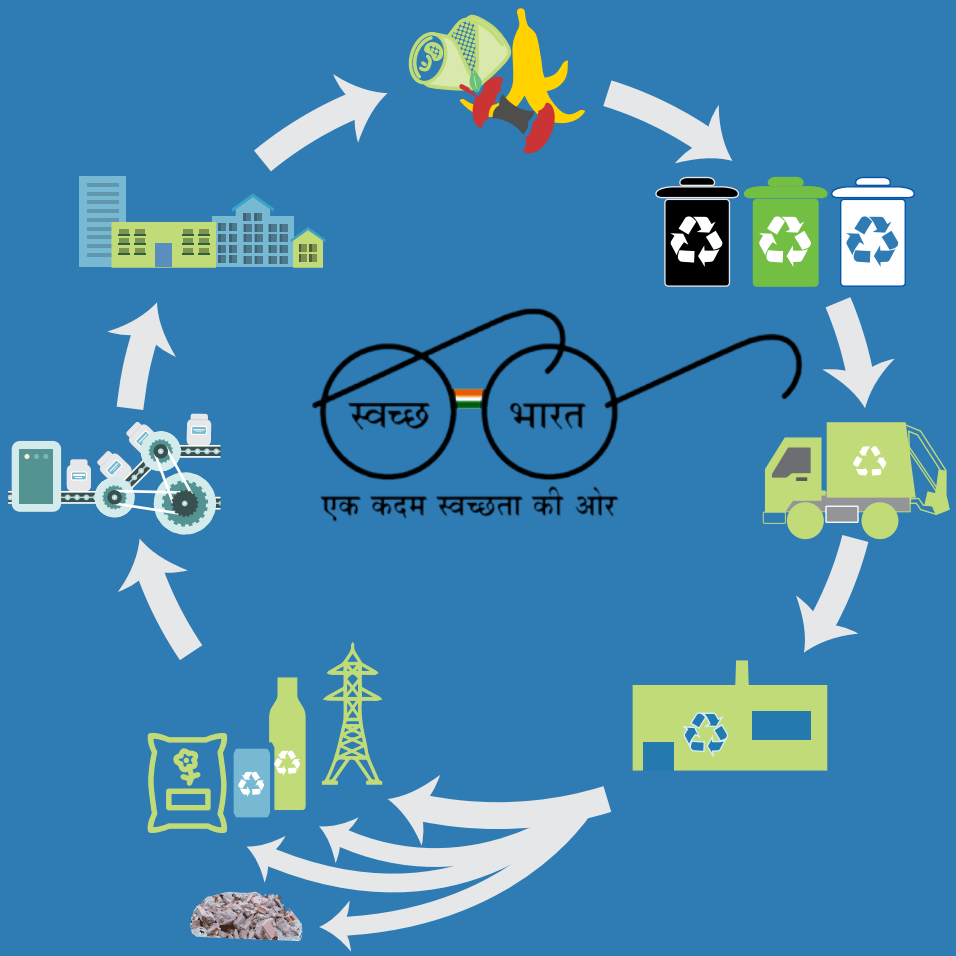
सत्यमेव जयते

GOVERNMENT OF INDIA

# SWACHH BHARAT MISSION

# MUNICIPAL SOLID WASTE MANAGEMENT MANUAL

## PART I: AN OVERVIEW




Central Public Health and Environmental Engineering Organisation (CPHEEO)

**MINISTRY OF URBAN DEVELOPMENT**

www.moud.gov.in

www.swachhbharaturban.gov.in

**2016**

सत्यमेव जयते

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# MUNICIPAL SOLID WASTE MANAGEMENT MANUAL

Central Public Health and Environmental Engineering Organisation (CPHEEO)

**IN COLLABORATION WITH**



**German International Cooperation**

2016

In keeping with the advancements in this sector, updates as and when found necessary will be hosted in the Ministry website: http://moud.gov.in/ and the reader is advised to refer to these also.



Designed under contract with GIZ by Aspire Design, New Delhi

# PART I:
# An Overview

# MESSAGE

एम. वेंकैया नायडु
**M. VENKAIAH NAIDU**

सत्यमेव जयते

शहरी विकास,
आवास और शहरी गरीबी उपशमन एवं
संसदीय कार्य मंत्री
भारत सरकार
MINISTER OF URBAN DEVELOPMENT,
HOUSING & URBAN POVERTY ALLEVIATION
AND PARLIAMENTARY AFFAIRS
GOVERNMENT OF INDIA

30th June, 2016

**Message**

Municipal Solid Waste Management in urban areas has emerged as one of the biggest challenges that our country faces today, not only in terms of environmental and aesthetic impact but also the potential threat to public health, resulting from improper & non-scientific handling of municipal waste. The issue is further aggravated by the fast pace of urbanisation that is taking place in our cities today.

Acknowledging the magnitude of this challenge, the Government of India launched **Swachh Bharat Mission** on 2nd October 2014 with a goal to make our country clean and open defecation free by 2nd October, 2019, as a mark of tribute to Mahatma Gandhi on his 150th birth anniversary. With the launch of the Swachh Bharat Mission (SBM), the issue of cleanliness and sanitation has taken centre stage in India's national mandate of development. Under SBM-Urban, 100% scientific management of Municipal Solid Waste has been identified as one of the critical objectives to be achieved by 2019. The Government has taken several initiatives to achieve these objectives.

As part of these initiatives the Government is facilitating **Market Development assistance** in form of fixed financial assistance of Rs. 1,500 per tonne on sale of city compost to farmers to boost sales of compost . The Central Electricity Regulatory Commission (CERC) on 07.10.2015 has notified **Generic tariff for Waste-to-Energy** of Rs 7.90 per unit of power and the Government has mandated 100% procurement of power generated from Waste to Energy Plants. These initiatives will ensure financial viability of setting up of Waste to Compost and Waste to Energy plants.

The Bureau of India Standards (BIS) has amended their specifications allowing usage of Recycled Concrete Aggregate (RCA) derived from Construction & Demolition (C&D) Waste in construction activities.

Recently Government of India has published the Solid Waste Management Rules 2016 to make them more effective, and serving the initiatives taken under Swachh Bharat Mission.

**Office:- Room No. 104-C, Nirman Bhawan, New Delhi-110108; Phone: 011-23061166, 23061162, 23062089 (Fax)**
**Residence:- 30, Dr. APJ Abdul Kalam Road, New Delhi-110011; Phone: 011-23019387, 23019388 (Telefax)**

The **Municipal Solid Waste Management Manual 2016** has been designed by the Ministry taken into account all these recent developments. I am confident that the revised **Municipal Solid Waste Management Manual 2016** will prove to be a highly useful guidance document to all officials of the Urban Local Bodies in the country to achieve the prime objectives of environmentally sound management of solid wastes and promoting resources recovery from the waste.

I would like to acknowledge the praiseworthy efforts of the Expert Committee members, the support extended by the Government of Germany, and the efforts of MoUD officials in undertaking this commendable initiative.

**(M. VENKAIAH NAIDU)**

# FOREWORD

राव इन्द्रजीत सिंह
RAO INDERJIT SINGH

सत्यमेव जयते

राज्य मंत्री (स्वतंत्र प्रभार)
योजना मंत्रालय तथा राज्य मंत्री, शहरी विकास
एवं आवास और शहरी गरीबी उपशमन मंत्रालय
भारत सरकार, नई दिल्ली–110001
Minister of State (Independent Charge) for Ministry of Planning
and MoS for Ministry of Urban Development and
Ministry of Housing & Urban Poverty Alleviation,
Government of India, New Delhi-110001

## FOREWORD

India's urban population has sharply increased from 19.9% in 1971 to 31.2% in 2011. This unprecedented growth, along with high economic growth, has resulted in a severe challenge for Urban India, in terms of addressing the incremental infrastructural needs of a fast-growing urban population. One of the major fallouts of this growth has been the challenge of scientific management of the Municipal Solid Waste generated in Indian cities.

The Swachh Bharat Mission – Urban aims to fulfil the objective of 100% scientific disposal of municipal solid waste in all 4,041 urban local bodies in the country. This will entail setting up and / or strengthening scientifically designed Solid Waste Management (SWM) facilities and systems across all states and cities.

The Municipal Solid Waste Rules 2000 had provided valuable guidelines to Urban Local Bodies for collection, segregation, storage, transportation, processing and disposal of municipal solid wastes. However, the dynamic nature of urban growth has also given rise to challenges which were not manifest earlier. This has prompted the announcement of the Solid Waste Management Rules 2016, to cater to the enlarged scope of challenges, including catering to urban conglomerations and census towns, making source segregation of waste mandatory, specifying responsibilities of bulk waste generators, Central Ministries, State Governments and Urban Local Bodies.

In order to assist States and cities to understand and effectively implement SWM systems, the Ministry of Urban Development, in partnership with the Government of Germany has published the revised **Municipal Solid Waste Management Manual 2016,** in alignment with the **Solid Waste Management Rules 2016.** I am confident that this manual, prepared as a practical handbook and guideline for the Urban Local Bodies, will prove to be of immense help and relevance to states and cities in taking effective decisions for solid waste management.

I am sure that this manual will also serve as a guide to policy makers, planners, and all practicing professionals in achieving the desired goals of the Swachh Bharat Mission.

**(Inderjit Singh)**

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# PREFACE

राजीव गौबा
सचिव
**Rajiv Gauba**
Secretary

सत्यमेव जयते

भारत सरकार
शहरी विकास मंत्रालय
निर्माण भवन, नई दिल्ली-110011
Government of India
Ministry of Urban Development
Nirman Bhawan, New Delhi-110011

## PREFACE

It is an accepted fact that the increasing pace of urbanization in India, along with economic growth and improved living standards have put added pressure on the already strained capacities of Urban Local Bodies to manage the increasing quantities of municipal solid waste generated daily. At present only 18% of the waste generated per day is getting scientifically treated which is a major cause of concern.

The Swachh Bharat Mission, launched by the Government of India on 2nd October 2014 aims to ensure 100% scientific disposal of municipal solid waste in all 4041 ULBs in the country.

In this regard, the revised **Manual on Municipal Solid Waste Management 2016,** prepared on the basis of experiences gained in solid waste management over the past 15 years, and in alignment with the latest **Solid Waste Management Rules 2016** will be a valuable ready reckoner tool for ULBs. The revised manual has three broad sections. **Part I** provides decision makers, elected representatives and senior municipal officials with an overview on key issues pertaining to MSW; **Part II** of the manual contains details of technical and managerial aspects of effective solid waste management (SWM), while **Part III** provides a compendium of rules, international best practices etc.

Overall, the manual provides guidance on all aspects of Municipal Solid Waste management - from storage of segregated waste at source, through primary and secondary collection, transportation, processing, treatment, and finally to safe disposal. It is also expected to assist policy makers and practicing professionals to plan, design, operate and maintain various Municipal Solid Waste Management systems efficiently and sustainably. I am sure that this comprehensive MSW management guide book would prove to be a very helpful tool for ULBs in their continued efforts at improving delivery of SWM related services to their citizens.

On behalf of MOUD, I would like to thank the members of the Expert Committee for preparing this manual in a timely manner. I also wish to acknowledge the concerted services rendered by Dr. N.B. Majumdar, Chairman of the Expert Committee, Dr. Dieter Mutz and his team from GIZ, Shri V.K. Chaurasia, Joint Adviser in CPHEEO, and his colleagues, for their valuable contribution in the preparation of this Manual.

**(Rajiv Gauba)**

# ACKNOWLEDGEMENT

**V. K. Chaurasia**
Adviser(PHEE) (I/C)
CPHEEO

भारत सरकार
शहरी विकास मंत्रालय
निर्माण भवन

GOVERNMENT OF INDIA
MINISTRY OF URBAN DEVELOPMENT
NIRMAN BHAWAN

नई दिल्ली - 110011, तारीख 20
New Delhi - 110011, Dated the 20

## ACKNOWLEDGEMENT

The Municipal Solid Waste Management (MSWM) sector is evolving rapidly with new principles for sustainability and technological advancements. The Government of India's Swachh **Bharat Mission** launched on 2nd October, 2014 has brought the Municipal Solid Waste Management sector to the forefront of governance in the Urban Local Bodies (ULBs). The Manual on Municipal Solid Waste Management was originally published in 2000. Since then, over the last 15 years, lot of developments have taken place in the sector requiring the revision/updating of the Manual.

In this background, Ministry of Urban Development (MoUD) undertook the task of revision of Manual on Municipal Solid Waste Management 2000 jointly with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ- the German International Cooperation), and the Ministry's technical wing, Central Public Health and Environmental Engineering Organization (CPHEEO). A Memorandum of Understanding (MoU) was signed between the Ministry of Urban Development, CPHEEO and GIZ in February, 2013 for the purpose.

The Ministry constituted the Expert Committee in 2013 consisting of experts from Central Ministries/ Departments, Academic & Research Institutions, Senior Engineers/Officials from State Departments & ULBs for reviewing & updating the existing Manual. The following is the composition of Expert Committee which includes certain amendments in the course of Manual preparation:-

| No. | Name | Designation/ Department |
|---|---|---|
| 1. | Dr. N.B. Mazumdar | Chairman, Expert Committee and Ex-Chief(SWM), HUDCO |
| 2. | Dr. M. Subba Rao | Director, Ministry of Environment, Forest and Climate Change |
| 3. | Mr. B.R Mishra | Director, Ministry of New & Renewable Energy |
| 4. | Dr. A.B. Akolkar | Member Secretary, Central Pollution Control Board |
| 5. | Dr. Krishan Chandra | Additional Director, Ministry of Agriculture |
| 6. | Mr. S. Venkatesh Shekar | Environmental Officer, Karnataka State Pollution Control Board |
| 7. | Mr. Umesh Sachdeva | Chief Engineer, South Delhi Municipal Corporation |
| 8. | Mr. Khader Sahib | Joint Director & Commissioner, MA, Hyderabad |
| 9. | Mr. R. Srinivas | Town Planner, Town & Country Planning Organization |
| 10. | Dr. M. Dhinadayalan | Joint Adviser (PHEE) CPHEEO MoUD |
| 11. | Mr. J.B. Ravinder | Deputy Adviser (PHE) CPHEEO MoUD |
| 12. | Mr. P.U. Asnani | Chairman Urban Management Consultants, Ahmedabad |
| 13. | Prof. Manoj Dutta | Professor, Department of Civil Engineering, IIT-Delhi |
| 14. | Mr. B.B. Uppal | Ex- Deputy Adviser CPHEEO |
| 15. | Prof. Sneha Palnitkar | Director, AIILSG Mumbai |
| 16. | Mr. P.Prasada Rao | Ex –Head Environment & Sustainable Division EPTRI Hyderabad |

| | | |
|---|---|---|
| 17. | Dr. Sunil Kumar | Senior Scientist, NEERI Nagpur |
| 18. | Dr. Gourav Vallabh | Professor (Finance), XLRI, Jamshedpur |
| 19. | Mr. R. N. Gupta | Former Engineer -in –Chief, Government of Chhattisgarh |
| 20. | Dr. Dieter Mutz | Director, GIZ- IGEP |
| 21. | Dr. Regina Dube | Former Head & Senior Advisor Sustainable Urban Habitat, GIZ-IGEP |
| 22. | Mrs. Vaishali Nandan | Senior Advisor, Sustainable Urban Habitat, GIZ-IGEP |
| 23. | Mrs. Shweta Dua | Technical Expert, Sustainable Urban Habitat, GIZ-IGEP |
| 24. | Mrs. Soumya Chaturvedula | Regional Manager, ICLEI-South Asia |
| 25. | Mr. V.K. Chaurasia | Joint Adviser (PHEE) CPHEEO, MoUD- Member Secretary |
| 26. | Mr. Amit Kumar Saha | Assistant Adviser (PHE) CPHEEO, MoUD- Member Coordinator |

In all, 4 Expert Committee meetings and 15 sub group meetings were held through 2013 and 2014. The Manual was prepared by the Expert Committee and GIZ team involving National & International experts. The experiences from different states, cities, private sector, community initiatives, manufacturers, companies, NGOs, experts and informal sector were shared with members of the Expert Committee and working groups during the process. The experiences of city level officials dealing the subjects were also availed and incorporated in the Manual.

The first draft of the Manual was thoroughly discussed in the National Stakeholders Workshop held in New Delhi in July, 2014 wherein delegates from Central Ministries, State Government Departments, Urban Local Bodies (more than 250) and representatives from various Academic Institutions, Technology Providers and Organisations from all over India participated and deliberated the draft contents of all three parts of the Manual in order to further examine and enrich its contents.

The revised Manual advocates proper planning and management of MSW through a **seven step approach**, advises on how to choose appropriate options for a city based on the amount of waste generated; local waste characteristics; local geographical conditions; availability of land and other relevant criteria. The holistic approach adopted in the Manual focuses on technical, institutional, financial and legal aspects of waste management. It also introduces the concept of State and Regional strategies, Regional landfill facilities, capacity building and handholding support to ULBs by the States/Central Govt. The need and type of community awareness required at different stages of the MSW management chain are also elaborated.

This revision process was steered to incorporate the framework of sustainable solid waste management, technological and organisational developments in the sector, financial sustainability models, public private partnerships, successful national and international case studies and implementation experiences that have been noted over the years since the Manual was last published. The Manual is fully aligned with the latest Solid Waste Management Rules 2016, Construction & Demolition Waste Rules 2016 and also the related rules like Plastic Waste Rules 2016 and E-waste Rules etc. Therefore, the approach adopted to revise the Manual was both participatory and iterative involving representatives from other Central Ministries, State Departments, Urban Local Bodies, NGOs, Academicians, Training Institutes and Experts in the sector.

The Revised Manual is brought out in the following three parts:

**Part I- Salient features of the MSWM Manual**: It gives an Overview, providing the decision makers the key points from the entire Manual which are of particular relevance for promoting an understanding of challenges and opportunities in the field of MSWM and guiding them in initiating necessary processes to achieve the goals of a clean city.

**Part II- Manual on Municipal Solid Waste Management**: This part provides target groups with guidance on the principles of sustainable municipal solid waste management; the planning required for SWM managing and operating systems and for undertaking concrete measures towards institutional strengthening and financial management leading to sustainable MSWM. It gives detailed understanding of various relevant Rules, detailed description of technologies to be adopted for collection, transportation, treatment, processing and disposal etc. It also touches upon the Management of special waste streams which are sometimes mingled with MSW and but need to be treated separately.

**Part III**- This part of the Compendium includes National and International case studies & relevant Rules on Solid Waste Management useful for the appropriate government.

I hope the revised Manual will meet the expectations of all those working in policy and programme formulation and would also be a very useful guidance document for formulation of Municipal Solid Waste Management projects for cities/towns, selection of technologies and implementation of SWM systems. Manual can also be used as ready reference for various prevalent Rules/Regulations in the sector.

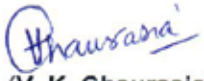
On behalf of the Expert Committee, I express my profound gratitude to the Ministry of Urban Development for extending all support and encouragement in the preparation of the Manual. I sincerely thank the **Joint Secretary, Shri Praveen Prakash and his predecessors Shri Neeraj Mandloi and Dr. Ashok Singhvi** for their support without which it might not have been possible to complete this massive task of revising the Manual. I also thank the Directors from the Ministry namely, Shri Ashutosh Joshi, Ms. Nandita Misra, Shri Parmod Kumar, Ms. Shubha Thakur, Shri Shailendra Vikram Singh and Shri Saurabh Jain for their continued support and encouragement during the process of revision/preparation of the Manual.

I also express my heartfelt gratitude to GIZ for extending its full support in the preparation of the Manual, They left no stone unturned to enrich the contents of Manual by adopting participatory approach and inviting experts and all those who are working on the ground in the country as well as from abroad. It flawlessly conducted all the meetings and looked after the comfort of Expert Committee members and all those who participated in deliberations.

I am duty bound to extend my gratitude and sincere thanks to Dr. N.B. Mazumdar, Chairman of the Expert Committee and Former Chief (Solid Waste Management), HUDCO, for agreeing to chair the Expert Committee meetings. He moderated the discussions in very decent and fruitful manner enriching the contents of Manual and making it user friendly. I also thank all the members of Expert Committee for their involvement and significant contributions made in revising the Manual.

I would also like to express my sincere thanks to Dr. Dieter Mutz, Director; Dr. Regina Dube (former Head & Senior Advisor); Mr Dirk Walther; Ms. Vaishali Nandan ( and their teammates from GIZ for revising the contents of Manual in good time. Furthermore, I take this opportunity to thank Mr. Alfred Eberhardt, International Expert and ICLEI- SA (team of National Experts) for their untiring efforts and iterative process of revising and closely monitoring/upgrading the quality of the Manual. I am grateful to the ADB India for undertaking peer review of the Manual.

I would also like to acknowledge the efforts of my colleagues namely Dr. M. Dheenadayalan, Joint Adviser (PHEE), Mr. J.B.Ravinder, Joint Adviser (PHEE), Mr. Rohit Kakkar, Deputy Adviser(PHE), Dr. Ramakant, Deputy Adviser (PHE) , Mr. A.K. Saha, Assistant Adviser (PHE) and Dr. S. Saktheeswaran, consultant for extending all possible assistance/useful contributions and feedback at all levels for enriching the contents of the Manual. I also acknowledge the support extended by the staff of PHE division and CPHEEO and all those who directly or indirectly contributed in the process of revising the Manual.



(**V. K. Chaurasia**)

# VISION STATEMENT

The Ministry of Urban Development's vision of Swachh Bharat emanates from the vision of the Government, articulated in the address of The President of India in his address to the Joint Session of Parliament on 9th June 2014:

> "We must not tolerate the indignity of homes without toilets and public spaces littered with garbage. For ensuring hygiene, waste management and sanitation across the nation, a "Swachh Bharat Mission" will be launched. This will be our tribute to Mahatma Gandhi on his 150th birth anniversary to be celebrated in the year 2019"

To accomplish the vision of Swachh Bharat expeditiously, particularly on solid waste management, the Ministry of Urban Development (MoUD), through this Manual, aims at guiding all waste generators particularly Urban Local Bodies towards Sustainable Solid Waste Management by adopting suitable measures for waste minimisation at source with an emphasis on the principles of 3Rs, comprising Reduce, Reuse and Recycle; with proper systems of segregation, collection, transportation, processing, treatment and disposal in complete harmony with the environment and in line with prevalent regulations.

# TABLE OF CONTENTS

# LIST OF FIGURES AND TABLES

## FIGURES



## TABLES

# ABBREVIATIONS

| | |
|---|---|
| ABC | Asphalt, Brick and Concrete |
| ABS | Area Based System |
| AD | Anaerobic Digestion |
| ADB | Asian Development Bank |
| ADDA | Asansol Durgapur Development Authority |
| ADS | Air Density Separator / De-stoner |
| AFR | Alternative Fuels and Raw material |
| ALM | Advanced Locality Management |
| AMC | Asansol Municipal Corporation |
| APITC | Andhra Pradesh Industrial & Technical Consultancy Organization |
| APPCB | Andhra Pradesh Pollution Control Board |
| ASR | Auto Shredder Residue |
| ASTM | American Society for Testing and Materials |
| BARC | Bhabha Atomic Research Centre |
| BBMP | Bruhat Bangalore Mahanagara Palika |
| BFB | Bubbling Fluidized Bed |
| BIS | Bureau of Indian Standards |
| BOD | Biochemical Oxygen Demand |
| BOO | Build Own Operate |
| BOOT | Build Own Operate and Transfer |
| BOT | Build Operate Transfer |
| C&D | Construction & Demolition |
| CA | Concession Agreement |
| CAA | Constitutional Amendment Act |
| CBG | Compressed Biogas |
| CBOs | Community Based Organizations |
| CCF | Clean City Foundation |
| CE | Combustion Efficiency |
| CEO | Chief Executive Officer |
| CFB | Circulating Fluidized Bed |
| CFL | Compact Fluorescent Lamps |
| CIPET | Central Institute of Plastics Engineering and Technology |
| CMA | Commissionerate of Municipal Administration |
| CMWMF | Common Municipal Waste Management Facilities |
| CNG | Compressed Natural Gas |
| CoC | Cochin Municipal Corporation |

| | |
|---|---|
| COD | Chemical Oxygen Demand |
| CoP | Corporation of Panaji |
| CPCB | Central Pollution Control Board |
| CPHEEO | Central Public Health and Environmental Engineering Organization |
| CPU | Carcass Processing Unit |
| CPWD | Central Public Works Department |
| CREDAI | Confederation of Real Estate Developers' Associations of India |
| CRRI | Central Road Research Institute |
| CSI | City Sanitary Inspector |
| CSP | City Sanitation Plan |
| CSTR | Continuously Stirred Tank Reactor |
| D2D | Door-to-door |
| DBFOT | Design, Build, Finance, Operate and Transfer |
| DBO | Design-Build-Operate |
| DBOOT | Design-Build-Own-Operate and Transfer |
| DC | Drain Cleaning |
| DEA | Department of Economic Affairs |
| DMA | Directorate of Municipal Administration |
| DMC | Durgapur Municipal Corporation |
| DPR | Detailed Project Report |
| DRANCO | Dry Anaerobic Composting |
| DRE | Destruction Removal Efficiency |
| DWCC | Dry Waste Collection Centres |
| EAC | Expert Appraisal Committee |
| EDMC | East Delhi Municipal Corporation |
| EIA | Environment Impact Assessment |
| EM | Effective Micro Organisms |
| EMP | Environmental Management Plan |
| EoI | Expression of Interest |
| EPF | Employment Provident Fund |
| EPR | Extended Producer Responsibility |
| EPS | Expanded Polystyrene |
| EPTRI | Environment Protection Training and Research Institute |
| ESI | Employees' State Insurance |
| ESP | Electrostatic Precipitator |
| ETP | Effluent Treatment Plant |
| EU | European Union |
| FAQ | Frequently Asked Question |
| FCA | Full Cost Accounting |
| FCO | Fertilizer Control Order |
| FGT | Flue Gas Treatment |

| | |
|---|---|
| FRP | Fiber Reinforced Plastic |
| GCL | Geo Synthetic Clay Liner |
| GDP | Gross Domestic Product |
| GHG | Green House Gas |
| GIS | Geographic Information System |
| GNCTD | Government of National Capital Territory of Delhi |
| GoI | Government of India |
| GPRA | General Pool Residential Accommodation |
| GPRS | General Packet Radio Identification |
| GPS | Global Positioning System |
| GSB | Granular Sub Base |
| GSI | Geologic Survey of India |
| HAPs | Hazardous Air Pollutants |
| HDPE | High-Density Polyethylene |
| HH | Households |
| HRT | Hydraulic Retention Time |
| HUDCO | Housing and Urban Development Corporation |
| IARI | Indian Agricultural Research Institute |
| IC | Internal Combustion |
| ICICI | Industrial Credit and Investment Corporation of India |
| ICT | Information and Communication Technology |
| IDBI | Industrial Development Bank of India |
| IDFC | Infrastructure Development Finance Company |
| IEC | Information, Education and Communication |
| IEISL | IL&FS Environmental Infrastructure and Services Limited |
| IFCI | Industrial Finance Corporation of India |
| IGCC | Integrated Gasification Combined Cycle |
| IL&FS | Infrastructure Leasing and Financial Services |
| ILO | International Labour Organization |
| IMD | Indian Meteorological Department |
| IPNM | Integrated Plant Nutrient Management |
| IREDA | Indian Renewable Energy Development Agency |
| IS | Indian Standards |
| ISWM | Integrated Solid Waste Management |
| ITB | Instruction to Bidders |
| JBIC | Japan Bank for International Cooperation |
| JMC | Jabalpur Municipal Corporation |
| JnNURM | Jawaharlal Nehru National Urban Renewal Mission |
| KfW | Kreditanstalt für Wiederaufbau |
| KKPKP | Kagad Kach Patra Kashtakari Panchayat |
| KKPNSPS | Kagad Kach Patra Sahkari Patra Sansthan |

| | |
|---|---|
| KMC | Kolkata Municipal Corporation |
| KPI | Key Performance Indicators |
| LCD | Liquid Crystal Display |
| LCS | Leachate Collection System |
| LCV | Light Commercial Vehicle |
| LDO | Light Diesel Oil |
| LDPE | Low-density polyethylene |
| LED | Light Emitting Diode |
| LEL | Lower Explosive Limit |
| LIC | Life Insurance Corporation of India |
| LoI | Letter of Intent |
| LPG | Liquid Petroleum Gas |
| M&E | Monitoring & Evaluation |
| MCD | Municipal Corporation of Delhi |
| MCGM | Municipal Corporation of Greater Mumbai |
| MIS | Management Information System |
| MMRDA | Maharashtra Metropolitan Regional Development Authority |
| MNRE | Ministry of New and Renewable Energy |
| MoA | Ministry of Agriculture |
| MoEFCC | Ministry of Environment and Forests & Climate Change |
| MoUD | Ministry of Urban Development |
| MPPCB | Madhya Pradesh Pollution Control Board |
| MRF | Material Recovery Facility |
| MSW (M&H) | Municipal Solid Waste (Management and Handling) |
| MSWMP | Municipal Solid Waste Management Plan |
| NABARD | National Bank for Agriculture and Rural Development |
| NABL | National Accreditation Board for Testing and Calibration Laboratories |
| NAC | Notified Area Committee |
| NAPCC | National Action Plan on Climate Change |
| NBCC | National Buildings Construction Company |
| NCC | National Cadet Corps |
| NCRPB | National Capital Region Planning Board |
| NCV | Net Calorific Value |
| NEERI | National Environmental Engineering Research Institute |
| NGO | Non- Government Organization |
| NGRI | National Geophysical Research Institute |
| NIMBY | Not in My Backyard |
| NMC | Nashik Municipal Corporation |
| NMMC | Navi Mumbai Municipal Corporation |
| NMSH | National Mission on Sustainable Habitat |
| NTPC | National Thermal Power Corporation |

| | |
|---|---|
| NUSP | National Urban Sanitation Policy |
| O&M | Operation and Maintenance |
| OEM | Original Equipment Manufacturer |
| OHSAS | Occupational Health and Safety Assessment System |
| OMC | Optimum Oxygen Content |
| OWC | Organic Waste Converters |
| PBG | Performance Bank Guarantee |
| PBVS | Parisar Bhagini Vikas Sangha |
| PCC | Pollution Control Committee |
| PCMC | Pimpri Chinchwad Municipal Corporation |
| PFDF | Pooled Finance Development Fund |
| PIL | Public Interest Litigation |
| PIM | Project Information Memorandum |
| PNG | Piped Natural Gas |
| PPE | Personal Protection Equipment |
| PPP | Public Private Partnership |
| PROM | Phosphate Rich Organic Manure |
| PS | Polystyrene |
| PSA | Pressure Swing Adsorption |
| PSP | Private Sector Participation |
| PTO | Power Take-Off |
| PUF | Polyurethane Foam |
| PVC | Polyvinyl Chloride |
| PVP | Parisar Vikas Programme |
| RA | Recycled Aggregates |
| RCA | Recycled Concrete Aggregates |
| RCC | Reinforced Cement Concrete |
| RDF | Refuse Derived Fuel |
| RFID | Radio Frequency Identification |
| RFP | Request for Proposal |
| RFQ | Request for Qualification |
| RMC | Ready Mix Concrete |
| RPM | Respirable Particulate Matter |
| RSPM | Respirable Suspended Particulate Matter |
| RWA | Resident Welfare Association |
| S.I. | Sanitary Inspector |
| S.O | Sanitary Officer |
| S.S. | Sanitary Supervisor |
| S.S.I | Sanitary Sub-Inspector |
| SC&T | Street Collection & Transportation |
| SCR | Selective Catalytic Reduction |

| | |
|---|---|
| SEAC | State Expert Appraisal Committee |
| SEHB | Shimla Environment Heritage Conservation and Beautification Society |
| SEIAA | State Environment Impact Assessment Authority |
| SHGs | Self Help Groups |
| SLB | Service Level Benchmark |
| SLF | Sanitary Landfill Facility |
| SMC | Saharanpur Municipal Corporation |
| SMS | Stree Mukti Sanghathana |
| SNCR | Selective Non-catalytic Reduction |
| SOP | Standard Operating Procedure |
| SPCB | State Pollution Control Board |
| SPFE | State Pooled Finance Entities |
| SPI | Society of the Plastics Industry |
| SS | Street Sweeping |
| SSD | Saturated Surface Dry |
| SSS | State Sanitation Strategy |
| STP | Sewage Treatment Plant |
| SWaCH | Solid Waste Collection & Handling |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TEAM | TERI Enhanced Acidification and Methanation |
| TERI | The Energy & Resources Institute |
| TOR | Terms of Reference |
| TPD | Tonnes per Day |
| TSDF | Treatment, Storage & Disposal Facility |
| UAFP | Up-flow Anaerobic Filter Process |
| UASB | Up-flow Anaerobic Sludge Blanket |
| UDD | Urban Development Department |
| UIDSSMT | Urban Infrastructure Development Scheme for Small & Medium Towns |
| UIG | Urban Infrastructure and Governance |
| ULB | Urban Local Body |
| UNDP | United Nations Development Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UV | Ultra Violet |
| VAT | Value Added Tax |
| WEEE | Waste of Electrical and Electronic Equipment |
| WMC | Warangal Municipal Corporation |
| WOW | Waste Out of Wealth |
| WPLF | Waste Processing & Landfill |
| WTE | Waste to Energy |

# CHEMICALS AND COMPOUNDS

| | |
|---|---|
| As | Arsenic |
| C | Carbon |
| $C_6H_5OH$ | Phenol / Carbolic Acid |
| Cd | Cadmium |
| $CH_4$ | Methane |
| Cl | Chloride |
| CN | Cyanide |
| CO | Carbon monoxide |
| Co | Cobalt |
| $CO_2$ | Carbon dioxide |
| Cr | Chromium |
| Cu | Copper |
| F | Fluoride |
| H2S | Hydrogen sulphide |
| HCl | Hydrochloric acid |
| HF | Hydrogen fluoride |
| Hg | Mercury |
| K | Potassium |
| $K_2O$ | Potassium Oxide |
| KF | Potassium fluoride |
| Li-ion | Lithium-ion |
| LSHS | Low Sulphur Heavy Stock |
| Mn | Manganese |
| MS | Multi station |
| N | Nitrogen |
| Ni | Nickel |
| NO | Nitrogen monoxide |
| NOx | Nitrogen oxides |
| P | Potassium |
| $P_2O_5$ | Phosphorus pentoxide |
| PAHs | Polychlorinated Aromatic Hydrocarbons |
| Pb | Lead |
| PCBs | Polychlorinated biphenyl |
| PCDD | Polychlorinated di-benzodioxins |
| PCDF | Polychlorinated di-benzofurans |
| PET | Polyethylene terephthalate |
| pH | Acidity or alkalinity of a solution |

| | |
|---|---|
| PM | Particulate Matter |
| POP | Persistent Organic Pollutants |
| PP | Polypropylene |
| Sb | Antimony |
| Sn | Tin |
| $SO_2$ | Sulphur oxide |
| $SO_4$ | Sulphate |
| Th | Thorium |
| TI | Thallium |
| TOC | Total organic carbon |
| TPH | Tonnes per Hour |
| V | Vanadium |
| VOC | Volatile Organic Compound |
| Zn | Zinc |

# METRIC CONVERSION TABLE

## AREA

| | | |
|---|---|---|
| ha | Hectares | 1 hectare = 2.47 acres or 1,07,639 square feet (sq ft) |
| sq.km | Square kilometre | 1 sq. km = 0.386102 square mile (sq mi) |

## LENGTH

| | | |
|---|---|---|
| km | Kilometre | 1 km = 1000 m |
| m | Meter | 1 m = 1000 cm |
| cm | Centimetre | 1 cm = 1000 mm |
| mm | Millimetre | 1 mm = 1000 µm |
| µm | Micrometre | |

## VOLUME

| | | |
|---|---|---|
| l | Litre | 1 l = 0.001 m $m^3$ |
| $m^3$ or cu.m | Cubic metre | 1 $m^3$ or cu.m = 10,00,000 $cm^3$ |
| $cm^3$ | Cubic centimetre | 1 $cm^3$ = 1e+21 $Nm^3$ |
| $Nm^3$ | Normal cubic metres | |
| TEQ / $Nm^3$ | Dioxin toxic equivalent per normal cubic metres | |
| KLD | Kilolitre per day | |

## MASS

| | | |
|---|---|---|
| MT or T | Metric tonne or tonne | 1 MT or T = 1000 kg |
| kg | Kilogram | 1 kg = 1000 g |
| g | Gram | 1 g = 10,00,000 µg |
| µg | Microgram | |
| gsm | Grams per square metre | |

## ENERGY

| | | |
|---|---|---|
| MW | Megawatt | 1 MW = 1000 KW |
| kW | Kilowatt | 1 KW = 1000 W |
| kcal | Kilocalories | 1 kcal = 1000 cal |

## TEMPERATURE

| | | |
|---|---|---|
| °C | Celsius | 1°C = 33.800 Fahrenheit (°F) |

# CURRENCY CONVERSION CHART

| INDIAN NUMBERING SYSTEM | INTERNATIONAL NUMBERING SYSTEM |
|---|---|
| One lakh<br>**1,00,000** | One hundred thousand<br>**100,000** |
| Ten lakhs<br>**10,00,000** | One million<br>**1,000,000** |
| One crore<br>**1,00,00,000** | Ten millions<br>**10,000,000** |
| Ten crores<br>**10,00,00,000** | Hundred millions<br>**100,000,000** |
| Hundred crores<br>**100,00,00,000** | One billion<br>**1,000,000,000** |

Part 1

# Salient Features of the Municipal Solid Waste Management Manual:
An Overview

## IN THIS SECTION

# 1. INTRODUCTION: HOW TO USE THIS MANUAL

## 1.1 BACKGROUND

Urban India is facing an ever increasing challenge of providing for the incremental infrastructural needs of a growing urban population. According to the 2011 census, the population of India was 1.21 billion, of this 31% live in cities. It is projected that by 2050, half of India's population will live in cities.

With this increasing population, municipal solid waste management (MSWM) in the country has emerged as a challenge not only because of the environmental and aesthetic concerns, but also because of the huge quantities of municipal solid waste (MSW) generated every day. According to Central Pollution Control Board (CPCB), 1,43,449 tonnes per day (TPD) of MSW was generated in India during 2014–2015, with an average waste of 0.11 kilogram (kg)/capita/day. Of the total MSW, approximately 1,17,644 TPD (80%) was collected, while only 32,871 TPD (22%) was processed or treated. Segregation at source, collection, transportation, treatment, and scientific disposal of waste was largely insufficient leading to degradation of the environment and poor quality of life.

In the 1990s, it became first evident that MSWM was getting critical when largescale concerns regarding unsuitable MSWM practices resulted in numerous public interest litigations (PILs), prompting the Supreme Court of India to constitute a committee to look into the status of MSWM in the country. The said committee submitted the report on Solid Waste Management in Class I Cities in India to the Supreme Court in 1999. Subsequently, the Supreme Court directed the Ministry of Environment, Forests and Climate Change (MoEFCC) to release the MSW (Management & Handling [M&H]) Rules, 2000 requiring all urban local bodies (ULBs) to establish a proper waste management system, including a timeline for installation of waste processing and disposal facilities by the end of 2003, not only for metro cities and class I cities but also for all ULBs in the country. The Ministry of Urban Development (MoUD) also developed an MSWM manual to provide technical guidance to all ULBs and published it simultaneously with the MSW (M&H) Rules, 2000.

Funds were allocated under 12$^{th}$ and 13$^{th}$ Finance Commission Grants, for improvement of MSWM under programmes like Jawaharlal Nehru National Urban Renewal Mission (JnNURM), Urban Infrastructure Development Scheme for Small & Medium Towns (UIDSSMT) in 2005. In 2008, National Urban Sanitation Policy was launched that covered urban sanitation including solid waste management as an important component.

However, despite encouraging pilots and achievements, most ULBs continue to face challenges not only in the areas of appropriate and advanced collection and transportation systems, technology selection, and disposal methods, but also in sustainable financial management of MSWM. The non-compliance

issue is still true after 16 years of the notification of the MSW (M&H) Rules, 2000.

In order to give a push to the municipal solid waste management in cities, the Ministry of Urban Development launched the Swachh Bharat Mission in 2014. The Swachh Bharat Mission (SBM) emanates from the vision of the Government articulated in the address of the honourable President of India in his address to the Joint Session of Parliament on 9th June 2014 wherein the indignity of homes without toilets and public spaces littered with garbage should not be tolerated. SBM seeks to promote cities as engines of economic growth through improvement in the quality of urban infrastructure, with assured service levels and efficient governance. SBM aims to address the challenges in management of municipal solid waste and to support cities in developing modern and appropriate systems.

The Ministry of Environment Forests & Climate Change has also recently revised the MSW (M&H) Rules, 2000 and renamed it 'Solid Waste Management (SWM) Rules, 2016'. The Ministry of Urban Development has also parallelly revised the MSWM Manual, 2000. The revised manual is based on 16 years of learning experience gained in India post the publication of its first edition in 2000.

## 1.1 SALIENT FEATURES

The revised manual includes:

- a wealth of practical experiences gained from many ULBs on what works and what may not work under specific conditions, post 2000;
- the reflection of new technologies and approaches available in the MSWM sector in India;
- improved institutional approaches and planning tools such as a combined planning for MSWM and urban sanitation;
- a better understanding of integrated solid waste management (ISWM) as a holistic approach that not only focuses on technical aspects of MSWM but also addresses issues of waste minimisation, reuse, and recycling, and of sociocultural (inclusivity), institutional, financial, and legal aspects;
- newly emerging issues or themes such as climate change, relevance of informal sector to MSWM, as well as its links to gender equity and gender-related issues; and
- the need for state and regional strategies and handholding support for MSWM by cities.

The revised manual addresses all aspects (planning, technical, institutional, financial, and legal) of MSWM.

## 1.2 STRUCTURE OF THE MANUAL

The manual has the following structure and addresses different target groups in its different sections:

**Part I:** An overview,provides the salient features of the MSWM Manual especially for decision makers, elected office bearers, and senior bureaucrats at different levels of governance. It provides decision makers with an overview on key issues of MSWM and promotes understanding of challenges and opportunities, thereby guiding them in initiating necessary processes to achieve goals.

**Part II:** The Manual, this is the main body of the manual and is primarily for the financial and technical heads of department at ULB level, health officers, technical staff, and private operators. This section provides a detailed description of technologies for treatment and processing of waste, applicability of evolving technologies, and planning frameworks to undertake concrete measures toward institutional strengthening and financial management leading to sustainable MSWM. Part II comprises of seven chapters:

**CHAPTER 1** Municipal Solid Waste Management Plan: Stepwise Guidance

**CHAPTER 2** Technical Aspects: Segregation, Collection, and Transportation

**CHAPTER 3** Technical Aspects: Processing and Treatment of Municipal Solid Waste

**CHAPTER 4** Technical Aspects: Municipal Sanitary Landfills

**CHAPTER 5** Municipal Solid Waste Management Plan Implementation

**CHAPTER 6** Management Aspects: Monitoring Municipal Solid Waste Management Service Provisions

**CHAPTER 7** Management of Special Waste Including Domestic Hazardous Waste

**Part III:** The Compendium, this comprises of national rules and guidelines, international practices on waste minimisation, detailed description and designs of compost plants and landfill. A sample state strategy on integrated municipal solid waste management from former Andhra Pradesh is also included. Part III of the manual is primarily for the operational staff, private operators, experts and training institutes, who need to understand in detail the different rules and design specifications for taking the informed decisions or for guidance.

## 1.3 LAYOUT OF THE MANUAL

The layout of the manual will help the target groups to navigate within its different parts and contents. Key elements of this "navigation system" are the following:

| ICON | Description |
|---|---|
| **Key messages as 'take away notes'** | **Segregation is the key to an effective waste management system** |
|  | Additional information |
|  | Ideas |
|  | Practical case examples |
|  | References to connected information in other chapters (Ch = Chapter, Sec = Section): |
|  | Calculations |
|  | Citation on texts in rules |

# 2. MANAGEMENT ASPECTS: PLANNING, INSTITUTIONAL AND FINANCIAL ASPECTS

## 2.1 THE REGULATORY FRAMEWORK: KEY REQUIREMENTS BY THE SOLID WASTE MANAGEMENT RULES, 2016 AND OTHER DIRECTIVES

CH 1

Some rules and guidelines regulate MSWM (including this manual), as given below:

| | |
|---|---|
| *MSW (Management and Handling) Rules 2000 and revised SWM, Rules 2016* | • *Municipal Solid Waste (Management & Handling ) Rules, 2000 by MoEFCC*<br>• ***Revised SWM Rules, 2016** circulated in the year 2016 by MoEFCC*<br>• *Designates Urban Local Bodies responsible for MSWM and lays down the mandatory functions to be performed by various stakeholders*<br>• *Separate rules for Construction and Demolition waste 2016* |

| | |
|---|---|
| *Revised Manual on Municipal Solid Waste Management, 2016* | • *Municipal Solid Waste Management Manual 2000 by MoUD and CPHEEO*<br>• ***Guidelines** published by MoUD through CPHEEO in the year 2016*<br>• *Provide implementation guidelines for all aspects of MSWM, including segregation, collection, transportation, treatment and disposal* |
| *Swachh Bharat Mission, (SBM), 2014* | • *Swachh Bharat Mission guidelines published by the MoUD in 2014*<br>• *cover Household toilets, community and public toilets*<br>• *solid waste management*<br>• *with special focus on reorienting institutions as well as sensitizing citizens for developing citywide approach to sanitation including solid waste management through IEC and capacity building of the citizens and workers*<br>• *http://swachhbharaturban.gov.in/writereaddata/SBM_Guideline.pdf* |
| *National Urban Sanitation Policy (NUSP), 2008* | • ***Policy** prepared by the Ministry of Urban Development in 2008*<br>• *Broadly covers aspects of urban sanitation, with a specific focus to eliminate open defecation in cities*<br>• *Focus on re-orienting institutions for developing city-wide approach to sanitation, covering all its aspects including Solid Waste Management* |
| *Rules for Special Waste* | • *Plastic Waste Management Rules, 2011 and revised in 2016*<br>• *Bio-medical Waste (Management and Handling) Rules, 1998 and amended 2003, 2011 and Bio-Medical Waste Management Rules, 2016*<br>• *E-Waste Management Rules, 2011 and revised in 2016*<br>• *Battery (Management and Handling Rules) 2001* |
| *Other Relevant Rules and Task Force Reports* | • *Inter-ministerial Task Force on Integrated Plant and Nutrient Management using City Compost, 2005*<br>• *Fertilizer Control Order (FCO), 2009; PROM, 2013 by Ministry of Agriculture*<br>• *Report of the Task Force on Waste to Energy, Planning Commission, 2014* |

### Management of Industrial Hazardous Wastes

Industrial hazardous waste is managed through the Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008 with subsequent amendments in 2009 and follows a regime different from the MSWM. Hazardous waste is typically identified with properties of ignitability, corrosivity, reactivity, and toxicity. ULBs need to ensure that industrial hazardous wastes do not get mixed with the MSW stream. Wastes containing toxic components which are usually included in MSW, such as batteries, compact fluorescent lamps (CFLs), tube lights, household cleaning agents, etc. are referred to in this Manual as "special wastes."

### Municipal Solid Waste (Management & Handling) Rules 2000 and revised SWM Rules, 2016.

The MoEFCC revised the MSW (M&H) Rules, 2000; and the revised and renamed SWM Rules, 2016 reflect new systems, technology developments, and concepts for an integrated MSWM. In particular, the Rules cover the following aspects:

- list of authorities involved in MSWM and their corresponding duties;
- mandatory MSWM policy and strategy to be prepared by the state or the union territory;
- mandatory MSWM plans to be prepared by the municipal authority;
- specific requirements for the MSWM including segregation into wet, dry, and special waste, as well as restriction on material to be disposed in landfills (only non-reactive, inert, and pre-treated waste may be disposed);
- levy of service fees by the municipal authority to make this service sustainable;
- provision of on-spot fine on those littering waste at public places;
- requirements for landfill sites including site selection and mandatory lining system;
- requirement of environmental clearances for setting up MSW processing and disposal facilities including landfills;
- standards for composting;
- standards of treated leachate;
- emission standards for incineration facilities; and
- mandatory annual reporting by the municipal authority on MSW operations.



Municipal authorities and all stakeholders must carefully go through the above provisions of the SWM Rules, 2016 and make concerted efforts to improve SWM systems and services accordingly.

## 2.2 MODERN INTEGRATED MUNICIPAL SOLID WASTE MANAGEMENT: CONCEPTS AND BENEFITS

The integrated solid waste management (ISWM) system is based on the waste management hierarchy (Figure 1.1), with an aim to reduce the amount of waste being disposed while maximising resource recovery and efficiency. Based on this waste management hierarchy, an assessment of local needs and conditions should lead to the selection of an appropriate mix of processes and technologies. The preferred waste management strategies within the hierarchy include:

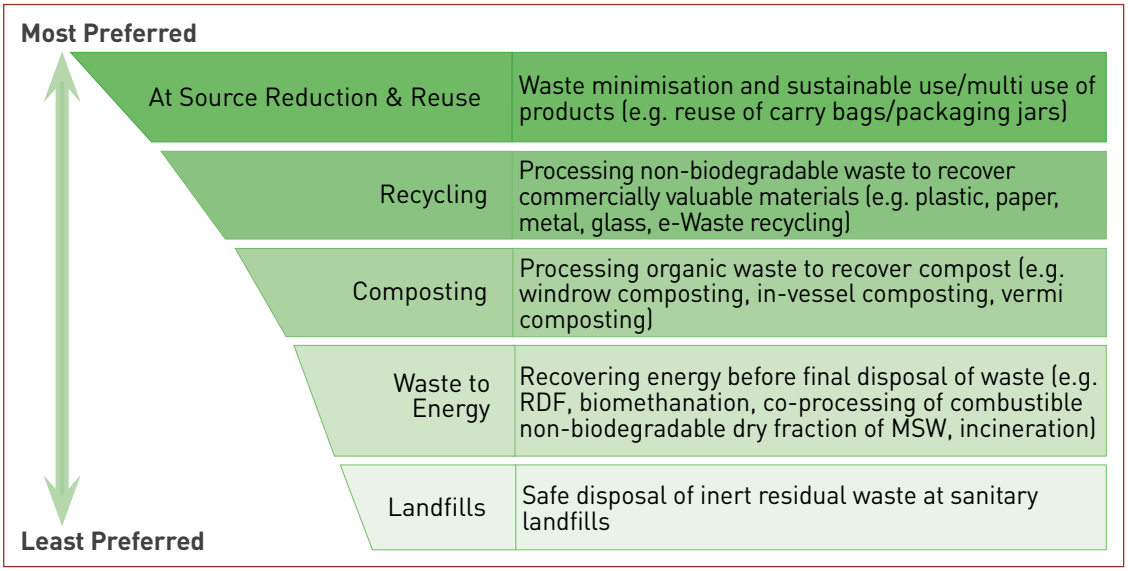
- **At source reduction and reuse:** The most preferred option for waste management is to prevent the generation of waste at various stages including the product design, production, packaging, use, and reuse. Waste prevention helps reduce handling, treatment, and disposal costs. It also reduces leachate, air emissions, and greenhouse gases which have significant impacts on the environment.
- **Waste recycling:** The next preferred alternative is the recovery of recyclable material resources and strengthening a waste recycling chain through

segregation, collection, and reprocessing to create new products.

- **Waste to composting:** The organic fraction of waste can be composted to improve soil health and agricultural production adhering to FCO norms.
- **Waste to Energy:** Where material recovery from waste is not possible, energy recovery from waste through production of heat, electricity, or fuel is preferred. Biomethanation, pyrolysis, gasification, waste incineration, production of refuse derived fuel (RDF), and co-processing of the sorted dry rejects from MSW in cement kilns are commonly adopted waste to energy technologies.
- **Waste Disposal:** Residual waste at the end of the hierarchy, which ideally comprises of inert waste are to be disposed in sanitary, lined landfills, which are constructed in accordance with stipulations of the SWM Rules, 2016.

The hierarchy implies that all options of waste minimisation should be exercised before treatment and disposal technologies are selected and implemented.

**Figure 1.1: Integrated Solid Waste Management Hierarchy**[1]




The ISWM concept, as described, is closely linked to the 3R approach (reduce, reuse, and recycle), which is also aimed at optimising MSW management from all the waste-generating sectors (households, commercial and institutional establishments, parks and gardens, construction and demolition, urban agriculture, and safety and healthcare facilities) and involving all the stakeholders (waste generators, service providers, informal sector, regulators, government, and community or neighbourhoods). The adoption of the 3R concept helps to minimize the amount of waste to be handled by the municipal authority, minimising the public health and environmental risks associated with it.

1 Developed by the Expert Committee for revision of MSWM manual (2013-15)

ISWM also reflects the following aspects:

- **Municipal solid waste and climate change:** MSW is related to climate change in several ways: (i) ISWM reduces the emissions of greenhouse gases (mainly methane) resulting from MSW and contributing to climate change. Waste minimisation, waste recycling, waste to energy strategies, and landfill gas capture and use are reduction strategies for greenhouse gases, either directly (landfill gas capture) or by better use of energy and resources inherent in products and materials (climate footprint). (ii) MSWM should also reflect needs for adaptation to future impacts of climate change. An example is site selection and design of landfills, which might have to reflect changing groundwater tables or rainfall patterns.
- **Gender equity aspects:** Women are involved in and affected by MSWM in multiple ways. They work in ULBs (e.g., many street sweepers and doorstep collectors are also women) and also in the informal sector. This requires interventions to protect women from the harmful effects of unhygienic practices which also affect their social functions in childcare and family food supply. Moreover, they are often the first customers of any MSW collection service and engage in segregation of waste at source at the household level. The MSWM system design should therefore consider the health and safety concerns of women. The MSWM system should also engage in a social impact assessment to bring gender gaps to the forefront for systematic analysis and corrective and appropriate responses.
- **Informal sector integration in Municipal Solid Waste Management:** An implication of the comprehensive understanding of ISWM is that it will involve various stakeholders, going far beyond a merely public task for the ULB. Important groups include the private sector (Chapter 1 of Part II) and the informal sector. The informal sector plays an important role in the MSWM value chain by recovering valuable material from waste. It includes both the "kabadi" system or scrap dealers and waste pickers that help reduce environmental impacts by improving resource recovery and reducing waste quantities for disposal. The integration of the informal sector into the formal MSWM system through resident welfare associations (RWAs), community-based organizations (CBOs), non-government organizations (NGOs), self-help groups (SHGs), and private sector will contribute to the reduction of the overall MSWM costs, provide support to the local recycling industry, and create new job opportunities.

CH 1
SEC 1.4.5.9

Options for enabling conditions and supportive actions for this inclusive approach involve:

- involvement of informal sector workers into formal system with legal recognition, reflection in relevant policy decisions and membership-based associations (cooperatives, SHGs);

- officially recognising these informal associations as viable partner organizations for solid waste management (SWM) service delivery;
- motivating private sector, NGOs, SHGs to involve these informal associations in SWM service delivery by upgrading them from being waste pickers on streets to waste collectors from source;
- promoting schemes to provide social security and health benefits to members of these associations;
- providing low-interest loans to registered organizations of waste pickers (e.g., SHGs) seeking to bid for tenders and contracts;
- providing incentives to encourage participation of informal sector associations through excise and tax exemptions and other fiscal concessions;
- giving priority to these associations in taking up small contracts of waste collection and small-scale processing as informal sector enterprises;
- reserving land in development plans for decentralised processing of biodegradable waste, and for setting up material recovery facilities; and
- supporting capacity development programmes for informal sector associations, especially catering to the special needs of women.

**Key messages for decision makers**

The MSWM system is dependent, among other things , on a well-planned implementation of the 3R concept and the involvement of the informal sector. ULBs may chart out well-defined strategies for waste minimisation, recovery, and segregation involving the informal sector directly (cooperatives, SHGs) or through RWAs, CBOs, NGOs, or the private sector.

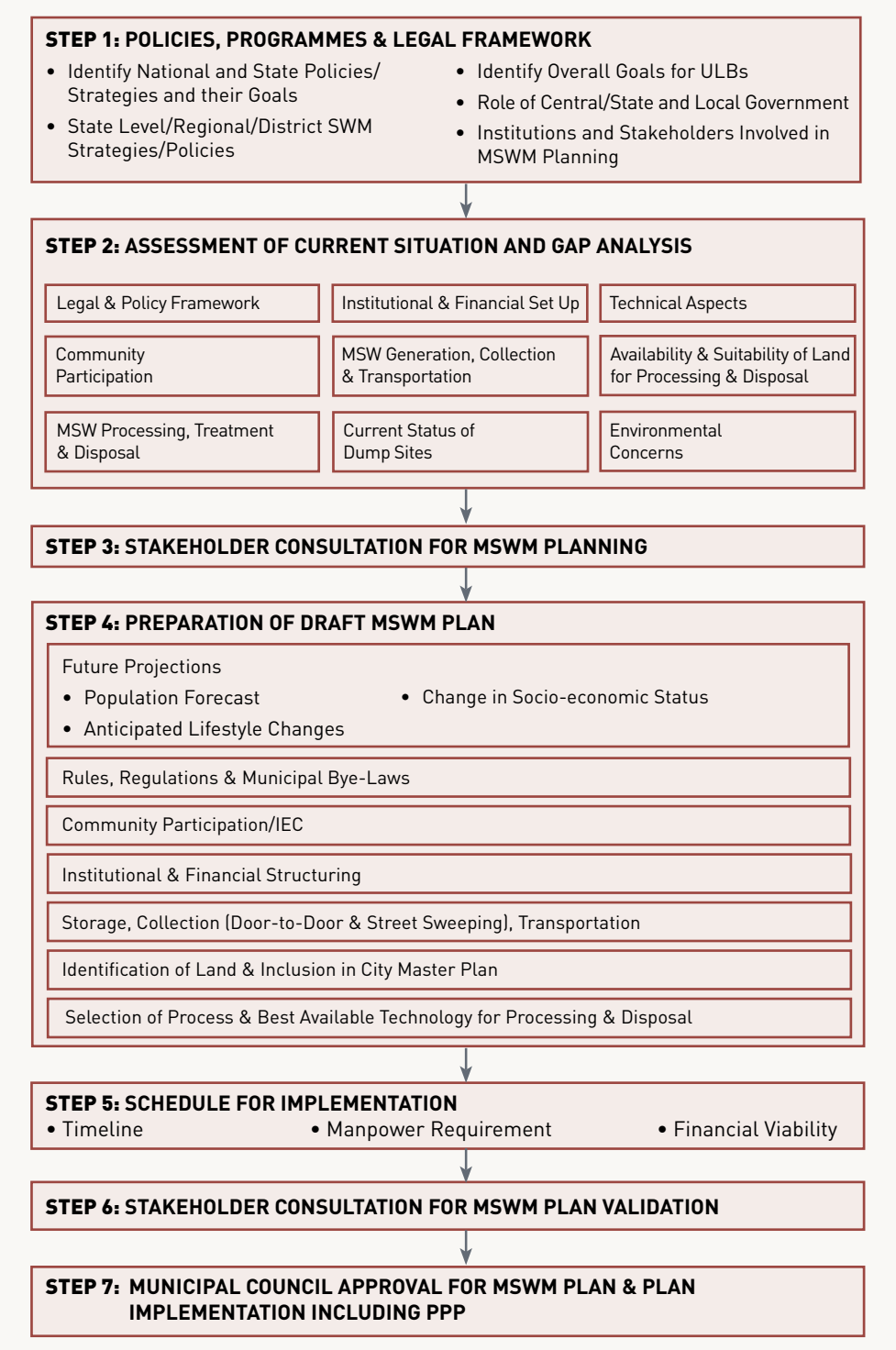
CH 1
SEC 1.4

## 2.3 PREPARATION OF A MUNICIPAL SOLID WASTE MANAGEMENT PLAN – A SEVEN STEP APPROACH

MSWM is essentially a municipal function, and it is mandatory for all municipal authorities to provide this service efficiently to keep the cities and towns clean, process the waste, and dispose of the residual MSW in an environmentally acceptable manner. In line with that, ULBs should systematically develop their MSWM systems including carefully accessing their requirements of tools, equipment, vehicles, and processing and disposal facilities in a way and at a pace that is locally doable, meets the long term needs of the ULB, and is also financially sustainable. It is imperative to take stock of the situation and develop a Municipal Solid Waste Management plan. This plan should be in consonance with the SWM Rules, 2016; the state policy and strategy on MSWM; and the state sanitation strategy (SSS) developed under the NUSP.

The development of a MSWM plan follows a seven-step process (Figure 1.2).

**Figure 1.2: Seven-Step Approach for Developing a Municipal Solid Waste Management Plan[2]**




2 The site conditions and selection of technology are inter-dependent. Proximity to habitation, hydro-geology and even climate dictate the selection of technologies

### 2.3.1 STEP 1: POLICIES, PROGRAMMES AND LEGAL FRAMEWORK

CH 1 SEC 1.4.1

Step 1 entails a detailed review and analysis of national, state, and municipal laws, rules, policies, programmes, and guidance that are related to MSWM. The ULB shall prepare a list of all mandatory and recommendatory actions as per the MSW (M&H) Rules, 2000; SWM Rules, 2016; the NUSP; the service level benchmarks (SLB) for MSWM service provision; the FCO, 2009, 2013; and all other relevant policy guidance to ensure that the MSWM action plan is developed within these framework.

### 2.3.2 STEP 2: ASSESSMENT OF CURRENT SITUATION AND GAP ANALYSIS

CH 1 SEC 1.4.3

The municipal authority should carry out a critical assessment of the current status of SWM in the city as per national, state, and local level rules, policies, and strategies for MSWM governing the ULBs. The assessment should clearly bring out the deficiencies or gaps that need to be bridged to meet the legal obligations. The assessment should also focus on the waste quantification and characterization. This is essential as quantities and composition of waste vary widely in urbanisation and affluence.

### 2.3.3 STEP 3: STAKEHOLDER CONSULTATION FOR MUNICIPAL SOLID WASTE MANAGEMENT PLANNING

CH 1 SEC 1.4.4

Due to the number of institutions and stakeholders involved in MSWM, it is important that the MSWM plan, which aims to bridge the gaps or improve the level of service, is developed through a consultative process. Stakeholders' views and their willingness to participate and pay for the service are also to be considered.

### 2.3.4 STEP 4: PREPARATION OF DRAFT MUNICIPAL SOLID WASTE MANAGEMENT PLAN

CH 1 SEC 1.4.5

Considering the identified gaps, future population projections and waste generation rates, current and future quality and quantity of waste (based on changing lifestyles and economic status), inputs from stakeholders, financial situation, and technical capabilities of the ULBs, the municipal authority should prepare its draft short term and long term MSWM plan.

### 2.3.5 STEP 5: SCHEDULE FOR IMPLEMENTATION

CH 1 SEC 1.4.6

The municipal authority should specify needs for institutional strengthening and financing. Subsequently, an operational plan should be prepared as an integral part of the MSWM plan. An implementation plan, indicating allocation of resources and specifying timelines,

should be prepared. Public private partnership (PPP) for infrastructure development and service delivery may also be fully explored during this exercise.

CH 1 SEC 1.4.7

### 2.3.6 STEP 6: STAKEHOLDER CONSULTATION FOR MUNICIPAL SOLID WASTE MANAGEMENT PLAN VALIDATION

Provision of effective SWM services is substantially dependent on community behavior and practices. Therefore, citizens and stakeholders should be made aware of the plans and consulted before finalization of the MSWM plan.

CH 1 SEC 1.4.8

### 2.3.7 STEP 7: MUNICIPAL COUNCIL APPROVAL FOR MUNICIPAL SOLID WASTE MANAGEMENT PLAN AND PLAN IMPLEMENTATION INCLUDING PUBLIC PRIVATE PARTNERSHIP

The final MSWM plan is to be presented to the elected body of the local authority to seek approval and to officially formalize the plan. Council should be made aware of the short term and long term actions to be taken and should also approve the financial plan and necessary institutional strengthening for implementation of these actions. The services to be outsourced (PPP model) or private operator should be made aware of the MSWM plan made by the ULB. Contracting models should be transparent and performance based. Both the ULB and PPP operator should be accountable for their roles to ensure successful and sustainable project implementation.

CH 1 SEC 1.4.1.4

## 2.4 ROLE OF STATE AND REGIONAL LEVEL AUTHORITIES

Besides the ULBs, states have specific responsibilities in MSW management. These can be summarised as follows:

- The Secretary-in-charge of the Urban Development Department (UDD) of the concerned state or union territory has the overall responsibility for the implementation of MSWM systems in cities and towns in line with SWM Rules.
- UDD is required to prepare a state policy and strategy for MSWM in the state.
- UDD has to report on SLBs for SWM service provision in ULBs to the Ministry of Urban Development (MoUD).
- UDD is also responsible for approval of land transfer from state to ULBs (for all projects).
- States have the power to regulate the creation of staff positions (technical and nontechnical) in the ULBs.

- The State Pollution Control Board (SPCB) is responsible for monitoring the compliance with the MSWM plan and the SWM Rules. And it is authorised to give environmental clearance to facilities as listed in the Environmental Impact Assessment (EIA) Notification, 2006.
- The power to authorize municipal authorities or operators to set up treatment and disposal facilities also lies with the SPCB.

### 2.4.1 CREATION OF REGIONAL FACILITIES

Finding suitable land in each city or town for a sanitary landfill is a matter of great concern in the country, and it is technically and financially unviable to operate small sanitary landfill facilities (SLFs). Both arguments favour that state authorities may bring cities together to set up shared landfill facilities, which might be organised at district or even regional level through inter-municipal agreements. The cooperation among ULBs might also include common treatment facilities for MSW besides common landfill, if financially viable.

**Key messages for decision makers**

The municipal authority should carefully look at the State policy, its directives and regulatory framework. It should also explore options for setting up regional or district level common processing or disposal facilities for groups of towns or cities in consultation with all stakeholders including political leadership of all participating towns. Stakeholders need to be convinced of the economic and environmental benefits of a common facility and the win-win situation arising out of such a decision. The top management should launch negotiations with potential cooperation partners in general and with the host city in particular, where the facility is proposed to be created.

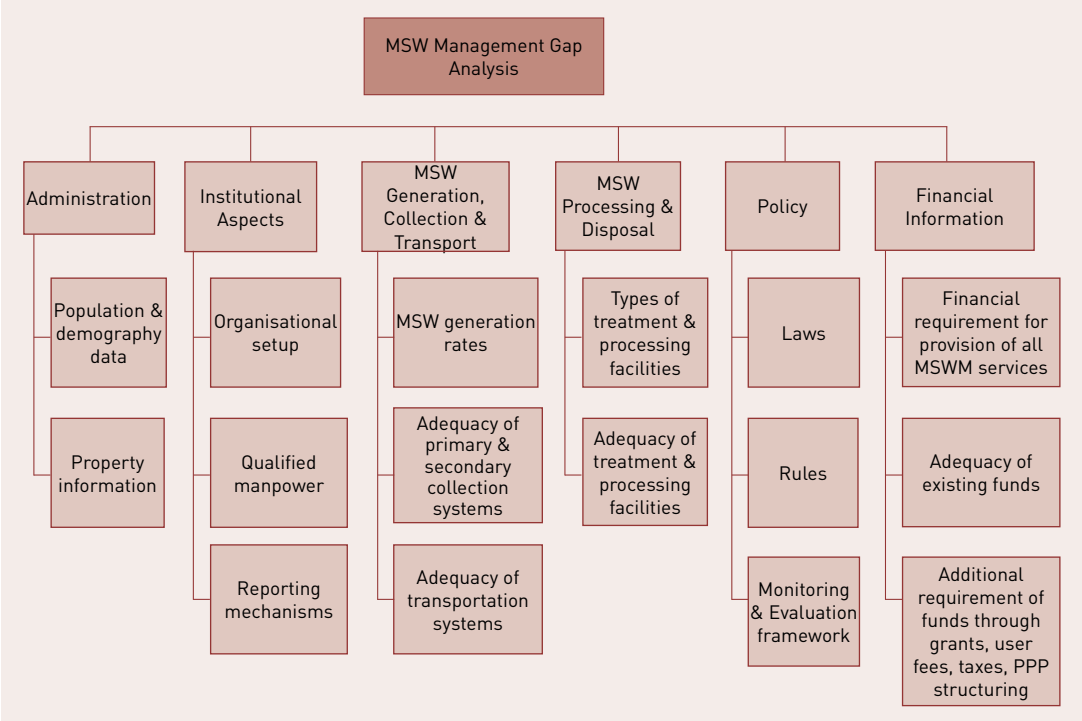
## 2.5 UNDERSTANDING LOCAL SOLID WASTE MANAGEMENT NEEDS

In order to develop a MSWM plan, the ULB should accurately assess the baseline of SWM services and analyze system deficiencies in the context of SWM Rules and utilize that information for further planning, implementation, and monitoring. Local conditions shall be considered while assessing the inadequacy of existing service and planning for the future with due consideration of local demography, physical location, growth objectives of the ULB, as well as social and environmental conditions.

CH 1
SEC 1.4.3

The assessment of the baseline in relation to the requirements of existing regulations, policies, guidelines and identified SLBs will result in an identification of key shortfalls in achieving the desired level of services and form the basis for preparing a plan to improve the MSWM system. Figure 1.3 is a schematic diagram depicting the issues to be considered while assessing gaps in MSW service provision.

**Figure 1.3: Municipal Solid Waste Management Gap Analysis**




CH 1
SEC 1.4.4

## 2.6 ROLE OF STAKEHOLDERS IN MUNICIPAL SOLID WASTE MANAGEMENT PLANNING

The main responsibility for preparing a MSWM plan lies with the ULB, specifically the SWM division. A core team or advisory team, also called as internal stakeholders, may be constituted for developing the MSWM plan. This team should be a multi-departmental team, involving all the departments concerned with, influenced by or influencing SWM services within a city. The commissioner or chief executive of the ULB should lead the internal stakeholder team.

Municipal officials may also seek advisory support from experts in the field, academicians, and environmental planners and engineers, if capacity is not sufficient within the ULB.

Informing and involving the community (external stakeholders), as well as creating channels for all stakeholders to participate in decision making, are all very important steps for successful implementation of MSWM strategies.

Typical stakeholders for a MSWM system include households, businesses, industries, informal sector, local government, NGOs, CBOs, SHGs, women's groups, secondary school and college students, or members of other institutions who may have a role in ensuring the involvement of the community.

Stakeholders are to be consulted at least twice during the MSWM plan preparation, initially in defining the objectives and goals of the plan, and later in discussing the proposed plan and seeking their inputs and approval (steps 3 and 6 of the Seven Step Approach). The ULB may constitute a stakeholder committee for the purpose, with members representing all concerned groups. These groups would need to represent the interest of men, women, youth, marginalised or vulnerable groups of people who are all part of the MSWM process. Specifically, the involvement of women's groups during the planning phase is essential.

## 2.7 ESTABLISH APPROPRIATE INSTITUTIONAL MECHANISMS

CH 1
SEC 1.4.5.4

Planning for an efficient and advanced MSWM system should not be limited to the procurement of vehicles, equipment, or adequate infrastructure, but should also include an effective institutional structure capable to steer and implement the MSWM system. By and large, MSWM services are currently looked after by the health department of the local authority, usually headed by a medical doctor, who is generally not well versed with emerging technologies and technological aspects of processing and disposal of waste. It is strongly recommended that large ULBs have a SWM department headed by an environmental, civil, or public health engineer while small ULBs have a specific SWM cell with technical and managerial personnel as recommended in this manual.

There is also an urgent need to train and build the capacities of staff involved in SWM activities. Professionalising the solid waste sector will not only build the capacities of workers to perform more effectively and efficiently but will also inculcate a sense of responsibility and pride towards their profession. This will lead to an improvement in service delivery and better management of activities.

Professionalising SWM services also demands that workers should perform their duties in a healthy environment under safe conditions. Adequate and appropriate personal protective equipment (PPE) should be provided to the employees and contractual workers. Adequate training should be given to them to ensure that they wear the PPE provided

CH 1
SEC 1.4.5.6

## 2.8 ENSURE SUSTAINABLE FINANCING FOR MUNICIPAL SOLID WASTE MANAGEMENT

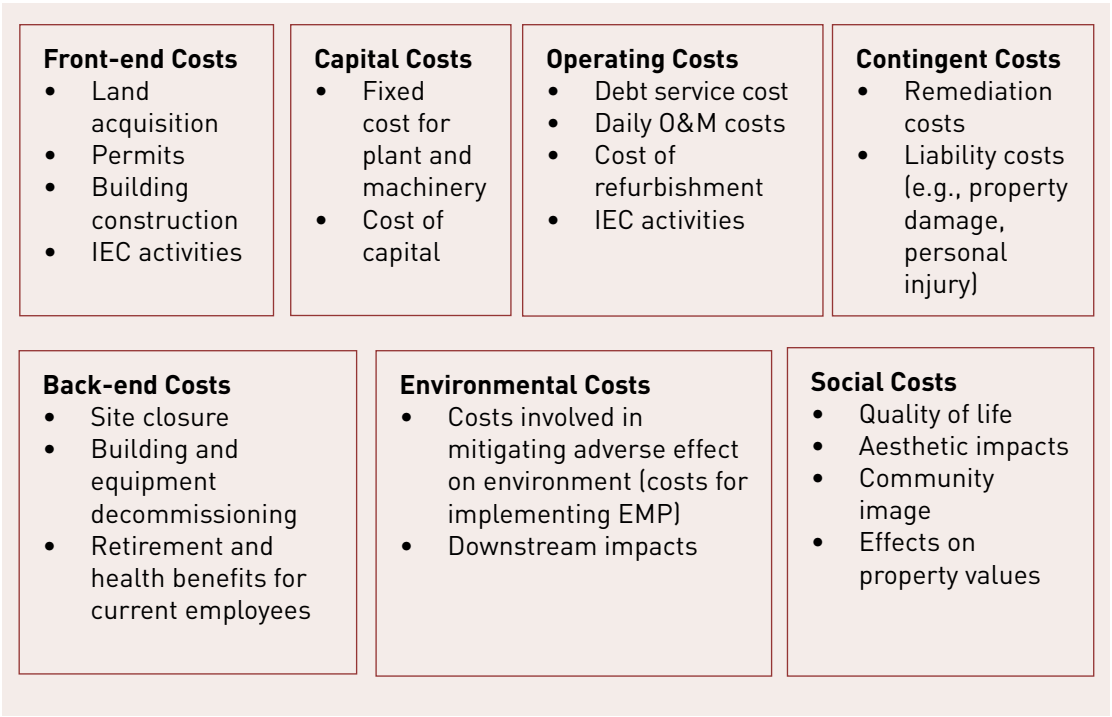
The planning for an advanced MSWM system should be based on accurate financial calculations, taking into consideration all relevant costs and most likely revenues to be realised. This important task within the planning process (steps 2, 4, and 5 of the Seven-Step Approach) is to ensure financial viability of the MSWM system and its sustainability in the long run. Full cost accounting (FCA) provides a framework for evaluating all costs associated with the integrated waste management operations. FCA for MSWM can be defined as a systematic approach for determining the full costs of the MSWM system at local level over a specified period. It tends to uncover hidden and overlooked costs and allocates costs to all the specific activities and operations. This helps the decision makers to compare present services with proposed services accurately, predict future costs reliably, and evaluate privatization or PPP options thoroughly.

The major types of costs considered for FCA of MSWM (Figure 1.4) are the following:

- **Front-end costs:** Examples of these are pre-operative investments and expenses necessary to implement MSW services.
- **Capital costs:** They include one-time, fixed costs for land, plant, machinery, etc.
- **Operating costs:** They include daily expenses of managing MSW, refurbishment costs, and operation and maintenance (O&M) costs.
- **Back-end costs:** They comprise of the expenditure required to wrap up O&M of MSW facilities at the end of their lifetime.
- **Contingent costs:** They include costs that might or might not be incurred in the future (e.g., remediating costs for disasters).
- **Environmental costs:** They result from environment protection or mitigation during MSW transportation, treatment, and disposal activities.
- **Social costs:** They are incurred to mitigate adverse impacts on health and well-being of local community on account of improper MSWM. An assessment and consideration of these costs is required before selecting waste management options.

These categories cover the life cycle of MSW activities from the "cradle" (front-end costs) to "grave" (back-end costs).

**Figure 1.4: Types of Costs to be Reflected in the Full Cost Accounting (FCA)**




### Sources of Financing

While deciding to introduce a new MSWM system or to construct and operate processing and disposal facilities, proper care should be taken to assess the capital sources and revenue implications. ULBs have to ensure that the needed resources for O&M of the MSWM system will be continuously available and that reserve funds will be kept aside to meet replacement costs of vehicles, equipment, plants, and machinery at the end of their lifetime. The following sources of financing should be considered:

i **Municipal resources that include taxes and duties:** Traditionally, property tax in India has been the main source of revenue for ULBs to finance municipal services including MSWM. Rationalization of the property tax is required to ensure financial sustainability of these services.

ii **Grants from central or state government:** It has been widely recognised that ULBs are unable to meet the expenditure for their activities solely by internal resources. Hence, ULBs require substantial financial support from the central and state government in the form of grants and funds. Some of the grants and funds available to ULBs presently are:

- finance commission grants;

- central government grants (e.g., Swachh Bharat Mission); and
- state finance commission grants allocated by the state to local authorities once every 5 years to support administrative, governance, and municipal service delivery.

iii **Public private partnership as a source of funding:** PPP are innovative approaches used by the public sector to attract private sector to make investments and take up certain responsibilities of service delivery, while the public sector retains the principal responsibility for these services. PPP mechanisms aim, as the case may be, at financing, designing, implementing, and operating public sector facilities and services through service provisions (short and long term, in some cases up to 30 years). A predefined contract agreement regulates how rewards and risks will be shared with the private contractor.

iv **Loans from bilateral and multilateral agencies:** Bilateral and multilateral bodies, also known as development agencies, like Asian Development Bank (ADB), German Development Bank (KfW), and the World Bank provide soft loans on long term basis and grants for infrastructure projects. Usually, these funds (soft loans) are given with a grant component for project preparation or capacity building. In certain cases, retroactive financing arrangements can also be agreed to, wherein funds spent in project preparation are financed after the loan agreements are finalised. For accessing funds from bilateral and multilateral agencies, it is a pre-requisite that there should be long term planning as well as state support.

v **National or state level infrastructure funds:** Infrastructure funds both at the national and state level play an important role for financing infrastructure projects. Financial institutions at the national and state level are set up that are supplemented by state-level infrastructure funds (from supply side) and pooled finance funds (from demand side) e.g., Tamil Nadu has provided funds for infrastructure projects. There is a dearth of these types of funds; however, the MoUD has recently issued guidelines for the formation of state pooled finance entities (SPFEs). The Finance Budget 2007 has also allowed SPFEs to issue tax-free municipal bonds. Union Budget 2013–2014 had proposed funding for waste to energy projects in MSW.

vi **Municipal bonds and debentures:** The ULBs issue bonds and debentures to the general public or to specific institutional investors. Municipal bonds can either be taxable or tax-free. In India, the municipal bond market is still in its nascent stages. Only ULBs, which are large and have a buoyant revenue base, have been successful in the past in raising funds through municipal bonds (e.g., Ahmedabad).

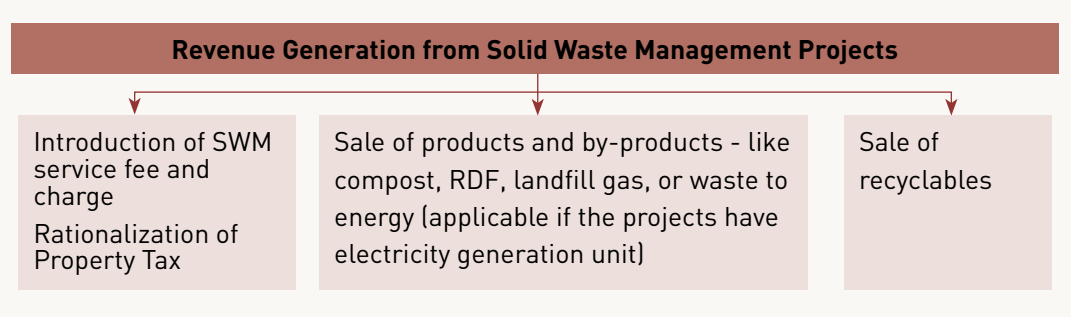
vii **Loans from financial institutions:** Specialised financial institutions–e.g., Infrastructure Development Finance Company (IDFC) and Infrastructure Leasing & Financial Services (IL&FS)–are agencies which provide loans and a variety of instruments for infrastructure financing. Other Indian financial institutions–e.g., Housing and Urban Development Corporation

(HUDCO), Industrial Credit and Investment Corporation of India (ICICI), Industrial Development Bank of India (IDBI), Life Insurance Corporation of India (LIC), etc. also provide funds for infrastructure projects. These institutions have access to funds with long repayment periods (e.g., loans from development agencies, bonds from the open market, foreign institutional investors, etc.) and are thus able to lend for relatively longer durations than banks. The credit rating of the ULB plays an important role here. The better the credit rating with respect to repayment of principal and interest, the lower the rate of interest because risk is lower, and vice versa. Certain financial institutions provide credit enhancement mechanisms, which are essential to improve the inherent credit quality and credit rating, thereby resulting in lower interest rates. This facility is now also being extended by the MoUD through its Pooled Finance Development Fund (PFDF) Scheme. Institutions may also provide guarantees for funds accessed from other sources.

viii **Bank Loans:** Banks have prescribed norms and well laid down procedures for grant of loans. Since the deposit base of banks is for short duration (generally 1–3 years), loans are provided also for a short to medium term. Banks generally do not cater to the long term needs of infrastructure projects. Bank loans are especially relevant to finance the short term needs of institutions e.g., as working capital loan, bridge loans, loans against property, etc.

ix **Enhancing continuous revenues in solid waste management projects:** It is of paramount importance for sustainable financing to strengthen project revenues and that the projects are planned in such a way that they are self-sustainable and can deliver desired outcomes for a longer period. MSWM operations usually depend on SWM taxes or fees and charges. Other sources of revenues might be relevant as illustrated in Figure 1.5.

**Figure 1.5: Illustration of Solid Waste Management Revenue Streams[3]**




x **Introduction of solid waste management service charge and user charges:** According to the 74th amendment to the Constitution, ULBs can impose taxes and raise funds for public health, sanitation, conservancy, and SWM. It is desirable to levy a dedicated tariff for

3 Toolkit for Solid Waste Management, Jawaharlal Nehru National Urban Renewal Mission, New Delhi, Ministry of Urban Development, Government of India. http://jnnurm.nic.in/wp-content/uploads/2012/11/SWM-toolkit.pdf

solid waste services. Following basic principles may be considered by ULBs while prescribing norms for levying user charge and service fee for SWM services.

- **Polluter pays principle:** Those responsible for waste generation should pay for its collection and safe disposal.
- **Proportionality:** The user fees should be in proportion to the quantity of waste generated and level of service provided to waste generators. Variable rates may be prescribed for different categories of waste generators, keeping in view their waste generation pattern. A fair user fees will facilitate better compliance.
- **Capacity to pay:** Affordability of tax payers should be considered.

**Key messages for decision-makers**

Sustainable financing of MSWM systems is crucial for effective service delivery. Make sure that the ULB finds a sustainable solution to financing investments and O&M. Levy of user fees is needed to sustain the service efficiently.

CH 1
SEC 1.4.5.6
CH 5

## 2.9 MAKE-OR-BUY DECISIONS AND PUBLIC PRIVATE PARTNERSHIP (PPP)

ULBs should first assess whether they are able to provide SWM services on their own or will need to outsource due to considerations of limited capacity, staffing, and other resources. The services to be outsourced should be deliberated upon and defined sufficiently and should fit into the larger SWM plan for the ULB. ULBs may contract private service providers for provision of specified solid waste collection, transportation, treatment, processing, and disposal services.

In principle, the following options exist for contracting out the services (Table 1.1).

**Table 1.1: Options for Contracting Services**

| MSW MANAGEMENT & OPERATION | CHARACTERISTICS | RELEVANT CONTRACT MODELS | EXAMPLES OF IMPLEMENTING ULBs |
|---|---|---|---|
| Collection and Transportation | • Large number of work force, vehicles and equipment<br>• Logistics-intensive<br>• Citizen interface<br>• Investment ranges widely depending on scope of work | Service contracts<br>Management contracts<br>Concession for 7 years or more | Bangalore, Surat, Ahmedabad, Chennai, etc. |

**Table 1.1: Options for Contracting Services [contd.]**

| MSW MANAGEMENT & OPERATION | CHARACTERISTICS | RELEVANT CONTRACT MODELS | EXAMPLES OF IMPLEMENTING ULBs |
|---|---|---|---|
| Street sweeping* | • Labor-intensive<br>• Logistics-intensive<br>• Minimal investment in tool and equipment<br>• Limited technical skills | Service contracts subject to contract labour (Regulation & Abolition) Act, 1970 | Delhi, Hyderabad, Chennai, Rajkot, Surat, etc. |
| Transport | • Capital-intensive<br>• Fleet management skills | Concession contracts | Bangalore, Delhi, Chennai, Ahmedabad, Surat |
| Processing and disposal | • Capital-intensive<br>• Technically skilled staffing required<br>• Experience of technology deployed | Concession contracts (DBO, BOO, DBOOT) for 20 years or more | Surat, Delhi, Hyderabad, Coimbatore Pune, etc. |
| Note: * Street Sweeping usually stays with the ULB to ensure employability of current workforce | | | |

Sourcing out MSWM services should be carefully considered taking into account all relevant aspects such as:

- technology assessment and specification of the technology selected and services to be outsourced;
- justification of the need for contracting and identification of appropriate contract models and their pros and cons;
- commercial feasibility of services to be outsourced;
- All PPP contracts shall be for a duration that may enable the concessionaire to recover their capital investments made in easy installments while also financing the O&M cost of service;
- specific outputs and performance standards for the contracted service;
- adequate social and environmental safeguards for service provision;
- possible assessment of technical, operational and financial risks. Is it realistic that liability for key risks can be transferred to the operator?; and
- where acquisition of land and rehabilitation of the community is involved, the ULB should follow applicable rules and guidelines at the national and state level.

Contracting models should preferably be performance-based and the payment to private partner be measured on outputs reflecting the service quality levels as defined in the contract. Both the ULB and the PPP operator should be accountable for their respective roles to ensure successful and sustainable project implementation. Private service

providers should be held accountable and monitored by the ULB to ensure effective and efficient provision of required standards of services.

Certain precautions must be taken while selecting a specific contractor for MSW service provision to ensure an efficient SWM system:

- Clearly address the specific requirements in the tender specifications. Prefer performance-based terms of reference;
- Select the bidder based on both technical and financial bids and not solely on the criteria of selecting the lowest bidder;
- In ULBs with a population of over 1,00,000, at least two contractors may be considered for outsourcing the collection and transportation services;
- Ensure timely payments for contracted services, thereby also ensuring the provision of the stipulated standard of service;
- Where contract labour is hired, the ULB shall ensure compliance with the provisions of the Contract Labour (Regulation & Abolition) Act, 1970;
- Monitoring mechanism and penal provisions shall be clearly spelled out in the contract and strictly adhered to. Record shall be maintained of observations made by the supervisory officers and of corrective measures taken. Penal provisions may be invoked if the concessionaire fails to perform after due notice.

The procurement process for a PPP should follow a systematic process of (i) preparing expression of interest (EOI), (ii) requesting for proposal (RFP), request for quotation (RFQ) document and concession agreement (CA), and (iii) awarding work to the selected firm. In a single step process, the EOI is not sought separately.

**Key messages for decision makers**

Outsourcing MSWM services should be carefully considered taking into account all relevant aspects. There is no one-size-fits-all solution for ULBs. Each PPP option should be assessed considering pros and cons of the respective community. Contracting models should be performance-based, and the payment to private partner should be based on measured outputs reflecting the service quality levels as defined in the contract.

For large projects and sophisticated technology applications, higher weightage of technical considerations (say, 70%–80%) is desirable plus strict performance monitoring.

## 2.10 CENTRALISED VS. DECENTRALISED MUNICIPAL SOLID WASTE MANAGEMENT SYSTEMS

CH 1
SEC 1.4.5.8

Conventionally, SWM systems were planned for and implemented at the city level, with centralised systems catering to the entire ULB.

Resource, technology, and capital-intensive SWM services are best planned and executed at the city level; centralised systems are preferred for waste processing and treatment plants like RDF plants, incineration plants and municipal sanitary landfills, which can benefit from economies of scale.

Decentralised waste management systems or community-level waste management systems reduce the burden of handling large volumes of MSW at a centralised location, with a corresponding reduction in costs of transportation and intermediate storage. Segregated doorstep collection is a pre-requisite for the success of decentralised facilities. All decentralised schemes should be assessed for long term sustainability, and their impact on the overall SWM system of a city should be identified and considered while planning for citywide waste management facilities.

Interactive planning with the community is required to decide the extent of centralised and decentralised MSWM systems for continued efficiency.

Advantages of centralised systems include (i) economies of scale, (ii) single monitoring point, and (iii) high-end technology and environmental controls.

Limitations of centralised systems include (i) larger tract of land, (ii) fund limitations, (iii) limited experience of ULBs in managing large contracts, and (iv) high potential for environmental failure of systems where environmental controls are not in place or monitored.

Some of the advantages of decentralised waste management are the following:

- Decentralised systems allow for lower level of mechanization than the centralised solutions. They provide job opportunity for informal workers and small entrepreneurs;
- Decentralised options can be tailored to the local waste stream and the climatic, social, and economic conditions;
- Decentralised systems reduce the cost of collection, transportation, and disposal of waste by the ULBs.

Decentralised SWM solutions are suitable in the following scenarios:

- Suitable land for waste management facilities (composting organic waste, recyclable sorting facilities, etc.) is available in the neighbourhood;
- There is no local resistance against the siting of the plant;
- Local experts or non-government organizations (NGOs) handhold the process in an environmentally acceptable manner;
- Municipality has in-house capacity of effectively monitoring decentralised systems;
- Market for compost and recyclables are accessible.

However, some of the limitations to implementation of decentralised waste management systems include:

- Availability of land in most urban neighbourhoods;
- Availability of technically qualified staff to ensure scientific and hygienic operations;
- Ensuring periodic check on product quality; and
- Ensuring financial viability of decentralised projects, specifically when qualified staffing is required.

**Key messages for decision-makers**

Decentralised SWM systems are preferred to reduce the environmental and monetary costs of transporting waste over large distances. Collection of recyclables and composting of organics are some of the activities which can be taken up at the local level, either at a colony level or ward level. Processing, treatment, and disposal facilities—which are viable only at a certain scale, like recycling facilities, RDF plants, incineration plants and municipal sanitary landfills—should be planned for at the centralised or regional level, depending on the size of the ULB. Decentralised MSWM facilities may be funded through community-based cooperatives, local NGOs, PPP mode, or municipal funds. Community ownership of decentralised systems is critical for their success and continued operation.

## 2.11 ROLE OF THE INFORMAL SECTOR

The informal sector, constituting of the kabadi system and waste pickers, plays an important role in the MSWM value chain by recovering valuable material from waste. They help reduce environmental impacts by improving resource recovery and reducing disposal requirements. The integration of the informal sector into the formal SWM system will contribute to the reduction of the overall system costs, provide support to the local recycling industry, and create new job opportunities.

The integration of the informal waste sector refers to several ways in which the waste pickers could be involved in formal waste management systems. This is made possible through a set of formal or informal arrangements among waste pickers themselves, organizations of waste pickers, organizations working with waste pickers, and local authorities. The integration process would typically result in the accrual of social benefits to waste pickers.

**Key messages for decision-makers**

Developing formalised material recovery systems are capital-intensive. Therefore, the informal sector should be encouraged to work in material recovery facilities (MRFs), which may be either centralised or decentralised, while ensuring environmental, health, and safety safeguards. Through the process of formalising the informal sector, social identity, social security, health care benefits, and a stable livelihood should be given to informal sector workers. Waste pickers and rag pickers could be employed in door-to-door collection activities, sorting recyclable waste, collection and segregation of recyclable material, and set-up and management of recyclable and reusable waste. They could also work in take-back or buy-back facilities and in processing facilities as waste sorters (e.g., at the sorting conveyor). Mechanisms to identify and recognize the informal waste workers should be constituted.

# 3. TECHNICAL ASPECTS: SEGREGATION, COLLECTION AND TRANSPORTATION

## 3.1 AT-SOURCE MINIMISATION: OPTIONS TO REDUCE THE AMOUNT OF WASTE

CH 2
SEC 2.1

The integrated solid waste management (ISWM) hierarchy (Figure 1) prioritizes waste minimisation (at source reduction and reuse) because it is the most effective way to reduce the quantity of waste, the cost associated with its handling, and its environmental impacts.

Waste minimisation strategies require policy interventions at the national, state, and local level, depending on the type of the intervention–e.g., minimising use of packaging material, promoting use of refill containers, buyback of reusable or recyclable packing material, introducing a national deposit system on beverage packages, etc. and the scale at which the intervention needs to be initiated for effective implementation. Initiatives which require a behavioural change in the community need to be supported by consistent awareness programmes.

Waste minimisation strategies requiring national or state-level interventions or support are the following:

- **Extended producer responsibility:** Extended producer responsibility (EPR) can be established for wastes like electronics, batteries, packaging, and consumer durables by state and national governments. States can take initiatives in this matter; regulations are usually legislated at state and national levels.
- **Promotion of voluntary action:** Business groups should be encouraged to reduce volumes of packaging while maintaining the requisite strength. For instance, Godrej has a "no packaging" policy for refrigerators. The company ensures that the packaging, in which the appliance is delivered, is taken back by the supplier and reused.
- **Frame rules and bye-laws:** It is banned to use or sell certain types of products and packaging that cannot be reused, repaired, recycled, or composted. With state support, local authorities are enabled to issue and enforce such ordinances.
- **Eco-labeling standards:** Eco-labeling standards for certain products should be developed, based on their potential for waste reduction and recycling.

Waste minimisation initiatives usually requiring ULB support or action are the following:

- **Awareness and education programmes:** Programmes that address different stakeholders should be promoted and implemented—such as residential, commercial, school, and industrial educational programs—to increase public awareness and participation in at-source waste reduction programs. Campaigns might include promotion of material substitution where possible (e.g., promoting the use of rechargeable batteries instead of single use batteries, buying refills, etc.).
- **Developing and promoting at-source reduction programmes:** These programmes in the community, e.g., domestic composting programs, can reduce the volume of food waste, leaves, and garden trimmings entering the city-level collection system.
- **Bans within local authorities' jurisdiction:** Banning the use of plastic bags is an example of a strategy of replacing non-recyclable products with recyclable and reusable material and products. Usually, national or state-level authorization is required.
- **Product stewardship and green procurement implementing programs:** Here the suppliers of a product are responsible for a take-back program to promote recycling. Take-back examples are computer monitors, auto oil, batteries, paper, milk pouches, etc. Procurement programs in local governments and businesses should be designed to give preference to recyclable products.

- **Consumer reward:** Local businesses should be encouraged to reward consumers for returning recyclable products or products which are toxic (e.g., batteries). These initiatives require existing manufacturers' EPR programs.
- **Business assistance programs:** These programmes advise businesses how to use material more efficiently and to reduce waste generation.
- **Supermarkets and retail stores:** These are often some of the most effective partners for a municipal waste minimisation program. These provide a central and consistent point for consumer education, packaging reduction projects, and collection of recyclable waste.
- **Promoting material exchange and reuse programs:** These help divert material from the waste stream going to landfill (e.g., programs which link sellers of used furniture with potential secondhand furniture buyers).
- **"Pay as you throw":** Supported by bye-laws, incentives for at-source reduction through the principle of "pay as you throw" can be established. ULBs can stipulate variable SWM charges, based on the quantities being disposed per household or establishment. Variable rates can be fixed for predefined ranges of waste quantities, progressively increasing with waste generation rates. This would also imply that the ULB has the resources to record waste generation quantities. This system will function successfully only if the progressively increasing tariff is restrictive enough to prevent waste generation.

**Key messages for decision-makers**

Waste minimisation strategies at ULB level are quite new. ULBs can play a pioneering role by reducing the amount of waste by propagating and promoting the 3R concept.

## 3.2 WASTE SEGREGATION, COLLECTION AND TRANSPORTATION

CH 2

MSW should be stored at the source of waste generation until it is collected for disposal by ULB staff or appointed contractors. It is essential to segregate waste into different fractions, commonly referred to as primary segregation. Segregation of MSW needs to be linked to primary collection of waste from the doorstep and given high priority by the ULBs. Unless primary collection of segregated waste is planned by the ULBs, the source segregation by waste generators will be meaningless.

The fractions into which the waste has to be segregated in detail should be based on waste characterisation, the ULB's capacities and facilities, and other framework conditions (existing kabadi systems, traditions in the community, available space in residential areas and in streets, etc.).

At a minimum level, indicated as the basic segregation, waste should be segregated by waste generators into three fractions: wet (green container), dry (white container), and domestic hazardous waste. This is referred to as the three-bin system. Apart from these wastes horticulture waste, construction and demolition and sanitary waste should stored and collected separately. The wet fraction should preferably be used for composting; and the dry waste should be sent for recycling (Figure 1.6) also to be ensured that sanitary waste should be wrapped securely, collected and handed over separately to the waste collectors. Also domestic hazardous waste should be collected separately and deposited at the designated collection centres.

**Figure 1.6: Bins for Collection of Dry, Wet and Domestic Hazardous Waste at Households[4]**


### 3.2.1 SEGREGATED COLLECTION AND TRANSPORTATION

Collection of segregated municipal waste from source is an essential step in SWM. Inefficient waste collection service has an impact on public health and aesthetics of towns and cities. Segregated collection of wet and dry waste enhances the potential of cost-effective treatment of such waste and of deriving optimum advantage from the recyclable material fed into the system.

Waste collection service is divided into primary and secondary collection. The different collection systems are illustrated in Figure 1.7.

**Primary collection** refers to the process of collecting waste from households, markets, institutions, and other commercial establishments and taking the waste to a storage depot or transfer station or directly

4 "Panjim's Initiatives in Solid Waste Management", Rodrigues, S. (2013). Available at: http://iipnetwork.org/Rodriguez_Towards-Green-Trash).

to the disposal site, depending on the size of the city and the prevalent waste management system.

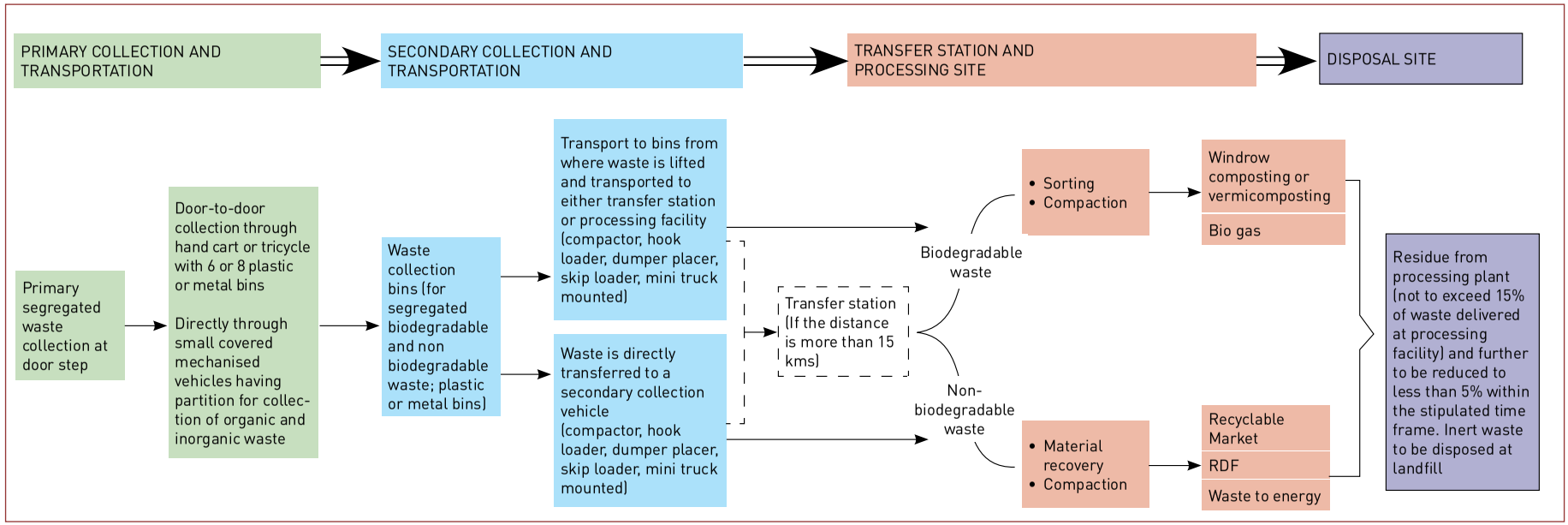
**Secondary collection** includes picking up waste from community bins, waste storage depots, or transfer stations and transporting it to waste processing sites or to the final disposal site. Primary collection must be introduced both in small and large towns and cities. Secondary collection systems are necessary in all cities and towns for collection of waste in the community bins or at the secondary waste storage depots or at decentralised sorting centres by sanitation workers for onward transportation of waste to processing and disposal facilities.

A well synchronised primary and secondary collection and transportation system is essential to avoid containers' overflow and waste littering on streets. Further, the transport vehicles should not only be able to transport segregated waste, but also be compatible with the equipment design at the waste storage depot to avoid multiple handling of waste. They should also be easy to maintain.

**Key messages for decision-makers**

Develop an appropriate system to ensure segregation, collection, and transportation of waste from source by deploying tools, equipment, and vehicles suitable under local conditions. A too complex system might not be manageable; a too simple system without any segregation might miss existing opportunities for recycling and composting. In a nutshell, segregated collection of solid waste and segregated transportation from source to destination are essential.

## Figure 1.7: Flow Chart of Household Waste Collection, Transportation and Disposal[5]




- The compactor is an appropriate vehicle for collecting biodegradable and recyclable component of MSW
- Skip loaders/ Hook loaders are preferred for collecting inert waste or Construction and Demolition waste
- Waste may be transferred to the transfer station if the processing site is located at least 15 kms away from the city

5 Developed by the Expert Committee for revision of MSWM Manual (2013-15).

### 3.2.2 STREET CLEANING AND DRAIN CLEANING

Street cleaning is an age-old fundamental service rendered by municipal authorities in India to ensure clean and hygienic urban conditions. Until recently, all domestic and trade waste was being discharged on the streets or in street bins, and street sweeping was the principal method of waste collection. With the introduction of door-to-door collection systems in many urban areas, there is a sizeable reduction in the quantity of waste and change in its composition. The street waste should ideally comprise of dust, leaves, and some litter; but, until door-to-door collection becomes effective, the street sweeping will also include sizeable portions of food waste as well as recyclable waste. Manual sweeping is commonly practiced in India, as many streets are congested and narrow road conditions are not conducive for mechanical sweeping. Inefficient waste collection systems coupled with public littering significantly contribute to waste piles in streets.

A wide variety of tools and equipment are available for manual and mechanical sweeping. Municipal authorities must avoid multiple handling of waste by converting traditional handcarts into containerised handcarts to facilitate direct transfer of waste from handcart to a container of collection vehicle. Through the introduction of efficient methods, municipal authorities can achieve significant improvement in quality of service and financial savings. ULBs should determine the frequency of street cleaning based on local conditions for efficiency of staff. Also, the time of street cleaning should be carefully defined to avoid conflicts with traffic, parked vehicles, and pedestrians.

In many cities there are open surface drains along the roadside which need to be cleaned regularly to permit free flow of storm or grey water. SWM authorities should ensure that citizens and sweepers do not dispose waste into drains, through training, campaigning, statutory regulations, and monetary fines. A further approach to prevent this is to make the same staff responsible for cleaning streets and for cleaning adjacent surface drains of up to a depth of 90 centimetres (cm).

It is very important to ensure that street sweeping and drain cleaning material are not allowed to be mixed with the waste collected from households and commercial establishments, as it can seriously hamper treatment and recycling options for the household and commercial waste and add to the cost of processing of waste.

**Key messages for decision-makers**

Ensure that street sweeping, drain cleaning, and waste collection form a consistent system. Prevent street sweeping and drain cleaning material from being mixed with waste collected from households and collected separately. Also, street sweepings should not be discharged into surface drains.

# 4. TECHNICAL ASPECTS: PROCESSING AND TREATMENT OF MUNICIPAL SOLID WASTE

CH 1
SEC 1.4.5.12
CH 3

## 4.1 WASTE TREATMENT: HOW TO SELECT APPROPRIATE TECHNOLOGIES

The selection and adoption of MSW processing technologies should be based on defined selection criteria and be subject to a detailed due diligence study, which ascertains the appropriateness of the technology to the prevailing conditions of the respective ULB. ULBs might even acquire external expertise to find the most viable solution among complex technologies. Selection criteria are listed in Table 1.2 and applied to a number of common strategies and technology options.

The financial implication of segregation on processing and treatment costs is substantial and should be considered before selecting any processing and treatment technology. Treatment and processing of segregated waste streams not only reduces operational costs but also increases the efficiency of the process.

**Key messages for decision-makers**

Ensure that selected MSWM technologies fit to the local conditions. Check for successful and proven project references and experiences in other ULBs. Seek opinions of independent experts. Consult the State Pollution Control Board (SPCB) for validation of the proposed technology.

**Table 1.2: Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies[6]**

| CRITERIA | WINDROW COMPOSTING | VERMICULTURE | BIOMETHANATION | RDF | INCINERATION | INTEGRATED SYSTEM (COMPOSTING + RDF) | SANITARY LANDFILL |
|---|---|---|---|---|---|---|---|
| TECHNICAL CRITERIA | | | | | | | |
| Facility Location[8,9] | To be located as per the buffer zone criteria mentioned below. | To be located as per the buffer zone criteria mentioned below. | To be located as per the buffer zone criteria mentioned below. | To be located as per the buffer zone criteria mentioned below. | To be located as per the buffer zone criteria mentioned below. | To be located as per the buffer zone criteria mentioned below. | Landfill sites must be located at least 500 m away from residential areas and should abide by the criteria mentioned in MSW Rules and state level guidelines. |
| Buffer Zone (No Development Zone) | 500 m for facilities dealing with 100 TPD or more of MSW<br>400 m for facilities dealing with 75–100 TPD of MSW<br>300 m for facilities dealing with 50–75 TPD of MSW<br>200 m for facilities dealing with 10–50 TPD of MSW<br>No buffer zone for facilities dealing upto 5 TPD of MSW<br>No buffer zone for decentralised plants handling less than 1 TPD of MSW (but adequate environmental controls are required) | | | | | | |

6 Adopted from various sources (JnNURM Toolkit, World Bank, CPCB, MoEFCC, GIZ, Manual on MSWM (First Edition), CPHEEO (2000), Expert Committee for the revision of MSWM Manual 2014, Task Force on Waste to Energy, Planning Commission.

8 Site selection criteria specified by the EIA Notification 2006 and its amendments shall be considered.

9 CPCB Guidance on Criteria for Site Selection for Landfills shall also be considered

**Table 1.2: Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies [contd.]**

| CRITERIA | WINDROW COMPOSTING | VERMICULTURE | BIOMETHANATION | RDF | INCINERATION | INTEGRATED SYSTEM (COMPOSTING + RDF) | SANITARY LANDFILL |
|---|---|---|---|---|---|---|---|
| Natural environment | Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation. | Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation. | | | | | Should be avoided in marshy land and in conditions where the ground water table is 2 m from the base of the liner. In marshy land, apart from ground and surface water contamination potential, there could be huge risks due to structural safety of the landfill (slippage and complete breakdown). |
| Land Requirement | For 300 TPD of segregated/pre-sorted MSW: 5 ha of land including buffer zone is required. | For 20 TPD of segregated/pre-sorted: 1.25 ha. | For 300 TPD of segregated/pre-sorted MSW: 2.5 ha of land is required. | For 300 TPD of segregated/ pre-sorted MSW: 2 ha of land is required. | For 1000 TPD of mixed waste: 5 ha of land including buffer zone | For 300 TPD of segregated/pre-sorted MSW: 6 ha of land (Note: Many of the processing units are shared). | For 300 TPD of MSW: 30 ha of land is required for 20 years. |

**Table 1.2: Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies [contd.]**

| CRITERIA | WINDROW COMPOSTING | VERMICULTURE | BIOMETHANATION | RDF | INCINERATION | INTEGRATED SYSTEM (COMPOSTING + RDF) | SANITARY LANDFILL |
|---|---|---|---|---|---|---|---|
| Waste Quantity which can be managed by a single facility. | 500 TPD | 1 TPD to 20 TPD. Higher capacities can also be planned if adequate land is available along with other necessary arrangements. | 1 TPD at small scale to 500 TPD at larger scale | 100 TPD of segregated waste and above | 1000 TPD and above of mixed waste (smaller plants are not techno-economically viable, given the cost of required environmental control equipment and boiler technology | 500 TPD and above (economically sustainable above 500 TPD plant size) | 100 TPD inert and above. Smaller landfills are not techno-economically viable |
| Requirement for Segregation prior to technology | High | Very high | Very high | High | High – Feed stock should be free from inerts and low on moisture content | Moderate because both dry and wet fractions are utilized | Only inert waste may be placed in landfills as per SWM Rules |
| Rejects | About 30% including inerts if only composting is done.[10] 15%* rejects with RDF, if located in the same plant | About 30% including inerts* | About 30% from mixed waste* | Around 30% from mixed waste** | Around 15%** | Approximately 15-20%*** | No rejects |
| Potential for Direct Energy Recovery | No | No | Yes | No (feed stock for energy recovery) | Yes | Yes | Not as per SWM Rules |

10 In cases of an integrated facility of composting and RDF, 15% rejects from mixed waste stream is expected

* Rejects from mixed waste fundamentally depends on the presence of non- biodegradable material which are taken out during pre-sorting stage

** For incoming mixed waste for RDF & Incineration Non combustible material is taken out during the sorting stage

*** Process rejects from segregated waste should be less than 10%

**Table 1.2: Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies [contd.]**

| CRITERIA | WINDROW COMPOSTING | VERMICULTURE | BIOMETHANATION | RDF | INCINERATION | INTEGRATED SYSTEM (COMPOSTING + RDF) | SANITARY LANDFILL |
|---|---|---|---|---|---|---|---|
| Technology Maturity | Windrow composting technique is well established | Community scale projects are successful | Feasibility for biodegradable waste is proven. In case of mixed waste, appropriate pre-sorting has to be carried out. | Quality of RDF should be based on end use, no clear consensus on quality requirements. Burning of RDF below 850°C for less than 2 seconds residence time can pose serious problems of health and environment. Rules regulating characteristics of RDF and guidelines for appropriate use not prescribed by concerned authority. | Technology is available. However constraints of low calorific value, high moisture content and high proportion of inert waste should be considered while undertaking the project commercially. | Composting and RDF combined facility is an upcoming phenomenon. Utilization of rejects from compost plants as input material for RDF production and sale. Rejects from integrated system are 15-20% as opposed to 30-40% from individual system. | Sanitary landfill is a proven method for safe disposal of waste, practiced world over. However it has environmental implications and efforts have to be made to minimize waste going to landfills. MSW Rules only permit inert wastes to be landfilled. |

**Table 1.2: Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies [contd.]**

| CRITERIA | WINDROW COMPOSTING | VERMICULTURE | BIOMETHANATION | RDF | INCINERATION | INTEGRATED SYSTEM (COMPOSTING + RDF) | SANITARY LANDFILL |
|---|---|---|---|---|---|---|---|
| FINANCIAL CRITERIA | | | | | | | |
| Indicative Capital Investment[11] | Typically 15-20 Cr for 500 TPD plant | 1 Cr. per 20 TPD | Typically 75-80 Cr for 500 TPD plant | Typically 17-20 Cr for 500 TPD plant | Very high capital, operating and maintenance costs. 15 Cr. per MW power production | Typically 25-30 Cr for 500 TPD plant) without a mechanical Hot Air Generator (HAG) for drying . However, moisture can be reduced by bio-drying with much less cost but slightly reduced efficiency. | High |
| Market for product/ By-Product | Quality compost compliant with FCO 2013 has a good market. IPNM Task Force (vetted by Supreme Court, 1 Sep 2006) has recommended co-marketing of 3-4 bags of compost with 6-7 bags of inorganic fertilizer. | Good market potential in urban and rural areas. However it is not adequately explored for bulk marketing. | So far, there is no appropriate system for pricing biogas. The system of pricing according to kerosene equivalent puts biogas at a disadvantage.<br>At present, there is lot of interest in conversion of biogas into automotive fuel by stripping $CO_2$. In this case, equivalent pricing with power/CNG again puts biogas at a disadvantage because of scale of economy. | Good market potential for RDF.<br>In small cities, RDF plants only become feeders of RDF to large RDF based power plants and cement plants. | Good potential of energy generation if power purchase agreements are made reflecting true cost of production including O&M costs | Quality compost compliant with FCO 2009 has a good market.<br>Good market potential for RDF.<br>In small cities, RDF plants only become feeders of RDF to large RDF based power plants and cement plants. | No potential, since it is stipulated by the SWM Rules that only inert wastes are to be disposed in landfills |

11 Toolkit for Solid Waste Management, Jawaharlal Nehru National Urban Renewal Mission, New Delhi, Ministry of Urban Development, Government of India. http://jnnurm.nic.in/wp-content/uploads/2012/11/SWM-toolkit.pdf

**Table 1.2: Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies [contd.]**

| CRITERIA | WINDROW COMPOSTING | VERMICULTURE | BIOMETHANATION | RDF | INCINERATION | INTEGRATED SYSTEM (COMPOSTING + RDF) | SANITARY LANDFILL |
|---|---|---|---|---|---|---|---|
| MANAGERIAL CRITERIA | | | | | | | |
| Labour Requirement | Labour intensive | Labour intensive | Less labour intensive | Labour intensive (based on current practice). | Non labour intensive but requires considerable technical capacity, | Labour intensive but requires considerable technical capacity . | Only inert wastes are to be deposited in sanitary landfills. Labour intensive but requires considerable technical expertise as well. |
| Predominant skills for Operation and Management | Technically qualified and experienced, and semi-skilled staff. | Technically qualified, experienced and semi-skilled staff.[12] | Technically qualified and experienced staff. | Technically qualified and experienced staff. | Technically qualified and experienced staff. | Technically qualified and experienced staff and semi-skilled. | Technically qualified and experienced, and semi-skilled staff. |
| ENVIRONMENTAL CRITERIA | | | | | | | |
| Concerns for toxicity of product | The final product is generally applied to soil and used as manure. Can contaminate the food chain if compost is not meeting FCO norms. | The product is generally safe as worms cannot endure significant contamination of raw materials. FCO Standards are to be met with. | The final product is generally applied to soil as a soil conditioner. Can contaminate the food chain if compost is not meeting FCO norms. | - | - | The final product is generally applied to soil and used as manure. Can contaminate the food chain if compost is not meeting FCO norms. | - |

12 On-site training is required for unskilled labour, as a minimum requirement for efficient operation

**Table 1.2: Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies [contd.]**

| CRITERIA | WINDROW COMPOSTING | VERMICULTURE | BIOMETHANATION | RDF | INCINERATION | INTEGRATED SYSTEM (COMPOSTING + RDF) | SANITARY LANDFILL |
|---|---|---|---|---|---|---|---|
| Leachate Pollution | Potential exists.<br><br>Varies with the climate of area and seasonal variation. In relatively dry seasons, leachate can be recirculated into the windrow to contain loss of nutrients and also pollution potential.<br><br>In high rainfall areas, the windrows need to be covered either temporarily or permanently to control leachate generation. However, the design of the shed should be such that good natural ventilation is maintained. | Insignificant quantities at low waste volumes per vermi-pit. | High if not treated appropriately | Low | High potential of leachate at the receiving pit. | Potential exists for compost<br><br>Varies with the climate of area and seasonal variation. In relatively dry seasons, leachate can be recirculated into the windrow to contain loss of nutrients and also pollution potential.<br><br>In high rainfall areas, the windrows need to be covered either temporarily or permanently to control leachate generation. However, the design of the shed should be such that good natural ventilation is maintained. | Polluted surface runoff during wet weather, groundwater contamination due to leachate infiltration<br><br>Moderate to high depending upon the leachate recycling and control systems. Leachate management during monsoons requires special attention |

**Table 1.2: Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies [contd.]**

| CRITERIA | WINDROW COMPOSTING | VERMICULTURE | BIOMETHANATION | RDF | INCINERATION | INTEGRATED SYSTEM (COMPOSTING + RDF) | SANITARY LANDFILL |
|---|---|---|---|---|---|---|---|
| Atmospheric pollution | Low (dust, aerosol etc.).<br>Odour issues. | Low.<br>Odour issues. | Low.<br>Leakage of biogas.<br>Odour issues | Low to moderate (dust, aerosols).<br>Very high if RDF is not burnt at required temperature.<br>Odour issues. | Very high if emissions not managed properly. Fly ash should be disposed safely in an engineered landfill.<br>(Emissions due to incomplete combustion of municipal refuse contain a number of toxic compounds, dioxins and furans, requiring appropriate emissions control systems) | Moderate, require appropriate emission control systems (Air emission include acid gases, dioxins and furans) | Air pollution and problems of odour and methane emissions if not managed properly. |
| Other | Fire and safety issues to be taken care of | Fire and safety issues to be taken care of | Fire and safety issues to be taken care of | Presence of inappropriate material in the RDF (chlorinated plastics).<br>Fire and safety issues to be taken care of. | Disposal of bottom ash/slag.<br>Fire and safety issues to be taken care of. | Presence of inappropriate material in the RDF (chlorinated plastics).<br>Fire and safety issues to be taken care of. | Spontaneous ignition due to possible methane concentration.<br>Fire and safety issues to be taken care of. |

## 4.2 RECYCLING AND RECOVERY

CH 3
SEC 3.1

Recycling is a process by which material that are otherwise destined for disposal are collected, processed, and remanufactured. Recycling diverts a significant fraction of municipal, institutional, and business waste from disposal and, thereby, saves scarce natural resources and reduces environmental impacts and the burden on public authorities to manage waste. Recycling can generate revenues, which result in reducing overall costs for MSWM. Benefits of recycling include the following:

For the urban local body (ULB):

- Reduced volume of waste to be managed
- Cost savings, if noticeable revenues (from sale of recyclables) can be generated
- Longer life span of landfills, since recyclables are diverted away from landfills
- Reduced needs for environmental management efforts by the ULB

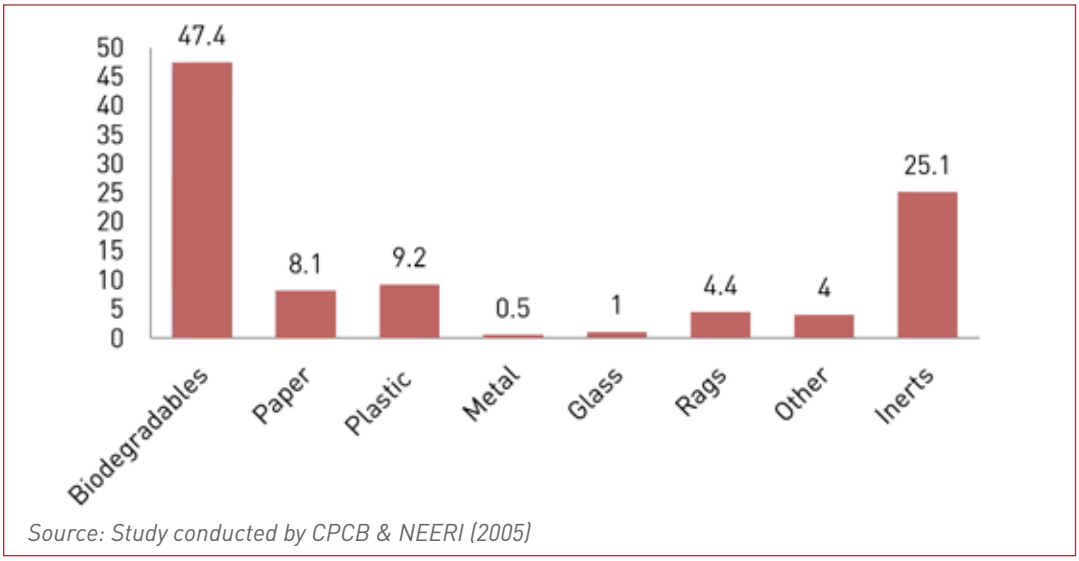
For the economy:

- Reduced use of raw materials, fertilizers, etc.
- Cheap products made from recycled materials
- Livelihood opportunities for the informal sector, and for recyclers and recycling industry

For the environment:

- Sustainable use of resources: less energy consumption and less pollution
- Reduced land use for disposal sites
- Reduced environmental impacts including climate change impacts

**Figure 1.8: Typical Fractions of Municipal Solid Waste Generated in India[13]**




*Source: Study conducted by CPCB & NEERI (2005)*

13 'Improving Solid Waste Management in India,' D. Zhu, et al., (2008). Available at: http://www.tn.gov.in/cma/swm_in_india.pdf

The India wide characterization of wastes in Figure 1.8 underlines that there is additional potential for recycling solid waste discarded by the citizens; it has to be noted that considerable amounts of recyclables are already taken up-front by the kabadi system or scrap dealers prior to waste disposal by the citizens. Efforts should be made to further segregate the recyclables currently being disposed by households, shops and establishments and to pass them on to the recycling industry. Every strategy for recycling (as also for other steps of MSWM) should be based on a thorough waste analysis or characterization in the respective city. Based on such studies, a detailed estimation of the recycling potential of each material needs to be done and strategies and technologies for recycling need to be identified. Successful case studies in India are given in various sections in Parts II and III of the manual.

The analysis should include identification of potential buyers for recyclables and affordable market prices.

CH 3

## 4.3 PROCESSING TECHNOLOGIES

The integrated solid waste management (ISWM) framework should be used as a guide for selecting most appropriate technologies for managing MSW. ISWM plants typically have pre-processing facilities to separate organics from recyclables and other high calorific waste. The organic waste is usually composted aerobically to produce manure or processed anaerobically (in absence of air) for production of energy. Recyclables are separated and sent to wholesalers for further supply to recycling facilities. High calorific wastes are then baled or processed and can be used as fuel or co-processed in cement plants.

### 4.3.1 MATERIAL RECOVERY FACILITY

A material recovery facility (MRF) is a place where non-biodegradable or recyclable solid waste collected from the doorstep is segregated, sorted and various components of recyclable waste recovered from it for resale. The MRF accepts mixtures of waste fractions (non-biodegradable or recyclable) and its configuration depends on the several factors like the type, quantity and quality of incoming waste materials. Here the material is basically segregated into different streams of waste fractions (paper, plastic, packaging paper, bottles etc) which is further sold to intermediaries who supply bulk material to the recycling industries. MRFs also require large storage spaces to temporary store sorted recyclables which can be made available to recyclers in bulk for improved resale value. Depending on the scale of operations and the level of mechanization in the facility, MRFs may be classified as manual or mechanized. Small scale units employ manual MRFs wherein manual sorting process is being carried and it's typically owned, operated and managed by the informal sector. Large scale units have mechanized MRFs with sophisticated systems and equipment that enable efficient separation of large quantity of material into different fractions.

### 4.3.2 COMPOSTING

CH 3
SEC 3.2

After waste minimisation and recycling systems, the ISWM hierarchy indicates adoption of resource recovery strategies and composting as the third preferred waste management practise, ensuring that waste is processed appropriately to facilitate further use of the material.

Composting is a controlled aerobic process of biologically "digesting" the MSW, so it may be recycled for other purposes—plant nutrient, stabilization of soil in remediation process, or soil amendment for recovery of poor soils.

Compost production can be carried out at the decentralised level (home composting, bin composting, box composting, vermicomposting, in-vessel composting) or at a centralised level (windrow composting, in-vessel composting, aerated static pile), depending on the feasibility of implementation. Both processes require significant pre-processing, and only segregated organic matter can be composted.

Compost produced should meet with quality criteria specified by the Fertilizer Control Order (FCO), 2009 and 2013. A market for the compost should be ascertained before sizing the compost plants.

### 4.3.3 WASTE TO ENERGY

CH 3
SEC 3.3

Where material recovery and composting from MSW is not possible or desirable due to local conditions or because of the nature of waste, recovery of energy from MSW is suggested as a feasible alternative. When high calorific value fractions of MSW are either incinerated (thermal process) or biodegradable fraction of MSW is processed anaerobically (biomethanation), the resultant energy, either as heat (incineration) or biogas (methane) can be reused either directly or converted to electricity using appropriate generators. Sale of this energy should result in the financial viability of waste to energy systems. Where the tariff of power is not high enough to ensure financial sustainability of the plant, a tipping fee may be considered by the ULB.

Appropriate care should be taken to ensure continued and stable supply of the waste for achieving requisite economies of scale. Proper environmental checks should also be in place to meet with stringent norms for incineration. Several technological options are available, however a technology should be selected depending on the quantity, quality of waste to be processed, land requirement, financial implications etc. Table 1.2 gives a brief overview of different waste to energy technologies for usage for different waste quantities that are generated across different sized urban local bodies. Where national legislation does not prescribe norms for emissions from different waste to energy technologies, the Central Pollution Control Board (CPCB) or State Pollution Control Board (SPCB) may consider accepted international emission control norms.

CH 3
SEC 3.3.3

### 4.3.4 INCINERATION

Incineration is a waste treatment process that involves combustion of waste at very high temperatures in the presence of oxygen, resulting in the production of ash, flue gas, and heat. It is feasible for unprocessed or minimally processed refuse besides the segregated fraction of the high calorific waste.

The potential for energy generation depends on the composition, density, moisture content, and presence of inert in the waste. About 65%–80% of the energy content of the organic matter can be recovered as heat energy, which can be utilized for thermal applications. Incineration is an option to be considered only after implementing suitable material recycling and recovery systems, or where other better options for processing are not feasible and land availability is a problem. Typically, only cities which are able to supply at least 1,000 tonnes per day (TPD) of waste should venture to install waste-to-energy plants. However, incinerator plants have the potential to cause significant environmental impacts through emissions and fly ash if plants are not operated efficiently and if appropriate emission control measures are not adopted. Therefore, due care should be taken to comply with operating and emission standards as prescribed under revised SWM Rules, 2016 along with adoption of emission abatement technologies

CH 3
SEC 3.4

### 4.3.5 BIOMETHANATION

Biomethanation is the anaerobic (in the absence of air or, more specifically, free oxygen) digestion of biodegradable organic waste in an enclosed space under controlled conditions of temperature, moisture, pH, etc. It is considered one of the most technically viable option for the Indian MSW due to MSW's high organic and moisture content. Biomethanation plant requires a consistent source of degradable organic matter free from inert material as well as a sustainable demand for the generated biogas at appropriate economic conditions. Biomethanation plant can be operated at decentralised level (up to 5 TPD) or centralised level depending on the feasibility of the implementation and waste inflow. The overall performance of the biomethanation plant is greatly influenced by the input feed specification, and the plant requires segregated biodegradable MSW (e.g., hotel and restaurant waste, market waste) for optimal plant performance. The homogeneity of the feed material is an important parameter from the efficiency viewpoint.

CH 3
SEC 3.5

### 4.3.6 REFUSE DERIVED FUEL

Refuse-derived fuel (RDF) refers to the high calorific non-recyclable combustible fraction of processed MSW, which is used either as a fuel for steam and electricity generation or as alternate fuel in industrial furnaces and boilers. The composition of RDF is a mixture that has higher concentrations of combustible materials than those present in the parent mixed MSW.

RDF should preferably be co-processed in cement plants. Co-processing of RDF in steel industry and for power generation is also indicated, but yet to be proven in India. Internationally, the co-processing of RDF for power generation is technically proven and widely practised as a part of their waste management strategy; however, not much information is available for co-processing of RDF in steel sector.

### 4.3.7 TECHNOLOGIES UNDER DEVELOPMENT

CH 3
SEC 3.6

Prevalent MSW treatment and processing technologies are based on long-lasting experiences in many countries. With respect to the applicability of upcoming technologies in India, some of these technologies are being tested with support from the Government of India. The results of these tests should be awaited.

Until these technologies are well established commercially, these should be regarded as experimental technologies and should be handled either as a research and development (R&D) project or through specially designed concession agreements. Successful commercial operation of new technologies for 5 years may be regarded as a safe bet. Pyrolysis, gasification, and bio-reactor landfills are a few technologies which are being tried on an experimental basis in India. Due to increased thrust on waste to energy, even plants with 300 TPD are reported to be viable with certain viability gap funding for pyrolysis and gasification based plants, however, none of these technologies have a proven track record for commercial application.

### 4.3.8 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

CH 3
SEC 3.7

Construction and demolition (C&D) waste means any waste generated during construction, demolition, or remodelling of any civil structure. Construction and demolition waste management Rules, 2016 now established lays special thrust on C&D waste management and its recycling.

C&D waste includes concrete, bricks, tiles, stone, soil, rubble, plaster, drywall or gypsum board, wood, plumbing fixtures, non-hazardous insulating material, plastics, wall paper, glass, metals (such as steel, aluminium), asphalt, etc.

ULBs should make arrangements for placement of appropriate containers (skips or other containers) and their removal at regular intervals or when they are filled, either through their own resources or by appointing private operators. The collected waste should be transported to appropriate site(s) for further processing and disposal, again either through their own resources or by appointing private operators. ULBs should monitor and record generation of C&D waste within its jurisdiction.

**Key messages for decision makers**

The choice of technologies for processing, treatment, and disposal of SWM in a ULB should be guided by the ISWM hierarchy. Collection of segregated waste improves the performance of processing and treatment facilities. The first preference should always be given to segregating recyclables for further reuse or recycling. Access to appropriate recycling industries is essential for safeguarding public health and environment. Organic waste may be composted aerobically or used for generating energy through anaerobic decomposition processes. High calorific value material should be further segregated and may be used for co-processing in cement plants or as fuel in appropriately designed and environmentally controlled industrial boilers. Different waste to energy technologies are available for varying quantities of waste generation. The technologies should be carefully assessed and chosen as per the characteristics and quantities of waste generated specific to each ULB. Incinerator plants should be planned for only in those ULBs where a minimum of 1,000 TPD of mixed waste can be supplied daily to the plant, after ensuring implementation of higher order technologies in the ISWM hierarchy. Process and environmental controls and monitoring of the entire system are critical for the environmentally sustainable functioning of these plants. Technologies which are still under development, like pyrolysis, gasification, and bioreactor landfills, should not be attempted, unless their commercial application is proven in India.

In consultation with expert institutions, the ULBs shall plan for appropriate management of C&D waste including processing facility and further plan to use the recycled products in the best possible manner. These institutions can also suggest ways to introduce "deconstruction" activity from the construction planning stage and provide assistance in this matter.

Municipal authorities should make bye-laws as well as special arrangements for storage, transportation, processing, and disposal of C&D waste as per the revised rules.

CH 4

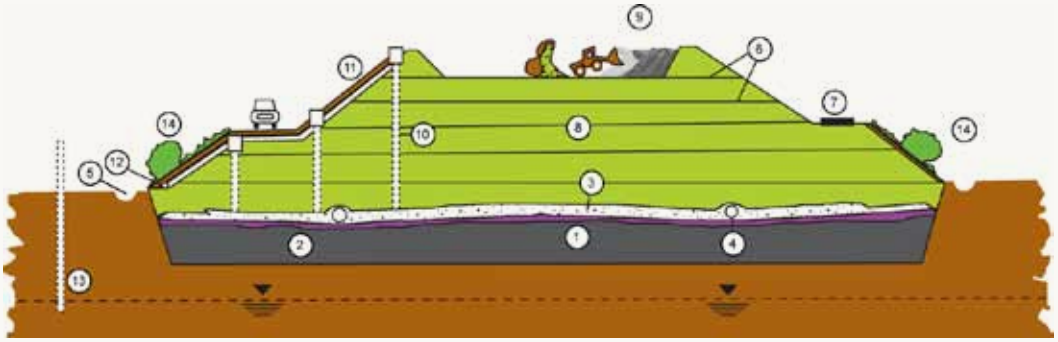
# 5. TECHNICAL ASPECTS: SOLID WASTE DISPOSAL IN MUNICIPAL SANITARY LANDFILLS

## 5.1 WHERE IT ALL ENDS: ENSURE PLANNING AND OPERATION OF STATE-OF-THE-ART LANDFILLS

Sanitary landfills are facilities for final disposal of MSW on land, designed and constructed with the objective of minimising impacts to the environment. The SWM Rules, 2016 provides comprehensive regulations on the siting, design, and operation of sanitary landfills.

A modern landfill complying with these requirements is a complex facility with various equipment to minimize environmental impacts. Figure 1.9 provides an overview on its basic components.

**Figure 1.9: Components of a Sanitary Landfill**



1. Geological barrier
2. Impermeable base liner
3. Drainage layer
4. Leachate collection system
5. Storm - water drain ditch
6. Bordering dams
7. Circulation roads
8. Landfill body
9. Filling and compacting in layers
10. Gas venting system
11. Protective cover system
12. Gas collectors
13. Grondwater control
14. Re-planting

### Waste suitable for landfilling

Condition and composition of waste suitable for disposal in a municipal sanitary landfill are regulated by the SWM Rules, 2016. Sanitary landfilling is necessary for the following types of waste:

(i) Non-biodegradable and inert waste (by its nature or through pre-treatment);

(ii) commingled waste (mixed waste) not found suitable for waste processing;

(iii) pre-processing and post-processing rejects from waste processing plants; and

(iv) non-hazardous waste not being processed or recycled.

Sanitary landfilling is not allowed for the following waste streams in the MSW:

(i) biodegradable waste or garden waste (composted preferably);

(ii) dry recyclables (recycled preferably); and

(iii) hazardous waste (needs hazardous waste sites with special containment).

### Site selection for a landfill

The selection of a suitable site for sanitary landfill is governed by the strategy identified in the state SWM strategy or policy and the MSWM plan of the ULB. The SWM Rules, 2016 provides criteria for the location of the sanitary landfill. CPCB's guidelines for the selection of site for landfilling should be used as a guiding document.

CH 5

# 6. MUNICIPAL SOLID WASTE MANAGEMENT PLAN IMPLEMENTATION

## 6.1 MUNICIPAL SOLID WASTE MANAGEMENT PLAN IMPLEMENTATION AND REQUISITE CLEARANCES

While preparing a MSWM plan, the following design periods (time frame) have to be decided depending on the necessity of the SWM plan:

1. Short term plan: 5 years
2. Long term plan: 20–25 years
3. Mid term review between 2nd and 3rd year of short term plan

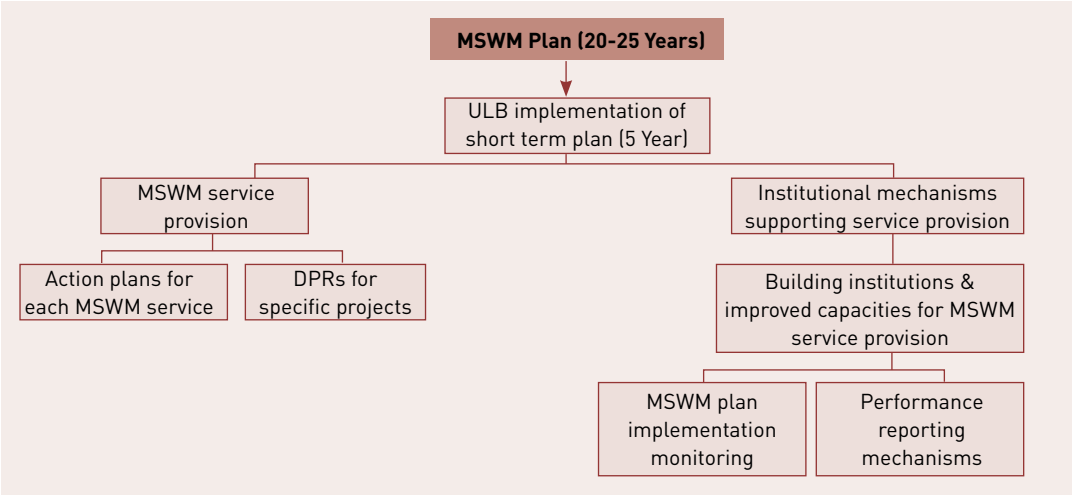
The long term plan should be further drilled down to identify short term action plans associated with time lines for implementation.

The five-year short term plan may be broken up into specific action plans covering various aspects such as institutional strengthening, community mobilization, waste minimisation initiatives, waste collection and transportation, treatment and disposal, and other policy changes as may be deemed necessary.

The chief executive of the ULBs a (municipal commissioner, secretary, or executive officer) is responsible for implementing the MSWM plan, which is to be developed in line with guidance given in Chapter 1 of Part II of this manual. The chief executive should operationalize the plan through the SWM department or cell of the ULB.

Key activities to be undertaken while implementing the short term MSWM plan are shown in Figure 1.10.

**Figure 1.10: Components of Short Term (5 years) Municipal Solid Waste Management Plan Implementation**



MSWM processing, treatment, and disposal facilities require legal or statutory clearances and approvals for their establishment, depending on the type of facility. SWM Rules, 2016 and the Environmental Impact Assessment (EIA) Notification, 2006 by the Ministry of Environment Forest and Climate Change (MoEFCC) provide guidance on the statutory requirements for establishing storage, processing, treatment, and disposal facilities. An indicative list of clearances and acts that govern the establishment of MSW disposal facilities is given below.

**Indicative List of Statutory Clearances or Acts and Non-statutory Approvals required by all Municipal Solid Waste Management Processing, Treatment, and Disposal Facilities**

**Statutory Clearances**

- Environmental Clearances: Water (Prevention and Control of Pollution) Act, 1974; Water (Prevention and Control of Pollution) Cess Act,1977; Air (Prevention and Control of Pollution) Act, 1981; Environment (Protection) Act, 1986, and Rules; Environmental Impact Assessment Notification, 2006
- Clearance from the State Pollution Control Board
- Clearance from the Airport Authority
- Fertilizer Control Order Clearance for compost based plants
- Land use from the Revenue Authority
- State Electricity Authority Clearance for providing grid connectivity
- Public Liability Insurance Act, 1991 and Rules, 1991
- Industries (Development and Regulation) Act, 1951
- Factories Act, 1948
- Motor Vehicles Act, 1938, amended in 1988 and Rules, 1989
- Petroleum Act, 1934
- Energy Conservation Act, 2001

**Non-statutory Approvals**

- Proof of Possession of Site
- Bank Loan Sanction Letter and Agreement
- Bank Appraisal Note
- Water Supply Agreement
- Power Purchase Agreement
- Municipal Solid Waste Supply Agreement with Municipal Authority

## 6.2 CONTRACTING ARRANGEMENTS FOR MUNICIPAL SOLID WASTE MANAGEMENT SERVICE PROVISION

The following essential aspects should be considered by the ULB while deciding to contract out MSWM services:

- The ULB should identify services that can be provided effectively by the existing staff and available financial resources.
- Subsequently, services which would need to be outsourced due to limited in-house technical know-how, capability, and financial resources should be identified.
- Benefits and potential issues with outsourcing services should be fully evaluated and understood. Justification for the need to contract out identified services should be prepared.
- Commercial and economic feasibility of outsourcing services should be ascertained, and appropriate contract models and their benefits should be assessed for each of the outsourcing services.
- Where contract labour is hired, the ULB should ensure compliance with the provisions of the "Contract Labour Abolition & Regulation Act, 1970.
- Sharing of all possible risks (technical, operational, and financial) between ULB and the operator should be detailed.
- Where acquisition of land and community rehabilitation are involved, the ULB should stand in for the contractor in addressing such issues.
- Contracts should specify the range of technology or technologies that can be adopted after the ULB undertakes a thorough assessment of available technologies for specific services.
- On ascertaining the benefit of outsourcing services, the ULB should prepare terms of reference for the contracted service.

Not all contracting models are suitable for each of the SWM operations. Municipal authorities may adopt one or more of the following contracting models:

- Service contract—door-to-door collection and transportation of waste
- Management contract—door-to-door collection, C&D collection, secondary storage, and transportation of waste
- Build and transfer contract—transfer station, sanitary landfill facility (SLF)
- Build–operate–transfer (BOT) contract—biomethanation, composting, SLF
- Build–own–operate (BOO) contract—composting, refuse-derived fuel (RDF), incineration

- Design–build–own–operate–transfer (DBOOT) contract—large compost plants, RDF plants, incineration, SLF
- Design–build–finance–operate–transfer (DBFOT) contract—large compost plants, RDF plants, incineration, SLF

ULBs may decide to bundle certain services while contracting out SWM operations to build system accountability and efficiency.

A transparent procurement process should be adopted for the selection of public private partnership (PPP) partner preferably through a transaction advisor after preparing a detailed project report. The municipal authority has an option of adopting a single stage selection process or a two-stage selection process for awarding contracts to the private sector.

### 6.2.1 ENABLING CONDITIONS FOR SUCCESSFUL PRIVATE SECTOR PARTICIPATION AND PUBLIC PRIVATE PARTNERSHIP CONTRACTS

The following conditions are essential for successful private sector participation (PSP) and PPP contracts:

- Availability of undisputed land for specific purpose
- A transparent bidding process
- Timely handover of site and facilities free from physical and legal encumbrances
- Clearances, approvals, and decision-making process need to be expeditious (delays in approval and clearances have serious consequences)
- A sustainable project structure and revenue model with appropriate risk allocation
- Contract should be based on price sensitivity for utility (diesel, power, water) and labour
- Product-based support system, e.g., compost, power, compressed biogas (CBG), etc.
- Political and stakeholder involvement and acceptance that these are crucial pre-requisites for successful PSPs and PPPs
- Revenue mechanism should be based on an assessment of full cost recovery for the project
- Carrying out evaluation based on the long term (concession period of 20–25 years) should incorporate capital, operation and maintenance (O&M) costs, e.g., major repair and replacement costs
- Factoring in any probable change in technology during the concession period

- Transparent subsidies and credit enhancement to expedite financial closure
- Clear performance-based indicators
- Appropriate incentives like tax breaks and duty exemptions

**Key messages for decision makers**

The Chief Executive Officer of the ULB is responsible for the implementation of the short term MSWM plan. Plan implementation includes planning for services which the ULB may undertake with its own staff and identifying activities which would require private sector participation. Institutional capacities and financial resources should be secured while beginning plan implementation. Outsourced activities will need to be tendered out as per specific provisions with adequate safeguards built into the bid documents. Depending on the nature of activities to be tendered out, one of several models of contracting may be adopted. A transparent bidding process and performance benchmarks combined with stringent monitoring ensures the success of PPP projects.

CH 6
SEC 6.1

# 7. MANAGEMENT ASPECTS: MONITORING MUNICIPAL SOLID WASTE SERVICE PROVISION

## 7.1 MONITORING MUNICIPAL SOLID WASTE MANAGEMENT PLAN IMPLEMENTATION

A comprehensive monitoring and evaluation system should be adopted for assessing progress towards meeting the targets in the MSWM plan and for monitoring successful implementation of the plan. The monitoring system adopted should (i) collect data regularly; and (ii) analyze collected information, take or propose corrective measures, and support the planning and implementation process.

Institutionalising appropriate quality assurance systems is essential to ensure a continuous and efficient MSWM system. The performance of all components of the SWM systems, from collection to processing and disposal, should be assessed daily. Monitoring and evaluation of MSWM within a management information system (MIS) has to follow a prescribed schedule, with regular reporting to show progress or gaps in provision of services. ULBs may appoint an independent body to evaluate service provision.

Provision of citizen-centric services shall also be monitored through a feedback mechanism which should primarily focus on concerns of the community regarding doorstep collection, primary storage, and transportation of waste.

Collection and analysis of data related to SWM is required to assess the existing situation and propose adequate measures to improve service delivery. The MIS system can store and retrieve information for

analysis, which can then be used by decision makers. Communication technologies, such as geographic information system (GIS), global positioning system (GPS), general packet radio service (GPRS), and radio frequency identification (RFID), are now integrated for monitoring the SWM system. These can be suitably adopted by cities to improve service efficiency.

The head of the SWM department should be responsible for monitoring and evaluation. A dedicated monitoring and evaluation team should be constituted with distinct roles and responsibilities. Field level staff should be inducted, and reporting schedules should be fixed.

Reports should capture critical information about the SWM of planning area. Reports should be effectively used for decision making, identifying gaps and corrective measures beneficial for decision makers. Standard formats should be developed for producing reports on daily, monthly, quarterly, or annual basis, as per requirement. Where possible, a MIS system should be developed to facilitate the collection and reporting of this information. This information should also be used for midterm review of the MSWM plan and for defining goals of future planning.

This information can also be used for the assessment of service level benchmarks (SLBs). State governments use SLBs to monitor long term progress of SWM service provision in ULBs. Release of funds from the State Finance Commission is partially contingent on achievement of predefined goals of SLBs.

The SLB indicators stipulated by the Ministry of Urban Development (MoUD) are shown in Table 1.3.

**Table 1.3: Service Level Benchmarks for Solid Waste Management[10]**

| S.NO. | INDICATOR | UNIT | VALUE |
|---|---|---|---|
| 1. | Household level coverage of MSWM services | As % of households and establishments covered by daily doorstep collection system | 100% |
| 2. | Efficiency of collection of MSW | As % of total waste collected by ULB and authorised service providers against waste generated within the project area (excluding the waste recycled through rag pickers) | 100% |
| 3. | Extent of segregation of MSW | As % of households and establishments that segregate their waste | 100% |
| 4. | Extent of MSW recovered | As % of quantum of waste collected, which is either recycled or processed | 80% |
| 5. | Extent of scientific disposal of MSW | As % of waste disposed in a sanitary landfill against total quantum of waste disposed in landfills and dump sites | 100% |

10 "Handbook of Service Level Benchmarking", MoUD, 2008.

| S.NO. | INDICATOR | UNIT | VALUE |
|---|---|---|---|
| 6. | Cost recovery in MSWM services | As % recovery of all operating expenses related to MSWM services that the ULB is able to meet from the operating revenues of sources related exclusively to MSWM | 100% |
| 7. | Efficiency in redressal of customer complaints | As % of total number of MSWM-related complaints resolved against total number of MSWM complaints received within 24 hours | 80% |
| 8. | Efficiency in collection of charges | As % of current year revenues collected against total operating revenues for the corresponding period | 90% |

CH 6
SEC 6.2

## 7.2 IMPORTANCE OF OPERATION AND MAINTENANCE FOR ENSURED SERVICE DELIVERY

Irrespective of whether the provision of services is by private contractor or ULB, operation and maintenance (O&M) plan has to be adhered to. The O&M plan should be drafted by the authority—either the ULB or the private operator—responsible for procurement and management of equipment and facilities. O&M plans developed by private operators should be ratified by the SWM department.

The O&M plan should include preventive maintenance schedules and responsibilities and also guidance for breakdown maintenance. It should be the responsibility of the supervisor and operator to regularly maintain and update the O&M plan. It should also indicate procedures for recording, reporting, analysis, and further action.

Preventive O&M of equipment, vehicles, and facilities ensures the long term sustainability of SWM service provision. All contracts to private sector players, irrespective of the mode of contracting, should include a provision for O&M of all vehicles, equipment, and installations during the contract period. The term of the contract should be co-terminus with the expected life of the vehicles and equipment particularly where the contractor is expected to invest in the procurement of vehicles and equipment.

Citizens should be provided an opportunity to report issues related to MSWM service provision. A citizen charter should be developed to inform citizens of the type of services provided and the complaint redressal process implemented in the ULB.

**Key messages for decision makers**

MSW service provision should be monitored continuously to ensure desired service levels on a regular basis. Management information systems (MIS) should be used to record periodic data, retrieve such information, and analyse it for decision making. O&M plans should be prepared by each of the operators-in-charge of SWM services or projects. The ULB should scrutinise and validate the O&M plans of private service providers. Preventive maintenance is very essential for ensuring roadworthy vehicles and well-functioning equipment. Budgeting for preventive maintenance and recording failures should be insisted upon by the ULB. Citizens should be given an avenue to report on and seek redressal for service issues through an appropriate complaint redressal system.

## 8. WHAT TO DO WITH 'SPECIAL WASTE INCLUDING DOMESTIC HAZARDOUS WASTE'?

CH 7

Special waste including domestic hazardous waste comprises of any solid waste or a combination of solid wastes that requires special handling and disposal because of its quantity, concentration, physical and chemical characteristics, or biological properties, in order to protect human health, as well as the environment and to exploit its potential for recycling.

In line with this definition, the following wastes are defined as special waste:

1. Plastic waste
2. Bio-medical waste
3. Slaughterhouse waste
4. Electric and electronic waste (e-waste)
5. Waste Tyres
6. Battery waste

Ideally, special wastes including domestic hazardous waste should not enter the MSW streams, but because many of the above wastes are also generated at household level, quite frequently they end up in the mixed MSW stream due to improper collection systems or lack of segregation at source. Some special rules besides the and SWM Rules, 2016—are applicable to these special wastes including domestic hazardous waste. In general, special wastes including domestic hazardous waste need separate collection and treatment systems in order to:

- avoid contamination of other waste streams (relevant for biomedical waste, slaughterhouse waste, e-waste, and battery waste);
- apply specified recycling technologies (relevant for plastic waste, e-waste, and waste tyres); and
- manage large quantities of waste.

Accordingly, the different types of special waste including domestic hazardous waste require specific collection and treatment systems which are specified in Chapter 7 of Part II of the manual.

**How Far Are ULBs Responsible?**

By far not all special waste including domestic hazardous waste require operational involvement of the ULB. The following options are relevant:

- **Systems of extended producer responsibility:** Batteries and certain types of e-waste can be collected and treated through return systems operated by producers or retailers of these products.
- **Full responsibility of the private sector:** Some special wastes such as end-of-life vehicles are usually recycled and treated in full responsibility of the private sector. The role of public agencies is restricted to control functions, e.g., with respect to the compliance with environmental requirements.
- **Public private partnership:** Certain waste types can be handled within PPP schemes. This might be especially relevant for biomedical and slaughterhouse waste.
- **Integrated urban local body operation:** Plastic waste is also a non-hazardous component of MSW. The ULB should establish special collection systems within their general MSWM operations.

**Key messages for decision-makers**

Take a critical look at which special wastes your ULB can and should reliably handle and at how this should be done. If necessary, establish sustainable and well-controlled solutions with or without third parties, as mentioned above.

## 9. ADEQUATE TRAINING AND CAPACITY BUILDING FOR MUNICIPAL SOLID WASTE MANAGEMENT STAFF

**As per SWM Rules, 2016:**

Clause15(zc) educate workers including contract workers and supervisors for door to door collection of segregated waste and transporting the unmixed waste during primary and secondary transportation to processing or disposal facility;

Any intervention can only be successful when the organization has the requisite technical and managerial skills to establish, operate, and maintain the system. Without these skills, new systems fail to deliver services. Therefore, capacity building, education, and training plays the

pivotal role in providing necessary impetus in creating the workforce and imparting knowledge.

Capacity building and training involves various stakeholders from communities to decision makers to ULB officials and waste handlers and operators. Each stakeholder has defined roles, responsibilities, and contribution toward waste management. Therefore, the training cannot be generalised; specific training should be designed to meet the need of different stakeholders.

## 10. EFFECTIVE COMMUNITY PARTICIPATION THROUGH INFORMATION, EDUCATION AND COMMUNICATION

Along with strategic planning, significant cooperation and support from various stakeholders (communities, ULBs, waste operators) is important for a successful and efficient waste management programme.

Information, education, and communication (IEC) is a multilevel tool for promoting and sustaining change in individuals and communities. IEC is key to the success of the modernization of MSWM. Awareness among community and different stakeholders to meet the demands of the new system for a cleaner environment requires a detailed and thorough understanding at every stage.

Development and implementation of an IEC campaign involves planning and implementing a comprehensive strategic set of interventions and activities to change mindset and behaviour of people at several levels to achieve the overall objectives of MSWM. The IEC programme should not only target households, commercial establishments, institutes, but also other stakeholders like municipal officials, elected representatives, schools, non-government organizations (NGOs), resident welfare associations (RWAs), informal sector, and media to ensure effective participation. However, involvement of community will remain the main thrust of the programme.

Various mediums of communication are available for the IEC program like print (magazines, posters, newspaper); audio–visual (radio jingles, TV ads, short films, CDs); internet, and interpersonal medium. Among these interpersonal communications are some of the most effective tools e.g., individual counselling, community-level interactions, RWA meetings, and door-to-door visits.

# 11. RESEARCH & DEVELOPMENT AND DEMONSTRATION PROJECT NEEDS FOR THE MUNICIPAL SOLID WASTE SECTOR

## 11.1 QUANTITY AND CHARACTERISTICS OF MUNICIPAL SOLID WASTE

Dependable long term data on quantity and characteristics of MSW is essential for effective planning. Most of the data available on quantity of waste are population based estimates using unit waste generation derived from short term studies. The characterization exercises are short term and depend on relatively small sample sizes.

Every ULB should chalk out a plan for quality and quantity check round the year, so that seasonal variations are captured. This should be repeated once in 3 years. After the first year, data collection would get streamlined and become easier for subsequent years.

## 11.2 SEGREGATED STORAGE AT SOURCE

This is easier said than done. However, this first step holds the key to sustainable waste management solutions, which are simpler and save a lot of cost incurred for segregation of mixed waste. Chances of contamination is negligible which means the products and by-products would be clean and of better quality. The type and size of bins which can be procured and used by the actual users plus the number of bins dependent upon the number of segregated streams need to be researched in collaboration with target communities. The same exercise has to be carried out in different parts of the country (for physio-geographic and climatic variations) and for different income groups.

## 11.3 COLLECTION AND TRANSPORTATION OF SEGREGATED WASTE STREAMS

Source segregation described above will be successful only when the segregated streams are not mixed at any stage and are taken to the respective processing or disposal facility directly or through a transfer station. This exercise may appear to be very difficult in the beginning but once started sincerely, should become easier in the times to come. Since this is so far absent on city wide scale, it is necessary to research with concerned municipal staff and experts and the ULB may start at ward level as pilot experiment.

## 11.4 PROCESSING OF MUNICIPAL WASTE MANAGEMENT

a. New technologies – pyrolysis, gasification etc.
b. Exploring possibility of improvement in existing technologies for increasing efficiency, techno-economic viability and long term sustainability.
c. Processing of recyclable items in are environmental and health friendly manner.
d. Setting standards for use of recycled material, for example, recycled plastics, paper etc.

## 11.5 SANITARY LANDFILLING

a. Design of SLF in seismic zones 4 and 5, especially in the North east (high rainfall areas).
b. Disposal of fly ash from waste incinerator plants (should the ash be stabilised in concrete matrix or disposed as dry loose powder).
c. Appropriate disposal of bottom ash from waste incinerators.
d. Design of landfill for different climatic and hydro-geological situations, detailed specifications of materials and methods, .e.g., of geo-membrane, geo-textile, substitute and supplement for good clay (which is not available at many places) etc.

## 11.6 REMEDIATION OF DUMPSITE

a. Conditions for closure (capping) and reuse.
b. Different hydrogeological situation, climate etc.
c. Hazard ranking of dumpsites for prioritising their remediation or capping etc.
d. Whether and under what conditions reclamation of dumpsites can be done in an affordable and environmental friendly manner for reclaiming the land?

# 12. ROADMAP

To ensure full implementation of SWM Rules 2016 and guidance of the MSW Manual, the following roadmap is suggested:

- Constitution of Central monitoring committee under the chairmanship of secretary (MoEFCC) comprising of MoUD, CPCB, and at least three representatives from State Pollution Control Boards, Urban Development Departments of State Governments or Union Territories, ULBs and subject experts to monitor and review implementation of the rules, and the committee constituted shall meet biannually.

- All States should plan their Solid Waste Management Strategy with a defined action plan covering all ULBs in the State.
- Developing a Municipal Solid Waste Management Plan following a 7 step approach. The plan should be in consonance with SWM Rules, 2016, the State Policy or Strategy on MSWM and the State Sanitation Strategy developed under the National Urban Sanitation Policy.
- A National or State Cadre for Solid Waste Management for technical professionals can be planned so that they get varied experience to enrich their professional capability.
- Some States have planned or implemented regional facilities for MSWM especially for regional landfill. However, actual experience of these facilities is still not available. These regional facilities should be studied and the experience documented. There maybe a need to set up more such facilities on pilot basis for thorough study and documentation to bring out suitability of this system in the Indian context.
- Regular assessment of waste characterisation studies should be conducted for all ULBs at regular intervals of 3-5 year in order to optimise processing and reduce material disposed in the landfill.
- Waste quantification assessment on a regular basis, which would be an important indicator for monitoring the collection efficiency of the ULB is also one of the indicators of SLB.
- R&D and demonstration plants need to be set up and operated for experience and information that will help improve overall MSW in the country.
- Adequate training and capacity building for MSWM staff in order to keep them abreast with the regulatory and techno-economic developments.
- Formulation or strengthening of policies and bye laws at State and ULB level for proper management of municipal solid waste.
- Effective community participation through IEC along with regular payment of municipal taxes and duties. Development and enforcement of the extended producer responsibility (EPR) schemes at the national level and state level.
- There is a need for formulation of conducive policy guidelines at national level and regulatory authority at the state level with respect to waste to energy plants, power purchase and tariff feeds.
- Government support should also be product-based.

सत्यमेव जयते
GOVERNMENT OF INDIA

स्वच्छ भारत
एक कदम स्वच्छता की ओर

# CLEANLINESS PLEDGE

Mahatma Gandhi dreamt of an India which was not only free but also clean and developed. Mahatma Gandhi secured freedom for Mother India.

Now it is our duty to serve Mother India by keeping the country neat and clean.

I take this pledge that I will remain committed towards cleanliness and devote time for this.

I will devote 100 hours per year, that is two hours per week, to voluntarily work for cleanliness. I will neither litter not let others litter.

I will initiate the quest for cleanliness with myself, my family, my locality, my village and my work place.

I believe that the countries of the world that appear clean are so because their citizens don't indulge in littering nor do they allow it to happen. With this firm belief, I will propagate the message of Swachh Bharat Mission in villages and towns.

I will encourage 100 other persons to take this pledge which I am taking today.

I will endeavour to make them devote their 100 hours for cleanliness.

I am confident that every step I take towards cleanliness will help in making my country clean.

## Do's

- Start cleanliness from home
- Keep surroundings clean and green
- Keep work place neat and clean
- Devote 2 hours a week on sanitation
- Dispose garbage in designated places.

## Don'ts

- Don't litter and don't let others litter
- Don't defecate and urinate in open
- Don't deface public properties
- Don't spit in public places
- Don't dump garbage in drains/water bodies

## Eligible Components Under Swachh Bharat Mission in Urban Local Bodies

Individual Household Toilets | Community Toilets | Public Toilets | Solid Waste Management

**MINISTRY OF URBAN DEVELOPMENT**
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www.swachhbharaturban.gov.in