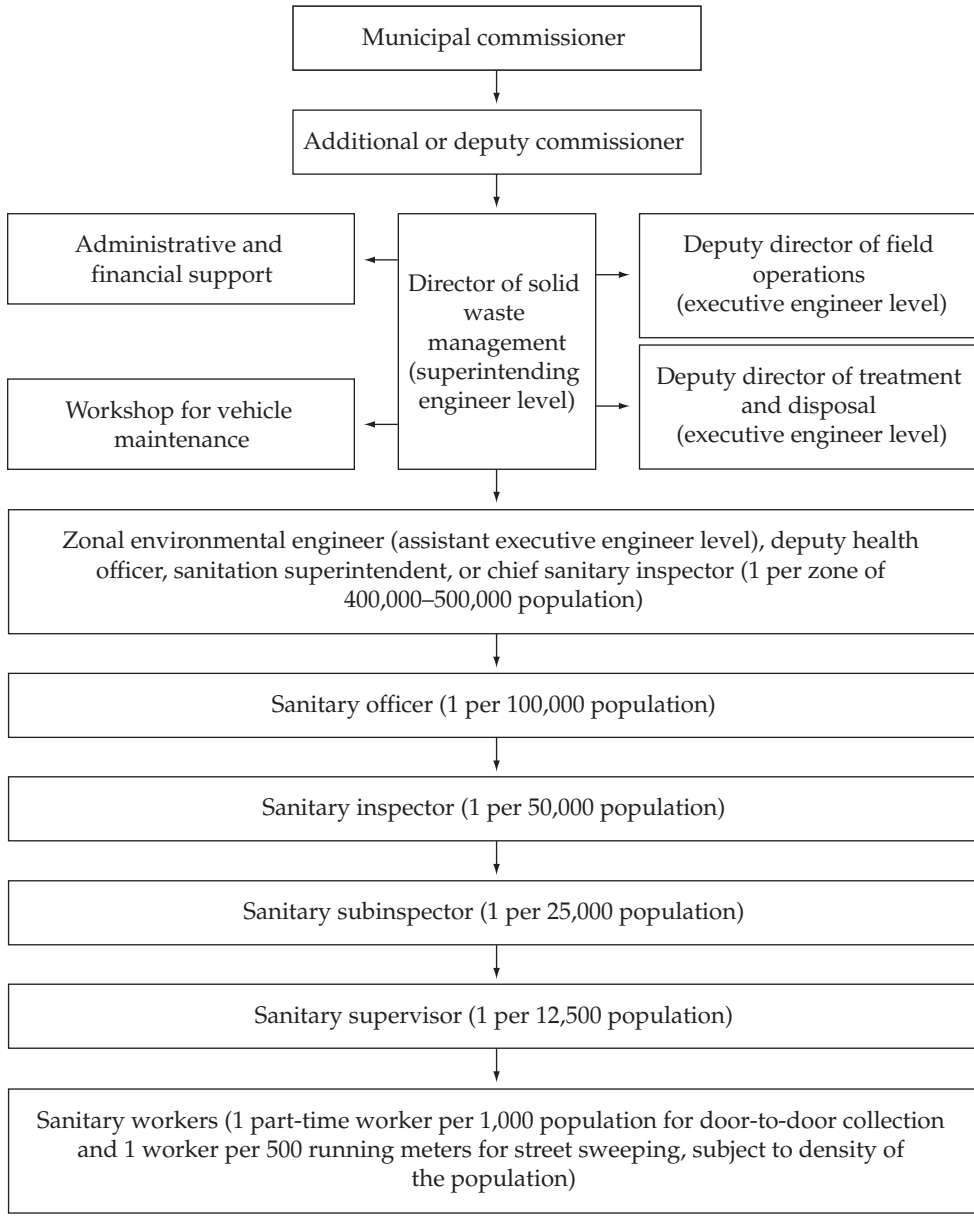
Source: Authors.

The suggested organigrams in figures 4.1 and 4.2 are based on the recommendations made in the *Manual on Solid Waste Management* (Ministry of Urban Development and Poverty Alleviation 2000).

Professionalization of SWM

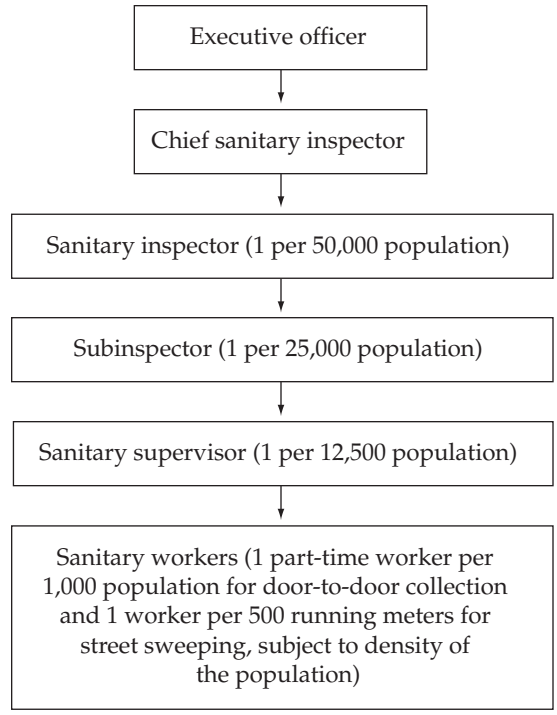
A step needed to improve SWM systems in India is to upgrade the profession of those working with waste. Most often, the profession is neglected and seen as very low status, ignoring the importance such a crucial job has for the well-being of the population. Professionalizing the solid waste sector means building the capacity of

Figure 4.1 Large Municipal Corporation



Source: Ministry of Urban Development and Poverty Alleviation 2000.
Note: A large municipal corporation serves a population of about 2 million.

Figure 4.2 Municipality



Source: Ministry of Urban Development and Poverty Alleviation 2000.
Note: A municipality has a population of about 100,000.

workers to perform more effectively and efficiently given the existing conditions. It also means that workers will perform their duties in a safe environment under healthy conditions, such as being provided with proper clothing and proper equipment to perform the job.

Training, motivation, incentives for outstanding service, and disincentives for those who fail to perform are essential for human resource development (box 4.2).

Box 4.2 Human Resource Development

Special Training for Unqualified Staff
Unqualified supervisory staff members should be given in-service training so that they can obtain the necessary qualifications for supervising sanitation workers.

Training for Supervisors and Senior Officers
All officers and supervisors must be exposed to training to learn of advances in the SWM sector and best practices adopted by different cities within the state, the country, and abroad.

Refresher Courses for Supervisory Staff
Refresher courses should be conducted for officers and supervisors at least every five years.

Promotional Opportunities
Adequate promotional opportunities should be available in the decentralized SWM hierarchy to encourage supervisory staff members to remain in the department.

Source: Authors.

The municipal authorities should make concerted efforts to inculcate among its officers and staff a sense of pride in the work they do and to motivate them to do their best to improve the level of services in the city and the image of the municipal administration.

The Supreme Court's expert committee on SWM has recommended hiring the following professionals in municipal services to scientifically manage municipal solid waste (Supreme Court 1999):

- One superintending engineer (public health or environmental engineering) per 2 million population
- One executive engineer (public health or environmental engineering) per 1 million population
- One assistant executive engineer (public health or environmental engineering) per 500,000 population
- One assistant engineer per 250,000 population
- One qualified diplomate chief sanitary inspector per 100,000 population
- One qualified diplomate sanitary inspector per 50,000 population or part thereof
- One qualified diplomate sanitary subinspector per 25,000 population or part thereof
- One sanitary supervisor (*mukadam*, who can read, write, and report) per 12,500 population or part thereof

The *Manual on Solid Waste Management* (Ministry of Urban Development and Poverty Alleviation 2000), which was developed by the Central Public Health and Environmental Engineering Organization (CPHEEO), recommends the following deployment of human resources in India:

Door-to-Door Collection

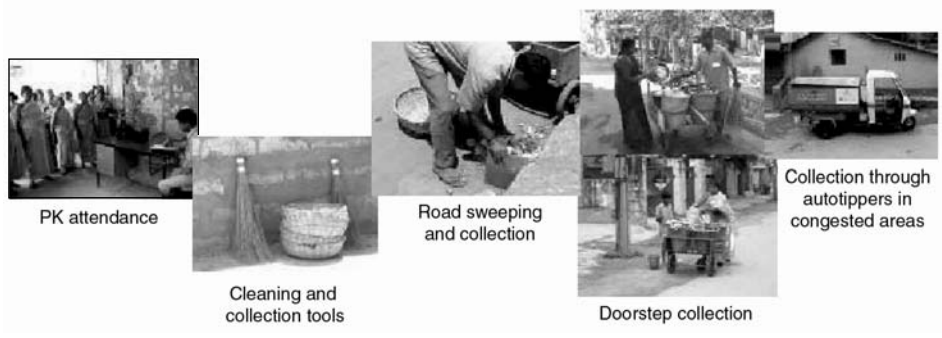
Given the local conditions of narrow lanes and the availability of a low-cost workforce, deploying people rather than machinery for door-to-door collection of waste is appropriate. One sanitation worker can provide door-to-door collection service to an average 1,000 people or 200 houses or shops in just four hours. This number varies depending on population density. In high-density areas, a part-time worker can cover even 300 houses, whereas in low-density, posh residential areas, one worker may cover only 125 to 150 houses. Ahmedabad, Bangalore (box 4.3), Namakkal, New Barrackpore, North Dum Dum, and Suryapet are a few examples of such an arrangement.

A vehicle such as a pickup van can be deployed for door-to-door collection in areas with a hilly terrain or in flat areas that do not have an adequate labor force. In such cases, a small van or other vehicle can cover 1,000 to 1,500 households and shops. One driver and one or two sanitary workers should be sufficient in such instances.

Indian culture requires that garbage be removed from the house in the morning. Therefore, four hours' deployment of labor for door-to-door collection is considered adequate.

Box 4.3 Case Study Norms for Door-to-Door Collection of Waste and Street Sweeping in Bangalore

In Bangalore, door-to-door collection of waste with pushcarts has been implemented throughout the city in the 112 health wards serviced directly by the Bangalore Mahanagara Palike. The remaining 182 health wards are serviced through private contractors who do such work, or *pourakarmikas* (PKs). The one-time collection of waste from households and commercial establishments by pushcarts and the direct transport of waste to the truck are aimed at minimal handling of waste. The PK is given a specified extent of area, which is based on the length of the road and the number of houses on the street. This area is referred to as a "block," and the garbage collection and street sweeping in a particular block are the responsibility of the PK. The start and end of the collection route and the timing for the work are well chalked out for each PK.



Tools and equipment such as these are used in Bangalore for street sweeping and collection. (Photos by the Centre for Environment Education)

Source: Centre for Environment Education.

Street Sweeping

According to the norms for street sweeping, city streets need to be grouped into three categories: high density, medium density, and low density. Sanitation workers are allotted a length of street needs in accordance with the following norms prescribed in the *Manual on Solid Waste Management* (Ministry of Urban Development and Poverty Alleviation 2000):

- High-density area = 250 to 350 running meters of road length
- Medium-density area = 400 to 600 running meters of road length
- Low-density area = 650 to 750 running meters of road length

SWM services must be provided on all days of the year, including Sundays and public holidays. Therefore, 17 percent additional staff is necessary to provide substitutes for weekly days off of the usual workforce. This additional staff must be built into the SWM system. Moreover, additional workers may be needed if the staff is absent or on leave for other reasons so that the continuity and reliability of service can be maintained. (See box 4.4 for a case study.)

Box 4.4 Street Sweeping in Hyderabad

Unit Area
In Hyderabad, a yardstick of 500 meters road length per one sanitary worker is used. A team of 15 female workers for street sweeping, 3 male workers for carrying the street sweepings in handcarts to the secondary waste storage depot, and 1 supervisor is assigned per unit area of 8 kilometers' road length.

Contracting Model
Using the state's minimum wage structure, requirements for tools and equipment, and a reasonable profit margin for the contractor, a unit cost of Rs 48,853 per month per 19 sanitation workers for cleaning the streets during the day and Rs 69,250 per month per 19 sanitation workers for cleaning of important roads at night was calculated. Contracts were prepared for 161 packages to cover approximately 75 percent of the city roads, measuring 2,238 kilometers in road length; 1,928 kilometers were assigned for day sweeping, and 310 kilometers were assigned for night sweeping. Only one unit will be allotted to each contractor.

A team of street sweepers in Hyderabad is assigned a per unit area of 8 kilometers of road length. (Photo by the Centre for Environment Education)

Source: Centre for Environment Education.

Transport of Waste

If a mechanized system of lifting the containers is used, one driver and one sanitation worker per vehicle per shift should be enough to operate the waste transportation system. One worker should be able to connect the containers to the vehicles and to facilitate the unloading of the vehicle at the transfer station or disposal site. Total human resource requirements should include a substitute for weekly days off and for leave days and other days of absence.

In Ahmedabad, contractors are paid for secondary storage and transport of waste on the basis of the number of trips per kilometer made to the disposal site, subject to the condition that a container must carry a minimum of 2.25 metric tons of waste. If the container carries a lesser load, the payment is reduced proportionally.

Work Norms for Vehicles

Work norms can be prescribed for a variety of vehicles used, depending on the distance to be traveled and the places to be covered. These norms may be prescribed after conducting time and motion studies. A tractor may make six to eight trips to the disposal site in one shift if the distance is less than 5 kilometers, but it may make fewer trips if the distance is more or if the city is congested.

Norms for Supervision

The norms for appointing supervisory officers are based on *Manual on Solid Waste Management* (Ministry of Urban Development and Poverty Alleviation 2000). Supervision of sanitary workers directly affects the quality of service. All supervisory officers of the SWM department must remain in the field for three to four hours in the morning between the time of street sweeping and lunch break. The schedule for lower- and middle-level supervisors could be from 7:00 a.m. to 11:00 a.m.; for senior-level supervisors, it could be from 8:00 a.m. to 11:00 a.m. or from 8:30 a.m. to 11:30 a.m. and again for an hour or two between 2:30 p.m. and 5:30 p.m. or between 3:00 p.m. and 6:00 p.m. The department head needs to prescribe and monitor all norms of work for the supervisors. The sweeping areas and the number of garbage collection points to be inspected each day by the various levels of supervisors and the inspection of processing and disposal sites need to be spelled out to ensure adequate output by the supervisory staff.

Professional Development for Supervisors

Senior officials should be frequently exposed to developments taking place in various parts of the state and country. They should be sent out on city visits and to attend seminars, workshops, and training courses. They should also be involved in all decision making. Local supervisors should be exposed to best practices within the state from time to time so that they can learn from the experience of others and be motivated to perform better.

Monitoring, Evaluation, and Information Systems

Monitoring and Evaluation

Because they are ultimately responsible for SWM, local governments need to implement monitoring mechanisms to evaluate performance and demonstrate achievements, ensure accountability and contract compliance, and demonstrate good use of funds. The results of monitoring and evaluation will show the various stakeholders how the system is performing and will help the implementing agencies identify and implement corrective actions. Planning for monitoring and evaluation systems should include the following:

- Select SWM indicators that will help measure the achievement of SWM objectives.
- Define the benchmarks or targets against which to judge service performance.
- Define a method for collecting data (see the following section).

Monitoring and evaluation should be done over time, and the methodology should include frequent reporting to show progress or gaps in provision of service. The municipality should appoint an independent body for this important task. That body will also be in charge of issuing permits and licenses and performing control functions. The monitoring agency should be able to show that each component of the system is performing in compliance with the existing laws and regulations and is meeting targets established in the SWM plans.

See table 4.2 for some suggested indicators. Note that indicators as well as benchmarks should be developed for each component of the SWM system (collection, sweeping, transfer, disposal, and recycling) and should be adapted to the local conditions.

Table 4.2 Indicators for SWM

Indicator	*Description*
Quality and accessibility	*How is the quality and coverage of service provided?*
Collection coverage	Percentage of the population covered by cleaning and collection
Collection frequency and reliability	Frequency per week, collection points, and distance to collection points
Cleanliness	Cleanliness of collection points
Efficiency	*Are resources being used optimally?*
Solid waste productivity	Average kilograms of refuse collected per working day per staff member
Cost-efficiency	Costs of cleaning, collection, transport, and disposal
Equipment performance	Percentage of equipment operational (average)
Absenteeism	Percentage of workers in service
Financial viability	*Can the service sustain itself?*
Accounting systems	Estimated total costs of SWM, including cleaning, collection, transfer, and disposal
Cost recovery	Percentage of total costs recovered (cleaning, collection, transfer, and disposal)
Sources of investment finance	Mechanisms to invest in the system
Legitimacy and social acceptability	*How the service is taking care of workers and customers?*
Labor conditions	Labor situation, job status, wages and benefits
Affordability	User charge as percentage of household income (in US$)
Customer service	Channels for customers to complain about service
Customer satisfaction	Perception about cleanliness of zone
Health and environmental sustainability	*How is the service taking care of the environment?*
Controlled disposal	Percentage of controlled versus illegal dumping
Reuse and recycling	Percentage of waste that is recycled or reused
Equipment pollution and emissions	Exhaust emission control of vehicles, control of litter, and washing of vehicles
Hazardous waste	Percentage of total hazardous waste segregated in separate bins and treated

Source: Authors' compilation.

Information Systems

Good management is the key to keeping a city clean, and good management requires the collection of critical information, not just for keeping the records up to date but also for taking corrective measures as well as properly planning for the future. Information must be collected to obtain an overall idea of the prevalent situation, deficiencies in the system, and likely requirements for the future. It is also essential to provide channels for citizens to impart their comments, suggestions, and complaints.

Information that highlights day-to-day deficiencies in the system and that can be used to take corrective measures has to be collected at regular intervals to monitor the services provided. Computerization of such information helps all levels work not harder, but smarter, and increases the level of job satisfaction. With advances in information technology, geographic information systems can be introduced in large cities and can be integrated with existing municipal information systems.

Data that need to be recorded and studied include relevant information about the department for planning processes as well as specific information to ascertain whether everyone involved in SWM services is performing his or her duty well. The latter includes information about workers, vehicles, materials, repair and maintenance, processing plants, landfills, and so on. Making good use of information collected might alert management when something unusual is happening and allow it to anticipate actions to avoid service delays.

Boxes 4.5 through 4.8 highlight the most important information that must be periodically collected by municipalities to operate and monitor SWM systems.

Box 4.5 Information to Be Collected for SWM Systems

General Information at the City Level

- Area of the city
- Population of the city
- Decadal growth of population
- Number of wards, their area and population
- Ward information regarding the following:
  - Population density of different wards
  - Number of households, shops, and establishments
  - Number of vegetable, fruit, meat, and fish markets
  - Number of hotels and restaurants
  - Number of hospitals and nursing homes
  - Number of factories and manufactories
  - Number of slum areas and their population
  - Road length and width
  - Percentage of area covered by an underground sewage system
  - Percentage of area having surface drains
  - Percentage of area having no drainage facility
  - Number of public toilets and toilet seats
  - Number of public urinals
  - Number of nuisance spots

Continued

Box 4.5 Continued

Waste Generation

- Average quantity of waste produced each day
- Seasonal variations in daily waste generation
- Total quantity of waste produced annually during the past three years
- Breakdown of the quantity of wastes generated:
  - Household, shops, and establishment waste
  - Vegetable and food market waste
  - Meat, fish, and slaughterhouse waste
  - Construction and demolition waste
  - Hospital waste
  - Industrial waste
- Average number of carcasses removed each day

Staff Positions

- Number of sanitation workers for collection
- Number of sanitation workers for the transport of waste
- Allocation of sanitation workers by ward
- Sweeper population ratio in each ward
- Sweeper road-length ratio in each ward
- Sweeper supervisor ratio in each ward

Waste Storage Depots

- Number of sites designated for temporary storage of waste (dustbins)
- Type and size of dustbin provided in each ward
- Quantity of waste generated each day by ward

Transport

- Number of vehicles available and their types, size, and age
- Number of trips made by each vehicle in one shift
- Number of vehicles used in the first, second, and third shifts
- Quantity of waste transported in each shift
- Total quantity of waste transported each day
- Percentage of total waste generated that is transported each day

Waste Processing and Disposal

- Number of waste processing and disposal sites in the city
- Their distances from the center of the city
- Area of these sites
- Quantity of waste treated or disposed of at each site
- Expected life of each landfill site

Financial Aspects

- Operating cost
- Cost of collection per ton per day
- Cost of transport per ton per day
- Cost of disposal per ton per day
- Allocation of revenue and capital budget

Source: Authors.

Box 4.6 Weekly Supervision and Inspection: Monitoring Data for SWM Systems

Collection of Waste

- Number of sweepers required to report for duty
- Number of sweepers actually reporting for duty
- Number of sweepers absent
- Areas left unattended
- Arrangements made or proposed to be made for clearing the backlog

Inspection by Supervisors for Street Sweeping and Primary Collection

- Number of people supervisor is required to supervise
- Number of people supervised during the day
- Number of cases where performance found satisfactory
- Number of cases where performance was not up to the mark
- Action taken or proposed to be taken
- Complaints received and responded to

Inspection of Cost-Recovery Services: Hotels, Hospitals, Commercial Streets, and Offices

- Number of cost-recovery sites under supervisor's charge
- Number of sites inspected
- Deficiencies noticed
- Complaints received and attended to
- Action taken or proposed to be taken

Inspection of Bulk Community Waste Storage Sites

- Number of waste storage sites in the area under supervisor's charge
- Number sites inspected
- Number of sites found well maintained
- Number of sites found ill maintained or in need of repair or replacement
- Action taken
- Number of unauthorized waste disposal sites identified during field visits
- Action taken

Inspection of Silt Removal Sites and Building Waste Disposal Sites

- Number of silt removal sites inspected
- Number of sites found satisfactory
- Number of sites where silt was found lying outside the manhole or surface drain
- Number of construction sites or construction waste disposal sites visited
- Number of sites where unauthorized disposal of construction waste was found
- Action taken

Transport of Waste

- Number and type of vehicles and equipment required to report for duty
- Number and type of vehicles and equipment that actually reported for duty
- Breakdowns reported during the day and action taken
- Number of trips made to the disposal site by each vehicle
- Number of bins cleared during the day
- Number and locations of bins left uncleared
- Arrangements made or proposed to be made for clearing the backlog

Quantities of Waste Transported

- Number of vehicles deployed during the day
- Number of trips made
- Quantity of waste transported
- Number of vehicles that did not make adequate trips
- Number of vehicles that transport waste but were not totally full
- Action taken or proposed to be taken against defaulters

Continued

Box 4.6 Continued

Monitoring of Complaints

- Number of complaints received
- Types of complaints received
- Action taken

Note: All complaints regarding SWM services should be registered at the relevant ward office and monitored on a daily basis by the ward officer, who should give a specific time limit to the supervisory staff of the sanitation department to dispose of the complaints and report compliance. Reviewing the number and type of complaints and whether timely corrective action is taken on each one forms an important part of the weekly review by senior officers.

Recovery of Additional Cleaning Charges

- Name of the ward
- Areas visited
- Additional cleaning charges recovered (number and amount):
  - From households
  - From shops
  - From offices
  - From other establishment
  - From roadside vendors and eating joints

Source: Authors.

Box 4.7 Monthly Supervision and Inspection: Monitoring Data for SWM Systems

Inspection of Processing Sites

- Was the plant functional during the week?
- Did it receive the garbage as prescribed regularly?
- Is the site properly maintained and is waste stacked properly?
- How much bioorganic fertilizer or desired material is produced?
- How much of the product is sold during the week?
- How much end product is in stock?
- Was any irregularity noticed?
- What action was taken?

Inspection of Waste Disposal Site

- What was the name of the site inspected?
- Was the entire staff present on duty during the week?
- Was the required machinery available on site on all the days?
- Are the approach road and internal roads properly maintained?
- Is the weigh bridge functional and properly used?
- How much waste was received at the site daily during the week?
- Was all waste spread, compacted, and covered on the same day received?
- Were communication facilities such as telephone or wireless functional during the week?
- Is shelter and drinking water facility adequate?
- Were any deficiencies noticed?
- Was remedial action taken or proposed to be taken?

Record of Trips Made by Transport Vehicle at the Processing and Disposal Sites

- Serial number
- Date
- Vehicle number

- Name of the driver
- Arrival time of the vehicle
- Trips made including this trip
- Waste source and route number
- Weight of waste in metric tons
- Deficiencies noticed
- Action taken

Workshop Performance

- Number and percentage of vehicles on road
- Number and type of vehicles under repairs at city municipal corporation or private workshop
- Nature of breakdown
- Duration of breakdown: under one week, one to two weeks, two to four weeks, or over one month
- Reasons for delay in repairs
- Date vehicle expected to be back on road
- Number and type of vehicles and equipment required to be given to the SWM
- Vehicles or machineries repaired by internal employees or by contractors
- Number and type of vehicles and equipment actually given
- Shortfall, if any, and reasons
- Alternate arrangements made

Source: Authors.

Box 4.8 Data Collection for Monitoring of SWM Systems: Monthly Reports

Cost Recoveries and Penalties

- Cost recoveries made every month for a variety of services rendered by ward
- Penalties or levy of administrative charges from offenders every month by ward

Legal Matters

- Number of cases filed in the courts each month for violation of sanitation laws
- Information collected for monitoring and other purposes analyzed
- Corrective measures taken

Note: Each member of the supervisory staff should have route maps and duty charts and should check whether work on-site is going as scheduled and whether vehicles and manpower are giving their optimum output. Wireless pagers or other communication networks are essential for effective communication and monitoring of services.

Monitoring Public Response

- Number of sweepers allotted for door-to-door waste collection work in each ward
- Number of sweepers getting good response from citizens in the matter of doorstep collection
- Number of sweepers not getting good response from the public
- Percentage of public participation
- Improvement in this area over the previous month

Source: Authors.

References and Suggested Readings

Bartone, Carl R. 1991. "Institutional and Management Approaches to Solid Waste Disposal in Large Metropolitan Areas." *Waste Management and Research* 9 (6): 525–36.

Cointreau, Sandra. 2001. "Declaration of Principles for Sustainable and Integrated Solid Waste Management (SISWM)." http://siteresources.worldbank.org/INTUSWM/Resources/siswm.pdf.

Ministry of Urban Development and Poverty Alleviation. 2000. *Manual on Solid Waste Management*. New Delhi: Government of India Publications.

Supreme Court. 1999. "Report of the Supreme Court Appointed Committee on Solid Waste Management in Class I Cities in India." Supreme Court of India, New Delhi.

5

Regional Landfill Planning

Pursuant to the Municipal Solid Waste (Management and Handling) Rules 2000, the municipal authorities in India are required to construct sanitary landfills for the disposal of waste. Therefore, they need to identify large parcels of land that meet the technical parameters prescribed by state pollution control boards and large enough for the disposal of waste for 20 to 30 years. Then they need to find a way to construct and operate the facilities.

For medium or small municipalities, finding land, building a sanitary landfill, and running the operations can be extremely difficult. The challenges are related to getting enough funds for the construction and operation, finding the technical personnel to operate the heavy machinery, and fighting the opposition from the neighborhoods where the landfill is located.

This chapter looks at regionalization as an option for small municipalities. In this situation, a group of neighboring municipalities creates a common landfill facility on a cost-sharing basis on a large parcel of land at a suitable location away from the cities. The operation and management is handled through a professional agency, the cost of which is shared by the participating municipalities in the form of tipping fees proportional with the waste delivered to the landfill site for disposal. Generally, the regional approach minimizes the scope of public objections and facilitates construction of large landfills that can be managed professionally in a cost-effective manner.

Mandatory Requirements for Disposal of Waste

The Municipal Solid Waste (Management and Handling) Rules 2000, state that waste should be disposed of in engineered landfills and never in open or unsanitary dumps. Sanitary landfills for municipal solid waste (MSW) are essential for the disposal of waste and unused residues from processing plants or other facilities when they cannot be further processed or recycled. Landfilling stands alone as the only waste disposal method that can deal with all materials in the solid waste stream. Other options, such as biological or thermal treatment, themselves generate waste residues that subsequently need to be disposed of in landfills. Consequently, landfills will always be needed in many solid waste management (SWM) systems.

The rules direct that landfill sites meet the specifications as given in Schedule III of the rules. Schedule III describes in detail site selection, facilities at the site, and specifications for landfilling; pollution prevention; water quality and ambient air quality monitoring; planting at the landfill site; closure of the landfill site; post-closure care; and special provisions for hilly areas. Landfilling must also be carried

out for residues of waste processing facilities as well as for preprocessing rejects from waste processing facilities. Disposal of mixed waste in a landfill should be avoided unless the waste is found unsuitable for waste processing. Sustainable SWM should reduce the waste going to landfill. Landfill is always the last option; waste processing, recycling, composting, and so forth are always the first option. If none of these options are available, waste goes to landfill. Without exception, landfilling shall be done following proper norms.

Schedule I of the rules stipulated that by year-end 2003 or earlier all municipal bodies in the country had to complete setting up of waste processing and disposal facilities. These rules apply to all 4,378 cities and towns in India.

Disposal Practices in India

Most of the MSW generated in Indian cities and towns is being disposed of in unsanitary landfills or open dumps. Most waste is disposed of in low-lying areas within or outside the city where waste is neither spread nor covered, thus creating serious problems of environmental degradation. Only seven cities and towns in India have established sanitary landfill facilities as of year-end 2006:

This waste dumpsite in Kolkata is unsanitary.

- Surat
- Pune
- Ahmedabad Urban Development Authority
- Puttur
- Karwar
- Navi Mumbai
- Bangalore

Following are the major constraints in setting up landfill facilities in India:

- *Unavailability of suitable land.* A major problem being faced by the municipal authorities is unavailability of suitable land that meets the state pollution control board criteria and can be used for 20 to 30 years for disposal of waste (table 5.1). The high cost of land close to cities and the NIMBY (not in my

Table 5.1 Criteria for Identifying Suitable Land for Landfill Sites

Place	*Minimum siting distance*
Habitation	500 meters
Rivers, lakes, bodies of water	200 meters
Nonmeandering water (canal, drainage, and so forth)	30 meters
Highway or railway line	300 meters from center line
Coastal regulation zoning	Landfill site not permitted
Earthquake zone	500 meters from fault line fracture
Flood-prone area	Landfill site not permitted
Airport	20 kilometers

Source: Authors' compilation.

back yard) syndrome make locating an appropriate parcel of land difficult. The NIMBY syndrome occurs when the population that is affected by the construction of a new landfill opposes its construction.

- *Lack of technical know-how and finances to develop and maintain the facility scientifically.* The criteria laid down for construction of a landfill are very stringent and difficult for a small municipal authority to meet. Most small municipal authorities do not have technical personnel and adequate financial resources to set up engineered landfills that meet the standards laid down in the 2000 rules. Moreover, they lack the knowledge and resources to operate and manage the facility once it is functioning.
- *Current approaches of municipal authorities.* Despite all the difficulties encountered by the municipalities, they have not attempted to find "outside the box" solutions. Current thinking revolves around setting up a disposal facility in each town on a small parcel of land within or outside the city because better options are not available.

The Regional Landfill Concept

Regionalization refers to bundling the waste disposal needs of several towns or cities and tackling the problem they share by creating one regional facility. The region could encompass a large metropolitan area that includes several contiguous municipalities. Alternatively, a cluster of small towns could share a common disposal facility.

Regionalizing the implementation of landfill facilities has many benefits. The single most important reason for considering regional facilities is economy of scale. Setting up and operating a sanitary landfill is a complex and expensive exercise. Creating small facilities is most often not practical or viable. Typically, for a sanitary landfill to be economically viable it needs to have a minimum capacity of 250 to 300 tons per day. An assumed per capita average waste generation of 0.3 kilograms per day would correspond to a city with a population of at least 800,000 to 1 million. For towns having lower levels of population—say less than 500,000—constructing disposal facilities would be economically unviable. Furthermore, municipalities cannot afford the expense of technical experts to construct and maintain a small facility because those experts will be underused; also, a small municipality will have more difficulty purchasing heavy machinery and paying for its day-to-day maintenance. The cost-effective and viable solution lies in adopting a regional approach that enables two or more municipalities to derive the benefits of economy of scale.

Financial Benefits of Regional Landfill

Regional landfills have a number of benefits:

- Reduction in the fixed costs (for example, lining, equipment, human resources, land, and overhead) per unit of waste because of the greater amounts of waste and the allocation of costs among several municipal bodies
- Cost saving because of sharing of overhead and maintenance costs among participating municipalities
- Sharing of professional management
- Improved bargaining power to buy better equipment and systems at lower costs

Technical Benefits of Regionalization

The technical benefits also should not be overlooked:

- The municipality has greater access to technical resources and professional expertise.
- It can use large and sophisticated equipment (for example, compactors).
- Large landfills allow waste to be stacked to greater heights—over 30 meters, compared with the common practice of 3 to 5 meters. Greater height also corresponds to greater depth of landfilling, which implies a substantial increase in available air space and, hence, waste disposal capacity per acre of land, meaning lower capital cost per ton of waste.
- A regional facility can be located at a considerable distance from the municipality, which helps overcome constraints on land availability.[1] Additional transport costs can be substantially offset by the cost savings in disposal and treatment.[2]
- A large landfill facility allows for proper planning and development of the site, with provision of an adequate greenbelt and other amenities that make the facility less offensive to the surrounding population. Over time, this improvement would help reduce the public opposition to location of landfill facilities.

The potential economy of scale is illustrated in table 5.2, which lists estimated costs of waste processing and disposal for various towns and cities of Maharashtra. As is evident, the cost per ton can drop sharply with rising waste loads. See also figure 5.1.

These economies of scale are evident in the terms of the recently signed contracts with private providers. For example, a midsized Indian city signed a contract for a 15-acre sanitary landfill catering to 150 tons per day, with a tipping fee of Rs 450 per ton. In contrast, a larger metropolis has entered into a contract for a 100-acre sanitary landfill catering to 900 tons per day, with a tipping fee of only Rs 185 per ton.

Challenges of Regionalization

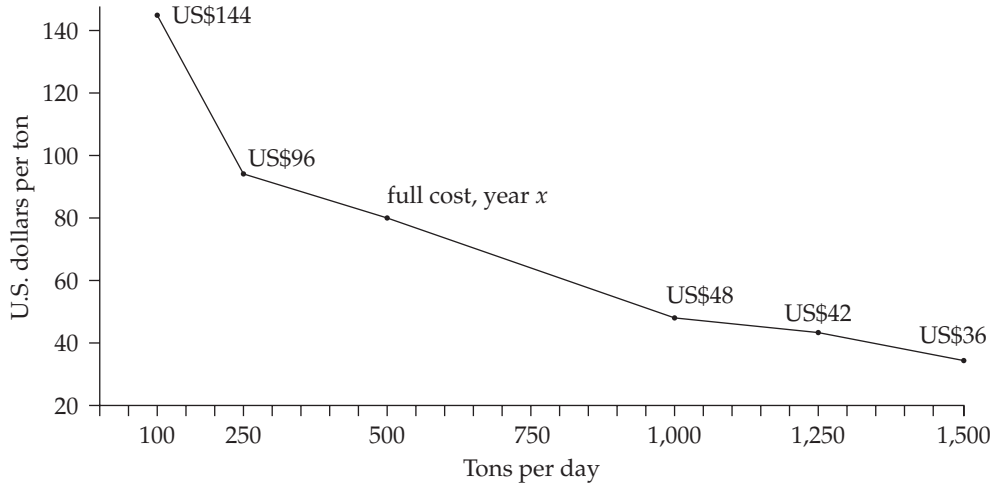
Despite all the advantages that regionalization of landfills brings, many challenges need to be addressed. The main challenge occurs when two or more municipalities come together with different resources and different goals. Although neighboring

Table 5.2 Economy of Scale for Treatment and Disposal of Waste

City (revenue division)	*Classification*	*Population (2001)*	*Waste (tons/day)*	*Estimated cost per ton of waste treatment and disposal (Rs)*
Aurangabad	Corporation	1,000,000	300	191.73
Latur (Aurangabad)	Class I	299,828	120	289.71
Wardha (Nagpur)	Class I	111,070	40	320.80
Yavatmal (Amravati)	Class I	120,763	25	562.72
Hingoli (Hingoli)	B class	69,552	15	617.19
Talode (Nandurabar)	C class	25,034	5	1,154.71

Source: Solid Waste Management Cell, All India Institute of Local Self-Government 2004.

Figure 5.1 A Cost Curve for the Current Costs of Landfill Disposal



Source: USEPA 1997.

Note: A *cost curve* relates the unit cost of an activity or path to the scale of that activity or path. In general, the greater the volume of units processed, the lower the per unit cost because fixed costs can be spread over more units and more efficient technology can be applied. This effect is referred to as an *economy of scale*. The per ton cost of MSW activities or paths in the long run will reflect their relative economies of scale.

municipalities share many common SWM needs and concerns, disparities in population, geography, industrial base, or other characteristics may make it difficult for them to agree on specific regional projects.

Municipalities considering regionalization should recognize that the costs and benefits of regional projects, although shared, will not necessarily be identical for all communities. Municipal officials might need to consider the trade-offs of sharing common facilities. For example, a community that sends its waste to a facility shared with another municipality benefits from not having to site and manage the landfill within its jurisdiction. However, it will probably be subject to fees levied by the community in which the waste management site is located. In contrast, for a municipality that hosts the site, the benefits come from cheaper waste disposal and the fees that it charges to other municipalities. However, it bears all the potential conflicts associated with siting a waste facility within its jurisdiction (see USEPA 1994).

Transport of waste across jurisdictions could also be a source of conflicts. Regionalization sometimes can require that waste be transported over long distances and through neighboring areas and communities. Moreover, routes leading to a regional solid waste facility might see an increase in traffic. The source of conflicts is related to the concerns over the resulting congestion, pollution, and roadway wear and tear.

Municipalities should explore these and other potential barriers thoroughly before embarking on any regional strategy. By acknowledging the potential obstacles up front, municipalities can take constructive steps to overcome these challenges. Most of the time, the benefits of regional landfills outweigh the potential problems, given room for negotiation among municipalities.

Establishment of a Regional Facility

Large opportunities exist for regionalization because most states have large parcels of wasteland that are away from the towns and that can be economically used for constructing a common facility for a group of towns. Using satellite imagery, the state of West Bengal has identified 29 sites to cover 126 cities and towns, the state of Gujarat has identified 44 sites to cover 168 cities, and the state of Rajasthan has identified 71 sites to cover 183 cities. Other states can follow the same example to economize on the cost of landfills.

To establish a regional facility, the parties initially should agree on the institutional arrangement that will enable the work among the different municipalities. This arrangement needs to address aspects such as decision-making powers, cost sharing, contracting, enforcement, and monitoring systems. A number of issues need to be considered when engaging in the regionalization of a landfill facility, as described in the following subsections.

Clubbing of Cities and Towns

Cities or towns that are close to a common parcel of suitable land and have good accessibility should consider a regional landfill. Ideally, the landfill will serve a cluster of towns totaling 500,000 to 1 million in population: the larger the population, the more viable the landfill.

For example, Ahmedabad Urban Development Authority clubbed together 12 municipalities situated around the city of Ahmedabad and created a common regional facility for integrated treatment and disposal of waste. The landfill site has been constructed with the help of a private party and will be in operation soon.

Collection of Data

Municipalities should request state government assistance in identifying suitable parcels of land. Access to satellite data can be helpful when selecting an appropriate large parcel of wasteland. Municipalities can use maps to study the parcels of land available and determine their proximity to the cities.

Evaluation of Other Options

Municipalities should consider and seriously evaluate other options. Regionalization, though often a good solution, might not be suitable for some municipalities.

After participating municipalities develop a list of goals for the regional effort—which might include reducing the amount of waste entering local disposal facilities, initiating recycling programs, and meeting state solid waste reduction goals—they should evaluate how regionalization will help meet those needs. Other factors to consider include transport distances, social and political influences, and environmental and social impact.

Financing of Regional Facilities

Various financing options are available for the construction, operation, and maintenance of a regional facility. For example, the budget could come from the central government, the state government, or the participating municipalities. Participating

communities can also apply for commercial loans and then repay the loans through tipping fees or taxes that are based on quantity of waste delivered to the facility or other parameters that may be agreed on by the parties in their memorandum of understanding. Private investor or contractor participation could also be an option. A more detailed discussion can be found in chapters 2 and 3.

Memorandum of Understanding among Interested Municipalities

State governments may encourage and facilitate municipalities to form regional entities and help them decide on the modalities for building and operation.

As part of the memorandum of understanding, an executive unit should be formed and authorized by the respective cities to deal with the issue of waste disposal. The executive unit may have powers to decide on contracting out the work of constructing the landfill and its operation and maintenance to another public agency or private contractor.

The operating agency might charge the participating municipalities tipping fees that are based on quantity of waste delivered at the disposal site or other parameters as may be agreed by the parties in the memorandum of understanding.

Sharing Information and Community Participation

Because local support is essential to the success of any project, municipalities need to consider ways of informing residents about regionalization and its advantages. Moreover, various societal groups have a stake in the SWM process, and they should contribute and share concerns during the planning process. Thus, the regionalization effort should include a public education component that

- Educates citizens about the purposes of regionalization and the expected benefits to the community
- Informs people about the ways in which planned changes in SWM could affect them (for example, a decision to collect and market recyclables in more than one jurisdiction, which could alter the way households dispose of their trash or separate their recyclables)
- Invites residents to participate in SWM decision making by using techniques such as conducting town meetings and having citizen representation on the committees

Different Types of Regional Organizations

The participating municipalities should establish a regional management organization. The regional management organization serves two key purposes:

- It serves as the formal management structure for regional projects.
- It implements the planned project, providing the necessary authority for financing, operating, and monitoring the SWM activities.

Different types of regional management structures are currently used. The type of structure chosen depends on such factors as available financing, applicable laws, and existing government bodies or regional organizations. Municipalities involved will make these decisions on the basis of the control they want to have over the

organization and the type of services or projects that the organization will oversee. For example, if a regionalization effort entails constructing waste management facilities or providing ongoing solid waste services, a formal, legal structure with financing capabilities might be needed. For a one-time project or a limited, clearly defined effort, such as arranging for equipment sharing, a more flexible arrangement might be appropriate.

Intermunicipal Agreements

Intermunicipal agreements are the most widely used type of organizational structure for regionalization projects. These agreements are contracts between two or more municipalities to perform a specific task together. They might be informal arrangements or more complicated legal contracts. (Note that only formal contracts are enforceable.) The primary advantages of intermunicipal agreements are flexibility and expediency.

Municipalities can combine their resources on specific projects without developing a formal organizational structure. One disadvantage to these agreements, however, can be difficulty in obtaining capital financing, because each participating municipality might have to raise money for the project individually. Consequently, intermunicipal agreements are often better suited for limited regional projects.

Authorities, Trusts, and Special Districts

In the United States, some communities create an authority, public trust, or special district to organize their regional program. Similar to government agencies, such organizations are dedicated to performing a specific, clearly defined public function (such as managing MSW). Authorities, trusts, and special districts frequently are granted the power to issue bonds, to levy taxes or assessments, or to use other means to raise funds for specific projects. Depending on state laws, they also can have the power to impose regulations, to contract with private companies, or to take other steps to perform their function.

These organizations often operate under a separate budget from member communities and are administered by a board of directors that is composed of private citizens rather than elected officials. Because they often have jurisdictional authority and the power to raise revenues, authorities, trusts, and special districts can have considerable political and financial independence. Such autonomy helps them sustain cooperative partnerships among communities and execute projects in an environment free of local politics. Most communities set up an advisory board or establish a reporting structure for the organization that ensures proper oversight. A number of states have legislative provisions to establish authorities, trusts, or special districts as part of SWM.

Nonprofit Public Corporations

Nonprofit public corporations that are owned and managed by the participating municipalities can also operate regional programs. Typically, they are run as independent businesses, and member municipalities pay dues. Nonprofit public corporations raise additional funds through fundraising. In some countries, these organizations are tax exempt, and they can issue tax-exempt bonds, making fund-

raising easier. A board of directors, made up of elected or appointed officials from each municipality, makes decisions concerning policies, budgets, and operations. The boardroom serves as a forum for resolving jurisdictional issues, for planning the scope of services, and for setting waste management priorities.

Although nonprofit corporations are less independent than authorities, trusts, or special districts, they often can make decisions that municipalities cannot. For example, a nonprofit corporation could borrow money to finance long-term waste management projects whereas municipal authorities might be pressured to avoid debt. Although nonprofit organizations offer communities many advantages, establishing these organizations can be very time consuming.

Regional Councils

Regional councils are another approach used for intermunicipal cooperation. They can be referred to as councils of municipalities, regional planning commissions, or regional development centers. Regional councils can be used to organize and manage all types of cooperative projects. A key characteristic of regional councils is their flexibility. Depending on state or local laws, member municipalities can organize regional councils according to their specific needs. Forming a regional council can be a first step in a regionalization project. Through the council, public and private decision makers can be brought together to consider a regional strategy. If regionalization seems promising, the council can then plan and implement the program.

Private Sector Participation

Municipalities can take advantage of regional SWM services offered by the private sector. Cooperative arrangements with private businesses can be used for a range of services, from transporting MSW to the regional landfill system to financing, construction, and operation. In this type of arrangement, regional organizations enter into binding agreements with businesses to provide specified services. These contracts can be structured to emphasize particular goals, such as quality of service or cost savings. Contracts between local governments and businesses generally are governed by the public contracting laws of the state.

Generally, commercial enterprises can offer a number of benefits to communities, including expertise in the latest solid waste technologies, lower costs, and extensive corporate experience. A disadvantage of using private companies is the potential loss of flexibility for participating municipalities. Another possible disadvantage is the lengthy and frequently complex competitive bidding process. Long-term contracts, while generally cost-effective, might work against the best interests of individual municipalities when market conditions or circumstances change significantly. In addition, the regional organization will need to monitor the contractor performance and compliance and to perform enforcement functions.

Notes

1. In some industrial countries, these distances may even be up to 200 or 300 kilometers from the point of generation.
2. Increased distances would, however, require the use of transfer stations to increase the efficiency of the transport system.

References and Suggested Readings

Ball, Jarrod M., ed. 1994. *Minimum Requirements for Waste Disposal by Landfill*. 1st ed. Pretoria, South Africa: Ministry of Water Affairs and Forestry.

Cointreau, Sandra. 2004. "Sanitary Landfill Design and Siting Criteria." World Bank/Urban Infrastructure Note. http://www.worldbank.org/urban/uswm/landfillsitingdesign.pdf.

Johannessen, Lars Mikkel. 1999. "Guidance Note on Leachate Management for Municipal Solid Waste Landfills." Urban and Local Government Working Paper 5, World Bank, Washington, DC. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2000/11/04/000094946_00101805321685/Rendered/PDF/multi_page.pdf.

Johannessen, Lars Mikkel, with Gabriela Boyer. 1999. "Observations of Solid Waste Landfills in Developing Countries: Africa, Asia, and Latin America." Urban and Local Government Working Paper 3, World Bank, Washington, DC. http://web.mit.edu/urbanupgrading/urbanenvironment/resources/references/pdfs/Observations.pdf.

Nie, Yong-Feng, Tian-Wei Li, Yan Gang, Ye-Yao Wang, and Xiao-Fan Ma. 2004. "An Optimal Model and Its Application for the Management of Municipal Solid Waste from Regional Small Cities in China." *Journal of the Air and Waste Management Association* 54 (2): 191–99.

Oeltzschner, Hansjörg, and Dieter Mutz. 1996. "Guidelines for an Appropriate Management of Sanitary Landfill Sites." Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Munich, Germany.

Rushbrook, Philip E. and Michael P. Pugh. 1999. *Solid Waste Landfills in Middle and Lower Income Countries: A Technical Guide to Planning, Design, and Operation*. Washington, DC: World Bank. http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000094946_02112104104987.

Savage, George M., Luis Diaz, Clarence G. Golueke, Charles Martone, and Robert K. Ham. 1998. *Guidance for Landfilling Waste in Economically Developing Countries*. Research Triangle Park, NC: International Solid Waste Association and CalRecovery.

Solid Waste Management Cell, All India Institute of Local Self-Government. 2004. "Action Plan for Implementation of MSW Rules 2000 in Maharashtra." All India Institute of Local Self-Government, Mumbai.

Thurgood, Maggie, ed. 1998. "Decision-Maker's Guide to Solid Waste Landfills: Summary." World Bank, Washington, DC; World Health Organization, Copenhagen; Swiss Agency for Development and Cooperation, Bern, Switzerland; and Swiss Center for Development Cooperation in Technology and Management, St. Gallen, Switzerland. http://www-wds.worldbank.org/servlet/WDSServlet?pcont=details&eid=000178830_98111703545138.

USEPA (United States Environmental Protection Agency). 1994. *Joining Forces on Solid Waste Management: Regionalization Is Working in Rural and Small Communities*, Washington, DC: National Association of Regional Councils and Environmental Protection Agency Office of Solid Waste.

———. 1997. *Full Cost Accounting for Municipal Solid Waste Management: A Handbook*. EPA 530-R-95-041. Washington, DC: USEPA. http://www.epa.gov/epaoswer/non-hw/muncpl/fullcost/docs/fca-hanb.pdf.

World Bank. 2003. Draft Report: Regional Solid Waste Management Project—Regional Guidelines. Mediterranean Environmental Technical Assistance Program, World Bank, Washington, DC.

6

Reduce, Reuse, and Recycle

This chapter highlights the 3R concept—reduce, reuse, recycle—as the state-of-the-art philosophy in waste management. Waste is reduced, reused, or recycled in order to minimize the amount that ends up in landfills. Waste must be regarded as a potential resource, so it is essential to make the best use of this material. Through minimization, recovery, and recycling, society not only saves scarce resources but also protects the environment and alleviates the burden on the public authorities that are responsible for managing waste.

The rapid pace of urbanization and change in people's lifestyles—especially for those with higher incomes—increases the consumption of products that have shorter life spans and higher volumes (paper, plastics, and the like). These products, as well as changes in food choices, are adding to the volume of waste burdening municipal authorities.

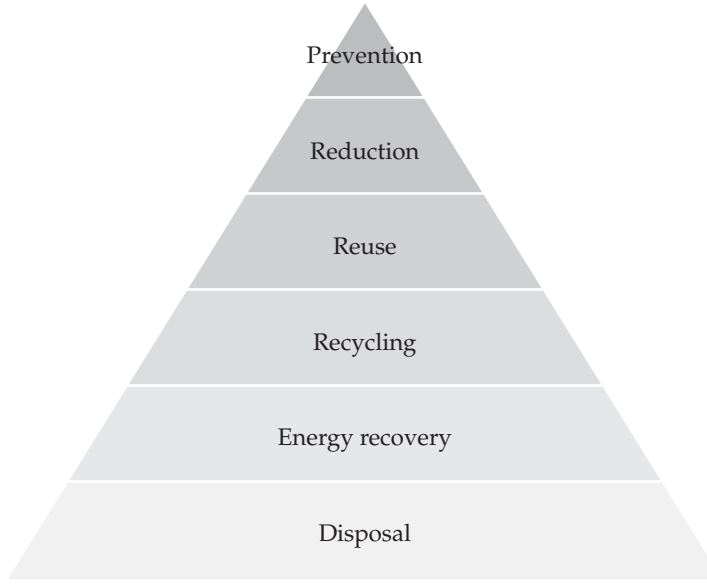
The still high fraction of organic waste in India suggests the need to develop strategies for recycling organic waste. Organic waste that can be segregated easily at the household level for further treatment can significantly reduce the amount of waste that must be disposed of. It also increases the value of that waste by facilitating the recycling of other materials in the waste stream.

This chapter provides information on the current practices of organic waste recycling in India and strategies for further improvements. It discusses the amount of recyclable materials currently available in the waste stream and informs on current and recommended measures and practices to strengthen the recycling sector, including its stakeholders (such as the informal sector of rag pickers). The goal is to show pathways that lead to improved reduction, reuse, and recycling and thereby to obtain more and better secondary raw material for the production sector. This chapter brings to the fore the unacknowledged services provided by informal rag pickers in conserving national resources and discusses various ways to enhance their contribution in this sector.

The Waste Management Hierarchy and the 3R Concept

The 3R concept is reduce, reuse, and recycle. The concept is based on the waste management hierarchy. This hierarchy classifies waste management strategies according to their potential to minimize waste. Waste reduction, reuse, and recycling are the main categories that we need to focus on regarding the 3R concept (see figure 6.1 to see how they fit in the hierarchy). As stated before, the main objective is to reduce the amount of waste that is disposed of in landfills. The 3R concept fosters cooperation among waste generators, waste collectors, processors, and manufacturers. It aims at reducing waste to be disposed of in landfills, thereby reducing

Figure 6.1 Waste Management Hierarchy



Source: Sandec 2004.

the deterioration of the environment, reducing the emissions that landfills produce, and saving energy and natural resources.

Waste Prevention, Reduction, or Minimization

Ideally, waste should be avoided. Waste that can be avoided stops being a burden for the municipality. Waste prevention is most effective if it is considered in the product design and production processes. By optimizing production processes, manufacturers can reduce waste or even allow it to be reused by another manufacturer. Valuable natural resources can therefore be saved.

Reuse

Reuse happens when something that already fulfilled its original function is used for another purpose. However, reuse does not involve reprocessing or transforming the item. For example, typical reuse strategies are the deposit refund system for glass bottles or polyethylene terephthalate (PET) water bottles, old tires that are used in fences or as boat fenders, steel drums that are reused as compost bins, or plastic bags that are reused as liners for household waste bins.

Recycling

Recycling means the reprocessing of used materials that would otherwise become waste. It breaks material down to its main component and produces new products. Recycling is most common for valuable materials or materials that are costlier if produced from virgin raw materials (such as metal, plastic, glass, and electronic waste). Recycling of organic matter produces compost, which can be used as a soil

enricher in gardens and horticulture and which contributes to improved agricultural production.

Recovery

Recovery relates mainly to energy recovered from waste. Waste that cannot be reused or recycled can be, for example, incinerated to generate heat or electricity. Another option—for organic waste—is anaerobic digestion to produce biogas. The appropriateness of such recovery strategies depends on the composition and calorific value of the waste.

Disposal

At the lowest level of the waste management hierarchy is final disposal. All remaining waste or residues from previous waste management processes must be stored in a final disposal site. The disposal site must be designed and operated as a sanitary landfill to protect people and the environment from the negative impact of waste. Even at this stage, some recovery options are still feasible. Landfills emit methane gas caused by the anaerobic biological degradation of organic waste within the landfill. If the landfill is set up and managed appropriately, this landfill gas can be recovered for several years. However, in India, the Municipal Solid Waste (Management and Handling) 2000 Rules mandate that municipal authorities treat the organic fraction of waste before disposal. The availability of organic content in municipal solid waste (MSW) after treatment will be minimal, leaving no scope for landfill gas recovery.

Strategy for Implementation

Before developing a strategy for implementing 3R practices, municipal authorities must answer the following questions:

- Who are the recyclers?
- What are the advantages of recycling solid waste?
- What is being recycled?
- What is not being recycled and why?
- What are the main challenges?
- What steps are necessary to improve the recycling and resource recovery of materials?

Ideally, the 3R concept will be applied as early as possible in the waste generation and management chain so that managers of waste

- Can maintain the high material quality and value of recyclable waste materials
- Can reduce the loss of valuable natural resources and virgin raw materials
- Can limit pollution of land
- Can reduce long-distance transport of waste
- Can reduce landfill space requirements and environmental pollution
- Can minimize the costs of both production of goods and management of waste

Recycling Materials

Almost every material can be recycled; however, the value of the recycled material can vary significantly depending on the demand and uses for it. Indeed the value of a material is the driving factor for private recycling initiatives or—in the case of many developing countries—the informal sector. If and how a material is recycled depends not only on local policies but also on the availability of a buyer, processing facilities, and a transport chain.

Advantages of recycling are as follows:

- For the managers of waste:
  - Reduction of waste volume
  - Cost savings in collection, transport, and disposal
  - Longer life span for landfills
  - Reduction of adverse environmental impacts
- For the economy:
  - Reduction of imports (for fertilizers or soil amendments) and thus less foreign currency required
  - Job opportunities and income for the people
  - Cheap products (made from recycled materials) for the poor
- For the environment:
  - Sustainable use of resources: for example, less energy consumption and thus less pollution
  - Reduced amount of waste going to storage sites, resulting in a more manageable system

Table 6.1 gives an overview of typical recycling materials and their potential treatment options.

Table 6.1 Important Recycling Materials: Advantages and Drawbacks

Material	*Advantages*	*Drawbacks*
Aluminum	• Aluminum has a high market value. • It can be easily recycled by shredding and melting. • It can be recycled indefinitely because it does not deteriorate from reprocessing. • Aluminum recycling requires significantly less energy than producing aluminum from ore.	• Separate collection is important. • Recycling is suitable only if a processing plant is available.
Batteries	• Recycling recovers valuable metals. • Recycling protects the environment from heavy metals such as lead, cadmium, and mercury.	• Large variation in type and size of batteries requires specific recycling processes. • Older batteries have high heavy metal content.

Material	*Advantages*	*Drawbacks*
Concrete and demolition waste	• Demolition waste can be crushed to gravel and reused in road construction and landscaping.	• Machinery required for crushing is maintenance intensive. • Recycled waste is valuable only if there is a lack of other construction material.
Glass	• Glass has a moderate market value. • It can be sorted into colors and melted. • Use of recycled glass saves energy compared with processing raw material. • Glass can be recycled indefinitely because it does not deteriorate from reprocessing.	• Broken glass can contaminate and eliminate opportunities for recycling.
Organic waste	• Most commonly recycled by composting or anaerobic digestion.	• Though compost is very beneficial to depleted soils, it still has a low market value.
Other metal	• Scrap metal has a high market value (especially steel, copper, silver, and platinum). • It can be recycled indefinitely because it does not deteriorate from reprocessing.	• High-value metals (such as copper and silver) are incorporated in electronic devices, but extraction can cause severe environmental impacts.
Paper	• Paper can be easily recycled; however, quality deteriorates with each cycle. • Paper or cardboard from recycled paper requires less energy to produce and protects forests.	• Appropriate technologies with circular processes are required to protect the environment.
Polyethylene terephthalate (PET)	• PET can be recycled if segregated from other waste. • Reprocessing into granulate is very easy. • PET has a high market value if processing plants are available.	• More "downcycling" than recycling occurs because quality decreases with every processing cycle.
Other plastic	• Other plastic, such as polyethylene or polyvinyl chloride, can be recycled but has less value on the market than PET; the value depends on recycling and manufacturing options in the vicinity.	• Recycling requires specific machinery.
Electronic waste	• Electronic waste (such as computers or mobile phones) contains high-value metals. • Electronic items can be dismantled, reused, or recycled.	• Metals are often covered with polyvinyl chloride or resins, which are often smelted or burned, causing toxic emissions.

Source: Sandec 2004.

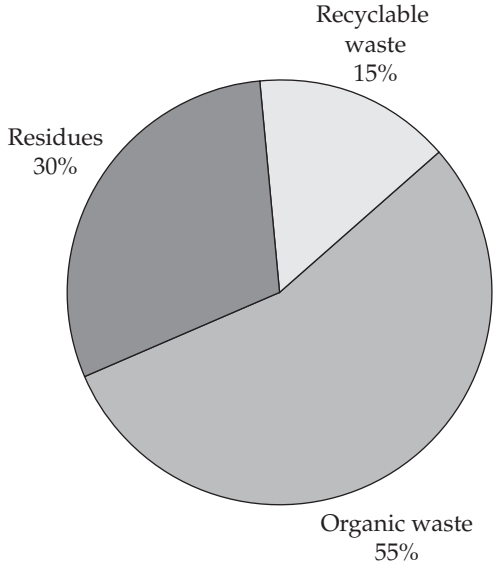
Different types of recyclable waste are generated from household goods (glass, plastic, and shoes).

Waste Generation and Composition in India

As discussed in chapter 1, the rate of waste generation in India is growing very quickly owing to urbanization and higher incomes. The current composition of waste carries a high potential for recycling that is barely exploited. Generally, about 15 percent of waste materials—which consist mainly of paper, plastic, metal, and glass—can be retrieved from the waste stream for further recycling (figure 6.2). Another 35 to 55 percent of waste material is organic waste, which can be converted into useful compost, leaving only 30 to 50 percent that needs to go to landfills.

Table 6.2 highlights the shares of different waste types generated in Indian cities that have populations of more than 1 million, as well as in state capitals and other important cities.

Figure 6.2 Recycling Potential: Intensive Recycling Reduces Waste to Be Disposed of in Landfills by 70 Percent



Source: Authors.

In India, waste materials such as paper, plastic, metal, glass, rubber, leather, and rags are recycled mainly through private initiatives and the informal sector. Organic waste recycling is still neglected by private initiatives, because of its low value and the lack of a market for compost. Composting is underdeveloped and remains the domain of the hundreds of small-scale schemes run by private initiatives at the household or neighborhood level and a few large-scale municipal composting sites.

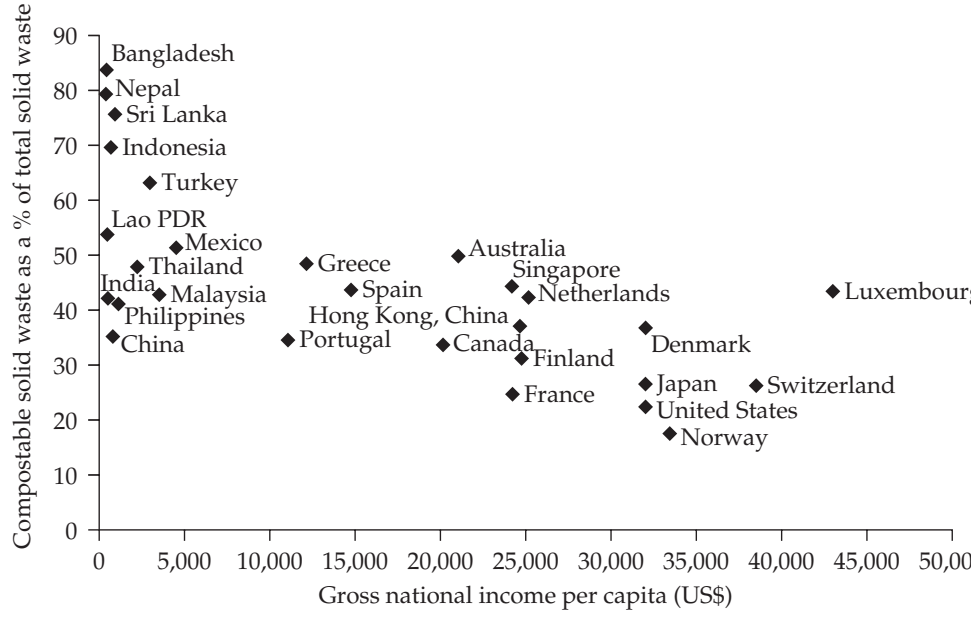
Statistical data show that when per capita income increases, the organic content of solid waste decreases (figure 6.3). Currently, the income level in India is still very low, and the organic content is much greater than in most industrial countries. These facts should be taken into consideration when urban local bodies make solid waste management (SWM) plans. Given the value and recycling potential of these

***Table 6.2 Physical Composition of Solid Waste in 1 Million Plus Cities and State Capitals in India* (Average Percentage Value)**

City	*Total compostable waste*	*Paper*	*Plastic*	*Glass*	*Metal*	*Inert materials*	*Rubber and leather*	*Rags*
Bangalore	51.84	11.58	9.72	0.78	0.35	17.34	1.14	2.29
Ahmedabad	40.81	5.28	5.29	0.79	0.30	39.28	0.92	5.00
Nagpur	47.41	6.87	7.45	0.92	0.29	18.01	5.38	9.48
Lucknow	47.41	6.87	7.45	0.92	0.29	18.01	5.38	9.48
Indore	48.97	6.10	5.77	0.55	0.15	31.02	2.95	2.41
Bhopal	52.44	9.01	12.38	0.55	0.39	18.88	0.09	2.65
Agra	46.38	6.12	8.72	0.85	0.11	30.07	1.97	3.92
Vadodara	47.43	5.98	7.58	0.47	0.47	27.80	1.28	4.86
Ludhiana	49.80	9.65	8.27	1.03	0.37	17.57	1.01	11.50
Patna	51.96	4.78	4.14	2.00	1.66	25.47	1.17	4.17
Jabalpur	48.07	7.67	8.30	0.35	0.29	26.60	2.15	4.42
Ranchi	51.49	3.17	3.45	1.79	1.45	25.92	1.45	4.97
Bhuwaneshwar	49.81	5.74	5.70	0.46	0.79	27.15	2.10	3.21
Nashik	39.52	9.69	12.58	1.30	1.54	27.12	1.11	2.53
Raipur	51.40	8.31	7.07	0.76	0.16	16.97	1.47	3.90
Allahabad	35.49	7.27	10.33	1.23	0.40	31.01	1.83	7.34
Faridabad	42.06	8.57	13.73	0.83	0.18	26.52	2.52	4.14
Visakhapatnam	45.96	14.46	9.24	0.35	0.15	20.77	0.47	2.41
Meerut	54.54	4.95	54.48	0.30	0.24	27.30	0.49	4.98
Asansol	50.33	10.66	2.78	0.77	0.00	25.49	0.48	3.05
Dehradun	51.37	9.56	8.58	1.40	0.03	22.89	0.23	5.60
Guwahati	53.69	11.63	10.04	1.30	0.31	17.66	0.16	2.18
Jameshdpur	43.36	10.24	5.27	0.06	0.13	30.93	2.51	2.99
Dhandabad	46.95	7.20	5.56	1.79	1.62	26.93	2.77	4.41
Gandhinagar	34.30	5.60	6.40	0.80	0.40	36.50	3.70	5.30
Daman	29.60	10.54	8.92	2.15	0.41	34.80	2.60	4.90
Agartala	58.87	8.11	4.43	0.98	0.16	20.57	0.76	2.17
Kohima	57.48	12.28	6.80	2.32	1.26	15.97	0.18	1.86

Source: Data from Central Pollution Control Board (n.d.).

Figure 6.3 Relation between the Amount of Biodegradable Waste and Income Level, 1999



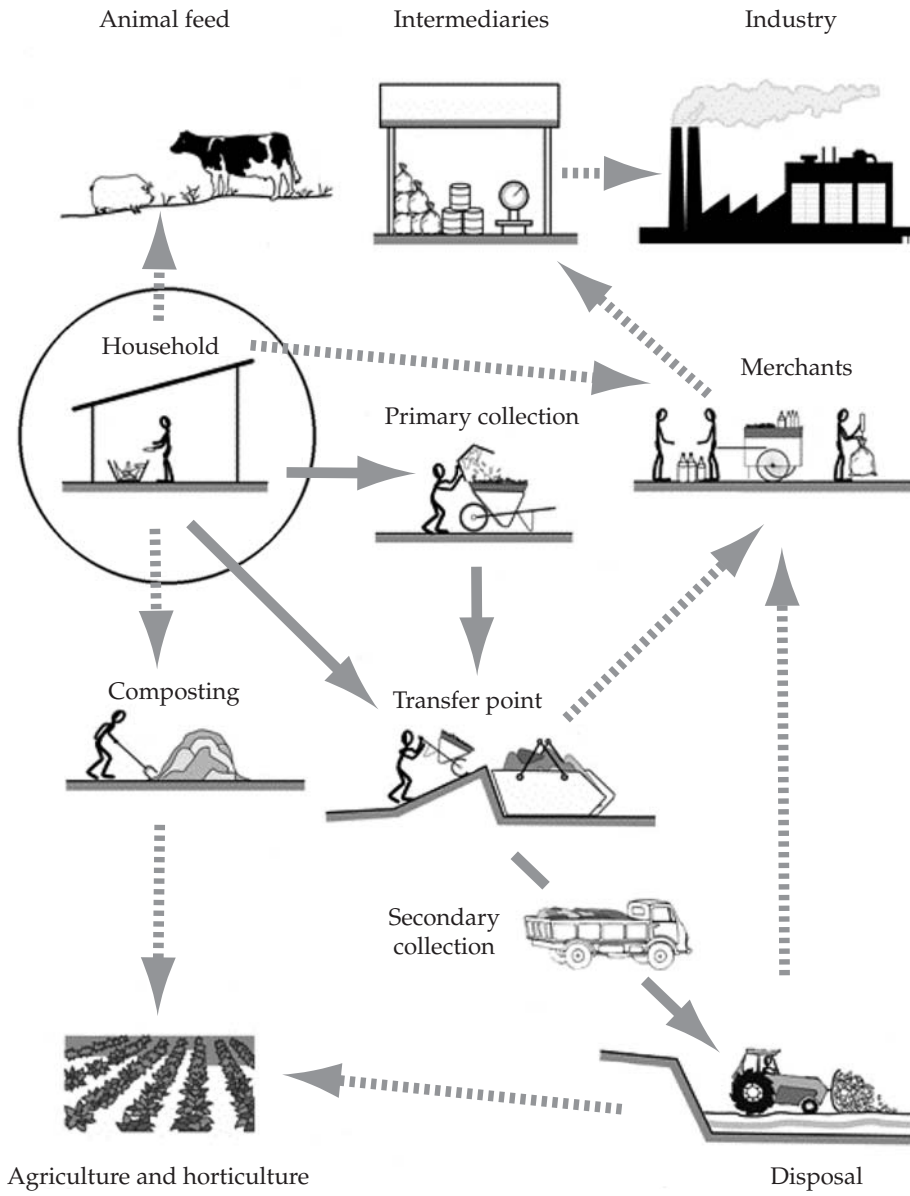
Source: World Bank 2001.

materials, the promotion of waste segregation in combination with waste reduction is the most important intervention for resource recovery.

Current 3R Practices in India

In most cases, materials that have some value are not lost in India. Recycling is practiced by several stakeholders at different points in the SWM chain (figure 6.4). However, at present there is a lack of coordination among the stakeholders and therefore still large scope for improvement.

Figure 6.4 Recycling and the Solid Waste Management Chain



Source: Sandec 2004.

Municipal Authorities

Currently, municipal authorities do not play a major role in recycling because they concentrate mainly on waste collection, transport, and disposal. They allow informal workers to act as intermediaries that fill the gap but with no legal basis. Some municipalities have recognized the potential of recycling to reduce the amount of waste going to landfills and are involved in recycling. They set up composting plants or support the recycling activities of nongovernmental organizations (NGOs). The 2000 rules require municipalities to take a leading role in improving the application of the 3R concept.

Households

The old tradition of households and small businesses selling reusable and recyclable materials such as newspaper, plastic bags, bottles, clothes, tins, and glass to waste purchasers at the doorstep is well known. The purchasers are known as *kabadiwalas*. However, as their incomes increase, people abandon the behavior of segregating waste at home and tend to throw away all such materials with other domestic (organic and inorganic) waste. One project by Infrastructure Professional Enterprises and the Centre of Environment Education studied segregation of household waste at the source; it was supported by the Japan International Cooperation Agency and implemented in three different economic areas of Delhi (JICA 2004). The project found that although the households in the lower-income colony generate the least quantity of waste per day, they keep the greatest number of types of material (plastics, glass, iron scraps, milk sachets, and so on) separate to sell to the recyclers. Middle- and high-income groups, which generate higher quantities of waste, keep a very limited range of materials (generally only newspapers) to sell and dump the rest of the materials along with other types of waste, which are subsequently sorted and sold by the waste collectors.

In an ideal situation, those who generate waste will segregate it, because waste segregated at source has a higher value. Segregation at source reduces the cost of segregating, cleaning, and handling recyclable material and protects the health of waste handlers. As shown in chapter 1, an increasing number of local initiatives are trying to link waste collection and waste recycling. NGOs train informal rag pickers and organize them in groups that offer door-to-door services to households. These services give rag pickers direct access to clean recycling materials. Unfortunately, these schemes do not have a significant effect at the city level because they are applied only locally and are barely acknowledged by municipal authorities.

The same principle could be applied to shops and other businesses, which still dispose of large amounts of recyclable waste in the municipal bins. This lack of recycling behavior adds a significant burden to the municipal authorities, who must manage more waste, and adds to the health and environmental problems of the inhabitants.

Informal Sector

Recycling—collecting and reselling waste materials with some value—represents an important livelihood strategy for the urban poor in India. Therefore, there is a well-developed system for the collection, reuse, and recycling of waste materials from

The informal sector plays an important role in waste recycling.

Recyclable waste is sorted and packaged at the intermediary's premises to be sold further.

domestic and commercial sources. As mentioned before, recycling activities are the domain of the informal sector, and municipal authorities are barely involved (box 6.1).

As shown in figure 6.4, waste is sorted and collected at all levels of the SWM chain. Rag pickers collect waste from households, public waste bins, the streets, and the landfill site. A well-organized—however informal—system of rag pickers, waste merchants, intermediaries, and recycling industries earns a living from recyclables (box 6.2). Rag pickers collect and sort recyclables and sell them to intermediaries, who have the space to further clean, sort, and store the waste. The intermediaries sell the material to merchants with sufficient means of transport, who then resell the material in bulk to the appropriate recycling industry.

The current practice of material recovery and recycling often causes additional littering in streets when rag pickers rummage in the waste bags and bins. This problem frequently leads to a ban on rag pickers in residential areas, although residential areas are the best places to retrieve recyclable waste. The harassment of rag pickers forces them to collect recyclables from landfill sites, a practice that leads to even higher health threats and environmental pollution.

The informal status of rag pickers also leads to unacceptable working conditions for many of them with regard to income and health issues. In most cases, rag pickers are women and children from low-income groups, the weakest groups in Indian society. They are often exploited by waste merchants because of their low

Box 6.1 Delhi: Recycling of Waste Electrical and Electronic Equipment

The purchase data for personal computers, refrigerators, and other electronic devices indicate the future waste production of these products. India has a well-established—however informal—recycling sector for such waste. Recyclers are mainly interested in precious metals (such as copper, silver, and platinum) but also in the glass, plastic, and batteries within these devices. Recycling is done in a way that poses serious threats to the health of workers and the environment. It will be a challenge to reorganize the recycling of waste electrical and electronic equipment in order to establish recycling methods that protect both workers and the environment. One measure would be the introduction of the extended producer responsibility concept, which means that the producer of an electrical or electronic device must guarantee the environmentally friendly recycling of sold products. Such a system is already in place in Europe.

Source: Streicher-Porte and others 2005.

Box 6.2 The Informal Sector of Waste Collection

The real number of workers in the informal sector of waste collection is not known. Ahmedabad alone has an estimated 30,000 rag pickers, more than 500 intermediaries, and about 10 bulk waste dealers. They retrieve about 150 to 200 metric tons of recyclable material each day from the streets, bins, and waste dumps and feed the recycling industry.

For all of India, the informal sector of rag pickers contributes substantially to reducing the amount of waste going to landfills. Estimates suggest that about 8 to 10 percent of the waste generated in urban areas (about 4 million metric tons) is retrieved by rag pickers and sold to the recycling industry. The value of this material is estimated at Rs 120 billion a year.

Source: Asnani 2006.

status. According to the report *Recycling Responsibility* (Srishti 2002b), a rag picker earns Rs 45 to Rs 80 a day. Children earn just Rs 10 to Rs 15 a day. Sometimes rag pickers receive advance payments from intermediaries to buy recyclable waste directly from households, a practice that creates an additional dependency because, in return, the rag pickers are obliged to sell the collected material back to the intermediaries. In addition to the small amount of daily income earned, the use of child labor should be of great concern to the government.

NGOs as Intermediaries

In the past 10 years, a growing number of NGOs in India have become active in improving the working and living conditions of rag pickers. Municipal services collect waste only from public bins; NGOs recognized the service gap and started offering door-to-door collection services to households. Knowing that recyclable waste should be collected at the source of its generation to maintain the value of the materials, NGOs tried to involve rag pickers in door-to-door collection. Rag pickers receive training on how to collect and sort waste and on how to deal with the intermediaries or households that they serve. The biggest challenge is to convince households to pay for the new service and to allow rag pickers to collect waste from the doorstep. Several success stories show that such efforts have significantly improved the living conditions of hundreds of rag pickers (boxes 6.3 and 6.4).

Box 6.3 Lucknow: Muskan Jyoti Samiti

Muskan Jyoti Samiti, a project in Lucknow, Uttar Pradesh, is working with 30,000 households. The services offered are door-to-door collection of waste and sweeping of roads twice a week. The project took two years to reach a financial stable position. The district authorities allocated 65 acres of land, free of cost, for vermicomposting as well as monetary assistance for preparing compost beds and pits and procuring cycle rickshaws. Currently, the project serves the upper-, middle-, and lower-income colonies. It charges different user fees in different colonies: Rs 15 to Rs 30 per household per month. It has employed about 900 rag pickers. Rag pickers are not paid any salary; however, they have a right to the recyclable materials they collect and, on average, they earn Rs 1,200 to Rs 1,500 per month from selling those materials.

Source: Toxics Link 2002–03.

Box 6.4 New Delhi: Vatavaran

The project initiated by Vatavaran caters to 150 households. Waste is collected door to door. The service area consists of both middle- and low-income communities. Through the efforts of the resident welfare association, the project has been successful in getting land from Delhi Development Authority for waste segregation and composting. Approximately 300 kilograms of waste is collected daily, of which 66 percent is compostable. A user fee of Rs 45 to Rs 50 per month is charged to the service recipients. An income of Rs 5,000 per year is generated from composting, and recycling helps generate Rs 2,000 per month.

Source: Toxics Link 2002–03.

NGO involvement in door-to-door collection has several advantages:

- Former informal rag pickers become formalized waste collectors and are accepted by the households they serve.
- They receive a regular income through the collection fees paid by the households.
- They have direct access to recyclable material, the sale of which will increase their income.
- They often find a safe storage place for the material and can gain higher profits, because they skip the intermediaries and sell directly to the merchants.

Again, because all these services are done on a private or nongovernmental basis, they do not disseminate and thus have only limited positive effects for the whole sector.

Waste recycling in India has many untapped potentials that can benefit the whole society. Given the current situation, there is a need to upgrade and reorganize the recycling system to increase the effectiveness of the waste collection and recycling system and also to improve the working conditions for rag pickers. It is crucial to involve all stakeholders (waste generators, rag picker organizations, NGOs, private companies, and municipal authorities). It is important to mention that the key stakeholder to lead this process is the municipal authority, because the municipality is ultimately responsible for waste management. The big challenges are to obtain public participation and to involve the private sector. The Supreme Court's expert committee acknowledged this potential in its report and recommended further actions toward intensified recycling that consider all stakeholders (Supreme Court 1999).

3R in the Municipal Solid Waste (Management and Handling) 2000 Rules

Schedule II of the 2000 rules lays out mandatory directions for waste segregation and processing within municipal management services. Awareness campaigns and community participation are key tools for implementing the 3R concept.

With respect to segregation of municipal solid wastes, the rules state as follows:

> In order to encourage the citizens, [the] municipal authority shall organize awareness programs for segregation of wastes and shall promote recycling or reuse of segregated materials.

Rag pickers mobilized by an NGO take recyclable waste from households in Vejalpur, Ahmedabad.

> The municipal authority shall undertake phased programs to ensure community participation in waste segregation. For this purpose, regular meetings at quarterly intervals shall be arranged by the municipal authorities with representatives of local resident welfare associations and non-governmental organizations.

The rules state the following with respect to processing municipal solid wastes:

> Municipal authorities shall adopt suitable technology or [a] combination of such technologies to make use of wastes so as to minimize burden on land-fill. Following criteria shall be adopted, namely:
>
> (i) The biodegradable wastes shall be processed by composting, vermi-composting, anaerobic digestion, or any other appropriate biological processing for stabilization of wastes. It shall be ensured that compost or any other end product shall comply with standards as specified in Schedule IV;
>
> (ii) Mixed waste containing recoverable resources shall follow the route of recycling. Incineration with or without energy recovery including pelletisation can also be used for processing wastes in specific cases. Municipal authority or the operator of a facility wishing to use other state-of-the-art technologies shall approach the Central Pollution Control Board to get the standards laid down before applying for [a] grant of authorization.

Given the key role and responsibility of municipal authorities, the following list of measures can support a municipality's efforts to improve waste segregation at source and make waste recycling efficient.

- Promote waste segregation among households and commercial areas through awareness campaigns, clear instructions, and incentives. But be aware that waste segregation makes sense only if waste is also collected separately.
- Promote separate door-to-door waste collection organized by residents' organizations, community-based organizations (CBOs), or NGOs if service cannot be covered by the municipal departments.
- Ensure reliable waste collection from public bins to support the door-to-door collection by local NGOs and CBOs. Door-to-door collection is accepted only if municipal bins are kept clean as well.

- Extend support to NGOs that offer professional training to rag pickers and organize door-to-door waste collection services in housing areas. If the municipal authorities acknowledge these schemes, households will also accept them.
- Permit waste collectors to take away the recyclable material for sale as an incentive to promote segregation and recycling.
- Provide land or basic infrastructure to NGOs or CBOs for decentralized waste treatment (such as composting) or storage of recyclables.
- Offer a citywide coordination platform for NGO or CBO activities, providing NGO and CBO representatives an opportunity for exchange with municipal officers, urban planners, and representatives of other organizations.
- Acknowledge the important role of rag pickers and the informal sector in general. Solutions are possible only if this group of people is involved in new recycling concepts.
- Ensure that public officers or police officers do not threaten or harass rag pickers who are involved in an NGO or CBO collection and recycling scheme.
- Seek collaboration with the private recycling sector to improve the quality of material and the efficiency of collection.

In addition to organizational measures, municipalities need to provide guidance for the selection of appropriate processing technologies in the recycling sector:

- Promote separate waste collection by providing sufficient storage space for local initiatives or official retailer organizations. Because the processing of recyclable materials such as paper, plastic, metal, and rags is already organized by the private sector, there is limited scope for influence from municipal authorities. However, because workers in the recycling industry are often exposed to unacceptable working conditions (such as burning toxic electronic waste), there is a need for action by the responsible municipal and state authorities.
- Promote decentralized composting of the organic waste fraction at the community level. Provide public premises for composting activities and ensure a formalization of such initiatives. Set quality standards for compost to ensure safe and accepted products. Because organic waste constitutes up to 55 percent of the total waste amount, decentralized composting will significantly reduce the burden on the public waste transport system.
- Collect waste from gardens, parks, and vegetable markets separately, because they are a good input source for medium-scale composting schemes at the fringe of urban areas. These schemes can be run by private entrepreneurs if the contract conditions allow a profit for the business and if a market for compost is well established.
- Try to improve the situation at landfill sites. Banning rag pickers from landfill sites is not a solution. Make arrangements with rag picker communities at landfill sites to improve the operation of the site, to improve the working conditions of workers, and to reduce negative environmental impacts.
- Select appropriate and realistic waste treatment technologies. For instance, incineration of mixed solid waste in India has not yet been successful, because the calorific value of the waste is too low. The high content of organic matter, along with the high moisture content, requires additional fuel input for incineration, thus increasing the treatment cost significantly. Special care must be given to realistic technical and financial planning of such waste-to-energy schemes for the treatment of MSW.

Recycling of Construction and Demolition Waste

Construction and demolition waste has been successfully recycled in cities such as Mumbai (box 6.5).

Box 6.5 Mumbai: Construction Waste and Debris Recycling

Mumbai generates about 2,300 metric tons of construction waste every day. In September 2005, the Municipal Corporation of Greater Mumbai issued the Demolition and De-silting Waste (Management and Disposal) Guidelines. However, the debris still ended up in dumping grounds, where it was mixed with other waste, thereby rendering it unfit for treatment. Youth for Unity and Voluntary Action (YUVA) came up with a decentralized solution for the problem of debris management.

The initiative got the support of the City and Industrial Development Corporation (CIDCO), the landowning and planning authority of Navi Mumbai. The collaboration resulted in the formation of the CIDCO-YUVA Building Centre, which has recycled more than 1,500 metric tons of waste in the past four years. The debris is recycled into construction material such as bricks and interlocking pavers.

The Process

An electric-powered machine used in pharmaceutical and chemical industries has been modified for the purpose. Cement and water are other inputs. The debris, sourced from construction sites, is broken down into particles that are 30 to 40 millimeters in diameter. The particles are then powdered by a pulverizing machine. Special screens enable the machine to grind the particles to desired levels of fineness. Coarse aggregates of about 10 millimeters in diameter, for example, require screens with large gaps. The dust controller sections of the machine filter out unwanted lightweight materials such as wood particles and other organic items.

Cement and water are then added to the pulverized material to mold it to a brick-like shape. Molded bricks are then cured (hardened by repeated wetting and drying) for 14 days and sun dried. Over a period, all waste material loses its ability to bind. But adding cement reinforces the debris's binding qualities so that it can be reused to make other products. CIDCO and Strucwel Laboratories, Mumbai, test the products for their compliance with Indian standards for moisture absorption, compressive strength, and abrasion. Setting up the plant costs about Rs 250,000. It can recycle about 1 metric ton of debris per day. YUVA gets its debris free, and people who supply the waste are given discounts on the products. One recycled brick costs Rs 1.35, and pavers cost Rs 16 per square foot.

Increasing demands for regular earthen bricks are being fulfilled at the cost of agricultural land. Many farmers in Mumbai's outskirts have become brick makers, and large tracts of fertile land have become barren. Loss of energy during transport is an added liability. In such a situation, debris recycling is both economical and ecological.

Drawbacks

The initiative does have several drawbacks:

- Most builders are not aware of the initiative, and those who are aware of it say that they cannot use the recycled debris until an authorized government agency such as the Central Building Research Institute certifies it.
- Getting funds to set up debris recycling plants has been a problem, and the unit should be supported by the municipal infrastructure.
- The delivery of debris by the local authority is not very efficient.
- Escalating cement prices increase the cost substantially.

Source: Karmayog 2005; Mehta 2006.

Collection of Construction and Demolition Waste. The report of the Supreme Court's expert committee (Supreme Court 1999) recommends that to facilitate the collection of small quantities of construction and demolition waste generated in a city, wards should create suitable debris banks. Containers could be provided at such locations, and a small collection charge could be levied for receiving such waste and for transporting it onward. Rates may be prescribed for such collection by the local body, and contracts could be given for managing such sites.

Recycling of Plastics. It is estimated that approximately 4,000 to 5,000 metric tons per day of postconsumer plastics—4 to 5 percent by weight of MSW—are generated in India. The major problems in plastics waste management are collection, segregation, and disposal. At present, plastics waste disposal is done through unorganized sectors, such as rag pickers and *kabariwalas* (junk dealers). More important, the collection, segregation, and (to an extent) disposal system is run by unscientific methods that create environmental problems. The Recycled Plastics Manufacture and Usage Rules 1999 (as amended in 2003) have been promulgated to address the problem. Some salient features of the rules follow:

- Rules apply in all the states and union territories.
- The prescribed authorities for enforcement of these rules are (in the states) state pollution control boards and (in the union territories) the pollution control committees.
- No vendor may use carry-bags or containers made of recycled plastics for storing, carrying, dispensing, or packaging foodstuffs.
- No person may manufacture, stock, distribute, or sell carry-bags made of virgin or recycled plastics that are less than 8 by 12 inches in size and less than 20 microns thick.
- Carry-bags and containers made of virgin plastic must be colored in a natural shade or be white.
- Every plastics manufacturing and recycling unit must be registered with the appropriate state pollution control board or pollution control committee and fulfill consent conditions.

See box 6.6 for more information about using recycled plastics in constructing roads.

Composting

Schedule II of the 2000 rules particularly highlights the importance of biodegradable waste treatment. This section provides more detailed information on composting, which currently is the most appropriate treatment option for India.

Composting plants such as this one operate in many Indian cities.

What Is Composting? Composting has been practiced in rural India for centuries by farmers treating their own domestic and agricultural waste and returning it as compost to their fields.

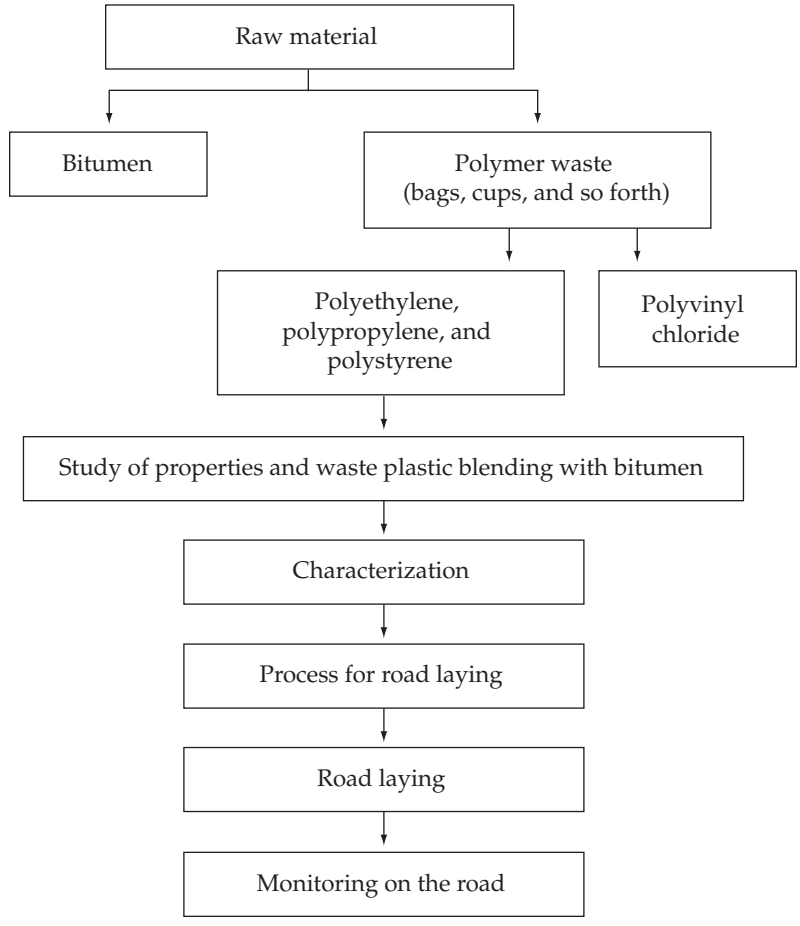
Box 6.6 Using Recycled Plastic in Constructing Roads

Reusing plastic waste to pave roads is an experiment that has been successfully conducted in many places, such as Kalamassery in Kerala and in Kolkata and Bangalore. The first technology approach, developed by Bangalore-based K K Plastic Waste Management Limited, entails using plastic waste along with bitumen—the ingredient conventionally used to make roads. Not only does the road become a receptacle for plastic waste, but it also has a better grip.

The Process

The plastic waste products (bags, cups, and so forth) made out of polyethylene, polypropylene, and polystyrene are separated, cleaned if needed, and shredded into small pieces that can pass through a 4.35 millimeter sieve. The aggregate (granite) is heated to 170°C in the mini hot-mix plant; as the shredded plastic waste is added, it softens and coats the aggregate. Immediately the hot bitumen (160°C) is added and mixed well. As the polymer and the bitumen are in the molten state, they get mixed, and the blend is formed at the surface of the aggregate. The mixture is transferred to the road, and the road is laid. This technique is extended to the central mixing plant, too.

Flowchart Showing the Method for Construction of Raw Road Material



Continued

Box 6.6 Continued

The process has the following advantages:

- Road strength is twice as strong as normal roads.
- Roads are resistant to water stagnation, so no potholes form.
- Less bleeding occurs during the summer.
- Burning of plastic waste is avoided.
- The process does not involve any extra machinery.
- The process does not increase the cost of road construction.
- The process helps reduce the consumption of bituminous mix and cuts down the cost.
- The addition of plastic waste to up to 10 to 15 percent by weight of bitumen results in higher values of softening point and lower values of penetration, which are appreciable improvements in the properties of the binder.
- The product withstands higher traffic loads and high temperature variations.

Several experimental stretches have been laid in more than 15 locations in Tamil Nadu using both mini hot-mix and central mixing plants.

Economics

There are two types of bitumen roads: dense bituminous macadam and bituminous macadam. They differ in three ways: (a) composition of the aggregate, (b) type of bitumen used, and (c) thickness of the layer. Bitumen is a useful binder for road construction. Different grades of bitumen are based on their penetration values, and these grades can be used as Indian Roads Congress specifications. Waste plastics (10 percent in place of bitumen) can be used for both types of bitumen roads. The technology of road laying is very much the same as prescribed by the Indian Roads Congress (Section 500, IV revision) Specifications. A detailed description of the material required for laying of semi-dense bituminous concrete, 25 millimeter road (on an existing road) follows:

- Bitumen: 11.25 tons (60/70 grade)
- Shredded plastics: 10 percent by weight (passing through a 4.74 millimeter sieve and retaining 2.36 millimeters)
- Bitumen replaced (saved) by 10 percent plastics: 1.125 tons
- Actual bitumen required: 10.125 tons
- Aggregate (11.2 millimeters): 70.875 cubic meters
- Aggregate (6.7 millimeters): 43.125 cubic meters
- Aggregate dust: 23.625 cubic meters

The total cost, including the materials, labor charge, and so on, at Madurai, is approximately Rs 500,000. However, the cost may be different from place to place and must be calculated accordingly. The cost breakout is as follows:

- Collection of littered plastics: Rs 500,000
- Cost of shredder and other equipment: Rs 500,000
- Laying of road with material, labor, and so on: Rs 400,000
- Total cost: Rs 500,000

Source: Authors.

Table 6.3 List of Roads Laid Using Waste Plastics

Location	*Process*	*Blend composition*	*Area*	*Date of construction*	*Nature of road*
Thiagarajar College of Engineering, Madurai	Polymer blending with bitumen	5% polyethylene; 1% polyethylene	60′ × 5'	March 23, 2002	Concrete
Kovilpatti	Polymer blending with metal and mixing with bitumen	10% polyethylene	600′ × 12'	October 4, 2002	Water-bound macadam
Madurai	Polymer blending with metal and mixing with bitumen	15% polyethylene	180′ × 10'	October 5, 2002	Concrete
Salem	Polymer blending with metal and mixing with bitumen	10% polyethylene	1,000′ × 12'	October 15, 2002	Concrete
Komarapalayam	Polymer blending with metal and mixing with bitumen	10% mixture	300′ × 12'	October 15, 2002	Concrete
Chennai	Polymer blending with metal and mixing with bitumen	12% mixture	600′ × 18'	November 22, 2002	Concrete
Trichy	Polymer blending with metal and mixing with bitumen	10% mixture	600′ × 18'	January 10, 2003	Concrete
Salem	Polymer blending with metal and mixing with bitumen	10% mixture	5,000′ × 18'	April 17, 2003	Water-bound macadam
Erode	Polymer blending with metal and mixing with bitumen	10% mixture	1,500′ × 24'	May 7, 2003	Bitumen
Theni	Polymer blending with metal and mixing with bitumen	10% mixture	300′ × 18'	May 10, 2003	Water-bound macadam
Nagercoil	Polymer blending with metal and mixing with bitumen	10% mixture	1,500′ × 18'	May 16, 2003	Water-bound macadam
Madurai-Kombadi	Polymer blending with metal and mixing with bitumen	10% mixture	1.4 kilometers	—	Water-bound macadam

Source: CPCB n.d.
Note: — = not available.

Urbanization in India has created a new problem. Domestic urban waste still contains up to 55 percent biodegradable waste but is cut off from rural reuse and therefore is disposed of in drains or landfills. The uncontrolled degradation of organic matter is causing hygienic and environmental problems in many urban areas.

Composting, in contrast, is a controlled biological treatment process in which microbes degrade organic waste under aerobic conditions to a humus substance called *compost*. Compost is a stable, dark-brown, soil-like material. Contrary to popular belief, mature compost does not smell bad—it can smell as fresh as a forest floor. Compost contains important plant nutrients (such as nitrogen, potassium, and phosphorus), though usually not as much as animal manure or chemical fertilizers. It can also contain a range of beneficial minerals and is rich in humus and micro-organisms beneficial to plant growth.

Composting is beneficial in a SWM system because it reduces organic waste to 25 to 30 percent of its initial weight. If waste is composted close to its source of generation (for example, at the household level or neighborhood level) significantly less waste must be transported and disposed of.

Currently, composting plants operate in about 50 cities in India. They cover a large variety of capacity and technology. Large-scale plants treating between 100 and 700 tons of mixed waste per day are capital intensive because of their high grade of mechanization. Composting of mixed waste should be avoided; research results show that compost from mixed waste barely meets national quality requirements for compost, owing to contamination with heavy metals and other pollutants.

In contrast, cities such as Bangalore, Chennai, Mumbai, and Pune have very active community-based and decentralized composting schemes, by which sorted waste is turned into high-quality compost. These schemes have capacities of up to 1 ton per day.

Composting Partnerships. Composting schemes are ideal opportunities for private sector participation or the involvement of NGOs. Municipal authorities rarely have the know-how and capacity to run composting plants; they need to coordinate and contract out the treatment of organic waste as required by the 2000 rules.

Public-private partnerships or public-community partnerships provide excellent opportunities if they are designed realistically. It must be pointed out that composting is hardly a financially viable business if it is financed only by compost sales. The market for compost is currently too weak. There is limited demand for compost in urban areas, and the market in rural areas still prefers chemical fertilizers because of a lack of awareness of compost and because of policies that favor chemical fertilizers. Therefore, composting projects must be accompanied by concerted marketing efforts and awareness campaigns in the agricultural sector. Municipalities need to take over their share by paying appropriate waste treatment fees to composting plants (as required by other treatment plants such as incinerators). Box 6.7 discusses the costs of composting.

Future Roles of Stakeholders in Implementing 3R in India

Municipal authorities must follow the directions of the 2000 rules to promote the 3R concept. They are key stakeholders in the coordination of recycling activities. The following section gives an overview of the responsibilities and possible roles of key stakeholders in recycling and the successful enforcement of rules.

Box 6.7 What Does Composting Cost?

A study by Sandec (2004) revealed the following investment costs for three types of small-scale composting sites.

For backyard composting a one-time investment of Rs 600 to Rs 800 is necessary. The lifetime of a drum is about five years. Marketing of compost is not an issue because the compost is used in the composter's own garden.
(Photo by Exnora, Chennai)

In community-based systems (less than 5 tons per day), investments show large variations from Rs 100,000 to Rs 7.1 million per ton per day capacity. The capacity depends on the organizational approach applied and the supporting infrastructure built or purchased (office building, collection vehicles, and so on). An average estimate is Rs 250,000 to Rs 350,000 per ton per day capacity. Operational costs of 70 to 90 percent for salaries are due to the manual labor used in these schemes. Markets for sales are usually restricted to the neighborhood, where prices are comparatively high but demand is low.
(Photo by Centre for Environment Education, Bangalore)

Medium-scale composting enterprises (less than 40 tons per day) benefit from lower investment costs per ton of waste because of economies of scale. An average of Rs 100,000 to Rs 1.4 million per ton per day capacity can be used as an approximation.
(Photo by Waste Concern, Dhaka, Bangladesh)

Limited markets for compost sales and low prices for compost are a major challenge that all systems face. Therefore, operation and maintenance costs often require supplementation with additional waste treatment fees or subsidies for these systems to become viable.

Source: Excerpted from Zurbrügg and others 2002.

Government Institutions: Setting Regulatory Framework for Action and Integrating the Informal Sector

To facilitate the improvement of SWM services in India, the state governments and municipal authorities must play a proactive role. They are responsible for setting and enforcing the regulatory framework, as well as integrating all stakeholders (such as private companies, communities, NGOs, and the informal sector). The following section provides structured guidance on how the institutions can establish partnerships and which tasks may be taken on by which party. Several Indian and international examples illustrate efforts already undertaken to improve municipal solid waste management.

The government can promote the 3R concept through a variety of strategic interventions:

- Encourage technological advances in waste recycling.
- Help create logistic chains and a market for recyclable products.
- Examine the issue of recycling within the framework of extended producer responsibility.
- Promote the use of reusable or ecofriendly packaging material.
- Direct industries to reduce packaging material and change its composition.
- Levy eco-surcharges on hard-to-recycle or ecologically unfriendly products or packaging to encourage compliance.
- Help market compost through extension methods in the agricultural sector.

Municipal Authorities: Coordinating and Monitoring Urban SWM

Municipal authorities are ultimately responsible for SWM, including collection, transfer, and final disposal. It is also the role of municipalities to encourage, promote, and give incentives for reducing, reusing, and recycling. This role includes several tasks:

- Promote segregation of waste at the source of its generation.
- Collect recyclable waste from the doorstep.
- Involve citizens, citizens' organizations, and NGOs in SWM planning (box 6.8).
- Integrate the informal sector in the formal SWM system by organizing rag picker cooperatives through NGOs for door-to-door collection, providing workplaces for sorting and sheds for storing recyclables, and providing marketing chains and direct links to industries for recyclables.

Municipal authorities need to provide a workplace for rag pickers through NGOs to facilitate sorting of recyclable waste. Recycling space is provided by Suryapet municipality for secondary sorting of recyclable materials. (Photo by Suryapet municipality)

Box 6.8 Mumbai: Recycling Cooperation between the Municipal Corporation of Greater Mumbai and Stree Mukti Sanghatana

Stree Mukti Sanghatana (SMS) is a women's organization working in Mumbai since 1975 for the empowerment of women. SMS started by initiating self-help groups of women rag pickers, providing educational opportunities for them and their children, organizing health camps and crèche facilities, and counseling their families. The Municipal Corporation of Greater Mumbai cooperated with SMS in this program.

Waste collectors were trained to collect and segregate waste. Women workers were also trained in composting and gardening to supplement their income. SMS carries out door-to-door collection, waste disposal, and conversion of wet waste into manure as well as road cleaning. SMS has been instrumental in making the township a zero-waste township.

Source: Jyoti Mhapsekar, Stree Mukti Sanghatana, personal communication.

Industrial Sector: Minimizing Waste in Production

Industries are concerned with two aspects of recycling. First, the production sector is responsible for designing environmentally friendly and long-lasting products in order to minimize waste generation. Particular attention must be given to packaging materials, which are an increasing challenge for urban SWM systems. Industries need to realize the problems that their packaging material creates once it is discarded by the purchaser of their products. Ideally, industries will commit (for example, in the form of a sector agreement) independently to reduce waste from packaging or to organize a system for returning packaging materials. These industries have a high potential for incorporating waste reduction or recycling in their production processes.

Second, many industries are involved in using the material that is segregated and sorted by households or the informal sector. Currently, they receive recycling materials at comparably low prices, causing unacceptable working conditions for many waste workers at the beginning of the recycling chain. Industries should consider international labor standards and pay for the recycling material accordingly.

If such self-commitment does not show the anticipated effect, the central and state governments may consider introducing the concept of extended producer responsibility, which makes the producer responsible for the safe recycling or disposal of its products (box 6.9).

Box 6.9 Extended Producer Responsibility

Extended producer responsibility provides an overall framework for linking formal systems of production to the informal system of recycling. The concept uses a product life-cycle approach that puts the responsibility on the producer. It provides an opportunity to resolve several interrelated waste management problems. Extended producer responsibility can act as a tool for pressuring big corporate houses, which generate large quantities of waste, to invest in recycling and take back their products at the end of those products' useful life. Discouragement of and higher taxes on packaging materials that are not recyclable can help reduce the problem of waste.

Source: Authors.

Box 6.10 Europe: Recycling System for Refrigerators and Cooling Devices

As refrigerators and other cooling devices pose a serious threat to the environment and the global climate, Switzerland and the European Union introduced a directive that regulates the safe recycling and disposal of cooling devices. Particular attention is given to the cooling liquid, which, once emitted to the environment, contributes to the destruction of the ozone layer. Households are obliged to bring old devices back to the shops. All shops selling these devices are ordered to take back old refrigerators for free and must organize their safe recycling and disposal. Private companies have qualified to become certified recycling service providers. The cost of such a system is covered by a prepaid recycling fee that is added to the price of the products. This levy must be paid by the purchaser of the device. In 2005, more than 82,500 tons of electronic waste were collected in Switzerland—75 percent of which could be recycled.

Similar systems have been introduced for polyethylene terephthalate (PET) bottles, machine oils, and tires in various countries (such as the Eco-Lef program for PET bottles in Tunisia). In all cases, the additional costs of the recycling system are covered by prepaid fees that must be paid by the consumers (for example, the price for drinks in PET bottles increased by 1 eurocent).

Source: Authors.

Box 6.10 describes a European case study for recycling.

NGOs and CBOs: Shaping New Municipal Solid Waste Management Practices in Recycling

The 2000 rules explicitly mention the key role of NGOs and CBOs in improving municipal solid waste management. NGOs have more leeway for their activities and can establish strong partnerships with municipalities. NGOs and CBOs are great institutions for organizing people and promoting citizen participation; they are also a natural venue for implementing waste minimization programs. The role of NGOs and CBOs includes several tasks:

- Undertake phased programs to encourage citizens to segregate waste at source.
- Train informal rag pickers to become professional waste workers in the private sector. Link them with households and neighborhoods in urban areas that are demanding door-to-door collection services for organic and recyclable waste.
- Establish cooperatives of rag pickers and facilitate direct access to recycling industries so that rag pickers get full value for the waste they collect.
- Promote conversion of waste materials (paper and plastics) into useful products.

Box 6.11 describes a case study for ecofriendly recycling.

Households and Communities: Taking Responsibility for and Participating in 3R Measures

Households are often willing to participate in recycling schemes; however, they require frequent information and motivation to segregate or recycle waste. Furthermore, it

Box 6.11 Centre for Environment Education: Waste to Wealth in Kodagu

In Kodagu (Coorg), a small but rich district of Karnataka, the Centre for Environment Education (CEE) has set up an Ecofriendly Reuse and Recycling Unit (CEE-ERU) to produce handmade paper and to weave plastic waste on a loom. Thin and flimsy plastic bags have an average useful life of two to three hours, after which they are discarded. They end up in gutters, in dumpsites, or on mountainsides—and even in the stomachs of animals. They are responsible for clogging, choking, flooding, asphyxiation, landslides, death, and destruction. However, if they are collected, even from roads, they can be washed, cleaned, dried, cut into strips, and woven into the basic plastic textile fabric, which can then be stitched into products such as mats, folders, handbags, and purses. In this manner, both plastic waste and paper waste become more manageable and less destructive.

With waste inputs from educational and commercial units, CEE-ERU has been functioning for five years, employing 15 rural women. Through various CEE offices, such units have also been established in Ahmedabad, Coimbatore, Delhi, Goa, Patna, and Tirupathi. The concept has been taken up by many women's self-help groups. Women in such groups gather raw materials either by collecting them door to door or by buying them from rag pickers.

The Nemiraj Memorial Demonstration Unit of CEE-ERU in Virajpet recycles paper and plastic carry-bags; promotes the concepts of waste segregation, waste minimization, and waste recycling; and provides employment opportunities.

At the Kodagu facility, polybags are woven on handlooms.

Source: http://www.ceeindia.org/cee/waste_m.html#bang.

takes a long time to introduce the concept. The following actions can lead to rapid and significant improvement of an SWM system:

- Promote the use of two domestic bins at home: one for biodegradable food waste and one for recyclable material.
- If waste is collected daily, prohibit waste disposal on the streets. Waste should be collected door to door or from nearby collection bins. Prohibit littering in streets.
- Promote composting at the household level where appropriate. Households can easily compost their kitchen waste, leaves, grass clippings, and garden plants within their premises if space is available.

International Examples

In many industrial countries, waste recycling is initiated, organized, and operated by the municipal authorities, supported by national policy. Segregation and recycling are enhanced by specific economic mechanisms. The leading principle is "the polluter pays," which means that the more waste is generated the higher the cost is for the household or industry. Waste fees are paid according to weight or volume. At the same time municipalities offer recycling schemes, which facilitate the segregation efforts of households. Minimizing waste or segregating recyclables thus reduces the financial burden on the household. Given proper infrastructure that facilitates recycling, people are willing to invest more time in segregating and recycling and are motivated by the savings in their waste management bill. Boxes 6.12 through 6.17 provide some international examples.

In the European Union, two-thirds of waste is landfilled. The European Union is now pursuing a policy of landfilling waste only as a last resort. Recycling levels increased steadily from 7 percent in 1990 to 15 percent in 2002. High recycling and recovery rates have been achieved for paper, metal, glass, and rubber (table 6.3). Plastic has the lowest recycling rate because technical and economic barriers are high in this sector. Boxes 6.18 and 6.19 describe recycling efforts in two European countries.

Box 6.12 Argentina: Efforts to Eradicate Child Labor with Waste

In Argentina, informal recycling became legal in 2002. Law 992 created the Urban Recuperator Program and gave it the responsibility of integrating urban recuperators into the formal waste collection system. Since the program's initiation, it has registered about 9,000 adult urban recuperators. A study counted a total of 8,762 people collecting recyclable material within the Buenos Aires city limits. Nearly half were under the age of 18.

Waste collection in Argentina poses serious health threats to adults and children because they are in direct contact with waste. Skin infections, respiratory problems, cuts, and scrapes are common. Furthermore, many children drop out of school to support their parents in waste recuperation.

In Argentina, various initiatives exist to improve the livelihoods of the waste recuperators. For instance, the White Train I is a child care center that hosts children of waste collectors during the typical working hours (4:00–11:00 p.m. The center also supports the enrollment of children in school. Though the center was a neighborhood initiative, the municipality now provides the financial support. Another program, Project Recuperar, is a microcredit system that aims to help migrant waste collector families access credit and start small businesses or regularize their migratory situation.

These are only two of several examples of support to the informal sector. All such projects seek ways to regularize and formalize the status and work of informal waste collectors in collaboration with municipal authorities.

Source: Summary of Koehs 2006.

Box 6.13 Brazil: Integrating Recycling Cooperatives in the Formal Waste Management System—The Case of Belo Horizonte

In 1987, in Belo Horizonte's streets, informal waste pickers recovered discarded paper from the streets and rubbish bins. They were seen by other people as part of such garbage and began to view themselves that way also. The Benedictine Fraternity, together with the Pastoral de Rua, initiated projects that assisted those who lived in the streets in naming what they do as work. It was essential that they see themselves as workers. There was no resistance from the waste pickers, who learned to respect their work. They created a cooperative called ASMARE (Association of Paper, Carton, and Recyclable Material Pickers–Belo Horizonte) to better organize themselves. However, several fights and efforts were necessary to legitimize the street workers' cause and get them acknowledged as citizens who contribute to keeping the city clean. With time and much effort, this recognition came. The municipal councilman, João Bosco Senra, started discussions with ASMARE to understand its members' needs and finally succeeded in approving their role in a new council project on the selective collection of garbage. He convinced city hall that the selective collection should be made by those who were already doing it—the waste pickers.

Finally, in 1993, after many years of discussions, advocacy, and fighting, a partnership was established between ASMARE and Belo Horizonte's city hall. The public power finally recognized the association as an enterprise that contributed to environmental and social welfare and to the development of Belo Horizonte. Using 150 wheelbarrows and three trucks, ASMARE collects paper, plastic, metals, and glass. It does this work at fixed collection points in the city's commercial and residential area. The waste material is sorted, compressed, weighed, and then sold by ASMARE directly to industry or to an intermediary.

Source: Adapted from Resende 1998.

Box 6.14 Tunisia: PET and Packaging Recycling

The Eco-Lef program started in 1999 with a collection strategy based on the voluntary input of citizens. Despite efforts made by ANPE (National Agency of Environmental Protection) to raise awareness—efforts supported by television ads and brochures—Eco-Lef did not witness much success. In fact, the quantities collected during the first two years did not justify the efforts and initiatives undertaken by the program.

In April 2001, ANPE launched a new collection program in parallel with the existing one. This program incites individual collectors to collect packaging wastes and deliver them at collection points set up by ANPE. At these points, the packaging is weighed and the collector is remunerated according to the quantity delivered. ANPE then transfers the quantities stocked at the collection points to sorting centers, where they are sorted and baled before being forwarded to recyclers for free. The new program has had satisfying results, and it contributes to the development of the collection and reuse of waste.

The quantity collected multiplied to reach about 4,000 tons over the two years. During the same period, 1,285 microenterprises, 52 collection points, and 3,850 jobs were created. The success of the new collection program is due to the various efforts deployed by ANPE, mainly in raising the awareness of citizens, municipalities, NGOs, neighborhood committees, and associations, as well as in collection campaigns. ANPE also provides funds to finance the collection points and remunerates collectors.

Source: World Bank 2004.

Box 6.15 Bangladesh: Composting in Dhaka

An organization called Waste Concern started a community-based composting project in 1995 to promote the concept of the 4 Rs—reduce, reuse, recycle, and recover waste—in urban areas. It is based on the idea that the organic content of Dhaka's household waste, which accounts for more than 70 percent of total waste, can be efficiently converted into valuable compost. This practice reduces disposal costs and prolongs the lifetime of landfill sites. It also reduces the harmful environmental impact of landfill sites, because organic waste is responsible for groundwater contamination and methane gas emissions. When organic waste is turned into compost, the soil in urban areas is improved.

The project involved setting up a number of small-scale enterprises in different neighborhoods. Activities include house-to-house waste collection, composting of the collected waste, and marketing of the compost and recyclable materials. The project was so successful that in 1998 the government selected Waste Concern to extend the project to five other communities of Dhaka, supported by the United Nations Development Programme. Waste Concern asked government agencies to provide land, water, and electrical connections to establish the community-based composting plants. It also built relationships with private companies to market the compost and recyclable materials. Waste Concern sets up community waste management committees and provides technical assistance and training to help them manage, operate, and maintain the services. Members of the committees are mostly women. They are trained in collection, waste separation, composting, and marketing. After a year of community mobilization and training, Waste Concern hands the project over to the community but continues to monitor it for three years.

There is a good market for compost in Bangladesh. Waste Concern helps the communities sell their compost to a number of businesses, such as fertilizer companies and plant nurseries. Each 50-kilogram bag of compost sells for US$2.50 to US$4.50. Waste Concern has been asked to install more community-based compost plants to meet the growing demand for enriched compost.

This program has significantly cleaned up communities, created jobs for poor people, reduced the Dhaka City Corporation's waste management costs, and created business opportunities. Composting all organic waste in Dhaka would create new jobs for about 16,000 poor people, especially women. It has become a model that several city governments and NGOs are now trying to copy.

Source: Sinha and Enayetullah 2000.

Box 6.16 The Philippines: Privately Initiated Resource Recovery and Recycling Program in Manila

Linis Ganda is a privately initiated resource recovery and recycling program. Although national in scope, it is most active in metro Manila. It has the following components: segregating waste at source, minimizing garbage dumping into rivers and streets, decreasing the volume of garbage brought to dumpsites and landfills, and helping to improve the social acceptability and living conditions of junkshop owners and waste pickers. Its network of program participants includes 17 environmental cooperatives in the 17 cities and municipalities of metro Manila, 572 junkshops, and 1,000 eco-aides or door-to-door recyclable collectors. In 1999, it reported a total of about 95,000 tons of municipal solid wastes collected from households and delivered to recycling establishments. In 1996, it was declared by the United Nations Habitat II summit in Istanbul, Turkey, as the best practice of handling garbage in the world.

Source: Authors.

Box 6.17 The Philippines: A New Solid Waste Management and Recycling Concept for Bais City

The municipal authority and the German development service established a new SWM system in Bais City (population 70,000). The system contains a managed landfill, a recycling center, and a composting site for green waste at the landfill site. The recycling is done by trained and authorized waste workers (former informal waste pickers) at the well-managed landfill site. The waste workers are allowed to sort the waste before it is compacted and covered in the landfill site. The workers have a storage room for the sorted materials and can sell it in bulk either to intermediaries or directly to the recycling industry. Green waste from markets, parks, and gardens is collected separately and composted. The recycling activity reduces the waste amount in the landfill by up to 20 percent. Diverting the green waste from the landfill site saves another 10 percent of the total waste to be disposed of in the landfill site.

Littering of juice wrappers was a major problem in the town. A women's cooperative started to collect these wrappers (mainly at ceremonial places); clean them; and produce bags, hats, covers, and other handy equipment for the national and international market.

Source: European Topic Centre on Waste and Material Flows 2004.

Table 6.4 Waste Generation and Recycling in European Union

Material	*Year*	*Consumption per capita per year (kilograms)*	*Waste generation consumption rate (%)*	*Recycling rate (%)*	*Recovery rate (%)*	*Main sectors*
Plastic	2002	95	56	15	38	Household
Paper and cardboard	2002	205	96	56	56	—
Aluminum	2002	22	—	84[a]	84	Transport, building, and packaging
Steel	2003	412[b]	—	55[c]	55	
Glass	2002	38	83[d]	59	59	Packaging
Rubber[e]	2003	7	—	47	73	Transport
Inert waste	—	—	—	—	—	Building
Textile waste	—	—	—	—	—	Household

Source: European Topic Centre on Waste and Material Flows 2004.
Note: — = not available.
a. Recycling for transport, building, and packaging as a ratio of consumption (not waste generation).
b. Production.
c. Metal packaging including aluminum.
d. Packaging glass only.
e. Tires only.

Box 6.18 Germany: Its Recycling Policy and Its "Green Dot" System

Waste separation at the household level is a prominent feature of German waste management systems, which are organized on a municipal level. Households separately dispose of paper and cardboard; glass; biodegradable waste; light packaging (plastics, aluminum, and tin); and the residual household waste. Residual waste, organic waste, and paper are collected in designated wheeled bins; packaging materials are collected in yellow bags or in a yellow bin. The waste is picked up at the curbside every week or every two weeks. Glass and sometimes paper have to be brought to community collection sites.

Incentive to segregate and recycle is given through the financing schemes for management—collection and disposal—of different waste components. The schemes have the following characteristics:

- *Residual household waste.* The annual or monthly waste fee varies depending on bin volume (for example, 40l, 80l, 1,20l, 2,40l, 6,60l, and 1,100 liters) and frequency of pickup. People either choose the frequency in advance or are billed according to the number of times they present their bin at the curbside for emptying. This price system is unit based, even though the calculation base is quite crude, because the volume of the bin is measured and not the content of waste, which can vary within the bin.
- *Organic waste.* The fee varies according to the bin volume chosen or is included in the residual waste fee.
- *Paper and cardboard.* Costs are covered by the residual waste fee or base fee and to a certain percentage by the Green Dot Program (described later).
- Pickup and recycling of light packaging materials and glass is financed by the Green Dot Program.

Some communities charge an additional base fee according to household size or number of bins or require a minimum bin volume to be paid for.

In 1991, the German government introduced the principle of producer responsibility for used packaging and placed a legal obligation on trade and industry to take back and recycle the packaging materials producers put in circulation. The producers have to prove that they meet a certain recycling quota for each material. Most producers joined forces in the Duales System Deutschland (DSD), which organizes the collection, sorting, and recycling of the packaging waste of its members. The system is financed through a license fee that considers the material and weight of the packaging and that allows its members to place a green dot on their packaging. The green dot indicates to consumers that the packaging waste can be disposed of in the yellow DSD bags or bins. The consumer still pays for the waste management, because the license fee translates into higher product prices.

The actual collection is delegated to the municipal waste management systems, which receive payments from DSD to cover cost in exchange. Because the producers that participate in the DSD do not physically dispose of their own packaging waste but instead pay a fee that covers the cost of disposal, the producer's responsibility to take back waste is effectively an advance disposal fee.

Similar producer responsibility systems, or Green Dot Systems, as they are called across Europe, are also in place in Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Estonia, France, Greece, Hungary, Ireland, Latvia, Lithuania, Luxemburg, Malta, Norway, Poland, Portugal, Romania, the Slovak Republic, Slovenia, Spain, and Sweden.

Source: Authors.

Box 6.19 Switzerland: Recycling

The Swiss Environment Protection Law stipulates that the producers of waste should bear the cost of solid waste disposal. Waste management is financed through different tariffs:

- A unit-based pricing system, charging for each bag
- A unit-based pricing system, charging for each bag in combination with a flat fee
- A weight-based system in combination with the bag-based system

This pay-per-bag scheme applies to residual waste. Waste bags for this residual waste can be purchased at large retail stores and are available in different sizes (for example, 17, 35, 60, and 110 liters in Zurich). The prices vary according to size (for Zurich they are CHF 0.90, CHF 1.80, CHF 3.10, and CHF 5.70, respectively, which translates into a unit price of about CHF 0.052 per volume liter). The waste bags are picked up at the curbside on a fixed weekday.

An extensive recycling system enables households to reduce the waste amount disposed of in official waste bags. The recycling system is financed through

- An advance recycling contribution, which is a voluntary contribution on every recyclable unit made by the producers to organizations that organize the collection and recycling (applied for PET bottles, aluminum cans and packaging, and steel and tin cans)
- An advance disposal fee, which the producer must pay by law on glass packaging and batteries and which is included in the retail price
- Taxes or a flat-fee component of a two-tier unit-based pricing system (applied for metals, paper, and cardboard)
- Revenues from sales of recyclable materials (applied for textiles)

The recyclable materials either are picked up at the curbside or must be brought to containers at the community collection point or returned to collection points at retail markets.

Source: Authors.
Note: CHF1 = US$ 0.85 (Sep 2007 rate).

References and Suggested Readings

Ahmed, Kulsum, and Carl R. Bartone. 2001. "Landfill Gas and Composting: A Potential GEF Strategy for LCR." World Bank, Washington, DC.

Asnani, P. U. 2006. "Solid Waste Management." In *India Infrastructure Report 2006: Urban Infrastructure*, ed. Anupam Rastogi, 160-89. New Delhi: Oxford University Press. http://www.3inetwork.org/reports/IIR2006/Solid_Waste.pdf.

Bartone, Carl R. 1990. "Economic and Policy Issues in Resource Recovery from Municipal Solid Wastes." *Resources, Conservation, and Recycling* 4 (1-2): 7–23.

Bennagen, Ma. Eugenia C., Georgina Nepomuceno, and Ramil Covar. 2002. "Solid Waste Segregation and Recycling in Metro Manila: Household Attitudes and Behavior." Research Report 2002-RR3, Resource, Environment, and Economics Center for Studies, Quezon City, Philippines.

CPCB (Central Pollution Control Board). n.d. "Plastic Waste Management." In *CPCB Division—Activities*. Delhi: CPCB. http://www.cpcb.nic.in/pcpdiv_plan6.htm.

European Topic Centre on Waste and Material Flows. 2004. "Waste That Works, www.ded.ph: Inventory of Existing Information on Recycling of Selected Waste Material." European Topic Centre on Waste and Material Flows, Copenhagen.

French Ministry of Environment. 1990. "Sorting/Composting of Domestic Waste." Technical Brochure 27, Administration of Water Resources Pollution and Risk Prevention, Paris, Ministry of Environment.

Han, Sun-Kee, and Hang-Sik Shin. 2004. "Performance of an Innovative Two-Stage Process Converting Food Waste to Hydrogen and Methane." *Journal of the Air and Waste Management Association* 54 (2): 242–49.

Hoornweg, Daniel, Laura Thomas, and Lambert Otten. 2000. "Composting and Its Applicability in Developing Countries." Urban and Local Government Working Paper 8, World Bank, Washington, DC. http://www.worldbank.org/html/fpd/urban/uswm/uwp8.pdf.

JICA (Japan International Cooperation Agency). 2004. "Final Report on Pilot Project on Segregation of Household Waste." New Delhi: JICA.

Johannessen, Lars Mikkel. 1999. "Guidance Note on Recuperation of Landfill Gas from Municipal Solid Waste Landfills." Urban and Local Government Working Paper 4, World Bank, Washington, DC.

Karmayog. 2005. "NGO Council Recommendations/Comments on C & D and De-silting Waste (M & D) Guidelines." Karmayog, Mumbai. http://www.karmayog.com/cleanliness/desiltingwastecd.htm.

Koehs, Jessica. 2006. "Forgotten Amidst the Waste? Health Hazards Linked to Informal Recycling in Argentina and Efforts to Eradicate Child and Migrant Labour with Waste." Presented at the Collective Working Group on Solid Waste Management Workshop, Kolkata, India, February 1–5.

Mehta, Payal. 2006. "Bricks, Pavers from Construction Debris: Construction Waste Recycled to Make Bricks and Pavers." *Down to Earth* 15 (11).

Obeng, Letitia A., and Frederick W. Wright. 1987. "The Co-composting of Domestic Solid and Human Wastes." Technical Paper 57, World Bank, Washington, DC. http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000178830_98101904165144.

Resende, Fernando. 1998. "Case Study on the Project ASMARE—Association of Paper, Carton, and Recyclable Material Pickers–Belo Horizonte." http://www.undp.org/governance/programmes/life/Case%20Study%20-%20ASMARE.doc.

Rouse, Jonathan. 2006. "Embracing Not Displacing: Involving the Informal Sector in Improved Solid Waste Management." Presented at the Collective Working Group on Solid Waste Management Workshop, Kolkata, India, February 1–5.

Sandec (Department of Water and Sanitation in Developing Countries). 2004. "Recycling Is Practiced at All Levels of the Solid Waste Management Chain." Sandec, Dübendorf, Switzerland.

Sinha, A. H. Md. Maqsood, and Iftekhar Enayetullah, eds. 2000. *Community Based Solid Waste Management: The Asian Experience*. Dhaka: Waste Concern.

Srishti. 2002a. *Making the Most of a Mess: A Handbook on Municipal Solid Waste*. New Delhi: Srishti.

———. 2002b. *Recycling Responsibility: Traditional Systems and New Challenges of Urban Solid Waste in India*. New Delhi: Srishti.

Streicher-Porte, Martin, Rolf Widmer, Amit Jain, Hans-Peter Bader, Ruth Scheidegger, and Susanne Kytzia. 2005. "Key Drivers of the E-Waste Recycling System: Assessing and Modeling E-Waste Processing in the Informal Sector in Delhi." *Environmental Impact Assessment Review* 25 (5): 472–91.

Supreme Court. 1999. "Report of the Supreme Court Appointed Committee on Solid Waste Management in Class I Cities in India." Supreme Court of India, New Delhi.

Toxics Link. 2002–03. "Case Studies Documentation: Review of Sustainability Community Based SWM Initiatives." Toxics Link, New Delhi.

van Eerd, Maajrte. 1997. "The Occupational Health Aspects of Waste Collection and Recycling: An Inventory Study in India." Urban Waste Expertise Programme Working Paper 4, Part II, WASTE, Gouda, Netherlands.

World Bank. 2001. "Relation between the Amount of Biodegradable Waste and Income Level." In *World Development Indicators: 2001*. Washington, DC: World Bank.

———. 2004. "Regional Solid Waste Management Project in Mashreq and Maghreb Countries, Final Report." World Bank, Washington, DC.

WRAP (Waste and Resources Action Programme). 2004. *Compost Specifications for the Landscape Industry*. London: Landscape Institute. http://www.wrap.org.uk/templates/temp_publication.rm?id=698&publication=285.

Zurbrügg, Christian, Silke Drescher, Almitra Patel, and H. C. Sharatchandra. 2002. "Decentralised Composting—An Option for Indian Cities?" Report of a workshop held in Bangalore, India, June 4–5.

7

Information, Education, and Communication

A clean city is a concerted effort by the city managers and the civil society. The decision-making process for managing solid waste in urban areas is going through a paradigm shift from the "decide, announce, defend" premise of local authorities to more involved public participation.

Solid waste management (SWM) is an activity in which public participation holds the key to success. An urban local body (ULB) can never be successful in SWM without active community participation. The solution is not in the hands of one stakeholder but depends on the interest and participation of all stakeholders.

Awareness and education campaigns should target municipal authorities, elected representatives, schools, nongovernmental organizations (NGOs), media, trade associations, families, and the public at large. To economically and efficiently operate a waste management program, regardless of the strategy, requires significant cooperation from the waste generators. Public involvement is therefore necessary in all waste management and disposal activities.

This chapter looks at building the capacities and enabling the training of ULBs, NGOs, and all other stakeholders to formulate a strategy for achieving effective public participation for SWM in their cities. This chapter also helps readers understand the various information, education, and communication (IEC) options available and steps to be followed for achieving effective community participation and mass action.

Community Participation in SWM

SWM requires the involvement not only of a technical staff with knowledge of the SWM system but also of the whole of civil society (box 7.1). Citizens, businesses, and industries are producers of waste, and the impacts of this waste directly affect their health, environment, and quality of life. Uncollected waste can be a factor in the spread of diseases such as typhoid, cholera, hepatitis A, leptospirosis, filariasis, malaria, dengue, and chickengunya. Moreover, waste that is not properly disposed of causes serious environmental problems.

Despite all its negative impacts, SWM has seldom been a priority issue in India. In urban areas such as Mumbai, where 60 percent of the population lives in slums, the daily needs of water, electricity, transportation, drainage, and other supplies become the major issues to consider, leaving waste management as a low-priority issue. Therefore, citizens keep suffering, and governments are slow to react because of a lack of proper strategies and concrete and permanent action plans.

Box 7.1 Why Community Participation Is Important in SWM

- It achieves the principles of reducing, reusing, and recycling waste.
- It reduces littering of waste on streets and into drains, open spaces, water bodies, and the like.
- It promotes storage of waste at source, segregated as biodegradable and non-biodegradable (so that hazardous waste and infected waste are kept separate).
- It results in arrangements for primary collection of waste through RWAs, self-help groups, NGOs, or individual waste collectors by paying for the services provided.
- It encourages and assists in local composting and recycling initiatives.
- It provides SWM services for low-income populations.

Source: Authors.

In the past few years, owing to increased concerns for health and the environment, citizens have become highly sensitized and are willing to give some of their time for appropriate SWM. Municipal administrations often lack the financial and technical abilities to provide proper SWM services, and the introduction of community-based schemes involving communities in collecting, sorting and recycling activities has proved a viable alternative (Zurbrügg and Ahmed 1999).

These community initiatives have proven the importance of involving the community in SWM, not only in the decision making but also in the day-to-day operation. Therefore, municipal authorities need to change their mindsets and improve their approach to and methods of involving citizens in the day-to-day governance of cities—especially with respect to SWM. Municipal bodies should allow innovation and entrepreneurship from the public, providing space and power within a governance structure where rag pickers, waste workers, slum dwellers, and small and medium entrepreneurs can work alongside health officers, engineers, commissioners, and the rest of the citizenry.

Unlike other highly centralized services, SWM requires a decentralized approach that needs active citizen participation rather than mere democratic representation. As has been discussed in chapter 6, it is important to segregate waste at source. Doing so requires an educated population willing to cooperate with the SWM system.

Planning for Community Involvement Initiatives

The first step for the local body is to define a methodology for reaching out to the community. Informing and involving the community, as well as creating channels for all stakeholders to participate in making decisions and to voice their concerns, are very important steps for successful SWM strategies.

A common approach is to consult these groups to ascertain people's perception of the existing SWM services, their expectations, and the extent to which they are willing to support and participate in the process. ULBs may approach NGOs, community-based organizations (CBOs), secondary school and college students, or members of other institutions for help in the task of involving the community.

The initial step is to identify the stakeholders. Stakeholders are all the people, groups, and institutions that are affected by the SWM system. Most generally, stakeholders include households, businesses, industries, rag pickers, and the local

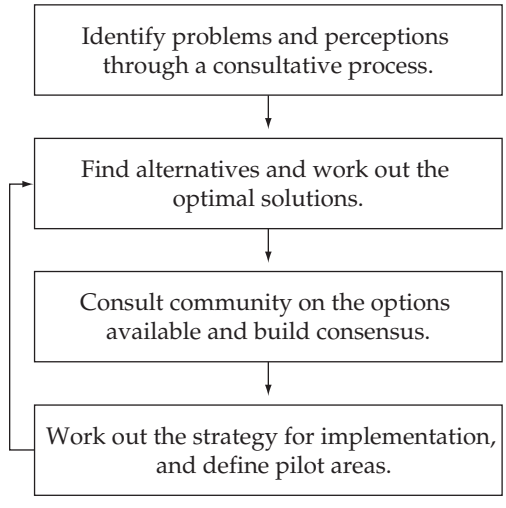
Door-to-door awareness programs have been the key to success of many projects.

government. Any intervention in the existing SWM system will affect stakeholders differently; some of the stakeholders can influence the decision-making process. It is important therefore to identify stakeholders who might have a negative impact (such as informal rag pickers) and those who can influence the decision-making process (such as business owners and neighbors of a new landfill). Figure 7.1 shows the steps to be followed in gaining an understanding of the situation.

After stakeholders are identified, the process of planning for the IEC campaign includes defining the messages to transmit and the main issues on which to get feedback, involvement, and consensus from the community. Box 7.2 describes a success story.

A consultation process can be formal or informal and can be carried out in central city locations or through door-to-door initiatives in which volunteers visit and talk with the residents. The main objectives are to establish meaningful interaction between municipal officers, citizens, and other stakeholders and to obtain consensus on a concrete plan of action. Representative groups should be consulted to

Figure 7.1 Community Consultations



Source: Authors' representation.

Groups of volunteers consult shop owners.

We first need a good understanding of the existing situation, public perception, and expectations before making any strategic decision.

Box 7.2 Bangalore: Swabhimana

Through Swabhimana, a platform of NGOs, stakeholders (different groups of citizens and governmental agencies) and waste retrievers were made aware of the SWM problem. Residents were motivated and formed into committees. Meetings and competitions were organized as were camps and treks. Programs in schools showed films and distributed posters, pamphlets, handbills, and songs. Through such programs, many other methods of communicating messages relating to waste management were shared with the citizens. Training programs were also held for all levels of officials of the government agencies working in the area. Meetings were also held with the contractors who were in charge of clearing the garbage.

Priorities were set on the basis of achieving maximum participation from citizens by involving them in the planning, in motivating their neighbors, and in executing the project through citizens committees. Both the Bangalore Development Authority and the Bangalore City Corporation are fully involved as implementing agencies along with Swabhimana. The citizens, because of these stakeholder analysis activities, have found a direct link to these government agencies.

Source: Shyamala K. Mani, Program Director, Solid Waste Management, Centre for Environment Education.

ascertain their perceptions of the SWM services, their expectations, and their willingness to support and participate in the SWM program.

The consultation process should identify the following:

- The ability and willingness of stakeholders to cooperate in the operation and management of the service
- Their ability and willingness to pay for the services, the mode of payment, and the periodicity of payment
- The demand they have for the type of service and frequency
- Their attitude toward and behavior in participating in experiments or pilot projects, particularly projects relating to source segregation, reuse, and recycling of waste and final treatment and disposal
- Their willingness to work with different sections of society, such as rag pickers, municipal workers, and entrepreneurs
- Their willingness to participate and make decisions regarding not only collection and transport in their localities but also larger issues such as treatment and disposal

Consultation processes should always produce a citizen charter that captures the voice of the citizens (box 7.3). The next step is for the government or stakeholder committee to prepare a white paper or plan for action. Finally, the stakeholder committee or implementing agency should take up the implementation.

Stakeholder Committees

To make the paradigm shift away from governments taking action without consulting other stakeholders requires community involvement. One option is to form stakeholder committees involving community leaders who represent the vision of their constituents. A strong stakeholder committee ensures maximum participation

Box 7.3 Citizens Charter in Namakkal: A 10-Point Charter to Achieve Zero-Garbage Status

By implementing the tasks on its 10-point charter, Namakkal became free of garbage. It announced its zero-garbage status on January 7, 2003. The charter follows:

1. Extend the scheme of door-to-door collection with segregation to the entire town and make streets and roads free of garbage.
2. Introduce night sweeping at bus stands and on important roads and maintain cleanliness throughout the day.
3. Extend door-to-door collection and street sweeping to holidays and Sundays.
4. Maintain parks, gardens, and open spaces through participation by NGOs and voluntary agencies.
5. Remove encroachments from roads and streets and prevent reencroachments.
6. Prevent the roadside hotels, truck repair shops, and other businesses from dirtying Salem Road and maintain the road by planting trees.
7. Remove stray pigs and dogs from the town.
8. Levy SWM service charges on hotels, *kalyanamandapam* (marriage halls), commercial complexes, and garbage-generating industries.
9. Generate vermicompost from organic waste through eco-friendly techniques by involving voluntary organizations and private bodies on a build, operate, transfer basis, sell the inorganic recyclable garbage, and convert the compost yard into *nandavanam* (gardens).
10. Engage two mop-up teams with two auto model carriers to remove waste around the clock and make the town free of garbage all the time.

Source: Supreme Court 1999.

and ownership of SWM initiatives, and cooperation among stakeholders produces long-lasting results. Consideration of the following will help ensure the participation of all stakeholders:

- Municipalities must facilitate stakeholder committees in which there is perception of equality and justice.
- Ego levels and government authority should be low.
- Partisan and political vested interests and disruptive forces should be minimized.
- Maximum representation needs to be ensured from stakeholders such as lower economic groups and disadvantaged groups, especially rag pickers, women, students, children, and senior citizens.
- Including traders, recyclers, media, market associations, religious institutions, and associations should be pursued.
- Regular meetings, minutes, implementation of decisions, and follow-up should be ensured.
- Facilitating delegation of responsibilities such as project management, fundraising, and monitoring is essential.

Because one city-level stakeholder committee may not be able to reach an entire city, subcommittees should be formed at ward or zone levels, especially in class I cities. Subcommittees help in promoting a customized, decentralized, neighborhood-oriented approach, looking at specific requirements and conditions as the basis for providing service and guidance to the various neighborhood committees.

The following stakeholders should be members of the pilot ward-level subcommittees:

- NGOs, CBOs, and volunteer groups
- A health officer or engineer
- Commercial establishments
- Citizens

Other representatives should be invited:

- Councilors
- CBO representatives
- Institutional representatives
- Representatives of the media
- Representatives from schools and colleges

Community-Based Schemes

In a community-based scheme, the community is organized to perform a specific function or task related to the SWM system. Communities can perform such tasks as collecting, sorting, or recycling waste. In some low-income areas, community-based schemes are the only solution available, given the lack of resources in the municipality to provide SWM services. In most cases, women and children are already in charge of performing these activities but lack the proper knowledge and resources (such as gloves, masks, and tools) to perform the activity safely and efficiently.

The following steps are recommended in organizing a community-based scheme:

- Assess current SWM practices.
- Identify the roles of key community members.
- Identify the resources available from the formal authorities and the resources to be provided by local citizens, community leaders, and businesses.

All this information should help define a proper strategy for communicating with and educating community members. To reach out to the community, mass media education, group campaigns, video forums, pamphlets, home visits, or other outreach formats can be prepared. As noted by Zurbrügg and Ahmed (1999), when communicating it is important to do the following:

- Give short and clear messages.
- Highlight personal responsibilities and obligations in sanitation and keeping an area clean.
- Define the role of the municipality within its capabilities and limitations.
- Inform people about the duties and responsibilities of both individuals and the community in cooperating with the municipality.
- Inform people about the advantage of cleanliness in maintaining health.

Within the community, it is important to form a committee to supervise the system. The committee can be formed of volunteers or by some other arrangement agreed to by the community. Boxes 7.4 and 7.5 describe pilot projects.

Box 7.4 Case Study: Karachi, Pakistan

In a pilot project in an urban slum in Karachi, Pakistan, volunteers from the community formed a financial and institutional committee to monitor and supervise waste collection. The volunteers consist of women—especially unmarried women who can devote more time to such voluntary activities—and come from the lanes and streets they supervise. Two such volunteers in each lane and street supervise the sweepers, ensure that the waste is collected timely and appropriately, and collect user fees. These women have formed a CBO, which is entrusted with the task of collecting funds and paying sweepers. Weekly and monthly meetings should ensure appropriate planning and evaluation of the system.

The charge for waste collection is US$0.25 per household per month. Widows with no source of income are exempt from charges. A grace period of one month is given to each household for the payment of the charge.

Source: Zurbrügg and Ahmed 1999.

Box 7.5 Bangalore: Pilot Projects the Key to the Success of City-Level Initiatives

Waste is collected in a Bangalore initiative. (Photo by Integrated Urban Environment Improvement Programme)

Bangalore has been the testing ground for various local SWM initiatives in the past 15 years. A number of NGOs and CBOs have conceptualized the popularly termed *decentralized SWM systems* by involving the resident community. Essentially these systems arose out of the need to compensate for inadequacies in the existing services. The initiatives included setting up systems for doorstep collection and localized composting. The system involved rag pickers and other employable men and women from lower economic strata to find resellable and recyclable items in discarded material. Education on and awareness of neighborhood cleanliness and experiments with the various composting methodologies were also carried out. Some activities are small scale, involving a number of blocks within a ward; others cover various wards or are citywide initiatives. It is important to recognize that these local initiatives are responsible for bringing about the changes and improvements in waste management systems now enjoyed under Swachha Bangalore.

Source: Author.

IEC Strategies for SWM

Many IEC methods can be used; the right one depends on the goals and objectives. It is important to make people understand the importance of having good SWM systems and the steps they can take to help municipal authorities and solid waste managers and workers perform their work better.

The main objectives of IEC are to make people understand

- The concept of and need for source segregation
- The need to store waste at source in two separate receptacles—one for biodegradable waste and one for recyclable waste—and the need to keep toxic and hazardous waste separate
- The role citizens can play in primary collection of waste from the household and handing over of the waste materials to rag pickers or waste collectors

- The need to pay for waste collection and disposal services
- The need to use litter bins on the roads and public places sensibly and sensitively
- The impact of solid waste on public health and the environment.

The strategies described in the following subsections are examples of communication and motivation campaigns.

Motivation and Training of Municipal Officials

Municipal officials should understand their role and relationship with the rest of the community. The following messages should be given to municipal officials:

- Health officers and engineers play key roles in the SWM system, but they need to understand that they ultimately respond to the needs of the population. Therefore, receiving feedback and concerns from stakeholders is essential.
- Many times people are skeptical of working with municipal authorities.
- In any community participation project, municipal officers need to take the backseat and share their powers with the waste management committee. However, they still have the technical knowledge and need to properly communicate when decisions are not suitable.
- Municipal officials need to enable the training and capacity building of resident welfare associations (RWAs). Officials should empower RWAs but not overburden them.

Training and Capacity Building of Local NGOs, CBOs, RWAs, and Other Stakeholders

Training NGOs, CBOs, and RWAs to motivate the community toward waste management is important for ensuring the sustainability of a system. Local NGOs can also be trained to set up appropriate pilot units for the selected waste streams. All stakeholders need to be oriented toward segregation at source and to understand the problems and health issues concerned with inefficient disposal of municipal solid waste. IEC is normally done by the key NGOs for CBOs, RWAs, and local municipal officials. Municipalities have been involving key NGOs through tender advertisements and calls for taking up training assignments of this nature.

Resident welfare associations can play a significant role in community-based SWM education.

Organizing and Training of Rag Pickers, Waste Collectors, and Kabadiwalas

Rag pickers and *kabadiwalas* (itinerant waste retrievers) should be trained for door-to-door collection of source-segregated waste. They also need to be trained in the benefits of segregation and the economic profits that they can get through selling recyclable items.

A household waste separator gives recyclable waste directly to a rag picker.

The ULB should mobilize NGOs or cooperatives to organize street rag pickers and turn them into doorstep waste collectors by motivating them to stop picking soiled and contaminated solid waste from the streets, bins, and disposal sites and instead improve their lot by collecting recyclable clean material from the doorstep at regular intervals. Considering the important role that rag pickers play in reducing waste and the cost of transporting waste, the ULB may even consider extending financial help to NGOs and cooperatives in providing some tools and equipment to rag pickers for efficient performance of their work in the informal sector. See box 7.6 for a success story.

It is important to create awareness of health and hygiene. Rag pickers need to be educated on the ill effects of abusing alcohol and drugs, rummaging through garbage piles without safety gear, contracting infections through unsafe handling of waste, and so forth.

Health concerns of waste retrievers are of prime importance because these workers are constantly handling different types of waste. Also, there is a need to evaluate occupational hazards, if any, in door-to-door waste collecting and sorting. Training in the right method of segregation and collection of waste should be given. Waste retrievers should also be taught to manage their time and to follow the route plan for each sector. They should be taught good behavior with residents and congenial working relations with their partners.

Box 7.6 Vejalpur, Ahmedabad: Rag Pickers Organized and Made Part of the SWM System

In Vejalpur, through an agreement, an NGO mobilized 350 rag pickers for door-to-door waste collection. Each waste collector was allotted 125 houses. Sixteen supervisors (1 supervisor per 20 to 25 waste collectors) were also appointed at a fee of Rs 1 per household per month (Rs 125 total). Because several households were involved, the amount for the supervisor was substantial (Rs 125×20 = Rs 2,500).

The rag pickers involved in door-to-door collection also earned extra income from the sale of recyclable material that they collected. Rag pickers are not marginalized and instead made part of the system.

Source: Documented under the SWM Learning Program in India, May 2006.

Training and Motivating the Self-Help Groups

Training workers in waste management and motivating entrepreneurship in waste management, especially recycling of waste products (sale of compost, paper, and plastic) involves self-help groups and women of the community. Local self-help groups need to be taught about the economic gains that they can get by recycling waste products. They should be trained in establishing paper or plastic recycling units and selling the materials in the local markets. They can also be trained to market compost and recycled products in the local markets. Local NGOs can do the training for the self-help groups and involve them in various activities.

A local self-help group demonstrates products made from household waste.

Public Awareness Methods

Many methods can be used to generate awareness among the public. Some are discussed here.

Door-to-Door Awareness and Motivation Programs

The most effective way to ensure that the right messages reach all participants is to launch a door-to-door awareness campaign. This step is very important. At all stages of the project, it establishes continuing contact with the participants, provides feedback, and builds a bond between the project and the beneficiaries.

Once the basic requirements for implementation of the door-to-door waste collection are in place, the door-to-door motivation program is launched. This step is also important, because construction of pits, purchase of tricycles and equipment, identification of waste retrievers, and their training all take a long time and require the dedicated attention of all staff members. Launching the door-to-door motivation program as the last step of the initial groundwork ensures a shorter time lag between information communication and actual waste collection.

The door-to-door visits kill any space for rumor mongering—a problem that sometimes can damage a project in its initial stages—because such visits do not focus on only a few individuals in order to access the community. Limiting dialogue to a few people can give rise to politics, party or otherwise, as some people try to corner project gains or peddle influence through the project.

Door-to-door visits build the confidence of the people, who begin to believe that the project means to deliver the goods. It also gives an opportunity to ask people to segregate waste, which all participants see as a major chore. Door-to-door motivation gives each household a chance to clear doubts and ask questions about the project. Printed educational materials such as posters, brochures, and pamphlets

Educational material such as this example tells people to segregate waste at source.

are given to each house or commercial establishment, and the entire concept of segregation of waste is explained through the materials.

Materials on SWM may include posters, leaflets, and handouts that can be distributed among the householders, shop owners, or office workers and can be displayed in prominent positions. The materials should use catchy words and slogans to convey their message. Posters must be attractive, with good photographs and short messages that are readable from a distance, and they should be displayed in various parts of the city. Pamphlets and handouts can give instructions in very simple, understandable language, showing actions through photographs and requesting public participation, and they can be circulated throughout the community.

Celebration of the Major Occasions

On all major occasions and festivals (such as Environment Day and Earth Day), waste management can be a prominent activity along with the celebrations. Waste management activities should be conducted by the community to build a sense of responsibility and the importance of the issue.

Rallies

Organizing rallies always builds excitement among the onlookers and propels the people who attend the rallies to motivate other members of society.

A rally organized for community awareness is held in Agra, Uttar Pradesh.

Street Plays

A street play is used in a community awareness program.

Holding regular street plays builds awareness about waste management and motivates nonparticipating residents. The main objectives of this tool of communication are as follows:

- Attract residents to participate in the ongoing SWM program.
- Emphasize the importance of segregation and disposal of household garbage in keeping streets clean.
- Drive home the importance of garbage reduction and waste recycling, and discourage use of plastics in daily life.
- Disseminate information on the benefits of composting wet waste and kitchen waste.

Cleanup Drives

Organizing regular cleanup drives that involve the local community and the district administration is very useful for ensuring community participation and building a sense of responsibility. Cleanup drives have always made the community realize the advantages of cleanliness.

Signature Campaigns

Signature campaigns can be used to get the opinion of various stakeholders on such topics as bans on plastics, temple waste management, segregation of waste, and sanitation.

Open Forums

Organizing open forums in each locality can be useful. At such forums, the views of the community can be collected openly, and mistakes can be rectified.

A signature campaign ensures community participation in SWM.

An essay competition is held in a school as part of an SWM eco-city initiative.

School Programs

Children are strong communicators. Because schoolchildren are the beneficiaries of a better tomorrow, emphasis on educating them to make them aware of the importance a clean and green environment and of waste segregation is very significant (box 7.7). This education can be done by organizing activities such as painting competitions, slogan writing, and cleanup drives. Students should also be trained to use recycled products (reuse paper and plastic carry-bags, use recycled paper, and so forth).

Adults who are otherwise uninvolved can sometimes be reached through their children. ULBs should hold regular meetings with principals, teachers, and students to explain the need for change and the usefulness to society of new ways to manage waste. The message can be reinforced by holding essay, debate, or drawing and painting competitions on the subject and publicizing the winning contestants. Parents generally do take note when their children win contests. Social clubs can be encouraged to sponsor such events and to keep the topic alive. The leading schools could be persuaded to work as role models for other schools in taking up awareness campaigns in the city through their students. Such campaigns should be highly publicized, and other schools should be persuaded to follow suit.

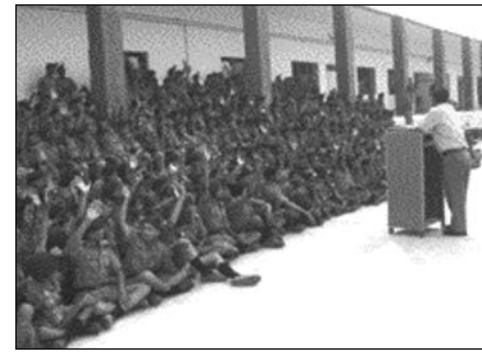
Box 7.7 Kannur: Clean, Green Schools

The Centre for Environment Education (CEE) is working on a project focused on waste management in eight schools. The students are made aware of the prevailing waste scenario. Eco-clubs are formed, and the students conduct surveys of the waste generated in their schools, houses, and towns. They also observe the ways in which people contribute to waste generation by using products unwisely. On the basis of this information and their work with CEE, they formulate action plans to minimize waste. The students also engage in green games, activities with strong environmental messages, community walks, cleanup drives, street plays, and nature walks.

Source: Shyamala K. Mani, Program Director, Solid Waste Management, Centre for Environment Education.

Involvement of National Cadet Corps, National Social Service, and Scouts

In the schools and colleges, many students participate in National Cadet Corps, National Social Service, and scouting activities. These students could also be sensitized to the public participatory aspect of SWM. As part of their activities, they can be involved in awareness campaigns to bring about a change in public behavior.



Students in the National Cadet Corps take a pledge to be responsible citizens by contributing to keeping their city clean.

Involvement of Religious Leaders

Religious leaders play a significant role in changing people's minds. Recommendation from a well-respected religious leader to keep surroundings clean, avoid littering, and manage waste as advised by the ULBs will go a long way toward improving the situation in urban areas.

Involvement of Mahila Mandals and Women's Associations

Women are generally found to be more concerned with the maintenance of health and hygiene, and they are involved in domestic waste management on a day-to-day basis. Awareness among women could be raised through Mahila Mandals and women's associations. The associations could be given talking points and literature produced in very simple, understandable language and graphics to create awareness among women.

Best Garden Competitions

In Bangalore, as part of motivating residents to segregate waste and benefit from composting, an annual best garden competition is conducted for all residents in Hennur Road Banaswa di Road Layout. About 20 houses participated in the first competition, and the number has increased year after year. Entries include rooftop and terrace gardens, kitchen gardens, lawns, and the like. They are judged by landscape specialists from the University of Agricultural Sciences, Department of Horticulture, Bangalore.

Residents are informed of the competition two months in advance through pamphlets. Residents are required to register for the competition. Gardens are categorized as general gardens, rooftop gardens, potted plants, and kitchen gardens and are evaluated on six parameters (aesthetics, vigor, variety, use of space, knowledge of gardening, and appreciation value). All participants are given complimentary bags of compost.

Mass Communication Methods

Mass communication methods include print media; television, radio, and the Internet; and cinema theatres.

Print Media. Advertisements may be distributed in a planned manner to educate the masses, and local newspapers can also be asked to insert messages on SWM at regular intervals. Newspapers should also be encouraged to start a regular suggestion box from which the ULB can pick up good ideas. Newspapers can be encouraged to cover successful initiatives that have resolved SWM problems. ULBs can also take advantage of newspaper delivery services by inserting handbills that announce the start of campaigns and that encourage adherence to the systems introduced.

Television, Cable Television, Radio, and Web Sites. Television, radio, and the Internet are very powerful media and can be used to inform citizens of new waste collection arrangements made by the ULB as such arrangements become operational and to ask citizens to participate effectively in the prescribed manner. Contact numbers of officials to call for problem solving or for reporting SWM grievances may also be publicized. These media may be used to publicize successful efforts in some localities to motivate other citizens to perform likewise and get similar recognition for their efforts.

Cinema Theaters. Slides can be displayed in cinema theaters to inform and motivate the public.

The Local Context

Without doubt there are many ways to carry out an IEC campaign or an awareness-raising campaign on waste management issues. The way a specific plan in a specific context is formulated will greatly depend on the local context, existing support and understanding of the problem, and previous campaigns or activities.

Lessons Learned

Lessons learned include the following:

- Citizens' awareness of and participation in the SWM process is essential for the sustainability of the SWM system.
- It is important to get the support and consensus of stakeholders for the SWM system.
- IEC campaigns are an effective approach in educating citizens to ensure their active participation.

References and Suggested Readings

Bernstein, Janis. 2000. *A Toolkit for Social Assessment and Public Participation in Municipal Solid Waste Management*. Washington, DC: World Bank. http://www.worldbank.org/urban/uswm/socialassesstoolkit.pdf.

Commonwealth Secretariat. 2004. "Effective Partnerships in Areas of Human Development, Water, Sanitation, and Waste Management." Commonwealth Consultative Group on Environment, London, United Kingdom. http://www.thecommonwealth.org/shared_asp_files/uploadedfiles/{E44377F4-04E8-4560-B9D1-D863225DECC7}_CCGE(04)1_Effective%20Partnerships.pdf.

Dahiya, Bhárat. 2003a. "Hard Struggle and Soft Gains: Environmental Management, Civil Society, and Governance in Pammal, South India." *Environment and Urbanization* 15 (1): 91–100. http://www.ucl.ac.uk/dpu-projects/drivers_urb_change/urb_governance/pdf_partic_proc/IIED_Dahiya_gender.pdf.

———. 2003b. "Peri-Urban Environments and Community-Driven Development: Chennai, India." *Cities* 20 (5): 341–52.

Supreme Court. 1999. "Report of the Supreme Court Appointed Committee on Solid Waste Management in Class I Cities in India." Supreme Court of India, New Delhi.

UNDP (United Nations Development Programme)–World Bank Water and Sanitation Program-South Asia. 1998. "Lessons for Improving Service Delivery: Learnings from Private and Nonformal Sectors in Solid Waste Management." UNDP-World Bank Water and Sanitation Program-South Asia, New Delhi, India.

———. 1999a. "Community-Based Action Planning for Effective Solid Waste Management, Kuppam, Andhra Pradesh." UNDP-World Bank Water and Sanitation Program-South Asia, New Delhi, India.

———. 1999b. "Effective Solid Waste Management with the Participation of Waste Producers." Seventh Meeting of the Urban Think Tank, Calcutta, January 7–8.

———. 1999c. "Profits from Waste: A NGO-Led Initiative for Solid Waste Management in Lucknow, Uttar Pradesh, India." UNDP-World Bank Water and Sanitation Program-South Asia, New Delhi, India.

———. 2000. "Pilot Project on Solid Waste Management in Khulna City: Community Organization and Management." UNDP-World Bank Water and Sanitation Program-South Asia, New Delhi, India.

UNEP-IETC (United Nations Environment Programme-International Environmental Technology Center). 2003. "Innovative Communities: Community Centered Approaches to Sustainable Environmental Management." UNEP-IETC, Osaka, Japan. http://www.unep.or.jp/ietc/kms/data/226.pdf.

World Bank Water and Sanitation Program and India Ministry of Urban Development. 1993. "Community-Based Solid Waste Management: Project Preparation Panaji Case Study." World Bank, Washington, DC.

Zurbrügg, Christian, and Rehan Ahmed. 1999. "Enhancing Community Motivation and Participation in Solid Waste Management." *Sandec News* 4 (January): 2–6.

Appendix 1

India Fact Sheet

Demographic and economic data	*Amount*
Total population (in 2005)[a]	1,100,000,000
Population growth (annual % in 2005)	1.4
Urban population (%)[a]	28
Urban population, total[b]	285,000,000
Urban population by 2015 (projected)[c]	400,000,000
Number of towns and cities[b]	4,378
Number of class I cities (population 100,000 and above)[c]	423
Number of class II cities (population 50,000 to 99,999)[b]	401
Number of class III cities (population 20,000 to 49,999)[b]	1,151
Number of metropolitan cities (1 million plus population)[c]	35
GDP growth (annual %, 2005)[a]	8.5
GDP (2006 estimated, US$)[d]	796,100,000,000
GDP per capita (2006 estimated, US$)	3,700
Solid waste data	*Amount*
MSW (annual generation)[b]	35,000,000–45,000,000[e]
MSW generated by major urban centers (approximate number of metric tons per day in 2000)[b]	100,000
MSW generated by major urban centers (approximate number of metric tons per year in 2000)[b]	35,000,000[f]
Average waste generated in urban areas[b] (grams per capita per day)	300–500[g]
Municipal expenditure on solid waste management services (as a % of municipal budget)[c]	
Small towns	30–50
Large cities	15–25
Estimated additional cost of landfills to meet 2000 rules[c] (Rs per ton)	300–500

Note: GDP = gross domestic product; MSW = municipal solid waste

a. World Bank 2006.

b. Hanrahan, Srivastava, and Ramakrishna 2006.

c. Office of the Registrar General 2001.

d. CIA 2007.

e. Likely to double by 2015 and double again by 2025, by which time India will be generating more than 150 million tons of waste a year.

f. Other sources suggest that the figure may be higher—up to 45 million tons annually.

g. Depending on the type of urban local body and population.

References and Suggested Readings

CIA (U.S. Central Intelligence Agency). 2007. *The World Factbook*. Washington, DC: CIA. https://www.cia.gov/library/publications/the-world-factbook/index.html

Hanrahan, David, Sanjay Srivastava, and A. Sita Ramakrishna. 2006. "Improving Management of Municipal Solid Waste in India: Overview and Challenges." World Bank, Washington, DC.

Office of the Registrar General. 2001. "Census of India." New Delhi: Ministry of Home Affairs. http://www.censusindia.net/.

World Bank. 2006. "Development Indicators for India." In World Development Indicators database, April. http://www.worldbank.org/india.

Solid Waste Management (SWM) is a matter of great concern in the urban areas of developing countries. The municipal authorities who are responsible for managing municipal solid waste are unable to discharge their obligations effectively because they lack the in-house capacity to handle the complexities of the process.

It is heartening to see that the World Bank has prepared this book covering all important aspects of municipal SWM in great depth. The book covers very lucidly the present scenario of SWM in urban areas, the system deficiencies that exist, and the steps that need to be taken to correct SWM practices in compliance with Municipal Solid Waste (Management and Handling) Rules 2000 ratified by the Government of India. The book shares examples of best practices adopted in various parts of the country and abroad, and very appropriately covers the institutional, financial, social, and legal aspects of solid waste management, which are essential for sustainability of the system. It provides a good insight on how to involve the community, nongovernmental organizations, and the private sector to help improve the efficiency and cost effectiveness of the service, and shows how contracting mechanisms can be used to involve the private sector in SWM services.

This book will be a very useful tool for city managers and various stakeholders who deal with municipal solid waste management in the design and execution of appropriate and cost-effective systems.

Shri S.R. Rao, IAS
Principal Secretary, Urban Development & Urban Housing Department,
Government of Gujarat, India

ISBN 978-0-8213-7361-3
SKU 17361

THE WORLD BANK