

# Swachh Bharat Mission

## Solid Waste Management Field Visit Manual

### 2018

**National Institute of Urban Affairs  
&  
Ministry of Housing and Urban Affairs**



**TITLE**

SWACHH BHARAT MISSION FIELD VISIT MANUAL 2018

**PUBLISHER**

NATIONAL INSTITUTE OF URBAN AFFAIRS, DELHI

**YEAR OF PUBLISHING**

2018

**CREDITS**

**Dr. Shyamala Krishna Mani, *Team Leader***

Swachh Bharat Mission Solid Waste Management Exposure  
Workshops Project 2016-2019

**Ms. Paramita Datta Dey, *Sr. Research Officer and Project  
Coordinator***

Swachh Bharat Mission Solid Waste Management Exposure  
Workshops Project 2018-19

Swachh Bharat Mission team members of 2016, 2017 and 2018-19.

**GRAPHIC DESIGN**

Deep Pahwa  
D S Rawat

**DISCLAIMER**

This booklet is intended as a Field visit Manual for exposure cum training workshops to help ULBs to develop capacity and awareness regarding the best practices in the field of municipal solid waste management. While every effort has been made to ensure the correctness of data/information used in this report, neither the authors nor NIUA accept any legal liability for the accuracy or inferences drawn from the material contained therein or for any consequences arising from the use of this material. No part of this report may be reproduced in any form (electronic or mechanical) without prior permission from or intimation to NIUA.

**THE FULL REPORT SHOULD BE REFERENCED AS FOLLOWS**

NIUA (2018) "SWACHH BHARAT MISSION FIELD VISIT MANUAL 2018"  
Delhi, India.

Text from this report can be quoted provided the source is acknowledged.

**Swachh Bharat Mission**

**Solid Waste Management**

**Field Visit Manual**

2018



# Acknowledgment

We wish to thank the Municipal Corporations of East, North and South Delhi, NDMC, Environment Department at Delhi Secretariat, all State Governments and Urban Local Bodies for deputing officials for the workshops, Ministry of Environment, Forests and Climate Change and Ministry of Housing and Urban Affairs, Government of India for sharing with us their valuable experience and insights.

We wish to thank organizations: IL&FS, NBCC, DMRC, Green Brick Eco Solutions (GBES), TERI, Excel Industries, Ramky Enviro Engineers Ltd., Chintan, Green Bandhu, Miranda House, ACT, Trash to Cash, Daily Dump, SAM Foundation, Gulmeher, RWAs of Defence Colony, Vasant Vihar, New Delhi, DLF Phase I & IV, Gurugram, Human Kind Foundation, Faridabad and several organizations and experts for sharing with us their information and experience.

We are deeply indebted to Ministry of Housing and Urban Affairs, Government of India for supporting us financially and technically and in making this project a success.

# Background Note

## **Swachh Bharat Mission Exposure Workshops for ULBs conducted by National Institute of Urban Affairs along with Ministry of Housing and Urban Affairs**

Swachh Bharat Mission (SBM) was launched by the Hon. Prime Minister of India on October 2, 2014. The main objectives of SBM Urban is to address both elimination of open defecation and solid waste management in all 4041 ULBs of the country by 2019.

### **SWM in SBM – A multipronged approach**

To address mainly Solid Waste management issues, the Swachh Bharat Mission has launched a multipronged approach to counter the cyclical effects of de-motivation and poor performance by infusing enthusiasm, financial support, a feeling of accountability among ULB staff towards cleanliness and massive awareness campaigns among citizens who are the primary generators of solid waste in the cities.

To help ULBs in various states develop capacity and motivation to modernize, incentivize, innovate & achieve compliance of Solid Waste Management Rules, 2016, the Phase I & Phase II of the Swachh Bharat Mission Exposure Workshops were conducted by NIUA for a total 24 batches (12 batches each) in which 647 officials were trained during May – October 2016 (Phase I) and May – October 2017 (Phase II).

### **Exposure cum training programme**

NIUA is planning to conduct Phase III in five parts:

In the first part, TOT handbook and Field Visit Manual would be prepared. In the second part training workshops would be conducted to train municipal officials of about 43 NCR cities. In the third part a national level workshop would be conducted for four members each from 10 Training Entities. The fourth part would cover training of officials from 1600 statutory towns by 10 TEs, through 80 city cluster workshops. And finally in the fifth part the research questionnaire and feedback forms collected from the workshops would be analyzed and reports would be prepared.

The workshops would mainly involve exposure visits to different SWM locations in Delhi and other parts of India with some classroom sessions on first and last days.

The purpose of the SWM Exposure Workshop Project is to enable ULBs:

1. Recognize the issues, challenges and constraints of SWM
2. Understand the SWM Rules 2016,
3. Be aware of the various approaches, technologies and their financial implications
4. Plan to implement solutions in their city.

### **Challenges to Solid Waste Management**

As regards Solid Waste Management, most cities in India face some typical challenges. These are:

1. Excessive littering by citizens and lack of pride among the city dwellers for cleanliness
2. Inability of ULBs to provide appropriate bins in public places for waste deposition and collection, personnel for regular cleaning and enforcement of fine instituted by ULBs
3. Inability of ULBs to establish systems and technologies required for segregated collection and processing of different categories of solid waste from households, commercial establishments, institutions and lack of coordination among departments
4. Outdated systems of primary and secondary collection and inefficient transportation
5. Inability to meet revenue expenses including salaries of staff, consumables, safety equipment and personal protective equipment (PPE)
6. Lack of motivation among staff and lack of will and skill among staff to implement
7. Financial crunch for modernizing SWM and adopting innovative and appropriate technologies
8. Poor or no collection of user charges because of poor services and hence cannot meet day to day expenses leading to a vicious cycle of poor performance.

### **Solid Waste Management Rules and Manual**

MoEFCC notified the Solid Waste Management Rules 2016 in April 2016 and has made citizens more accountable for their actions, requiring them to be more responsible towards their environment by reducing generation of waste, segregating what they generate into various categories and handing them over as such to door to door waste collectors so that the different categories can be reused, reprocessed and recycled rather than only dumped on the roadside and thereafter outside the cities. To operationalise the SWM Rules, this manual would help expose the participants to various options and actions so that they can implement them in their cities.

### **Need for Capacity Building**

To draw maximum advantage of these changes and the financial support being infused into the system by the Central Government, it is also necessary for state governments and local self governments to develop capacity and the will to implement them so that by 2019, all cities are able to bring about visible changes in the solid waste management status and improve their environment.

# Abbreviations

ADS	Air Density Separator
C&D	Construction and Demolition
CBO	Community Based Organisations
CPHEEO	Central Public Health and Environmental Engineering Organisation
CSE	Centre for Science and Environment
CSR	Corporate Social Responsibility
DPR	Detailed Project Report
EM	Effective Micro organisms
FCO	Fertilizer Control Order
GAIL	Gas Authority of India Limited
GCV	Gross Calorific Value
HAG	Hot Air Generator
HDPE	High-Density Polyethylene
IEC	Information, Education and Communication
IL & FS	Infrastructure Leasing & Financial Services
ISWM	Integrated Solid Waste Management
LCO	Low Density Oil
LFG	Landfill Gas
LTP	Leachate Treatment Plant
MoEFCC	Ministry of Environment, Forest and Climate Change
MoHUA	Ministry of Housing and Urban Affairs
MoU	Memorandum of understanding
MRF	Material Recovery Facility
NBCC	National Building Construction Corporation Ltd.
NGO	Non Governmental Organization
NPK	Nitrogen Phosphorous Potassium
ODF	Open Defecation Free
PET	Polyethylene Terephthalate
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
QCI	Quality Council of India
RCA	Recycled Concrete Aggregate
RDF	Refuse-Derived Fuel
RWA	Residents' Welfare Association
SBM	Swachh Bharat Mission
SLF	Sanitary Landfill
SWM	Solid Waste Management
ULBs	Urban Local Bodies
WtE	Waste to Energy

# Contents

	Page Nos.
<b>INTRODUCTION .....</b>	<b>viii</b>
<b>CHAPTER 1 : WASTE DISPOSAL-LANDFILL .....</b>	<b>1</b>
1. Ghazipur Landfill Site.....	1
<b>CHAPTER 2: WASTE TO ENERGY .....</b>	<b>6</b>
2.1 Ghazipur Waste to Energy Plant .....	6
2.2 TEAM Technology .....	11
2.3 Containerised Biomethanation .....	15
<b>CHAPTER 3: COMPOSTING.....</b>	<b>18</b>
3.1 Centralised System-Okhla Composting Plant.....	18
3.2 Decentralised System - GPRA Complex New Motibagh, New Delhi .....	21
3.3 Decentralised System - Defence Colony, New Delhi .....	26
3.4 Decentralised System - Vasant Vihar, New Delhi .....	30
3.5 Decentralised System for Composting - .....	34
Miranda House, Delhi University, Delhi	
3.6 Decentralised System for Composting - Regency Park II, DLF Phase IV, Gurugram.....	38
3.7 Decentralised System for Composting - Faridabad Sector 21A .....	40
<b>CHAPTER 4: RECYCLING .....</b>	<b>44</b>
4.1 Construction and Demolition Waste Recycling - Burari, New Delhi .....	44
4.2 Material Recovery Facilities (NGO) - Chintan .....	51
4.3 Recycling (NGO) - Trash to Cash.....	55
4.4 Recycling (CSR) - Gulmeher .....	58
<b>CHAPTER 5: INTEGRATED SOLID WASTE MANAGEMENT (ISWM)     FACILITY AT NARELA - BAWANA.....</b>	<b>61</b>
<b>CHAPTER 6: PLANNING AND IMPLEMENTATION .....</b>	<b>67</b>
<b>CHAPTER 7: IEC FOR SOLID WASTE MANAGEMENT.....</b>	<b>76</b>
<b>CHAPTER 8: MONITORING AND EVALUATION ‘SWACHH SURVEKSHAN’ ....</b>	<b>78</b>
<b>ANNEXURES.....</b>	<b>82</b>
<b>REFERENCES .....</b>	<b>106</b>

# Introduction

The Field Visit Manual on Solid Waste Management for Swachh Bharat Mission developed by the National Institute of Urban Affairs, New Delhi is an example of a manual that can be used for creating awareness and providing technical information to Urban Local Body (ULB) officials as well as citizens on the various approaches and technologies for achieving sustainable solid waste management in our cities. This Field Visit Manual meant for the Delhi National Capital Region (NCR) pertains to some of the activities and technologies that are being tried out in the NCR both by government agencies and the civil society. However, such manuals can be created for any region, state or cluster of cities as per their requirement.

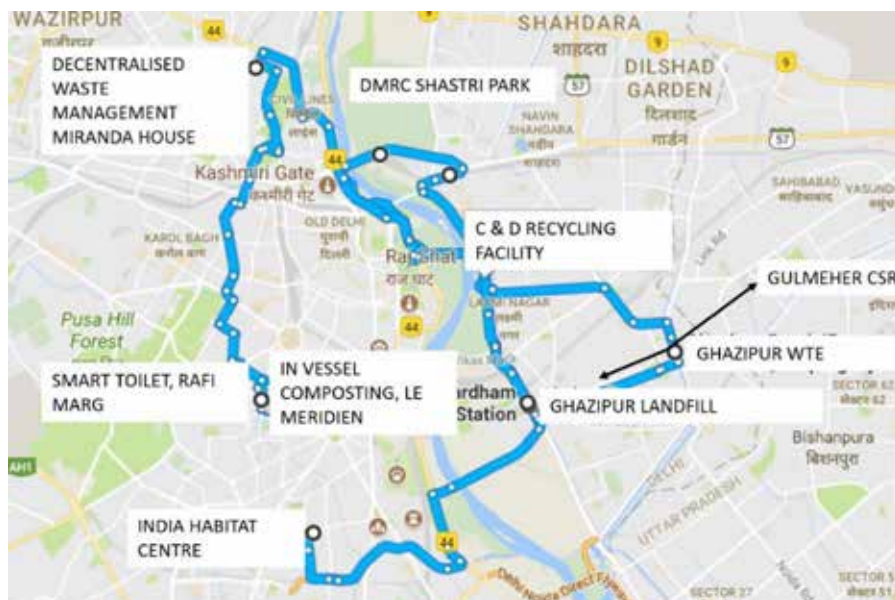
The Field Visit Manual has been chapterized in the following sequence with the first chapter describing the most common method of waste management in our cities, which is currently dumping or landfilling, which pertains to the waste 'Disposal' habit. In this chapter Ghazipur Landfill site has been described which has the technology for Landfill Gas Extraction and Leachate trapping, which is necessary if one follows this type of waste disposal. The next set of technologies pertains to 'Waste to Energy' where waste to energy by Incineration is described as found in the Ghazipur Waste to Energy Plant. Decentralised Biomethanation plants, namely TEAM technology at Delhi Gymkhana and the Containerised Biomethanation at the DMRC campus in Shastri Park have also been described under waste to energy chapter since both these are energy positive technologies, where biogas generated from segregated kitchen waste, market and slaughter house waste is used for cooking but can also be used for lighting, electricity generation with street lighting option etc.

The third chapter is on 'Composting', both Centralised and Decentralised using mechanical, electrical and human energy for segregating and composting with simple inputs like adding crushed dry leaves and saw dust, turning the pile once in a few days to complex in-vessel composting techniques, where the composting mix is turned electrically once in an hour to enhance aerobic composting producing high quality manure. The fourth chapter, which is on 'Recycling' emphasizes the necessity of segregation at source, especially items like the Construction and Demolition waste, 95% of which can be recycled and processed into useful products like paver blocks, sand and aggregates, as seen in the Burari and the Shastri Park plants in Delhi.

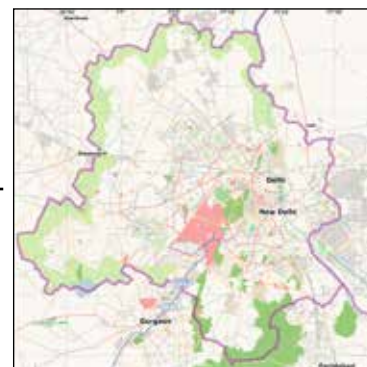
Provision of space by the various ULBs for informal waste collectors to collect wet and dry waste door to door, which need to be further sorted into categories at the Material Recovery Facility (MRF), provision of personal protective equipment (PPE) to waste workers, simple recycling equipment for crushing, baling, recycling of paper, plastics, glass, metal and others along with separate storage of domestic hazardous waste, sanitary waste and their safe transport to common facilities for their treatment and disposal is a necessity in every city and ULB. Subsidy or arrangement for transporting segregated waste to industries that can process segregated

waste further and CSR support for awareness building, storage, procurement of bins, and waste transportation are all essential parts of waste management. The fifth chapter is on Integrated Waste Management at the Narela-Bawana site where in addition to processing of wet waste through centralised composting, incineration of non-recyclables, there are also scientifically constructed Secured Landfill and Leachate Treatment Facility especially catering to the northern part of Delhi.

In chapters six, details have been given on planning, DPR preparation and formats through which ULBs can access Swachh Bharat funds. Details of planning an IEC strategy is given in chapter seven and details of the Swachh Survekshan marking system to help ULBs gather data that is required for the Survekshan and be regarded as a clean city is given in chapter eight. In the annexures, sample multiple choice questions have been given for checking immediate learning objectives at each site.



Field Trip Day I



Field Trip Day II

Location of Field Trips Delhi NCR



# Chapter 1

# Waste Disposal - Landfill

## 1. Ghazipur Landfill Site

### 1.1 Introduction

The Ghazipur landfill site is spread over an area of 29.6 hectares and has been in operation since 1984, with the current average waste disposal rate of 2,200 Tons of waste every day, which is about one third of the total waste being generated in the state. On an average the landfill receives about 2,000 TPD of MSW from north, south Shahdara, NDMC, Sadar and Paharganj. Total accumulated waste at the site is estimated to be around 4.7 million tons spread over the area of about 29.6 ha. However, Ghazipur landfill site has more than 70% of the biodegradable waste and therefore it has potential to utilize landfill gas into energy.

In this regard, GAIL R&D department has identified a R&D pilot project for Land Fill Gas (LFG) utilization and has signed MoU for 5 years with MCD for implementation of this project for one portion of the existing dumpsite at Ghazipur. The project area comprises of 10 acres of waste disposal area in north-eastern part of the landfill site. As compared to the total accumulated quantity of a million cubic meter, the GAIL

project area contains only 0.9 million cubic meter of waste, which is about 15% of the total accumulated waste.

### 1.2 Setting up LFG Extraction Wells and Pressure Wells

Based on the available plain area 3 main LFG extraction wells were installed at the minimum spacing of 40 m from each other. Each set has 1 main landfill gas extraction well surrounded by 9 monitoring wells drilled along 3 directions from the main extraction well. These directions are 120 degrees apart. Along each direction, 3 monitoring wells have been drilled for pressure and landfill gas quality observations at a distance of 3, 15 and 25 m, respectively from the main landfill gas extraction well. The depth of monitoring wells has been kept as 10 m, except the shallow wells located at 3m distance. Depth of the monitoring wells at 3 m spacing has been kept as 4 m, as these are the shallow wells to check for the infiltration of air.

The selected landfill section has 3 main boreholes of 500 mm



Waste pickers at Landfill site



View of Gazipur Landfill site



Spread & compaction of waste



Waste to energy plant (IL&FS)

**Fig.1.1 Processes involved in Gazipur Landfill Site**

diameter each, which have been drilled up-to a depth of 15 m from the surface level of the landfill. To extract the landfill gas, 6 inches diameter PVC pipe is usually inserted into each of these extraction wells. Further, the annular core is filled with 1-1.5 inches sized gravels. The top has been sealed with bentonite and capped.

### 1.3 Drilling of the Pressure Wells

Around each gas extraction well, 9 pressure wells of 250 mm diameter have been drilled to induce lateral pressure for facilitating lateral landfill gas movement. The construction procedure of these pressure wells is the same as the main boreholes. The deep pressure probes (6 in total at 15 m and 25 m from main extraction boreholes) have been drilled up to a depth of 10 m from the top surface of the landfill.

Besides the deep pressure probes, 3 shallow pressure probes have also been installed at 3 m distance from the main borehole with a depth of 4 m, to check the air infiltration under suction. In both, deep and shallow pressure wells, the diameter of the core is 250 mm with a 2 inches diameter of perforated PVC pipe.

### 1.4 LFG Generation Potential

Specialists in Energy, Nuclear and Environmental Sciences (SENES), Canada has conducted LFG pump testing at GAIL project area in January 2011. Based on the pump test results and IPCC First order Decay (FOD) models, LFG projections and baseline methane emissions for the site has been carried out. The projections along with the CER potential have been done for the next 15 years, beginning from the year 2012.

Since, the landfill gas is known to have high methane content, i.e. up to 50% by volume and has high calorific value of 39820 kJ/kg, the captured landfill gas from the GAIL project area can be upgraded and utilized as Compressed Natural Gas (CNG).

### 1.5 Technical Design of the Project for LFG Collection

In order to extract the LFG from the waste confined area, the first and foremost step is to cover the site with impervious layer, followed by installing network of LFG extraction wells

and a piping system to collect the gas from these wells. Simultaneously, a system is required for extraction and management of leachate.

Various components for the installation of LFG collection system are as follows:

1. Site delineation and protection- To allot 10 acre GAIL area and also to protect it from any external access, the site has been delineated by a fencing work.
2. Slope reformation and waste leveling- The existing 3-D surface area of the landfill at the controlled GAIL area is about 6 ha (although the planimetric area is about 4 ha). The waste at this section is accumulated with non-uniform side slopes (1V:3H with flat benches of 5m width upto 35m spacing), which are slightly steeper than the desirable side slope of 1V:4H, as per MSW. Handling Rules, 2000. Also, these flat benches have been used for installation of LFG extraction wells.
3. Surface Cover- Over the final finished profile of the fill (i.e., on the top and side slopes), a cover layer is provided. The final cover for closure of landfill is composed of several layers, each with a specific function. Various components of the surface cover are designed to maximize surface drainage, minimize infiltration, erosion and control the release of the landfill gas.
4. The cover layer for the GAIL section has been designed to allow for fully controlled and maximum recovery of landfill gas to produce energy out of it thereby minimizing the loss of gas to environment.
5. Vegetative layer is made up of top soil of thickness 45 cm. The soil for this layer was transported from approved burrows pits suitable for growing vegetation and developing landscaping.
6. A LFG collection layer is made up of granular soil of permeability coefficient (k) greater than 10.2 cm/sec. A top soil layer of 15 cm thickness has been put below the top soil to accommodate network of header and feeder pipes for LFG collection. Here, Construction and Demolition (C&D) waste (of 25 mm size) can also be utilized.
7. In place of granular soil, 6 mm drainage composite (Drainage layer) has been put below the LFG collection

layer for drainage purposes.

8. Proper overlapping, jointing and anchoring of HDPE (impervious layer) has been provided to avoid leakage of water/landfill gas. The liner has been extended by an additional 5 m along the inner periphery to avoid air infiltration. It also includes an additional protective layer of amended soil (20 cm) below the liner to safeguard against any infiltration.

## 1.6 Landfill Gas Management System

The landfill gas collection system has been designed to extract maximum amount of landfill gas under a suction pressure without any air infiltration. The system has the following components:

1. LFG extraction wells with network of header and feeder pipes
2. Condensate control system and
3. Twin-lobe Blowers for pumping of gas at vacuum.

## 1.7 Design of leachate Management System

During the gas pump test conducted at Ghazipur by SENES during December 2010 and January 2011, it was observed that the selected section has very high leachate levels, within 1.5 to 2 m below the surface level. Such high levels of leachate adversely affect the landfill gas extraction rate. Therefore, in order to improve the landfill gas extraction efficiency, a leachate management system comprising of one electric pump submerged in each gas extraction well extracting leachate into the pipe network is proposed to be laid along the gas collection network. About 50 nos. of pumps with 3-4 gallon per minute discharge capacity are proposed for Ghazipur landfill. Leachate would be collected through feeder pipes and conveyed to the header pipes.

## 1.8 Surface runoff Management System

Delhi receives average 790 mm of precipitation every year. Once the surface layer is in place after the closure of the landfill, more than 85% of the precipitation (in GAIL area) will contribute to the surface run off. This surface run off would be managed through a system of peripheral surface water drain around the waste foot-print of GAIL area and a grit

removal basin. From the grit removal basin, the supernatant will be drained into the nearby Hindon Canal situated in the eastern side of the landfill.

## 1.9 LFG Composition and Characteristics

The constituents of Landfill gas is as follows:

1. Methane- 40%-70%
2. Carbon Dioxide- 30%-60%
3. Hydrogen Sulfide- 800 ppm
4. Benzene- 30 ppm
5. Toluene- 300 ppm
6. Organic Acids- Traces
7. Organo-sulphur Compounds- 50 ppm

In addition to the above, different percentage of oxygen and nitrogen are also observed in the landfill gas, which are present mainly on account of air infiltration.

## 1.10 CNG Composition and Characteristics

LFG, when purified and cleaned can be a source of natural gas. Natural gas derived from conversion of LFG has following composition

1. Methane - 90-95%
2. Nitrogen - <7%
3. Carbon Dioxide - <4%
4. Oxygen - <2%
5. Hydrogen sulphide - <5 ppm

Due to the low density of Natural gas (0.72 kg/m<sup>3</sup> at 0° C and 1atmospheric pressure), it can be compressed to a pressure of 200-250 kg/sq.cm to produce CNG. Being lighter than air, natural gas rapidly disperses upwards and to a state of low concentration when released into the environment, making it a far safer form of fuel in the event of a leak or accident.

## 1.11 Process Description

The process for conversion of LFG to CNG comprise of the following 3 stages:

1. Extraction of landfill gas from the landfill site.
2. Purification of landfill gas to convert it to natural gas by removing contaminants and non-acceptable components

from LFG ( $\text{H}_2\text{S}$ ,  $\text{CO}_2$ , particulates, siloxanes and moisture content).

3. Compression of natural gas to CNG to make it suitable for direct supply to gas pipelines or storage in cascades for further transportation.

## 1.12 Conclusion

The proposed system for conversion of LFG to Pipeline Quality CNG at Ghazipur, New Delhi has been designed to meet the possible available technological options and latest

environmental Rules. The design parameters considered for the project are based on the results obtained from landfill pump test conducted by SENES and the quality of output expected from the system. Landfill Gas flow rate is 300-600  $\text{m}^3/\text{Hour}$  at ambient temperature 30 degree Celsius. The Landfill gas density is 1.35  $\text{kg}/\text{m}^3$  which produces 30 kWh electricity from extracted LFG.

Source: Field visit and Pamphlet given by East Delhi Municipal Corporation, Delhi.

# Chapter 2

## Waste to Energy

### 2.1 Ghazipur Waste to Energy Plant

#### 2.1.1 Introduction

Urban India constitutes around 32% of the total Indian population of 1.2 billion and is a major contributor to the generation of Municipal Solid Waste (MSW). Average waste generated in our country is estimated at around 500 grams per capita per day. Currently, the urban areas of India generate around 70 million tons of MSW annually.

Urban population in India is increasing at a rate of 3-3.5% per annum of waste along with a estimated yearly increase in per capita generation by 1.5%, collectively resulting in an increase of waste generation by around 5% annually. This is leading to huge accumulation of waste in our landfill sites, which in turn causes air, surface water, ground water and soil pollution.

#### 2.1.2 About the plant

Ghazipur WTE project is a Public Private Partnership (PPP) of IL & FS and Delhi Government with a 25 yr concession agreement. The project would process 2000 tons MSW per

day for EDMC (East Delhi Municipal Corporation). The plant has 2 parts, the Processing plant and the Power plant.

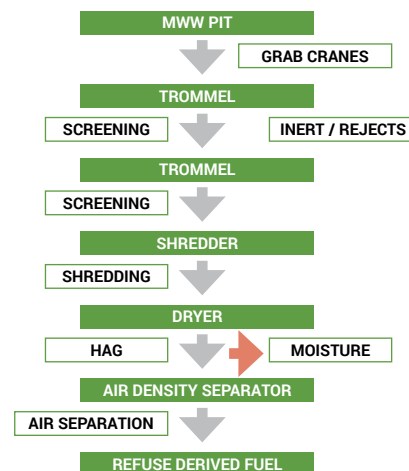
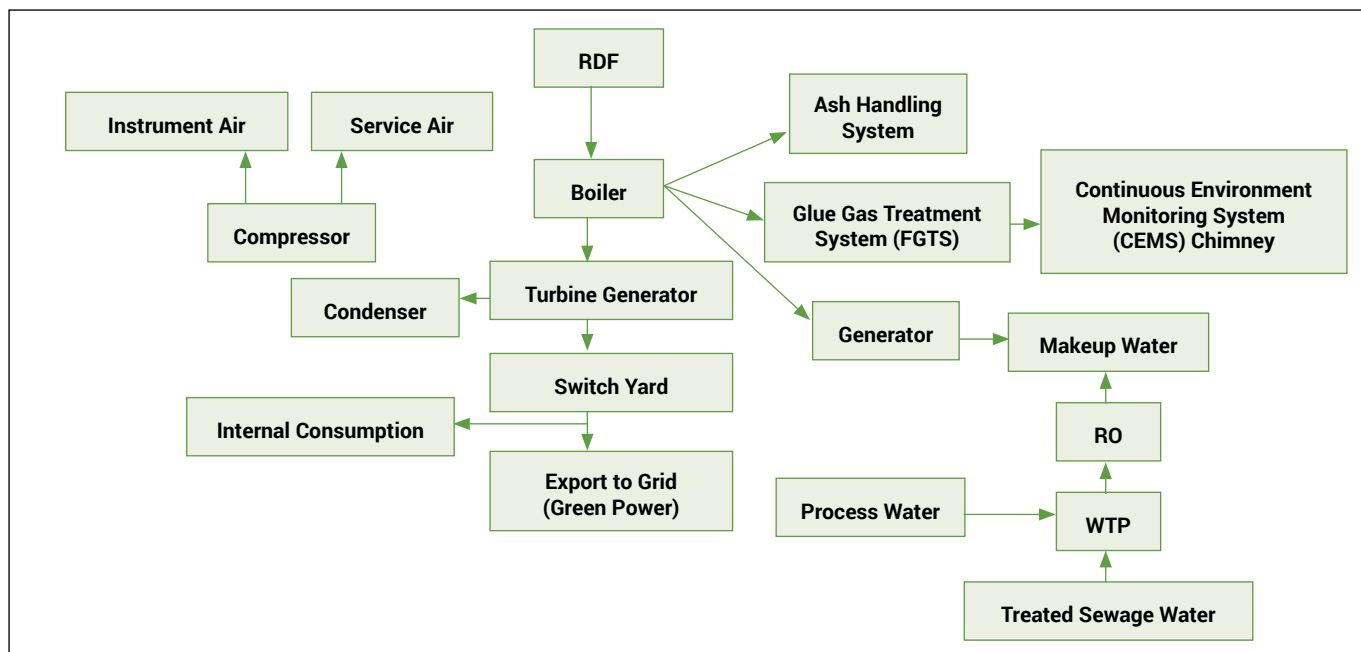


Fig.2.1. Flowchart of the processes involved



**Fig.2.2 Processes involved in Gazipur Waste to Energy Plant**



**Fig.2.3 Flowchart of the Processes involved in Power Plant**

The scientific steps involve manual and mechanical segregation of waste followed by sizing and homogenization. Then moisture reduction and air classification are carried out to produce the Refuse Derived Fuel (RDF).

Firstly, the non-recyclable mixed waste is collected by EDMC out of which C&D wastes, metal components are separated from biodegradable and other organic wastes. Here, a tailor made moving, reciprocating, tumbling gate and triple pass boiler (specially designed for handling Indian MSW) has been sourced from Keppel Seghers, Belgium. Seghers have more than 300 operating lines of Waste to Energy globally. Selective combustion is carried out in this plant using RDF, which reduces pollution to a large extent.

A specialized ventilation system in the MSW storage area maintains a negative pressure. So, fresh air flows in continuously in order to create a healthy working environment.

At the same time, the odorous air is drawn out and diverted to be burnt as primary air in the boiler, to eliminate the odor and particulate matter present in it.

### 2.1.3 Making of Refuse Derived Fuel (RDF)

The conversion of MSW to RDF incorporates following stages:

1. Manual Segregation
2. Shredding
3. Screening to separate inert and biodegradable matter.
4. Rotary conveying
5. Fine Screening
6. Density Separator, which involves ballistic separation.

MCD supplies MSW at plant site in two or three shifts, where the initial stage is to weigh and inspect the waste. Trucks are brought to MSW storage area and are unloaded into the pits. After unloading, MSW is sprayed with herbal pesticide to delay

its decomposition. The overhead cranes with their respective grab buckets pickup MSW and put it onto the 'Vibrating Feeders', which are installed at the second floor of the processing building. After that, the main conveyor discharges MSW to a manual inspection conveyor at elevated level of about 7 m. From the slow moving inspection conveyor, all the odd sized and unwanted objects are manually separated, at the manual separation station. The wastes segregated at this stage are mostly large textile pieces, large twigs and woody pieces, stray dead etc. The unwanted substances are put into trolleys and are periodically taken out from the processing system and are suitably disposed off.

The materials after manual inspection are passed through magnetic separator, to remove ferrous objects. After inspection and magnetic separation, MSW are fed into a primary shredder. Format of the moving and fixed blades decide the size of the end products. During this operation, all the materials get homogenized and their sizes are reduced to lesser than 100 mm. These shredders are very sensitive to hard materials. Therefore, separations by manual operation previously deployed need to be very effective. The MSW after inspection is fed into a de-dusting or pre-drying system, to remove dust/sand/earth (10 mm particle size) in fine Separation Rotary Screen, in which hot air is injected.

After the fines separation, MSW are fed into another Rotary Screen to classify the material into two fractions:

1. Over size >150 mm and
2. Undersize <150 mm.

Undersize fraction (<150 mm) primarily contain organic matter and is directly fed through a belt conveyor in to the Rotary Dryer. On the hand, the oversize fraction (>150 mm) is fed into a Primary Shredder through a Magnetic Separator (to separate ferrous material) to reduce its size to <150 mm. The output from the Primary Shredder is then fed into Rotary Dryer, to dry the material by using hot air in a co-current manner. The hot air is generated in a fixed grate in a specially designed Hot Air Generator (HAG), in which woody biomass segregated from MSW is combusted.

Suitable pollution control equipment are incorporated in HAG. The output from the Rotary Dryer is then fed into the Rotary Trommel to separate the fines through 8 mm screen. The fine fraction so separated has significant quantum of organic matter that is useful as a soil enricher. After screening, the material is subjected to Air Classification in a specially designed Ballistic Separator, wherein lighter components are entrained in the air and collected separately. The heavy material such as stones, glass falls through the classifier and is separated as Inert. The light fraction, thus, separated comprises of biomass, paper, textiles and other combustible material and is termed as Refuse Derived Fuel (RDF) Fluff, having an average Gross Calorific Value (GCV) of 2,600 to 3000 kcal/kg.

The RDF fluff has following properties:

1. Calorific value- 100-2600 kcal/kg
2. Particle Size- (-) 100 m<sup>3</sup>. Ash- 5%-20%
3. Bulk Density- 80-100 kg/m<sup>3</sup>
4. Moisture- 5%-20%

### **2.1.4 Leachate Treatment Plant (LTP)**

The municipal waste which arrives at the plant is unloaded into two 9 m deep pits, which are covered. The small quantities of leachate generated is collected in and treated in the Effluent Treatment Plant.

The plant (LTP), comprises of the following components:

1. Equalization tank
2. Coagulation tank
3. Stripping Tank
4. Primary and Secondary tube settlers
5. Activated Carbon filter
6. Pressure sand filter
7. Anaerobic Hybrid reactor
8. Chemical and Biological Sludge tanks
9. Filter feed tank
10. Filter press
11. Aeration unit with PVA gel media
12. AHR feed pump
13. Clear Water tank

Coagulation tank involves the coagulation process with ferric chloride ( $\text{FeCl}_3$ ) or with ferrous sulphate ( $\text{FeSO}_4$ ), to every batch of raw leachate with similar operating conditions. In this tank, suspended solids content reduction (60-80%) and the organic matter removal occurs. In Biological treatment processes, the ultrafiltration membrane bioreactor, completely retain suspended solids. Thereby, releasing and storing clear water in the Clear Water Tank.



**Fig.2.4 Clean Water obtained from Leachate Treatment Plant (LTP)**

## 2.1.5 Conclusion

This Integrated Waste Management (IWM) facility has a capacity to process 1300 tons per day of MSW and generate about 433 MT of RDF. The boiler for the power plant consumes about 16.27 tons per hour of RDF Fluff for power generation. The power plant has air cooled condenser for condensing the exhaust steam from turbo generator to reduce the water requirement to a large extent. The water requirement, in the plant is generally  $471 \text{ m}^3$  /day. It uses about 16.27 tons of RDF per hour in boiler (generating 50 TPH of steam) for the generation of 10 MW of power. The dust emissions, occurring during the processes, are monitored by the provision of dust control systems such as cyclones, bag filters, to control the dust emissions. This process thus, results in the average annual reduction of  $\text{CO}_2$  by 1,11,949 tons.

### Sources:

1. Visited the centre and interacted with different officials, workers.
2. [file:///C:/Users/HP/Downloads/615\\_IJAR-2338%20\(2\).pdf](file:///C:/Users/HP/Downloads/615_IJAR-2338%20(2).pdf)
3. <http://www.energynext.in/ghazipur-landfill-to-be-used-as-wte-plant/Okhla WTE>

## 2.2 TEAM Technology

### 2.2.1 Introduction

Apart from many environmental problems, solid waste generation is one of the visible environmental concerns, which must be managed sustainably to reduce its detrimental impacts on the surroundings.

### 2.2.2 Brief description about TEAM (TERI's Enhanced Acidification and Methanation) Technology

The Energy and Resources Institute (TERI), established in August, 1998) is actively engaged in Research & Development (R&D) of various technologies that help the society in waste minimization and utilization such as anaerobic digestion etc. The wet waste, generated from the houses, hotels, restaurants, vegetable markets etc. is a very good source of biogas, which can be used to harness energy for multiple purposes.

TEAM (TERI's Enhanced Acidification and Methanation) technology is one such technology that promises effective utilization of organic solid wastes into manure and biogas production. This patented technology has been assigned Patent number 2655/Del/97.

This technology has been successfully verified in the field for the generation of useful resources such as biogas and manure with different types of organic solid wastes. The results so obtained ensure the viability of the technology for waste minimization and utilization.

This technology has been designed so that the basic obstacles encountered in conventional anaerobic digesters viz., long retention time, floating of waste, scum formation

etc. can be avoided. In addition to this, it also incorporates the techniques to separate the acidification and the methanation phase, which can solve the issue of regulating pH, which occurs during the methanation process of digestion.

Its distinctive design and biphasic nature, can process any type of organic solid waste with a short retention time of 7 days only using some energy. The various additional salient features of this technology are as follows:

1. Digested waste has high NPK value.
2. High methane content in biogas (>75%).
3. High rate methane producing reactor.
4. Successfully tested for leafy waste, food waste, press mud, food -processing waste, tea waste, vegetable market waste, township waste etc.
5. Elimination of Scum formation - a feature in small size plants.
6. Production of non-flowable / semisolid digested residue
7. Low HRT of 7 days.
8. Very low water requirement, due to the recycling occurring within the process.
9. No environmental negative impact.
10. Aesthetic look with low maintenance cost.

For ease, this technology can also be designed in the modular form starting from 0.05 TPD to 10.0 TPD.

### 2.2.3 Process Description

TEAM technology incorporates two stages to process the waste, namely:

1. **Acidification** – where the organic content of the waste is filtered out, to make concentrated liquid residue by decomposition of the waste with discontinuous



**Fig.2.2.1 Process involved in TEAM Technology**

sprinkling of water.

2. **Methanation** - In this phase, high strength leachate is treated in a high rate UASB (Up -flow Anaerobic Sludge Blanket) reactor to produce biogas.

Thus, this technology has three main steps:

1. **Pre-processing** – It involves the size reduction of the wastes, in which equipment works with minimum power inputs. It reduces the size of the waste material from centimeters to a few millimeters. Unlike other technologies in the market, this unique device does not require water for crushing of the waste.
2. **Digestion** - As this technology is biphasic, so there are two distinct set of equipments used for digestion (acidification) of the waste and for biomethanation process. For acidification, there are 6 rectangular reactors, which are called 'Acidification Reactors (AR)' and are labelled as AR-I to AR-VI. In these ARs the shredded waste (received from step one) are placed and charged.
  - a. After charging the waste into ARs, water is poured in the reactors in the ratio of 1:2 i.e. in the ratio of waste: water and with the help of lid, the digesters are closed. This is a necessary step, so that anaerobic conditions inside the reactors can be maintained. The water inside the reactor is mixed regularly with the help of a pump so that homogenous conditions are maintained throughout the process. One pump is used for two acidification reactors and therefore, overall 3 pumps are installed for 6 ARs.
  - b. On 7<sup>th</sup> day leachate from ARs are collected in a separate tank, whereas residue so obtained are removed with the help of motorized chain pulley supported on monorail with a lifting capacity of 2 tons.
  - c. The volume of waste reduced in this phase of the TEAM technology is 40% and the digested sludge, after drying, is used as good quality manure which generates revenue.
  - d. The leachate gathered from the reactor is fed into the UASB reactor for biogas generation and the gas generated is collected in the biogas holder.
3. **Post-processing of the digested manure** - it involves

equipment for separation of the solid and liquid from semi-solid contents or digestate, which is generated from the acidification process. The additional removal of water from the digestate aids in quick drying of the manure which can be used as a soil conditioner and the liquid obtained can be fed into UASB reactor for biogas generation.



Fig.2.2.2 Equipment used for post-processing

## 2.2.4 Conclusion

The biogas generated from TEAM technology thus can be used for thermal applications such as kitchens, canteens etc. The minimum biogas yield is 50-60 m<sup>3</sup>/ton, which is equivalent to

- a. 25-30 kg LPG
- b. 55-65 kg coal

The digested sludge coming out of the plant can be utilized as manure for enriching soil fertility. The manure is 10% of the total waste, which has 1.2% of Nitrogen, 0.1% of Phosphorus and 0.6% of Potassium.

Thus, this technology has promising features for achieving sustainable waste management. It has been implemented at various locations such as, 250 kg/day plant at NMMC, Mumbai, 500 kg/day plant at NRL, Assam and 250 kg/day plant at IOCL Naphtha Cracker, Panipat.

The TEAM plant installed at NTPC Jhajjar, Haryana has following salient features:

- Capacity of the plant - 50 kg/day
- Type of waste treated - Household kitchen waste



**Fig.2.2.3 50 kg per day TEAM Plant at NTPC, Jajjhar, Hararyana**

- Material of fabrication - Mild steel
- Year of installation of the plant – 2006
- Amount of waste treated - 146 tons
- LPG replaced till date - 2.9 tons
- Manure generated - 14.6 tons
- Savings on GHGs - 44 tons of CO<sub>2</sub> equivalent

- Type of waste treated - Canteen waste
- Material of fabrication - Stainless Steel
- Amount of waste treated - 250 tons
- LPG replaced till date - 6.5 tons
- Manure generated - 25 tons
- Savings on GHGs - 100 tons of CO<sub>2</sub> equivalents

The SKSS Ltd plant at Guragon, has following salient features:

- Capacity of the plant - 100 kg/day

Sources

Pamphlets and write up shared by Mr. D.C. Pant, fellow at TERI and visit to the plant Delhi Gymkhana.



**Fig.2.2.4 100 kg per day plant SKSS Ltd at Gurgaon**

## 2.3 Containerized Biomethanation

### 2.3.1 Introduction

About 40-45% urban solid waste is the organic fraction, which can be easily treated by anaerobic digestion. Solids in the organic waste decompose rapidly and can be treated by biomethanation process method. In this process, solid waste is treated in closed vessels where, in the absence of oxygen microorganisms break down the organic matter into a stable residue and generate a methane-rich biogas in the process. This biogas so formed can then be used as a source of renewable energy to produce electricity whereas solid residue can be utilized as manure.

A group of IIT alumni started Green Brick Eco Solutions (GBES), which is an environmentally sustainable and renewable energy firm, working with stakeholders in business, society, academia and polity to create and design clean technologies and solutions. It is currently, leading the domain of biogas and provides end-to-end solutions in the following spheres:

1. Biogas generation.
2. Biogas purification and bottling.
3. Biogas to power.
4. Biogas monitoring systems.

GBES has strategic tie-ups with technology institutions and companies across the globe to develop and promote various renewable energy biogas technologies.

In Delhi, BioBoxX has several Biomethanation plants; the significant ones being that at DMRC, Shastri Park and Basti Sarai, where the land has been provided by the railway colony for biomethanation process.

### 2.3.2 Process Involved

The anaerobic digester system (for anaerobic digestion of biodegradable waste) is used for biogas production and recovery. It includes, considerably fixed horizontal digester (for digesting the waste with biogas production) and transmitting the biogas to a biogas storage balloon overhead. The digester, in a preferred form, has a feed inlet; which is coupled up with feed preparation tanks (pre-digester) and acts as a homogenizer. The specially designed mixing mechanism inside the digester prevents clogging, froth and scum formation inside the digester. The mixing mechanism when coupled with a unique heat/temperature maintenance system inside the main digester (and insulation of main digester) stabilizes the temperature inside the digester throughout the year. Further the biogas outlet is connected to the biogas storage balloon after removing the waste-organic manure through the outlet.

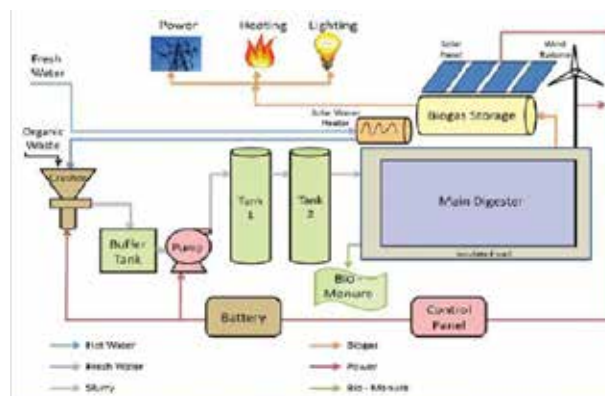


Fig.2.3.1 Flow diagram of the process involved



**Fig.2.3.2 Process involved in Containerized Biomethanation**

The characteristics of the process, described above are:

1. Treatment Process - Mixing/ Feed preparation tank
2. Feedstock Load - 5000 kg/day
3. Assumed Operating Temperature - 35 to 40 °C
4. Biogas Generation Variation:  $\pm 10\%$
5. Totally expected Biogas Production - 80-90 m<sup>3</sup>/day from 1 TPD plant
6. Methane Content - upto 70%
7. Operating days- 350 days/year

The total power utilized by the plant is 20 kWh /day.

BioboxX, incorporates biodegradable kitchen waste, green plant waste, green grass, animal remains in abattoirs, cow dung, plant leaf litter, crop residues, sugarcane, etc. The non-bio-degradable wastes are paper, plastic, glass, concrete, etc. Initially, the waste is segregated, to remove non-biodegradable material, if the waste is unsegregated, and then it is homogenized to make slurry. It is then followed by an anaerobic process. The end product of the process is Biogas, which has high methane content and organic manure which acts as a soil enricher. The benefit of this plant is that this can be setup in any part of the country where the ambient temperatures goes low during the winter season, a solar water heater (of suitable size) has been included to supply for heating water, for bringing the slurry to an optimum temperature.

### 2.3.3 Salient Features of Bio-boxX

1. Multi feed / Kitchen / Organic / Horticulture Waste etc.
2. Plug and play / Compact / Factory-fitted / Modular unit.
3. Outputs:
  - a. Biomanure, and
  - b. Biogas for cooking/lighting/power generation.
4. Odour free operations.
5. Renewable green energy.
6. No dedicated manpower required.
7. Long life – 15 years – Corrosion resistant FRP material.



**Fig.2.3.3 BioboxXTM spotted at the site, designed and developed by GBES (In association with ArkaBRENStech) for decentralized organic waste management**

8. Suitable for all climatic conditions.
9. Hybrid renewable energy system to harness wind and solar power

The technical specification of Bio-boxX of 1 TPD plant includes the following:

1. Size i.e. space required- 40 ft x 8 ft
2. Processing Capacity- 1000 kg/day
3. Power Equivalent of Biogas- 100-110 units/day
4. Biogas Generation- 80-90 n.cu.m./day
5. Bio-manure production-1600 lts/day
6. Electricity consumption- 20 units per day
7. Manpower- 2 (part time)
8. Fresh Water requirement- 400-500 liter/day

Source

Visited at the centre and interacted with different officials and workers.

## Chapter 3

# Composting

### 3.1 Centralised System- Okhla Composting Plant

#### 3.1.1 Waste management - An Urban challenge

Urban India generates over 70 million tons of Municipal Solid Waste (MSW) each year, of which less than 10% is scientifically processed. In the year 2000, the Ministry of Environment and Forests introduced the MSW Rules, which mandated the processing of waste and scientific landfilling of rejects. Ministry of Environment, Forest and Climate Change has notified the Solid Waste Management Rules 2016 recently mandating separation of compostable, recyclable and domestic hazardous waste at source and processing the three fractions separately. Delhi currently generates over 9,000 tons of MSW every day, which is likely to increase to over 15,000 tons per day (TPD) by 2020. Delhi's landfill sites are already overflowing and the landfills in most of the Indian cities are not exceptions to this process. Most urban landfills are dumps that leach waste into the water

system and pollute ground water and rivers.

#### 3.1.2 Introduction about the plant

The Okhla compost plant was set up on Public Private Partnership (PPP) framework in association with the Municipal Corporation of Delhi (MCD) in 2008 with IL&FS to finance and operate. Today, the plant processes 500 tons of MSW each day and produces 75 TPD of organic compost which is compliant to the Fertilizer Control Order (FCO). The plant focuses on quality and refinement, ensuring removal of inerts and other unwanted material. It is spread across 3.2 ha of area at Okhla behind the Sewage Treatment Plant.

The objective of Okhla MSW Composting Project at Delhi is to avoid methane emissions from anaerobic decomposition of Municipal Solid Waste (MSW) in landfill sites through controlled aerobic decomposition in windrow composting



**Fig.3.1 Processes involved in Okhla Composting Plant**

process. The aerated composting process will avoid methane emissions and will also result in compost as a product that can be utilized as organic fertilizer for agricultural purposes. The Okhla Project treats biodegradable waste predominantly from vegetable market(s) of Delhi and on average diverts approximately 73,000 tons of MSW per year (200 TPD) that otherwise would be disposed in nearby landfill site if the project was not constructed. Since 2007, the plant has converted 2 lakh tons of MSW into manure through 'aerobic composting technology'.

The Okhla compost facility has the distinction of being the first MSW composting plant in the world to receive Carbon Credits and Rs.25 lakh from the United Nations Framework Convention on Climate Change (UNFCCC) for helping the environment. The project will mitigate about 2,34,000 tons of carbon dioxide in 7 years (till 2016). The additional revenues from Carbon Credits will improve the financial viability of the project. IL&FS Environment has upgraded this plant; by its ability to produce Refuse Derived Fuel (RDF) in an eco-friendly manner in order to reduce the rejects. It can be used for the generation of heat and power in cement, thermal and power industries, as an alternative feed; thus, substituting the carbon-intensive coal.

The output from processing unit, other than the 20% rejects to the landfill from this plant, comprises of:

1. Compost- 15%
2. Refuse Derived Fuel (RDF)- 20%
3. Recyclables- 5%
4. Loss of Moisture- 40%

### 3.1.3 Process Adopted for Compositing

The process followed for preparation of compost in the Okhla plant incorporates various stages like:

1. Windrow formation
2. Monsoon Shed Storage
3. Coarse Segregation
4. Refinement
5. End product
6. Packing

The Municipal Solid waste is taken and dried. Once dried it is sent to the shredder. The waste of size more than 70 mm is filtered out and is used as Refused Derived Fuel. The remains are sent to a sieve of pore size 35 mm wherein the components of size more than 35 mm are rejected and the rest are kept in Windrows for 8 weeks and is turned once a week. The waste from these Windrows is taken to the 16mm sieve. The particles with size more than 16 mm are rejected and the remainder left for curing for 2-3 weeks. After the curing is done the waste is sent to a 4 mm sieve. The particles with size less than 4 mm are sent for final finishing and the Compost is formed.

The quality of compost being produced at Okhla compost plant is good and adheres to the specifications given by Ministry of Urban Development (MoUD), now Ministry of Housing and Urban Affairs (MoHUA) and Central Pollution Control Board (CPCB). The following products are made at this plant:

### 3.1.4 Harit Lehar and Home Garden

The compost produced at Okhla Composting Plant is a humus rich organic compost, compliant to standards of Fertilizer Control Order (FCO) and improves soil fertility, retains soil moisture and enhances crop yield. It also increases diseases and pest resistance, promotes growth of beneficial microorganisms which increases uptake of essential macro and micro nutrients

### 3.1.5 Refuse Derived Fuel (RDF)

It is obtained as a by-product of Reject Management System in waste management facilities producing compost. A cleaner, highly volatile fuel which can be used for generation of heat and power, RDF can be used in cement and thermal power industries as an alternative feed thus, substituting the carbon-Intensive Coal. Use of RDF prevents rejects going to over flowing dumpsites, which has huge environmental benefits.

Source

Visited the centre and interacted with different officials and workers and Pamphlets given by the plant.

## 3.2 Decentralised System - GPRA Complex New Motibagh, New Delhi

### 3.2.1 Introduction

The Zero Waste Project at GPRA Complex, New Moti Bagh at New Delhi is a unique model of decentralized Solid Waste Management with the support of Ministry of Urban Development, now Ministry of Housing and Urban Affairs (MoHUA) Govt. of India and National Building Construction Corporation (NBCC). GPRA Complex in New Moti Bagh is a 110 acre complex with over 1000 families residing in the complex. The average waste treated at the complex consist of 1.5 tons of household waste and 1 ton of green and horticultural waste daily. The waste is collected and brought to the segregation site from where the Organic, Green and Plastic segregated waste is treated at the plant. The dry waste is stored and sent for recycling to the respective recycling plants. The resultant product from organic waste treatment is Organic Fertilizer (Organic Khad) and from green waste the plant produces biomass pellets. Plastic Waste is treated to produce Low Density Oil (LDO), Carbon and Liquified Petroleum Gas (LPG).



Fig. 3.2.1 Plastic waste to fuel oil

LDO can be further refined to a better quality fuel like Petrol and Diesel.

### 3.2.2 Aerobic Compost from Kitchen Waste

Of the household waste, the wet compostable waste from households is about 1 ton per day which is converted to compost using the Excel method, using a composter, which does size reduction as well as mixing of wet waste with the inoculum. This is followed by composting in trays kept on racks, humidified and turned daily for about 2-3 weeks yielding about one fourth of its weight as compost, which is cured, sieved and packaged to be sold at Rs.5 per kg.

### 3.2.3 Pelletization of Garden Waste

Similarly, a pelletization assembly for cutting, drying, compressing and pelletizing garden waste generates about half its weight in pellets to be sold at Rs.8-9 per kg. The



Fig.3.2.2 Process of Pellet Making



Collection of segregated waste



Processing Machine



Collection Vehicle



Waste water treatment process



Solar lighting and Solar water heating at GPRA Complex

**Fig.3.2.3 Processes involved in GPRA Complex, New Moti Bagh**



**Fig.3.2.4 Process of Compost Making**

operating cost for all activities is Rs.3,02,800 per month.

It is estimated that about 25-30 tons of compost and pellets are generated per month yielding about Rs.2 to 2.5 lakhs. Sale of recyclables especially paper helps to attain break-even of the project. In addition, a plastics to fuel oil equipment has also been installed whose economics and contribution to the revenue is yet to be calculated. One of the major drawbacks is that residents do not segregate wet from dry waste, which has to be done by waste workers at the segregation area and the company is not insisting that the residents do it.

The energy savings from 300 solar street lights at the GPRA complex, covering internal roads, common areas, parking lots and bungalows, help in saving Rs.32.28 lakhs per annum. Along with solar water heaters, the savings on electricity is close to Rs.35 lakhs a year.

Therefore, a decentralised integrated solid waste, waste water and energy project for about 1000 households can achieve clean and green surroundings and financial savings to the tune of Rs.40-50 lakhs per annum. Green surroundings, ground water recharge and the reduction in carbon footprint achieved are yet to be monetized.



**Fig.3.2.5 GPRA Complex, New Motibagh, New Delhi**

The initial response when one is told that the decentralised system is making a net saving, resulting in the green environment that we see at the GPRA complex, is one of skepticism.

### 3.2.4 Integrated System

This experiment of decentralized solid, liquid and energy management at the GPRA complex, New Motibagh is unique because of the efficient functioning of a well planned and executed waste and energy management system, which demonstrates that clean environment is not a burden on the exchequer or the ecosystem. In fact, the benefits to the ecology and the ecosystem in terms of reducing the burden on the water table, energy and resources is by reduced transportation of waste water and solid waste from the complex and water and compost to the complex besides the saving on electricity by solar street lighting and water heating. Therefore, there is ample justification for adopting the decentralized system. Furthermore, if the savings from all the three systems are taken together, there is substantial financial savings as well.

**Solid Waste Management:** Similarly, for the Solid Waste Management project installed by M/s Green Planet Waste



**Fig.3.2.6 Waste water treatment plant at GPRA complex, New Motibagh, New Delhi**

Management (P) Ltd. (Operator) in collaboration with NBCC, there is a departmental expenditure of Rs 20 Lakhs on account of providing 4000 Sqft for covered sheds. All other expenditure of approximately Rs 50 Lakhs on machinery, garbage bins at common places, collection trolleys/ cycle rickshaws and O&M have been made by the Operator. The Operator has been authorized to use the campus for green slogans, sponsorship and other advertisements for revenue generation.

Similarly, for enhancing segregation of all dry waste at source, a campaign to separate dry waste in homes besides the materials recovery shed would increase the revenue generated from selling recyclables and reducing hazardous components in the compost.

**Waste Water Management:** Of the 8 lakh litres of water which is consumed by the residents, 5 lakh litres is treated in a decentralized waste water treatment plant within the campus using the Moving Bed Bio-reactor (MBBR) technology. The direct savings of the decentralized waste water system is Rs 14.60 lakhs per annum on account of saving surcharge of 50% on water bill for non-disposal of sewage to municipal system. The indirect savings are towards laying long trunk sewer and irrigation lines. The recycling of sewage to obtain secondary treated water from the decentralized Sewage Treatment Plant (STP) and using the same for gardening/ horticulture in the campus to the tune of about 5 lakh liters per day saves



**Fig. 3.2.7 Compost plant at GPRA complex, New Motibagh, New Delhi**

Rs 27.50 lakhs per annum. Use of sludge cake from the STP for horticulture, is responsible for saving an additional Rs 2 lakhs per annum. The total net saving is Rs. 5 lakhs per year after the fixed cost and O&M are deducted. Consumption of manure/chemical fertilizers has also been considerably reduced due to use of treated waste water which has organic content. In addition, the complex is able to give about 50,000 litres per day of treated water to NDMC for its gardens and parks at no cost.

**Savings:** The total monthly expenditure including depreciation, return on investment, management charges, consumables, work force salary and maintenance as claimed by the operator is about Rs.3 lakhs while the monthly revenue generation from sale of 12.5 tons of compost (there is a 50-60% reduction by weight during composting due to evaporation etc.) at Rs.5000 per ton, and recyclable materials fetches about Rs 2.37 lakhs per month, according to the operator. Although the operator is presently claiming a shortfall of Rs.65,300 per month, the pellets made from the garden waste like lawn cuttings and garden prunings, using a well-designed garden waste dryer and pellet maker, have not been marketed and are lying packaged at the site. It is estimated that of the 12-12.5 tons of pellets generated per month, if 10 tons of pellets from garden waste is also sold every month after using about 2-2.5 tons in the boiler for drying and heating the garden waste for converting to pellets,

this would cover the shortfall and generate a small surplus since biomass based fuel pellets currently sell at about Rs.9000 per ton, which would yield Rs.90,000 per month.

**Land requirement for Decentralized Waste Management:**

Hence, it is implied that less than 10,000 sq.ft, which includes both the facilities for carrying out waste water treatment and solid waste management, is enough for about 1000 households in the GPRA complex. However, it is estimated that for solid waste and waste water management, the land requirement would probably be around 6000-7000 sq ft for 6000 persons in a well-planned locality but not as sprawling and generously endowed as the GPRA complex, which is about 10 ft<sup>3</sup> (taking an average height requirement of 10 ft) or 0.28 m<sup>3</sup> per person almost permanently since the space is also recycled along with waste being recycled. In the case of mere dumping of waste in a dumpsite/ sanitary landfill, the per household land requirement per year is 0.0003 cm<sup>3</sup> or .0075 m<sup>3</sup> for 25 years, which will be exhausted in 25 years or less if the average household garbage generation is 0.5 kg/day or more. Hence, a landfill of 100 acres with the allowable height of 20 meters will barely last for 20-25 years. Therefore, perhaps 0.28 m<sup>3</sup> per person permanently for waste management within the city is worth it.



**Fig.3.2.8 Solar Street Lighting and Solar Water Heating at GPRA Complex, New Motibagh**

The question is whether we have 0.2- 0.3 m<sup>3</sup> per person in the city today for waste management especially in the densely populated areas where the Economically Weaker Section (EWS) of the population resides? Planning a city to include this can solve our problems of the Solid Waste Management and Waste Water Management permanently.

Source

Field visit and Material shared by NBCC.

## 3.3 Decentralised System - Defence Colony, New Delhi

### 3.3.1 Introduction

Solid waste collection and disposal are an important part of environmental hygiene and need to be integrated with environmental planning and policies. Improper collection, storage, treatment and disposal can lead to environmental degradation and serious health hazards. But sustainable waste management can be promoted through practice by various innovative techniques.

One such example of sustainable Solid Waste Management in Delhi can be seen at Defence Colony. The RWA in Defence Colony took the problem of waste management with help from environmental advocacy group Toxics Link in 2005. They created a success story, which is now a model for other housing colonies in Delhi.

It began when Toxics Link received a message from Mrs. Shammi Talwar, a member of Residents' Welfare Association (RWA), A Block, Defence Colony for establishing an environmentally sound municipal waste management in their community. This facility was set up at a cost of Rs 70,000 in 2005, in a small unused corner of the neighborhood.

Toxics Link decided to develop a model of decentralised solid waste management, with the resident community as the key stakeholder. In the beginning, while launching this project it was made clear that RWA would have to actively engage in this system to drive the project, to achieve long term success.

Respective roles and responsibilities were described to ensure that the community takes optimum ownership of the process and its sustainability. This is the first model established in



**Fig. 3.3.1 Door to door collection of solid waste**



**Fig.3.3.2 Kitchen Waste in one of the compost site**



Site information



Waste collection vehicle



Kitchen waste



Garden waste



Compost Pit



Manure from Compost

**Fig.3.3.3 Process involved in Decentralised System - Defence Colony**



**Fig.3.3.4 Compost pit of the site**



**Fig.3.3.5 Waste collected from different households**

the society for decentralised waste management.

### 3.3.2 Activities

Total of 4000 households in Defence Colony area, give away their domestic waste (wet, biomedical and dry) every day to garbage collectors. Garbage collectors with their helpers collect waste from these households and segregate the waste into dry, wet and biomedical. Dry waste is used by the collectors to sell in the market, biomedical waste is disposed in the 'Dhalao'. Wet waste is the important component of this (composting) system, which is retained in the colony.

The wet waste is used to make organic manure. A small composting area has been assigned for this work. The area consists of 6 composting pits, each pit having a size of 6x4x4 ft (approx.). The pits don't have bricks at their base to maintain the natural water flow. Effective Microbes (EM) solution is regularly sprayed on the compost at an interval of 2-3 days to maintain the moisture of the compost as well as to reduce the odor.

### 3.3.3 Compost

Each household gives about 0.3-0.5 kg of wet waste every day. Each compost pit produces 200 kg to 300 kg of manure every three months. This manure is sold at a nominal price of Rs.10 per kg to local people and is used for gardening

purposes. For instance, this manure is being sold to societies in Noida region, New Friends Colony etc. Toxics link has tested the compost samples for the presence of any kind of impurity against the standard values, and has not found the presence of any contaminants and hence the compost is used freely to generate revenue.



**Fig.3.3.6 Bird spotted at the site**

### 3.3.4 Garbage collection system

There are 16 garbage collectors, each having their individual helper working in this area. Including two helpers at the compost unit, a total of 34-35 people are employed here. Each garbage collector is paid Rs.100 per month per household for kitchen waste collection and a separate Rs.100 for biomedical waste. Segregation of the waste is done by the garbage collector itself and the dry waste is his to sell and earn some extra amount.

Even though they have been provided with gloves to work with, these workers are not habituated to using them. Workers are trained to identify E-waste and Bio medical wastes from mixed waste received at this site; they are also taught to segregate it accordingly. Every Wednesday meetings are held with the garbage collectors, composters and the residents

to interact and to maintain a transparent system for the sustainable solid waste management.

Timings for door to door waste collection are from 8.30 a.m. to 2.00 p.m. and the compost unit is open till 5.30 p.m. every evening. RWA pays for park maintenance. Till now, SDMC has not enforced prohibitions on this project. Currently, it is being used as a model in places like Friends Colony, Gulmohar Park etc.

Water conservation is also a part of this composting site, as they have facility for water harvesting also. RWA has installed 18 water harvesting pits around the colony. In addition to this, colony has 32 parks, out of which 20 are solely maintained by the residents.

Source: Visited the centre and interacted with Mrs. Shammi Talwar and other RWA members.

## 3.4 Decentralised System - Vasant Vihar, New Delhi

### 3.4.1 Introduction

According to an article published by The Indian Express on 30<sup>th</sup> May, 2016, Delhi produces 9,000 metric tonnes of garbage every day. Professionals from waste management discipline, recommend that this waste generation issue can be substantially resolved if residential societies process their organic waste such as, dried leaves, grasses, vegetable and fruit peels, rice etc. In this manner, they will not only reduce the waste by processing it sustainably but will also help generate revenue from the products obtained after the waste is processed. However, it can be accomplished only when biodegradable waste is not contaminated with non-biodegradable and toxic waste, which can be monitored at the local level easily. Moreover, it also helps in reducing the release of methane gas ( $\text{CH}_4$ ), which usually emanates from a landfill area when biodegradable waste is dumped and begins to decompose anaerobically.

One such initiative, to decompose and sustainably utilize the products obtained from the waste locally processed, is done by Vasant Vihar RWA, Delhi. It is widely known for converting wet organic waste into manure by aerobic composting technique. This kind of waste management in Vasant Vihar was started by Ms. Promila Vohra in 2003.

Instead of depending on the civic body to clear the garbage, the RWA of Vasant Vihar has created a composting facility at the 3 acre Shaheed Rajguru Park in Vasant Vihar D-7 Block, to turn wet waste into manure. By visiting the site it was evident that it is a unique community initiative, wherein residents of Vasant Vihar have taken responsibility to manage the waste generated by their block.

South Corporation standing committee chairman and area councilor, Shri. Radhey Shyam Sharma, in 2005 inaugurated the 'Community Composting Station' in the colony. He further decided to replicate this model in 6,400 parks under the corporation's jurisdiction.



**Fig.3.4.1 Ms. Promila Vohra launching the composting unit cell in Vasant Vihar in 2003**

### 3.4.2 Mechanism Involved in the Composting Process

The strategy for the process is divided into 3 major steps namely:

1. **Collection of the Organic Waste** - The waste from 200 households from D block of Vasant Vihar are brought to a dhalao just outside Shahid Rajguru Park. The waste collectors collect mixed waste from door to door from



Site Information



H to H collection vehicle



Entrance to Compost Site



Composting Shed



Manure Ready to Use



Dustbin

**Fig.3.4.2 Process involved in Decentralised System - Vasant Vihar**

different households and bring the collected waste to the nearest dhalao and carry out the process of segregation.



**Fig.3.4.3 Door to Door Collection of mixed waste in the Colony**

2. **Segregation** – The trolleys stacked with waste are unloaded near a dhalao to carry out the segregation of waste into different categories. Wet organic wastes such as, dried leaves, grass, vegetable and fruit peels, rice,



**Fig.3.4.4 Shaheed Rajguru Park in Vasant Vihar, a site responsible for composting the waste generated there**

leftover food, bread, curd etc, are separated from dry non-biodegradable wastes viz., bottles, packaging materials, paper, plastic bags, etc. The RWA has been working on the segregation mechanism of waste for about 2 years now and has trained their waste collectors efficiently to identify and store the segregated waste so obtained. The dry waste is sold by the waste collectors in the market and the wet waste is processed for composting.

3. **Composting** – The compost heaps or windrows are made at Shaheed Rajguru Park. The RWA has pioneered composting in this part of the block. They are also responsible for maintaining the composting facility in the park. Currently, it is a zero-waste park that even composts dry leaves and twigs into leaf mould.

The wet segregated organic wastes are then transferred and are arranged in heaps, followed by covering of the waste (with dried grass and leaves), to allow organic wet garbage to decompose for approximately 40-45 days. It is then dried and sieved and used as manure.

The process, is thus, accomplished by applying windrow composting technique and using EM solution on piled up waste, which aid in converting it into nutrient rich humus i.e., organic manure. The humus, so formed as the by-product is





**Fig.3.4.5 Segregated heap of wet waste at the Composting site**

used as the soil conditioner in parks and other parts of the colony.

In addition to this, they also compost neem leaves, which are used as insecticides. The RWA has created a nursery that has medicinal herbs and ornamental plants viz., wood apple, aloe vera, shyam tulsi, giloy amrita, papaya and lemon grass within the park for the use of the residents.

The other recyclable materials such as paper, packaging material, plastic bags, etc. are sent to recycling industry and in this way garbage being sent to landfills is reduced by nearly 70% from this colony.

In the colony, there are around 300 members in the RWA who contribute Rs 200 per month and 6 workers are employed for waste collection and segregation.

### 3.4.3 Other Initiatives

Broadening their objectives to conserve environment, RWA of Vasant Vihar has also stood up for further implementing steps to comply to Solid Waste Management Rules 2016



**Fig.3.4.6 Humus obtained after processing wet organic waste for about 40-45 days**

such as:

1. Separate areas are assigned at the RWA office for storing the collected E-waste from households, which helps in transportation of toxic waste away from the colony by an authorised E-waste collector.
2. There are 3 rainwater harvesting units in the park which aid in ground water recharge, as underground water level is declining at the rate of 1.7 to 2 meters, every year.

### 3.4.4 Conclusion

Such initiatives at local or community level depicts a strong and collective approach for waste reduction and sustainable utilization of its waste at source. It is necessary to sensitize other localities too, to reduce their dependence on waste management systems of government bodies and landfill areas.

#### Sources

1. Visited the site and interacted with Ms. Rashmi Gupta, a RWA member of Vasant Vihar.
2. [http://www.nswaienvs.nic.in/National\\_news\\_Sept15/News24.aspx](http://www.nswaienvs.nic.in/National_news_Sept15/News24.aspx)
3. <http://indianexpress.com/article/cities/delhi/delhi-the-high-rise-garbage-landfills-2825046/>

## 3.5 Decentralised System for Composting - Miranda House, Delhi University, Delhi

### 3.5.1 Introduction

Currently in India, about 960 million tonnes of solid waste is being generated annually as products during industrial, mining, municipal, agricultural and other processes. Out of this, approximately, 350 million tons are organic wastes from agricultural and domestic sources; 290 million tons are inorganic waste of industrial and mining sectors and 4.5 million tons are hazardous in nature. With rapid urbanization, the solution to manage waste sustainably is becoming critical. However, to safeguard our environment, efforts from various eco- activists, are being made for recycling different wastes and utilising them in value added applications.

‘Green Bandhu’ is one such organization, which assists and enables waste minimization and utilization in an urban landscape. It is known for operating a decentralized composting plant at Delhi University. As mentioned by Saurav Bardhan (co-founder and technical head of Green Bandhu Environmental Solutions and Services), every hectare of an urban green space produces 100 kg of horticulture waste every day. According to the research conducted by Green Bandhu, Delhi produces roughly around 1,100 TPD of horticulture waste, which is generally incinerated by street sweepers, which otherwise can be mixed with kitchen wastes to make the best mix for composting process.



Fig.3.5.1 Composting strategies followed by Green Bandhu



**Fig.3.5.2 Process involved in Decentralised System - Miranda House**

### 3.5.2 Approaches Involved

Green Bandhu uses composting practices for degrading wet organic waste into manure. In December 2013, Miranda House installed a new composting system, called as Hybrid-Rapid Composting System, with the assistance of Green Bandhu. It incorporates following approaches for composting method:

1. **Collection of the waste** – The garbage for composting process is collected from canteen, gardens / lawns and hostel mess, at least twice a day.
2. **Segregation** – The trolley or dustbins loaded with waste are unloaded at the site and is segregated by workers into 2 components,
  - a. **Biodegradable Waste** – This generally consists of leftover food, bread, curds, dried leaves, grasses, vegetable, fruit peels, rice etc.
  - b. **Non-biodegradable Waste** – It comprises of bottles, packaging materials, plastic bags, paper etc., which are stored separately in a big bag and disposed from the college at the nearest dhalao.
  - c. The college recycles paper into hand-made paper.
3. **Composting Process** – The biodegradable waste, so

obtained, is mixed with garden and kitchen waste in 1 : 3 proportion followed by crushing using Chipy Chopy Organic Waste Crusher or Shredder, which are available in different capacities such as 1HP, 2HP, 3HP etc. Further, rinsing and dehydration of excess water, liquid or moisture from the waste is done through Eazy Squeezy De-hydrator.

The process is then followed by Rolimoli and Rolipoli, in-Vessel Aerobic Composting Systems, which are also available in various capacities i.e. from 50 to 400 kg, by Green Bandhu Environment Solutions and Services. The composting period is usually 15 to 20 days, with a land requirement of 60 m<sup>2</sup>. Alternatively, the composting is carried out in large canvas bags of 1m<sup>3</sup> capacity each.

### 3.5.3 Conclusion

Currently, the college produces 60 kg of compost per day from about 200 kg of wet waste composted per day. The college uses about 50% of the manure in its gardens and lawns as soil conditioner. The rest of the manure is sold to earn revenue of Rs. 4,000 per month which prevents Rs. 12,000 on transportation of wastes outside the college. In 2013, the college spent Rs. 4 lakhs on a plant to make organic manure



Fig.3.5.3 Flow chart of the process involved by Green Bandhu to process biodegradable waste

from bio-degradable wastes. According to an estimate, the electricity used by the Hybrid-Rapid Composting Technology does not exceed Rs. 5,000 per year and is capable of handling from 1 kg up to 8 tons of waste per day. Thus, this makes the technology economically more feasible and practical which can be used in hotels, restaurants, temples, parks, gardens, schools, colleges, fruit/vegetable/flower markets, railway stations, municipal wards etc.

Such low cost innovations and practices thus help in reducing waste and in increasing the utilization of bio-degradable waste sustainably and at a rapid rate.

#### Sources

1. <http://www.downtoearth.org.in/coverage/make-wealth-from-waste-47164>
2. <http://futureag.info/news/india-sets-up-waste-management-system-to-boost-composting/>
3. Write up shared by Mr. Saurav Bardhan through interaction with college teachers and students.

## 3.6 Decentralised System for Composting - Regency Park II, DLF Phase IV, Gurugram

The Regency park II condominium, DLF Phase IV is a good example of 100% source segregation of solid waste in Gurgaon city. The Governing Body of the Complex Administrative Council, Regency Park II, undertook the project of introducing Waste Segregation at source and processing of Solid Waste in their premises. The whole process is environmentally friendly and sustainable.

The program is implemented by spreading awareness among the inhabitants of 500 residences, through distribution of pamphlets and explaining to them about what waste segregation is, why we should do it at source and how we can achieve it. Initially face-to-face training of all household staff, part-time and live-in staff was conducted by Ms. Priya Mehrish. Firstly, all the staff members were introduced to the steps of the solid waste management program started in the campus and the knowledge of solid waste management and source segregation was shared through pamphlets and talks. Second, all the household staff and maids who were given

blue ribbon bearing their name tag for initial training were given a red ribbon after completion of training. After providing training to the staff, the security personnel were told to keep a look-out for new inductees and train them on SWM. Further more, the Condominium personnel, like Housekeeping and Security, who are integral to the successful implementation of any process, were also trained. The premises for processing of Solid Wet Waste and Solid Dry Waste were identified and fitted with the required equipment.

The efforts made by the committee in communicating to and training residents and staff, paid off and resulted in total compliance within three days. Waste segregation by residents is almost 100% and processing of Solid Wet Waste yields 800-1000 kg of organic compost every month. The Dry Waste is being collected separately for recycling purposes. The solid waste is segregated in two different categories. Dry waste is disposed in blue polybags and wet waste is collected in green bags. Both are segregated at source. These are not



Fig.3.6.1 Compost plant at Regency Park, DLF Phase IV



**Fig.3.6.2 Regency park compost vessel bag**



collected if the waste is not segregated properly at source. While green bag is sent to the Composting shed the blue bag is sent to Dry waste shed at the other end of the campus.

The quarterly maintenance charges paid by each house hold for several services including Solid Waste Management Rs.5000 and the waste pickers and workers in the shed are paid their monthly remuneration from the collected maintenance charges only. The technology for composting plant was installed by Mr. Saurav Bardhan of Green Bandhu, a small start-up. Their technology is fully functional in the campus and is taken care of by the staff.

The success of this endeavor has resulted in the Waste Management Programme of Regency Park II being showcased through site visits in workshops for municipal representatives country-wide, being conducted by National Institute of Urban Affairs, on behalf of the Ministry of Urban Development, now Ministry of Housing and Urban Affairs (MoHUA) GOI, under the Swach Bharat Mission.

Today, Regency Park II is contributing to the environment by reducing the volume of waste that ends up at landfills, as well as reaping the benefit, in terms of cost and quality of organic compost. Residents live in a clean and green environment, free of the unsightly sight and smell of un-segregated garbage.

Approach Involved:

1. The Hybrid-Rapid Composting system is installed inside campus for composting. The following method is used:
2. Wet Waste (Biodegradables) – generally consists of leftover food, bread, curds, dried leaves, grasses, vegetable and fruit peels, rice etc.
3. Dry waste (Non- biodegradable) – consists of bottles, packaging materials, plastic bags, paper etc.,.
  - Collection of waste – The waste is collected in two different bags at each house hold.
  - Segregation – The segregation is done at two different levels. Dry waste goes into Blue bags and then bins and Wet waste goes into green bags and then bins.
4. Composting Process – the wet waste is mixed with garden waste and crushed using Chipzy Chopzy Organic Waste Crusher or Shredder, which are available in different capacities such as 1HP, 2HP, 3HP etc. Further, rinsing and dehydration of excess water, liquid or moisture from the waste is done through Easy Squeezy De-hydrator.

The wet waste is mixed with dry leaf litter from their gardens and put in various canvas container Bins/ Bags. C/N ratio is maintained and pH values lies between 6.9-7.2 . The compost for use is ready in 20-30 days. The Dry waste is taken by a waste collector/ recycler at a specified time once a day.

## 3.7 Decentralised System for Composting - Faridabad Sector 21A

This decentralized project of door to door collection and composting has been set up at sector 21 A bypass road in Faridabad with the support of the Municipal Corporation of Faridabad (MCF). The MCF has allotted about half an acre of land for the purpose of waste segregation and composting at a common site belonging to it, which is besides the waste water treatment facility at Sector 21 A. This project caters to around 600 households. An NGO, Human Kind Foundation has been given permission by the MCF to create a facility, collect, segregate the waste and compost the wet waste at the allotted site and run the operation with the revenue from user charges collected from the households. Humankind Foundation requested Rotary International Club in Faridabad to donate two e-rickshaws and large bins for collection, which they did.

### 3.7.1 Collection of waste from homes:

Waste is collected in both E-rickshaws and brought to the site daily by 2 waste collectors. They start at around 7a.m in the morning and complete the collection of waste from the households around 2:00pm. They bring the waste to the site at about 2.30 pm. The time taken for collection is long because most of the waste collected is non segregated, which they partly segregate just after collection in the e-rickshaws but mostly at the site. At the waste management site, secondary segregation is done, where non-biodegradable waste, hazardous waste like batteries, bulbs and sanitary waste, if any, are removed.

### 3.7.2 In-Vessel Composting System:

Large pieces of biodegradable waste like coconut shells, parts of vegetables and fruits like the hard parts of cauliflower, pineapple etc., are removed and crushed in a shredder. The grinder is also used for shredding dry leaves collected earlier

and kept ready for mixing with the wet kitchen waste when it arrives. On an average 300 to 400 kg of bio-degradable waste is prepared for composting through a process known as In Vessel Composting.

After segregation and shredding of bio-degradable waste, that is the wet waste, is mixed with bio-inoculum and crushed dry leaves or saw dust and introduced into the machine through a conveyor belt. This process is done every day. After the first 20 days, the first batch of compost is taken out through the outlet. After this, compost is generated every day. The compost which comes out of the machine is left out in the sun for drying for at least a couple of days to a week to remove all pathogens and for 'curing'. After sieving the cured waste, it is packed in bags of different sizes. Human Kind Foundation is one among several NGOs which are trying to do something to address waste related issues. The Foundation started this "Green Footprints" project in August 2017 and is continuing till date.

Approximately 1.5 to 2 tons of compost is harvested every month depending upon the quantum of incoming waste. Recyclables are segregated and taken by garbage collectors daily to sell in the market for some additional revenue. Rejected waste is disposed in the MCF Bins. There are two on-site working personnel and two waste collectors working in this project. The monthly expenses incurred in the project is Rs.50,000 approximately. The total cost of the project was Rs.18,00,000 (Rupees Eighteen Lakhs) that includes the cost of the in- vessel composting machine, shredder, weighing machine, construction cost of the shed etc. Land was provided by the Municipal Corporation of Faridabad free of cost for a period of 5 years. The readymade packaged compost is currently being sold at a rate of Rs.30 per kg to



**Fig.3.7.1 Door-to-Door collection of household waste by waste collectors**



**Fig.3.7.2 Segregation of waste after collection**



**Fig.3.7.3 Shredder for crushing dry leaves and horticultural waste as well as hard parts of vegetables and fruits**

the residents and Asian Hospital at Faridabad. However, the Foundation is on the lookout for permanent customers to make the project sustainable.

### 3.7.3 Specifications of the In-Vessel Composter:

GBES Bio-Composter is a containerised 'energy positive' natural composting system that uses in-situ heat to decompose organic/horticulture waste to produce highly nutrient rich compost. They have horizontal rotating cylinder design which ensures better aeration and mixing of compost. They have electrical components like shredder for feeding properly shredded waste, a small motor and a gearbox for

rotation of cylinder and blower for proper aeration.

Organic waste feeding into these systems is always done with 10-20 % of sawdust and 0.1 % of bio-culture/ bio-inoculum. Saw Dust ensures adequate carbon and moisture content to enable aerobic composting whereas bio-culture accelerates the process of composting and makes the decomposition process thermophilic causing liberation of heat. This natural heat causes evaporation of extra moisture and makes highly nutrient rich compost in 15 – 20 days. Therefore, no external/artificial heat is required which reduces electricity consumption when compared with automatic 24 hour machines. These composters



**Fig.3.7.4 Transportation of waste to the In Vessel Composting site**

run on negative pressure so that entire air gets sucked in and passes through an activated carbon based filter to produce odour free air. This makes these composters and composting process 'smell free'.

These composters comes in the capacity ranging from 25

kg/day to 1000kg /day. All internal contact parts are clad with 5 mm SS to check corrosion and ensure long life. This entire system is PLC based so that internal components get switched on and off at regular intervals. GBES Bio-Composters not only gives you nutrient rich compost but also makes 'Containerised Composting process Energy Positive.

## Chapter 4

# Recycling

### 4.1 Construction and Demolition Waste Recycling - Burari, New Delhi

#### 4.1.1 Burari Construction and Demolition Recycling Facility (C&D Facility) Summary

This unique large scale C&D recycling facility is located in Burari, North Delhi and operating since 2009, is a joint effort of the IL&FS and the Municipal Corporation of Delhi. It receives construction and demolition waste from all over Delhi. The system is engineered to handle and process mixed C&D waste. The plant started on 2<sup>nd</sup> February, 2009 and is continuing till date.

This Burari C&D waste processing facility had a capacity to manage 500 tons of waste which has now been upgraded to 2000 tons.

It uses recycled water (treated STP water) for the recycling process.

This system of separating the construction and demolition

waste at source and taking the same for recycling to the plant is reducing the burden on the landfill sites.

This system is able to recover about 95% of the incoming waste. It has already processed about 15 lakh tons of C&D waste since its inception in 2009. Only 5% of the residue reaches the WTE.

The recovered products include:

1. Soil (Earth) – 29-32%
2. Sand – 22-27%
3. Brick mix aggregates – 35-40%
4. Stone and concrete aggregates - 50% Current Scenario of C&D Waste

About 1.2 cr. tons (10-12 million tons) of C&D waste is generated annually in India. Delhi generates about 5,000 TPD of C&D waste. C&D waste is a high density waste consists mostly of inert material.



Brick Making



Concrete Aggregate



Administrative Building



Aggregate

**Fig.4.1.1 Process involved in C&D Facility, Burari**

## Composition of C&D waste in Delhi

- Per Sqm waste generation:
  - New Construction activities: 35 kg/ sqm
  - Re-Construction activities: 350 kg/ sqm

**Table 4.1.1: Composition of C&D waste in Delhi as per different surveys**

Percentage Composition of C&D	As per TIFAC	MCD Survey, 2004	Survey 2005 by IL&FS Ecosmart
Soil/Sand, Gravel	36.0	43.0	31.5
Bitumen	2.0	-	-
Metals	5.0	-	0.4
Masonry/Brick	31.0	15.0	59.0
Concrete	23.0	35.0	-
Wood	2.0	-	1.5
Others	1.0	7.0	7.6
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

(Note: Metal, Timber, glass, plasterboard and plastic are almost entirely recycled.)



**Fig.4.1.2 Flowchart of the process**

## 4.1.2 Engineering Properties of C&D Waste

**Tests Conducted by NCCBM and DCE on the samples from four sites.**

Aggregated Crushing test, LA Abrasion Test, Impact Test, Test for shape, Water gravity.

Absorption and Specific

**Test results have indicated the following:**

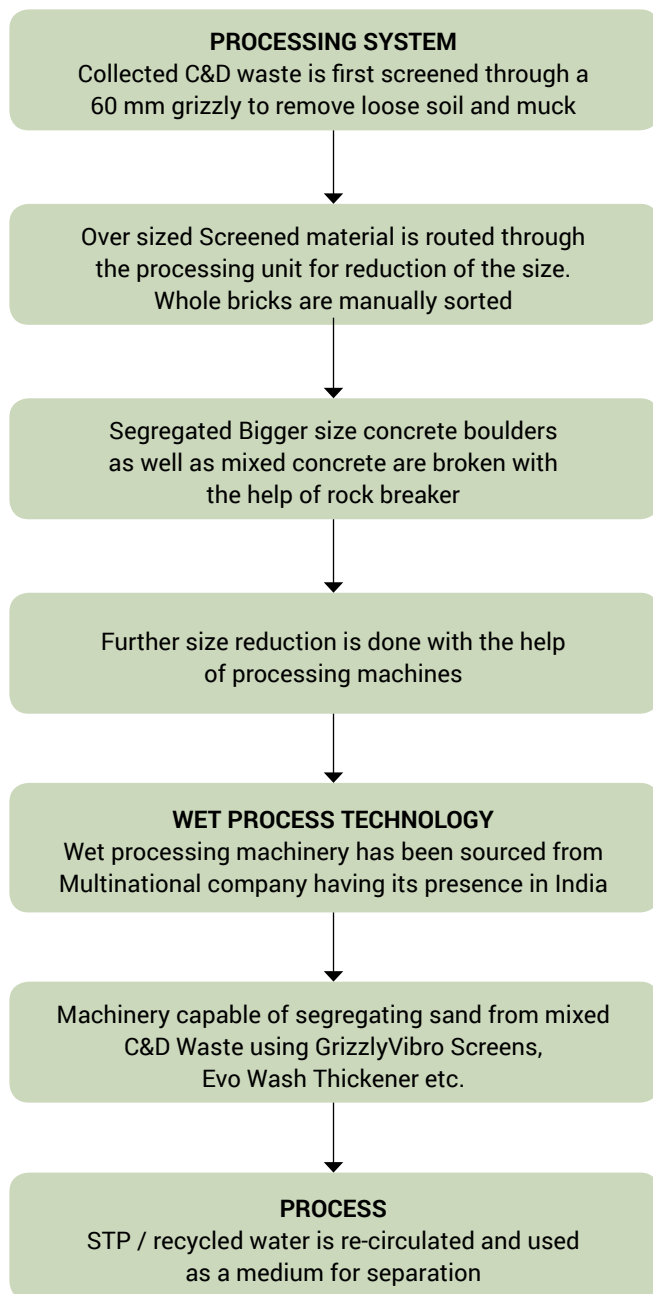
- Can be used for normal structural applications in roads.
- Permeability is high, making it more suitable for structural fills.
- Compaction, consolidation and compressibility of the test material are similar to medium and fine sands.

**Environmental and Social issues associated with C&D waste**

- Lack of public awareness
- Non availability of local collection sites
- Lack of enforcement mechanisms
- Traffic congestion due to dumping on roads
- Water logging due to clogging of drains
- Insanitary and unhygienic conditions
- Habit of MSW to be dumped over C&D waste



**Fig.4.1.3 Various recycled products made at the processing facility**



**Fig.4.1.4 Processing system for C&D waste**

**Table 4.1.2: Value Addition by Processing till date**

C&D Waste Processed (for making useful products) Tons	Not usable-silt/loose soil less than 4 mm (Cum) Tons	Material Produced			
		Aggregate Produced (Tons)	Granular sub Base Produced (Tons)	Sand Produced (Tons)	Total (Tons)
<b>1,53,000</b>	1,01,421*	<b>117054</b>	<b>5632</b>	4289	21626

Products	Total Casted/mixed/processed (Cum)
Cast Products	2016
Ready Mix Concrete (RMC)	5947

### 4.1.3 Performance of the Project

55% of hard constituents of C&D waste can be granular sub-base, bricks, etc converted into different form of aggregates which can be used again as building material for non-load bearing sections.

Burari Plant's emphasis is to separate concrete from mixed rubble.

1. Recycled concrete aggregate (RCA) consists of aggregates produced by crushing concrete separated from C&D waste. This aggregate is used for making value added products like pavement block, kerb stone, drain covers and other non-load bearing products.
2. Recycled aggregate (RA) consists of aggregates produced by crushing clean C&D consisting of bricks and concrete pieces. This constituent is used to make aggregates such as mortar sand, granular sub-base, bricks, etc

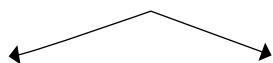
### 4.1.4 Products

1. Recycled Concrete Aggregate (RCA)
2. Recycled Aggregate (RA) (consisting of concrete & brick pieces)
3. Pavement Blocks & Kerb stones, drain cover, any other non load bearing pre cast product

Mixed C&D waste



Recycled Aggregate (RA)



Aggregate 10-20mm



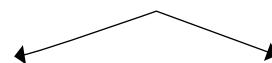
Aggregate 3-10mm



Concrete waste



Recycled Concrete Aggregate (RCA)



RCA 3-10mm



RCA 10-20mm



**Fig.4.1.4 Material Recovered from the C&D Plant at Burari**



**Fig.4.1.5 Pavement Blocks**



**Fig.4.1.6 Kerb Stones**

4. Brick Pozzolana, Coarse Sand and Silt, Ready Mix Concrete
5. Concrete Blocks and Hollow bricks

### 4.1.5 Innovation in the Project

This is the first project of its kind in the country, the selection of processing equipment and methodology adopted for processing has had to undergo a number of iteration / improvements. Due to the heterogeneous nature of the incoming C&D waste, company had to constantly fine tune the production process as well as the technology adopted for recycling. It will be worth mentioning here, that so far, the plant has processed approximately 20 lakhs tons of C&D waste till date at Jahangirpuri/Burari.

1. IEISL has invested close to 25 cr. in the project as capex.
2. This endeavour has been well appreciated by Ministry of Urban Development (MoUD), now Ministry of Housing and Urban Affairs (MoHUA) which has asked all states to look into the possibility of installing such facilities in cities having population above 10 lakh.
3. The major purpose / objective of this activity is to separate C&D waste from MSW stream and to reuse & recycle C&D waste into useful building material. This will, in turn, help increase the life of landfill sites.

### 4.1.6 Key Variations Implemented

1. Mechanical and Manual separation of concrete from

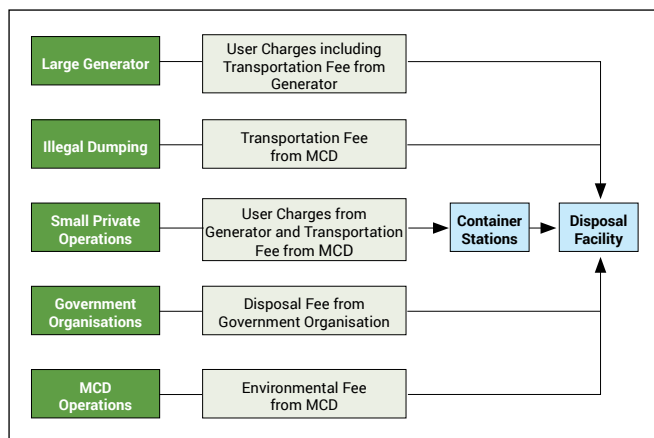
mixed C&D waste.

2. Processing of concrete and mixed C&D in batches.
3. Size reduction of C&D by use of Impact crusher, as by use of Impact crusher better cleaning of aggregates is achieved (as compared to conventional jaw and cone crusher).
4. Advance technology to produce manufactured sand.
5. Inter connection of process lines so that aggregates in usable sizes as per market demand can be made.
6. Design mix of Ready Mix Concrete using 100% recycled concrete aggregates.
7. Production of products like pavement blocks, pavement tiles, roof tiles.
8. With the implementation of the wet processing facility, a fraction of upto 95% is obtained from the C&D waste, whereas, earlier only 40% was obtained.
9. The 5% remaining comprises of wood and other material, which is sent for RDF generation.

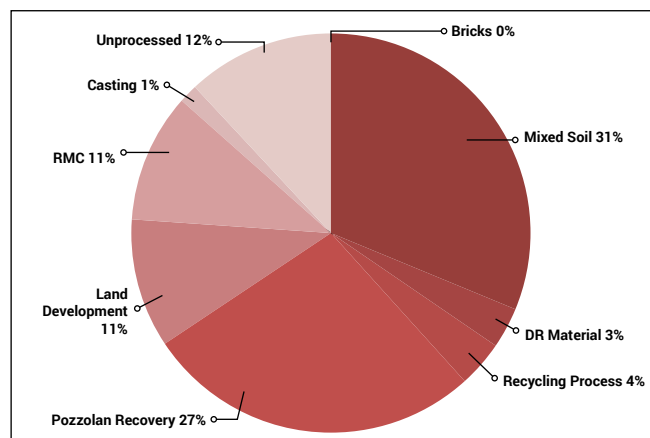
**Therefore, the facility is a Zero - Waste plant.**

### 4.1.7 Social & Environmental Impact

1. Improvement in C&D Debris Management Situation in Delhi.
2. C&D Waste has been processed as per Compliance with C&D Waste Management Rules 2016.
3. Urban areas have huge dump sites where Municipal Solid Waste for years has been dumped. C&D waste also



**Fig.4.1.7 Flow chart representing financial model of the project**



**Fig.4.1.8 Pie chart representing financial model of the project**

- continues to go to this dumpsite. By reuse of C&D, load on overflowing dumpsite is reduced.
4. City will be cleaner.
5. Drain clogging is less.
6. C&D waste which is indiscriminately dumped throughout the city is processed and made into products, which can be used by the building Industry.
7. Professional and Scientifically Managed Projects.
8. Improving efficiency of Composting and Energy Efficiency processes.
9. Long-Term Sustainable Solution.

10. Constant endeavor for improvement through R&D.
11. Recycling and reuse of C&D Debris.
12. Gradual shift of illegal C&D debris dumping to legalized utilization system.
13. Phase wise transfer of C&D debris management cost to the generator / polluter.
14. Assurance to make buyback arrangements of pavement blocks and kerb stones.

Source

IL&FS and Mr. Pradeep Khandelwal, Chief Engineer, East Delhi Municipal Corporation, Delhi

## 4.2 Material Recovery Facility (MRF) - Chintan

### 4.2.1 Introduction

Every day, millions of people across India earn a living by working in trash—this includes over a million waste pickers, as well as itinerant buyers, small and large waste traders, workers in these godowns and reproprocessors. Their work involves picking waste, segregating it, cleaning it, dismantling it, transporting it and trading in it. They are effectively the primary recycling system in India and help keep the environment cleaner than it would otherwise be. But the work of the recyclers themselves is far from being a green job, and very far from being secure.

While they offer invaluable services to the city, recyclers have few rights and operate on uncertain and poor working conditions. Every day, they are exposed to poisons, are forced to pay bribes simply to do their job, are harassed and suffer violation of their basic rights.

Chintan addresses this by helping build green businesses at the bottom of the pyramid, chiefly among waste pickers. Our understanding of green jobs in the Indian context builds on the widespread international understanding. We define a green job as one that not only results in environmentally sustainable goods and services, but also one that enables a worker to earn minimum wages, work safely and legally and not be exposed to toxins. Some examples of this are doorstep waste collection, composting, primary treatment of PET plastics, and safe dismantling of complex electronic waste (e-waste).

### 4.2.2 About the centre

1. Chintan works with partners such as the New Delhi Municipal Council (NDMC), Ghaziabad Nagar Nigam, a range of RWAs across the Delhi region, Safai Sena

and other agencies to help set up solid-waste handling systems that result in green jobs. In most cases, this involves doorstep waste collection. In the NDMC area, they have been contracted to serve over 6,000 households as well as other establishments.

2. Chintan also works with informal doorstep waste collectors to help them formalize their work through legal contracts with RWAs. In Ghaziabad, Chintan has worked with Safai Sena to provide professional doorstep collection services to over 20,000 households.
3. Apart from doorstep collection, Chintan has trained waste pickers to handle waste from several offices, hotels, malls, large buildings, restaurants and railway stations.
4. In the materials recovery facility at the New Delhi Railway Station, there are a total of 70 workers. They are providing services to 30 trains currently. They work in three shifts.
5. They receive about 3 tons of mixed waste. The wet waste, which is about 40 % of the total waste, is separated and sent for composting. The wet waste is inoculated with EM solution, which through a consortium of bacteria enhances composting and controls odor.
6. Currently they have 30 composting pits and one organic waste convertor. They are able to produce at an average, about 600 kg of compost per month. During summers the production of compost increases and they are able to recover it every twenty five days. This prepared compost is purchased by the New Delhi Railway station authority or other landscapers who utilize it for creating gardens and parks.
7. About 5 tons of PET bottles are received per month. Initially the bottles are separated from their wrappers and cap. The bottles are crushed separately after which they are collected, transported and stored at their Bhopura MRF until it acquires an amount of 5 tons (or three trucks)



Fig.4.2.1 Collection Segregation of Waste

after which they transport and sell the same.

### 4.2.3 Chintan Material Recovery Facility At Bhopura

The Bhopura material recovery facility run by Chintan, an NGO working in Delhi is a centre at Bhopura, Ghaziabad, which manages tons of unsorted garbage from houses, hotels, roads etc., which would otherwise end up in landfill dumps outside the city. It is segregated here into organic



**Fig.4.2.2 Women segregating the mixed waste**

and non-organic waste by trained workers at the centre. The sorted dry waste is then passed onto various waste buyers and recycling centres, for recycling. The centre has currently 120 rag pickers; who are provided with the ID cards, to give them formal recognition of being waste collectors at Chintan. By collecting and recycling waste, they not only help in segregation of the wastes and recycling of it into various products, but also protect the environment from various health hazards. The centre is operational in 3 shifts every day, wherein mornings and nights are for collection purposes and day is meant to segregate and process the collected wastes.

Most of the workers here are women who earn daily wages through segregation of wastes into different categories. The facility employs 105 women and 15 men for waste segregation and recycling. They are able to earn Rs 8000 to 9000 per month along with health insurance facilities. The employees are provided with protective gear of shoes, gloves and masks.

The mode of waste collection is mostly through using cycles (58%), followed by walking (24%) and rickshaws (18%). The average distance travelled by waste pickers using these three environmental friendly modes of transport is 11-16 km.



**Fig.4.2.3 Compositing Area in the plant**



**Fig.4.2.4 Hand-crafts built from waste glass materials**

## 4.2.4 Activities

The centre is spread across an area of 1242.15 m<sup>2</sup> and recycles 1 ton of waste per day which usually contains organic matters, plastic bottles, tissue papers, soft drink cans, newspapers etc. Due to improved techniques and innovative ideas, the centre has now been able to withdraw 83 items from mixed waste, such as paper, glass, PVC, improved recyclable items and non-recyclable item like 'Kurkure' packets. E-wastes are also collected from the mixed waste and are sent to authorized centers for dismantling and recycling.

Composting is another activity, which is carried out in the centre, to degrade the wet waste segregated from mixed waste. It is carried out across an area of 2.07 m<sup>2</sup> and has overall 30 pits, to carry out the aerobic composting process, which produces 3 tons of manure. The pit size is 3' x 6' and has a capacity to accommodate 150 kg of wet waste. The compost is lab tested and is therefore used for marketing purposes as well. They generally use dry leaves for composting purpose instead of wooden chips, to prevent spoilage of compost.

The centre has waste paper collection unit as well, which not only helps in recycling but it also aids the plant and workers to generate extra revenue.

Approximately, 4 tons of waste per day and 120 metric ton of waste per month is collected and resold at this centre, which otherwise would have been dumped into some landfill areas. The costliest recycled product at this centre is PET bottle, followed by LD and HD bottles. The selling price of PET bottles is Rs 30 to 34 per kg, after shredding. The price of multilayered non-recyclables was initially Rs 205 per ton, which is now being raised 303 per ton, which is sold to WTE.

The centre is also known for producing handicrafts from different glass material separated from wastes like lamps, flower vase, glass bottles, decorative items etc.

### Source

1. Visited the centre and interacted with different officials and workers.

## 4.3 Recycling of Dry Waste and Floral Waste - Trash to Cash

### 4.3.1 Introduction

The Trash-to-Cash unit has a group of 36 adults with intellectual disability who create the basic fabric, sheets of paper, dried petals for Holi and Rangoli colour etc. A production team comprising 59 people who are hearing impaired, visually impaired or physically challenged are trained to make the products such as bags, coasters, folders, and conference items. Women with disability form the core of this section. Most of them have some basic skill in tailoring, and are honed on-the-job. The group is inclusive with 25% “able” but educationally and economically deprived persons.

Dr. Madhumita Puri, the CEO of the NGO, who was previously clinical psychologist in 2000, started her efforts to educate people with disabilities. Thereafter in 1992, it resulted in the

establishment of The Society for Child Development and a school called Prabhat for people with intellectual disabilities. It was launched to address the issue of quality education and life skill training for children and young adults with intellectual disability.

The raw material for the products range from old cassettes, CDs, egg shells, flowers, magazines and vinyl banners from the Delhi Metro etc. Nothing goes waste here, as innovative ways of recycling and re-purposing are thought of daily.

The following strategies were developed, keeping in mind a vision to create a self sustainable employment unit, which was not donor driven and with no examples to model upon. They are:



Fig.4.3.1 Different handcraft products manufactured at the centre



**Fig.4.3.2 Process involved in Recycling (NGO) - Trash to Cash**



**Fig.4.3.3 Adults and Children, engaged in various recycling activities, at the centre**

1. To start a training facility with a manufacturing endpoint that utilized the strengths of this group.
  - a. Ability to learn and carry out simple repetitive tasks
  - b. Regular attendance (their parents were keen they left the house to enable them – the parents – to carry out their own economic activities)
2. To create products that utilized basic manufacturing processes, which were endemic to the region.
3. To source raw material that was low-cost, widely available and easy to get.
4. To create a product line that had a unique quality.
5. To use master trainers who were easily available.



**Fig.4.3.4 Recycled products crafted by differently abled people, at the centre**

Today, 15 years later, one can find marketable products made by the differently abled people, with a view of letting them earn an independent livelihood. The process involved in the centre to train the individuals, is basic to execute with ease; but the resultant product is so beautifully crafted that compels the consumers to buy.

#### Sources

1. Visit the centre and interacted with different officials, workers and children.
2. <https://www.lifepositive.com/from-trash-to-cash/>
3. <http://www.samhita.org/social-organisation/trash-to-cash/>

## 4.4 Recycling and Rehabilitation - Gulmeher

### 4.4.1 Introduction

Gulmeher is a producer company of women artisans who were formerly waste – pickers working on the 20 year old waste dump in Ghazipur, East Delhi. The area is home for 350 waste pickers, who depend on the landfill for their livelihood. Gulmeher is one such CSR initiative that has helped these slum dwellers, by giving them dignified jobs and earnings. It demonstrates a sustainable business model centered on women's groups in the slum community for alternative and sustained livelihood through usage of discarded flowers from the Flower Market to produce products that can be used as decorative items such as, greetings cards, colours, and recycled paper.

It was established in May 2013 as part of extended commitment to the social infrastructure to the Waste to Energy plant. It was planned with the help of an NGO, Institute

for Development Support (IDS) and designers from National Institute of Fashion Technology (NIFT), who imparted skills needed for the project planned by them. IL&FS provides technical training and working capital support to this organization. Since, May 2013, over 35 women have been skilled in alternative income generation making handicraft products like folders, notepads, greeting cards and calendars, which are being sold in the market. In addition to this, they use recycled paper originating from IL &FS offices in Delhi and flowers dumped as daily wastage in the neighboring wholesale flower market.

The centre is also engaged in periodic health check-ups for the women and children and awareness workshops for the community. The Financial Inclusion Program that Gulmeher has initiated, no-frills banking services have also started in the centre now, to aid their employers in banking and financial



Fig.4.4.1 Handicraft products manufactured at Gulmeher



Fig.4.4.2 Women artisans working at the centre



**Fig.4.4.3 Activities involved in Recycling (CSR) - Gulmeher**

management.

### 4.4.2 Strategy

The Gulmeher Livelihood Centre established within the waste-picker community, anchors all social initiatives. The women are being organized to create a self-help group. The goal is to:

- Engage the community, especially women, and provide them a broader range of income, streams that result in a safe and dignified occupation
- Create a marketable Gulmeher brand and empower the women to take leadership in all management processes
- Establish a producer company where each woman owns shares and has ownership
- Sustain a nurturing environment in the Livelihood centre and let it function as an area resource centre for the community

### 4.4.3 Programs

The following programs are actively run by the organization-

- Livelihood Development
- Handicraft products with Dried Flower Decoration
- Dried flower Color Making
- Recycled Paper Unit



**Fig.4.4.5 Crèche for children and women at the centre**

### 4.4.4 Gulmeher Crèche

Gulmeher Crèche for children and women was established to provide the women artists of Gulmeher with safe and efficient child care. Till now, 43 children from Crèche have been mainstreamed into local government schools. They also sports program for children between 6-14 years and remedial and bridge schooling centre for 50 children between ages 6-14 years.

#### Sources

1. Visit the centre and interacted with different officials, workers and children.
2. [http://www.ilfsindia.com/pdf/2014/A\\_About\\_the\\_Comapny.pdf](http://www.ilfsindia.com/pdf/2014/A_About_the_Comapny.pdf)



**Fig.4.4.4 Cards, Sanitary Napkins and Paper recycling Unit at the centre**

## Chapter 5

# Integrated Solid Waste Management (ISWM) Facility at Narela – Bawana

### 5.1 Introduction

In the past few decades, Solid Waste Management (SWM) has become a global concern due to growing urbanisation and changing lifestyles. India is among the top ten countries generating the highest amount of MSW in the world, partly due to the sheer size of its urban population and partly to the high-consumption lifestyle, urban residents have recently adopted. As a result, it has become imperative for managing the waste sustainably in an urban landscape. One such innovation that enabled us in accomplishing such a purpose is the Integrated Solid Waste Management (ISWM) Facility. ISWM of Municipal Waste at Narela - Bawana is the application of suitable techniques, technologies and management practices, covering all types of municipal solid wastes from all sources to achieve the following objectives:

1. Waste reduction,
2. Effective Management of Waste produced after waste reduction
3. Generation of Electricity from waste



**Fig.5.1 Site view of Integrated Solid Waste Management (ISWM) of Municipal waste at Narela – Bawana**



View of W to E Plant Bawana



Leachate Treatment Plant



Waste Dumping Site



Processing Plant

**Fig.5.2 Integrated plant of Waste to Energy and Compost Plant at Narela Bawana**

The plant is spread across 100 acres of land and has the facility to process 4000 TPD of waste in two phases namely,

**Table 5.1: Phase of waste processing at Narela-Bawana Plant**

S. No.	Phase	Quantity Processed	Components
1	Phase - I	1000TPD	MRF, Composting, RDF, SLF
2	Phase - II	3000TPD	Power Plant, SLF

The site is characterised by the high tension line and the sewage line passing through the site. However, out of 150 acre of total site area, 50 acre area falling under the high tension lines, towards the Western Yamuna canal side, has been left out. Approximately 12,86,260 tons of solid waste is disposed off in this facility, which has been planned for 25 years. The different facilities of the plant are summarized.

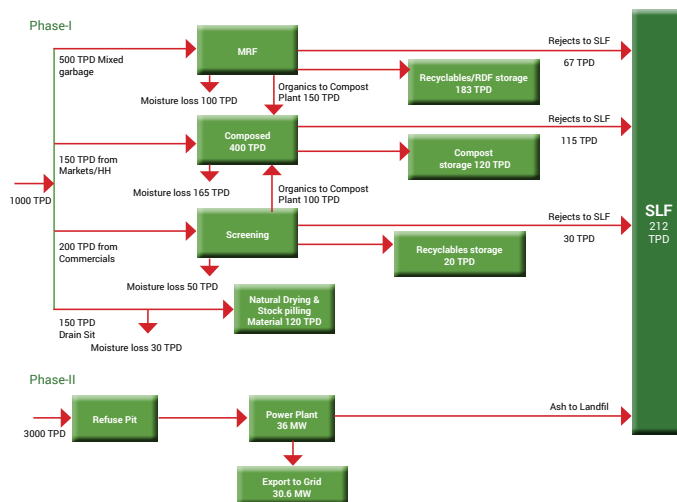
**Table 5.2: Facilities present at Narela-Bawana Plant**

S. No.	Facility	Area (Ha)
1.	Material recovery facility (including RDF)	0.27
2.	Compost Plant	2.7
3.	Recyclables storage Area	0.27
4.	Power Plant	13.1
5.	Landfill 1, 2 & 3	16.1
6.	Green Belt & other Infrastructure	8.03

## 5.2 Process Description

4000 TPD of municipal solid waste is treated in two phases; Phase-I processes 1000 TPD of waste and is composed of a material recovery Facility (MRF), to reclaim metals and recyclables, and sort out organic and combustible material for composting and RDF facilities. Phase-II is composed of a power plant based on Mass-burn technology, which will process 3000 TPD of waste.

Following is the process flow chart for the entire process involved in ISWM facility:



**Fig.5.3 Material Balance of Municipal Solid Waste**

## 5.3 Material Recovery Facility

A materials recovery facility (MRF) accepts materials, whether source separated or mixed, and separates processes and stores them for later use as the raw materials for

- Remanufacturing and
- Reprocessing

The main function of the MRF is to maximize the quantity of recyclables processed, while producing materials that will generate the highest possible revenues in the market. MRFs can also function to process wastes into a feedstock for biological conversion or into a fuel source for the production of energy. It's the first step for mixed waste processing prior to Composting and RDF facility.

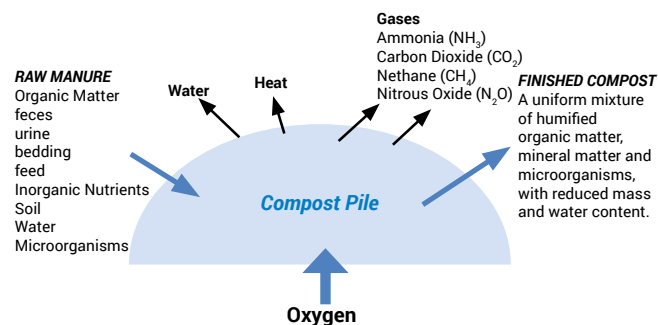
There are basically four components of a MRF facility:

1. Sorting
2. Processing
3. Storage and
4. Load-out

These activities promoted efficient and effective operation of a recycling program.

## 5.4 Composting

The main processing technology involved in composting is Aerobic Composting. The biodegradable material present in MSW is converted into stable mass i.e. manure by aerobic decomposition. Aerobic microorganisms oxidize organic compounds to carbon dioxide, oxides of nitrogen and carbon from organic compounds and are used as a source of energy, while nitrogen is recycled.

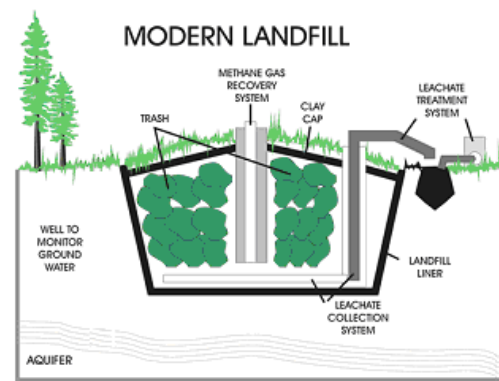
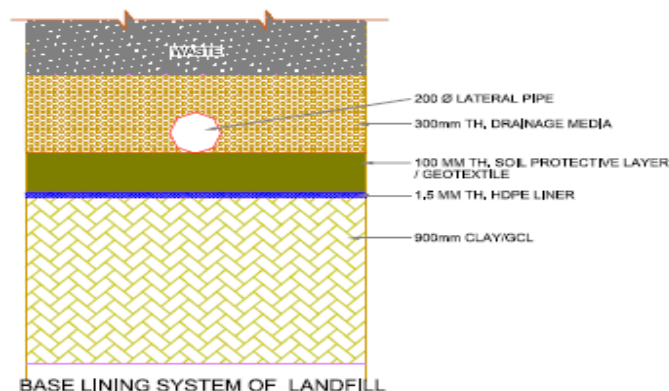


**Fig.5.4 Flowchart of Aerobic Compost process applied at the site**

The windrow system of compost facility has the capacity of 400 TPD of MSW, i.e. 150 TPD from incoming solid waste, 150 TPD from MRF, and 100 TPD from screening section. The height of each windrow is 2.5 meters, to ensure effective aeration. An appropriate microbial culture is applied for biodegradation and the retention period for the waste in the windrows is about 6 weeks.



**Fig.5.5 Compost unit at Narela- Bawana**



**Fig.5.6 Typical Cross Section of MSW SLF**

The windrows are turned every week to ensure proper aerobic conditions. Each windrow is monitored daily and corrective actions are taken to facilitate fast and steady composting. The inoculums are spread over the heap to avoid odor. During exothermic composting process moisture gets evaporated and volume gets reduced to approximately 50%. The semi digested matter so formed is then further used for screening and stabilization by curing.

## 5.5 Sanitary Landfill (SLF)

The primary objective of SLF facility in the plant is for safe long-term disposal of wastes, both from health and environmental view point. Ultimate solution for Waste

Disposal involved in the plant is an engineered Sanitary Landfill. All efforts done by way of processing and recovery of recyclables are aimed at reducing landfill burden as well as for reducing pollution potential of the wastes sent to Landfill.



**Fig.5.7 Waste to Energy (WtE) plant at Narela – Bawana**

## 5.6 Waste to Energy (WtE) Plant

The Integrated MSW management facility encompasses energy recovery facility by establishing a 36 MW power plant. It processes 3000 TPD of MSW wherein about 20% of ash, so formed, is sent to Landfill. The power plant constitutes 5 Boilers, at 42 bar and 410 °C, having capacity (Steam Output) 37.5 TPH and 5 multistage, impulse, nozzle governed Steam Turbine Generators of 7.5 MW nominal capacity each. The Total Power Generation of the plant Installed is 315.36 MU and the In – House Consumption is 47.3 MU. Thus, net saleable power generated is 268.05 MU.

## 5.7 Water Management

The source of water is from Delhi Jal Board for Phase- I & II of the plant. The aggregate water requirement for the Phase-I has been estimated to be about 155.2 ML /day, whereas for Phase-II demand is 1117 ML / day.

## 5.8 Waste Water Management

The wastewater (Leachate) generated from the compost, landfill, domestic and other sources like boiler blowdown, cooling-tower blowdown, treatment plants, are taken to the

Effluent Treatment Plant (ETP). Quantity of waste-water/ leachate produced from Phase – I & II is summarized below:

**Table 5.3: Quantity of Waste water generated from Phase I and II of the plant**

S. No.	Source	Quantity m <sup>3</sup> / day
<b>Phase -I</b>		
1.	Drinking and cooking	4.16
2.	Other domestic uses	5
3.	Leachate from Landfill	15
4.	Leachate from Compost	130
<b>Total</b>		<b>154.16</b>
<b>Phase-II</b>		
1.	Boiler	25
2.	Cooling Tower	57
3.	WTP	27
4.	Domestic purpose	12.8
5.	Leahae from Landfill	55
6.	RO-DM plant	55
<b>Total</b>		<b>231.8</b>



**Fig.5.8 Leachate Treatment Plant (LTP) at Narela - Bawana**

The treated water is examined under the following parameters:

**Table 5.4: Showing the parameters of the treated water and their values**

S. No.	Parameter	Unit	Value
1.	pH		6-9
2.	Suspended Solids (SS)	mg/l	<100
3.	Biological Oxygen Demand (BOD) @ 27°C	mg/l	<30
4.	Chemical Oxygen Demandc (COD)	mg/l	<250
5.	Oil & grease	mg/l	<10

## 5.9 Conclusion

Growing urbanization results in excessive MSW generation. Therefore, to achieve sustainability in waste management, it is imperative to implement Integrated Solid Waste Management technologies, which efficiently helps in waste minimization and reduction.

Source  
Visited the plant & interacted with different officials & workers.

## Chapter 6

# Planning and Implementation

### 6.1 Introduction

Formulating a plan to implement the various solutions which the participants were exposed to is the final step of the workshop. Planning is an integral part and the foundation for effective solid waste management so that concrete steps can be taken to achieve Swachh Bharat Mission's objective of "Modern and Scientific Municipal Solid Waste Management".

As per the Swachh Bharat Mission Guidelines it should be the endeavor of ULBs to formalize and streamline SWM systems along with integrating and upgrading the working conditions of the informal sector workers in waste management (rag pickers) by integrating them into the formal system of SWM in urban areas.

Municipal Solid Waste Management refers to a systematic process that comprises of waste segregation and storage at source, primary collection, secondary storage, transportation, secondary segregation, resource recovery, processing, treatment, and final disposal of solid waste. For this purpose, ULBs are to prepare DPR (Detailed Project Reports) for Solid Waste Management of their city in consultation with state governments. DPRs can be formulated to implement any of the solutions suitable for managing the solid waste of the area under consideration.

### 6.2 Salient Features of DPRs as per Swachh Bharat Mission Guidelines

1. The DPRs should be bankable, with a viable financial model.
2. DPRs should be prepared emanating from the needs identified in the City Sanitation Plan.
3. Only new projects will be considered under the Mission and it will be ensured that there is no duplication. Projects will be considered as "new" if they are not projects already sanctioned and ongoing under state and central schemes and externally-aided programmes.
4. DPRs should be aligned with Govt. of India's goals and rules outlined in:
  - a. Municipal Solid Waste (Management and Handling) Rules, 2000 by MoEFCC
  - b. SWM Rules, 2016 circulated in the year 2016 by MoEFCC
  - c. Separate rules for Construction and Demolition Waste Management 2016
  - d. Municipal Solid Waste Management Manual 2000 by MoUD, now Ministry of Housing and Urban Affairs (MoHUA) and CPHEEO
  - e. Guidelines published by MoUD, now Ministry of Housing and Urban Affairs (MoHUA) through CPHEEO in the year 2016
  - f. Revised Manual on Municipal Solid Waste Management, 2016

- g. Swachh Bharat Mission guidelines published by the MoUD, now Ministry of Housing and Urban Affairs (MoHUA) in 2014
  - h. National Urban Sanitation Policy (NUSP), 2008
  - i. Plastic Waste Management Rules, 2011 and revised in 2016
  - j. Bio-medical Waste (Management and Handling) Rules, 1998 and amended 2003, 2011 and Bio-Medical Waste Management Rules, 2016
  - k. E-Waste Management Rules, 2011 and revised in 2016
  - l. Battery (Management and Handling Rules) 2001
  - m. Inter-ministerial Task Force on Integrated Plant and Nutrient Management using City Compost, 2005
  - n. Fertilizer Control Order (FCO), 2009; PROM, 2013 by Ministry of Agriculture
  - o. Report of the Task Force on Waste to Energy, Planning Commission, 2014
5. Street Sweeping and litter control interventions will be part of DPR which is essential for a clean city.
  6. The economic and technical appraisal of DPRs proposed by ULBs will be done by institutes of national repute authorized by a State High Powered Committee. The State Level high power committee will approve the DPR as well as the financial model of solid waste management.
  7. The implementation of SWM projects will be as per directions of State Level High Power Committee.
  8. Central government incentive for the SWM projects will be in the form of a maximum of 35% Grant / VGF for each project. The balance funds can be generated from various other sources of fund which are:
    - a. Private Sector Participation
    - b. Additional Resources from State Government/ULB
    - c. Beneficiary Share
    - d. User Charges
    - e. Land Leveraging
    - f. Innovative revenue streams
    - g. Swachh Bharat Kosh
    - h. Corporate Social Responsibility
    - i. Market Borrowing
    - j. External Assistance
  9. SWM projects will be sanctioned by the State level HPC which shall include a representative of the MoUD, now

Ministry of Housing and Urban Affairs (MoHUA).

10. In DPR approval and procurement process, all provisions and procedures as prescribed by respective State Governments must be followed. The entire approval procedure for MSW projects except for release of Central funds will end at the State Level.

## 6.3 Preparation of Draft Municipal Solid Waste Management Plan

The MSWM plans are prepared based on a systematic process of:

### Step 1: Identifying the Focus Area

Recognizing the existing problems pertaining to SWM prevalent in the area by critically assessing the situation of SWM in the city based on the national, state, and local level rules, policies, and strategies for MSWM. The assessment should bring out waste quantification and characterization along with other deficiencies and gaps which need to be bridged in order to effectively achieve SBM objectives.

### Step 2: Stakeholders Consultation

A strategy to tackle the problem is formulated in consultation with various stakeholders and institutions like households, businesses, industries, informal sector, local government. NGOs, CBOs, SHGs apart from the municipal officials and ULB members, for effective MSWM.

### Step 3: Preparing a Draft Plan

A MSWM plan is prepared for implementation with respect to a time frame. The following design periods (time frame) can be used for a SWM plan:

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

A long term plan should be further streamlined to identify short term action plans along with time lines for implementation. The five-year short term plan should be further detailed into task specific actions and written in form of detailed project reports (DPRs)

### Step 4: Financing the Project:

Sustainable financing is an integral part of planning for an efficient MSWM system. In order to ensure financial viability full cost accounting (FCA) for the various projects and MSWM system is essential. FCA determines the total cost associated with integrated waste management systems at local level over a specified time period. The major types of costs considered for FCA of MSWM are as follows:

**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.

With the help of FCA the concerned stakeholders can take into consideration the following source of financing and choose the source best suited to their proposed project:

1. **Municipal resources that include taxes and duties:** To finance municipal services ULBs have traditionally used revenues from various tax collected for example property tax.
2. **Grants from central or state government:** It is difficult for ULBs to finance projects solely through internal sources and hence the state and central government provides grants and funds for various projects. The funds available are: i). Finance commission grants ii). State commission

Grants iii). Central Government Grants (Swachh Bharat Mission)

3. **Public private partnership as a source of funding:** PPP model includes a systematic process of allocating and outsourcing services under the MSWM system to an external party. This process requires a standard procurement process to be adopted for the selection of a PPP partner.
4. **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.
5. **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.
6. **Municipal bonds and debentures:** The ULBs issue bonds and debentures to the general public or to specific institutional investors.
7. **Loans from financial institutions:** Specialized financial institutions—e.g., Infrastructure Development Finance Company (IDFC) and Infrastructure Leasing and Financial Services (IL&FS)—are agencies which provide loans and a variety of instruments for infrastructure financing.

### Step 5: Evaluation of the Projects undertaken:

The progress of the plan and various projects under it should be evaluated from time to time. 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.

## 6.4 Process of formulating a Detailed Project Report (DPR)

### What is a Detailed Project Report?

DPR is a base document for planning and implementation of any project, and helps in delivering sustainable services and infrastructure effectively. DPRs are used for appraisal, approval and subsequent implementation of the project and hence should be made carefully with all the required details.

### Major sections of Detail Project Report

#### 1. Sector background context and broad project rationale:

This section of the DPR must provide the following details:

- It must tell about the existing status of the physical infrastructure.
- Information of user coverage and access (by different user categories/segments including urban poor)
- It must give a list of various proposed projects in the City Development Plan (CDP) and how this project can be aligned with the other projects.
- It must give a list of other supported projects with capital expenditure supported by other schemes.
- Cost recovery method with existing with existing tariff must be mentioned.
- It must have a detail of past five year trends.
- It must provide detail on existing per unit cost and existing per unit service delivery price in terms of per capita basis and the method of calculation should be provided.
- Any other qualitative information for example list of key issues that are of importance to the project, Importance of the project to the sector.

#### 2. Project definition, concept and scope:

The complete scope and extent of the project must be clearly demarcated in this portion of the DPR. Along with the “to be constructed portion” the project scope should also include the infrastructure which already exists for use. Hence this part of the DPR includes:

- Land:
  - Total land required and being provided for the project
  - Confirmation and proof that the required land is owned /already purchased by the ULB

#### b. Physical Infrastructure:

This section includes the detailed description of physical infrastructure required and available for the project. The physical infrastructure required for a Solid Waste Management Project can be divided into various components (component 1, Component 2, Component 3.....) as can be seen in the Table 1:

**Table 6.1: Physical infrastructure requirements for Solid Waste Management<sup>1</sup>:**

Major component	Sub component
Primary Collection	System of Collection (door-to-door collection, segregation of waste) Waste storage and collection bins (Household bins, Community bins) Primary collection vehicles (for collection and transfer to transfer stations)
Transfer Stations	Development of Transfer Stations Equipment
Transportation	Vehicles (for transfer from transfer stations to disposal site) Vehicle Depot
Disposal of Waste	Development of disposal site (land-fill site, compost plant, vehicle depot) Equipment at disposal site Recycling plant (briquette, waste-to-energy, etc.)

- Environmental compliance / Protection measures / Improvement Measures:
  - Environmental Impact Assessment
  - Environment Management Plan
- Rehabilitation and Resettlement
- Specialized procured services for design, independent supervision, and quality assurance
- Other information:
  - Details of surveys and investigations required to be carried out (site, customer, etc.)
  - Assessment of requirements related to utilities shifting
  - List of clearances and agencies from which these are to be obtained
  - Disaster related risk assessment and broad countermeasures (including earthquake/other natural disaster resistant design of structures)

<sup>1</sup> Adapted from JNNRUM Detailed Project report Preparation toolkit

### 3. Project cost:

The project (construction) cost should cover distinct elements listed below:

- a. Physical infrastructure component-wise cost
- b. Environmental compliance cost
- c. Rehabilitation and resettlement cost (to be borne by ULB/ parastatal/ state government)
- d. Cost of surveys and investigations
- e. Cost of shifting utilities
- f. Cost of consultancy services:
  - i. Design
  - ii. Supervision
  - iii. Quality Assurance
- g. Other statutory compliance costs if applicable
- h. Finance/interest cost during construction
  - i. Contingency
  - j. Any other

All cost assumptions (rates, methods of calculations etc.) are to be clearly stated either in the main text or attached in the appendix of the DPR. In this section capital costs of the project are

### 4. Financial Structuring:

The financial structuring is done for the examination of the sources of funding of the project. In this section, the DPR must provide the detailed information. For financing of a project ULBs can use a combination equity, grant, debt and finance from private participation.

### 5. Project Phasing:

In this part of the DPR project implementation schedules are to be presented. Schedule planning is one of the most important part of DPR and need to be prepared for the activities as per requirement of the city planners. The various schedules are as follows:

- a. Schedule for tendering/selection for procurement of services.
- b. Schedule for bringing in State level and ULB level contributions to the project.
- c. Schedule for obtaining all clearances (along with list of major clearances).
- d. Schedule for shifting utilities

### 6. Project Operations and maintenance (O&M) framework and planning:

The O & M framework is planned in terms of:

- a. Institution framework and Billing strategy: Under this the DPRs should have information on the following:
  - i. About the institution which will be engaged in O&M of the assets.
  - ii. About the method used in making bills and collection.
  - iii. Description of the key issues and obstacles in regard to O&M.
  - iv. It should tell if there is any scope for private entity/ NGO in terms of O&M.
- b. Tariff and user cost recovery:

With regard to tariff and user cost recovery, the DPR should provide:

- i. Unit cost of service and unit price.
- ii. A plan to arrange tariff system full cost recovery user charges

### 7. Project Financial Viability / Sustainability:

Project viability assessment is based on a combination of the perspectives given below:

- a. Overall project perspectives:

The DPR is to provide financial analysis for (Net Present Value) NPV and (Internal Rate of Return) IRR defined in the following two ways:

- i. NPV and IRR (overall): examines overall project viability, including finance cost and asset replacement cost
- ii. NPV and IRR (O&M): examines only O&M viability

The complete supporting project cash flow projections along with underlying assumptions have to be presented. (A reference project cash flow template is provided in Annexure-1).

The Project financial assessment should clearly state the cost of capital considered and the calculation methods used.

- b. ULB level perspectives and financial situation assessment

The DPR is to provide the following information:

1. ULB cash flow:

This includes a complete cash flow covering the last 5 years

on an actual basis and projections for the next 20 years. The underlying assumptions for the projections also need to be mentioned (a reference format for ULB Cashflow is given in Annexure 2).

An assessment of the annual impact of the project on the ULB's finances for the Mission Period is to be provided showing the impact being high/medium/low (more than 20 %; between 20% and 5%; less than 5% respectively). The base year to be considered for this exercise is the last completed financial year. A format for providing the impact is given in table 3:

**Table 6.2 : Annual Financial Impact of Project on ULBs<sup>2</sup>**

S. No	Head	Impact Low/ Medium/ High (more than 20 %; between 20% and 5%; less than 5% respectively)						
		2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1	2	3	4	5	6	7	8	9
1.	Revenue Receipt							
2.	Revenue Expenditure							
3.	Capital Receipt							
4.	Capital Expenditure							

Base year: \_\_\_\_\_ (last completed financial year)

## 2. Debt situation assessment

This includes:

- Debt schedules and terms for all debt taken (to be provided in Appendices to the DPR.
  - Debt service coverage ratio (DSCR) Debt-equity ratio for the project and the ULB
3. Other financial information:
- Has the ULB been credit rated? If yes: provide the name of the rating agency, type of rating and existing rating details.
  - In case of Special Purpose Vehicle (SPV) or Joint Venture (JV) as a separate legal project implementation

<sup>2</sup> Adapted from JNNRUM Detailed Project report Preparation toolkit

entity, the Profit and Loss (P&L) Statement and Balance Sheet forecasts for the next 20 years shall be provided. In this context, the given project cash-flow template (as per Annexure 1) may be used as the initial reference format on which appropriate modifications can be made.

## 8. Project Benefit Assessment:

This part of the DPR provides a critical assessment of the project from a societal stand point. This should include:

- List of benefits (Social and Economic)
- Benefits are to be focused on project outcomes and specially on their impact on citizen's/user segments covering elements
- List of negative externalities or adverse effects (Social and economic)
- Identification of adverse impacts facilitates planning for possible countermeasures and also recognizes possible trade-offs in taking up the project
- Along with explanation of the benefits and adverse effects in qualitative terms
- Quantitative analysis of the benefits and adverse impact of the project.

The following table 4 can be used for this purpose:

**Table 6.3: Project benefit assessment table <sup>3</sup>**

S. No	Benefits Description	Comments	Quantitative Impacts and Underlying Assumptions
Societal Benefits			
1.			
2.			
3.			
Societal Negative effects			
1.			
2.			
3.			

For projects above 100 crores a structured estimation

<sup>3</sup> Adapted from JNNRUM Detailed Project report Preparation toolkit

of the Economic Internal Rate of Return (EIRR) would be prescribed as a part of the Social Cost-Benefit Assessment. The EIRR would incorporate monetization of the identified (quantifiable) social benefits and adverse impacts.

Following the given structure ULBs can write a complete DPR for various Municipal Solid waste management projects. A DPR checklist of the Ministry of Urban Development for SWM projects has also been given for reference in Annexure 3, on the basis of which ULBs can access if their DPR is complete with all the required information. **Model DPR**

## 6.5 Process of writing a Request for Proposal

### Procurement procedure of PPP

After a DPR is approved a standard transparent procurement procedure is adopted for the selection of the PPP partner. This process includes:

1. Preparation of expression of interest (EoI) (**Model EOI**), **Request for proposal (RFP)**, and concessionaire agreement
2. Obtaining approval from concerned authority
3. Issue of notice for pre-qualification or EOI
4. Short-listing of firms
5. Issue of RFP to the shortlisted firms
6. Conducting pre-bid meeting
7. Receiving technical and financial bids in separate packets in response to the RFP and opening of technical bids
8. Evaluation of the technical bid document received
9. Opening of financial bids of the bidders
10. Evaluation of financial bids
11. Selection of most preferred bidder
12. Negotiation and signing of agreement
13. Award of contract

## 6.6 Tendering Process

This tendering process can either be a single stage process or a two Stage process. In a Single stage bidding process technical and financial bids are submitted simultaneously in response to a RFP. Whereas the two stage selection process includes an initial prequalification stage, followed by RFP stage, which is applicable only to pre-qualified bidders. The

bidding schedule for the two tendering process are as follows:

### Schedule for Bidding – Two Stage Process

#### Stage 1: Pre-Qualification Stage (Minimum: 3 months)

1. Sale of request for qualification (RFQ): zero date
2. Submission of query by the perspective applicants: +15 days
3. Pre-bid meeting: +20 days
4. Authority response to queries: +30 days
5. Bid submission due date: +60 days
6. Opening of technical qualification bids: +60 days
7. Acceptance of technical qualification evaluation report by Tender Committee: +80 days

#### Stage 2: Bid Stage (Minimum: 6 months)

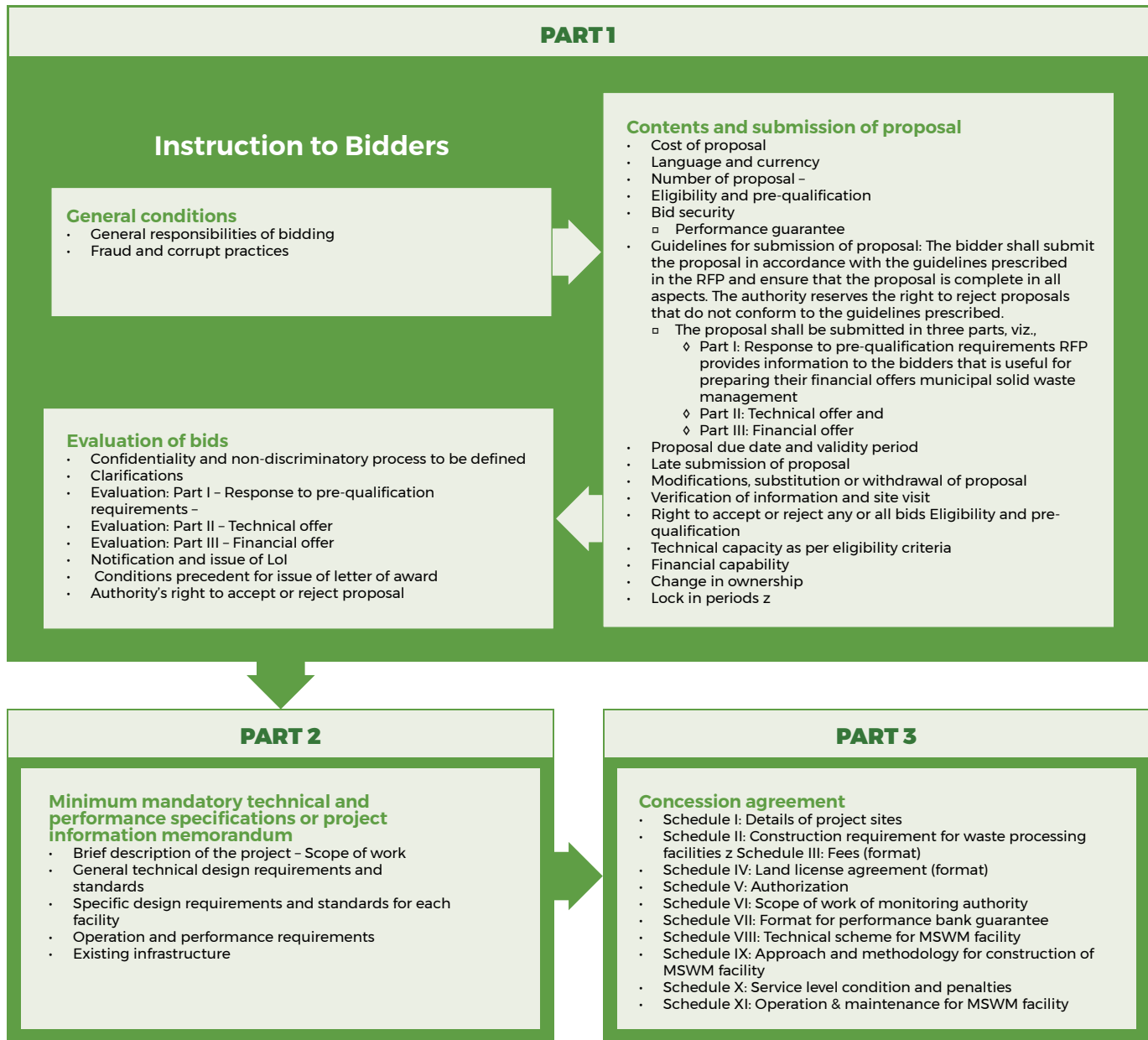
1. Sale of request for proposal (RFP) short-listed applicants: +90 days
2. Submission of query by the perspective applicants: +105 days
3. Pre-bid meeting: +110 days
4. Authority response to queries: +130 days
5. Bid submission due date: +150 days
6. Opening of bids: +150 days
7. Letter of Intent (LOI): within 30 days of bid opening date
8. Contract signing: +30 days of award of LOI

Notes: 1. The bidding process takes 6 months minimum. However, depending upon the urgency and requirement of the project execution the bidding process could be done within 60 days. 2. "+x" days means time duration from the zero date, i.e., date of publication of RFP

### Schedule for Bidding: Single Stage Process

1. Sale of bid or request for proposal (RFP) to short-listed applicants: zero date
2. Submission of query by the perspective applicants: +15 days
3. Pre-bid meeting: +20 days • Authority response to queries: +30 days
4. Bid submission due date: +60 days
5. Opening of technical bids: +60 days
6. Acceptance of technical evaluation report by Tender Committee: +80 days
7. Financial bid opening: +90 days
8. Letter of intent (LOI): within 30 days of bid opening date

## RFP Content List<sup>4</sup>



<sup>4</sup> Adapted from CPHEEO Manual on Municipal Solid Waste Management 2016

9. Issue of letter of award to bidder: +30 days of issue of LOI  
10. Contract signing: within 30 days of award of LOI

Notes: 1. The bidding process takes 4 months minimum. However, depending upon the urgency and requirement of the project execution the bidding process could be done within 60 days. 2. +“x” days means time duration from the zero date, i.e., RFP’s date of publication.

Both the bidding processes require formulation of a Request for Proposal (RFP) by the ULBs

## 6.7 Formulating Request for Proposal

A Request for a Proposal (RFP) is a document formulated by the ULBs to obtain bids from the service vendors for projects specified in the DPR. A well written RFP is essential in ensuring well costed, innovative bids from the suppliers. A good RFP is crucial for effective project management as it enables the service vendors to understand the project and facilitates them to write a proposal or a bid explaining how they can meet the requirements for the project. An RFP clearly describes the deliverables of the project and various

assumptions and assessments by the authority in relation to the project. A standard Request for Proposal must be divided in three parts:

**Part 1:** Instruction to Bidders

**Part 2:** Minimum mandatory technical and performance specifications or project information memorandum

**Part 3:** Concession agreement

Checklists for Submission and Scrutiny of DPR are provided in Annexure II.

### Sources

1. [http://cpheeo.nic.in/WriteReadData/Cpheeo\\_SolidWasteManagement2016/Manual.pdf](http://cpheeo.nic.in/WriteReadData/Cpheeo_SolidWasteManagement2016/Manual.pdf)
2. <http://urban.bih.nic.in/Docs/CDP/DPR-Toolkit.pdf>
3. <http://moud.gov.in/pdf/57f1f2e1ac08aGUIDELINES%20of%20DPR%20and%20technology%20selection%20for%20SWM%20with%2012th%20Finace%20commission%20grant015.pdf>
4. <http://moud.gov.in/pdf/57f1e55834489Book03.pdf>

## Chapter 7

# IEC For Solid Waste Management

### 7.1 What is IEC?

Information, Education and Communication (IEC) is simply a process of working with individuals, communities to develop a communication strategy to bring about behavioral change according to the need of the situation. IEC consist strategies, approaches and methods that enable individuals, families, groups to attain awareness and actively participate in the development activity.

### 7.2 Importance of IEC

The most important role IEC plays is in mobilizing people and making development participatory through public awareness and advocating the transfer of knowledge, skills and techniques to the people. It brings about transparency in the implementation of the schemes and various programmes related to it at field level and push forward concept of accountability and social audit. There is no thumb rule and techniques can vary according to the scenario and specific areas. Some of the effective ways of communication are mass communication and person to person communication.

### 7.3 Steps in Developing IEC Activities

The framework is developed with the help of the information gathered through needs assessment. The major steps to be followed when designing an IEC activity are:

1. A need assessment should be conducted.

2. The goal should be set. It means what is to be achieved with the targeted population in the end.
3. Set up of behavioral objectives that will assist to achieving the goal.
4. Develop the IEC activities and involve as many other partners as possible. The IEC activities should be developed in such a way that once these activities are implemented these should make a significant impact on achieving the behavioral objectives.
5. Identification of the potential barriers should be done and ways to tackle those barriers should be find.
6. Identification of potential partners, resources, and other forms of support for your activities and gain their sustained commitment.
7. Prepare evaluation and monitoring plan.

The indicators should deflect the level of success achieved in the behavioral objectives. Presence of such specific indicators brings about an ease in the monitoring process and keep a check on progress and impact of activities. Process indicators can also be set to track how all the planned activities have been carried out.

### 7.4 An objective must be SMART

It should be remembered that the objective should satisfy the following characteristics:

1. S-specific and sustainable (what and who)
2. M-measurable and manageable (something which is visible)
3. A-area specific and applicable (where)
4. R-realistic and replicable (achievable)
5. T-time-bound and transparent (when)

If any IEC materials on Solid Waste & Waste Water Management Capacity Building for SWM are available, its impact should be analysed and if found appropriate should be used instead of making a new one.

Pre-testing of the IEC material should be done on the small groups belonging to the targeted population as it will help in developing educating material. It's a method of analyzing whether the intentions of the message can be achieved or not.

The suitable methods of communication should be determined. After the identification of the targeted population the key messages are chosen with the selection of media and combination of information channels. Each channel has its own strength and weakness that depends on what kind of role the information channel has to play in the IEC.

Different messages should be made for different media like radio, stories, poems, songs, posters according to the need. The persons using the material should be properly trained as it is necessary to ensure to achieve the envisaged goal.

The key pillars to Solid Waste Management are volunteerism and public participation that play a vital role in achieving success. Along with the technology, public attitude and behavior can make a difference. A solid waste management IEC Plan should focus on the given points:

1. Following the 4-R concept i.e. reduce, reuse, recycle and recover the waste.
2. Storage and segregation at source.
3. Assimilate the civic sense of keeping the locality clean.
4. Willingness of the citizen to accept civic responsibilities.
5. Willingness to eradicate unscientific solid waste disposal.

Awareness should be created on the dangers of unscientific SWM

1. Health hazards
2. Aesthetic damage
3. Environmental issues
4. Creation of awareness on the different technical options available of solid waste management that explores the possibility of converting waste into a valuable source.
5. Proximity theory of SWM. (Scientific disposal of waste at the nearest point of source. For example biogas plant at a market; composting at households etc.)
6. Willingness to pay for services.

Adoption of integrated approach.

1. The institutional mechanism created for collection and transportation of waste could, in return, be used for sale of manure manufactured at the compost plant
2. Using recycled materials for manure packaging
3. The manure packets could contain IEC messages etc.

## 7.5 Funding pattern of IEC

IEC concludes of the total 15% of the central allocation. Out of this 15%, 12% will be earmarked for States to conduct campaigns on public awareness on issues like public health, hygiene and the environment by different means like short films, radio, social media, plays, workshops. 3% will be earmarked for the Ministry of Urban Development to run a national media campaign and developing standardized methods for campaigning. Newspaper and TV is excluded item from this component for the state government or for the ULB's as it comes under ministries of Government of India. States should make an action plan with all the details of state funding. State HPC should approve the Public Awareness & IEC plan and minimum 50% of the IEC fund in each annual plan should be given to the urban local body for IEC activities. The authority to give power to use state level funds will be HPEC under the approved plan. Urban local body has to spend a minimum 50% part of the ULB level funds, as per approved plan. This fund cannot be use for any other purpose like purchase of vehicles, construction and maintenance of buildings, payment of salary etc. A minimum of 25% is mandatory for the states to contribute towards IEC & Public awareness to match 75% Central Share which is 10% for the North Eastern states and states with special category in each annual plan.

## Chapter 8

# Monitoring and Evaluation 'Swachh Survekshan'

The Monitoring and Evaluation of Urban Local Bodies (ULBs) on Solid Waste Management (SWM) and Urban sanitation parameters, is an annual exercise commissioned by a third party on behalf of Ministry of Housing and Urban Affairs (MoHUA). Ministry of Housing and Urban Affairs (MoHUA) introduced 'Swachh Survekshan' (SS) a ULB ranking exercise to foster the spirit of city competitiveness amongst cities of India w.r.t. cleanliness and sanitation. The objective of the survey is to encourage large scale citizen participation and create awareness amongst all sections of society about the importance of working together towards making towns and cities a better place to live in.

### 8.1 Swachh Survekshan 2018

Swachh Survekshan 2018 (National cleanliness survey) is the largest impact driven project commissioned by **KARVY** on behalf of Ministry of Housing and Urban Affairs (MoHUA). The scale of **Swachh Survekshan 2018** project was ten times larger than Swachh Survekshan 2017. In SS 2018, 4203 ULBs participated with enthusiasm whereas 434 ULBs were covered under SS 2017. On May 16 2018, Ministry of Housing and Urban Affairs announced top three performers under SS 2018, which are Indore, Bhopal and Chandigarh; and fifty two awardee cities under various predefined class of population

and award categories. The ranking is being undertaken over a predefined set of '**Solid Waste Management (SWM) and Urban Sanitation**' parameters and indicators. The SS 2018 Assessment toolkit was designed by MoHUA in consultation with **National Program Management Unit (N-PMU)** and was further improvised by subject experts of Karvy.

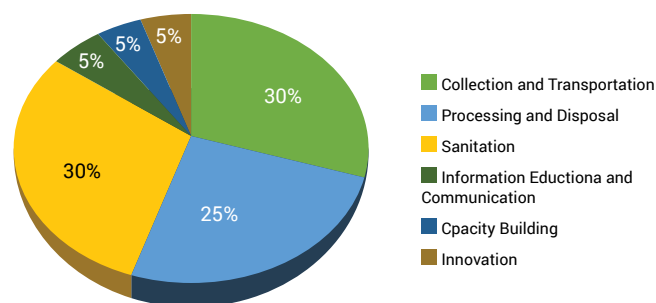
### 8.2 Trifurcation of survey

#### Part 1 - Service Level Progress (Municipal documentation with respect to each parametric question)

This involves collection and verification of data from ULB. The Chairperson/ Commissioner/ SBM Nodal Officer of the ULB has to make official submission of municipal documents for with respect to each question of under Part 1 of the SS 2018 toolkit. Assessment is signed-off by the Chairperson/ Commissioner/ SBM Nodal Officer of the ULB to avoid any ambiguity/disagreement at later stage. Further, the ULBs were encouraged to track their performance before the final day of assessment through self-assessment portal, which helped them to understand the gaps and areas of improvement. Part 1 comprises of 1400 Marks in total and has 6 sections which has 44 questions in total.

**Table 8.1 Service Level Progress  
(Part 1 Municipal Documentation)**

Service Level Progress (Part 1 Municipal Documentation)	Max. Marks	Percentage	No. of Questions
Collection and Transportation	420	30	13
Processing and Disposal	350	25	8
Sanitation	420	30	11
Information Education and Communication	70	5	7
Capacity Building	70	5	4
Innovation	70	5	1



**Fig. 8.1: Outcome parameters and their respective weightages**

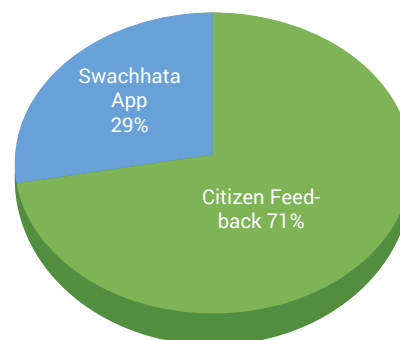
## Part 2: On-ground Assessment (Sample based on-ground verification)

Part 2 is further bifurcated into: Part 2A (Independent Validation) and Part 2B (Direct Observation). Under Part 2A, the claims made by the ULB officials during Part 1 assessment is validated on-ground and negative marking is done (if any claim is found invalid); whereas Direct Observation is a sample based physical observation of the city.

## Part 3 - Citizens Engagement (Citizen Feedback and Swachhata App)

- Citizen Feedback – Citizens feedback is recorded by various means, Interactive Voice Response System (IVRS), face to face etc.
- Swachhata App- Swachhata App download and usage

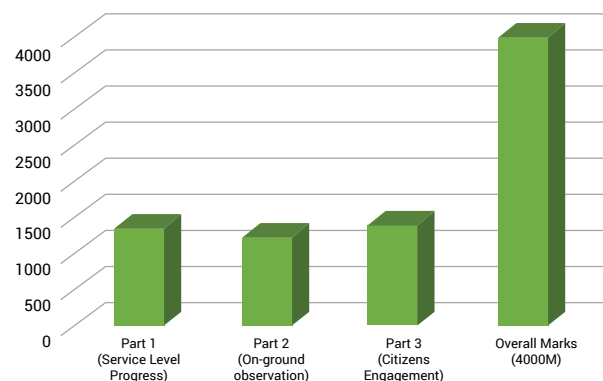
with respect to filing and resolving cleanliness related complaints by the concerned authority of the ULB.



**Fig. 8.2 Marking Scheme under Part 3 Citizens Engagement**

The Monitoring & Evaluation of ULBs goes through 3 level of Quality Check (QC). Moreover, the on-ground assessment by the Junior Assessor is monitored & tracked by a real time monitoring cell which is headed by subject experts and professionals.

The SS 2018 toolkit holds 4000 marks in total. The overall marking scheme of Swachh Survekshan 2018 is depicted below:



**Fig.8.3 Marking Scheme of SS 2018**

### 8.3 Swachh Survekshan the emphasised majorly on following:

1. Source segregation of waste into Dry and Wet.
2. Onsite waste processing facility for all Bulk Garbage Generators (BGGs)
3. Twice a day sweeping (including ones at night) of all commercial streets.
4. Identification and deployment of Informal Waste Pickers (IWP) in all wards of the ULB by ensuring better livelihood, as per SWM Rules 2016.
5. Ensuring usage of Personal Protective Equipment (PPE) by staff associated with direct handling of waste.
6. Penalizing offenders for littering, open urination and open defecation by spot fining.
7. Twin bin facility to be made available in commercial areas after every 500m for convenience of floating population and general public.
8. Construction of community/ public toilets with appropriate number of seats as per sanctioned target of the ULB, to make city Open Defecation Free (ODF).
9. Installation of Google Toilet locator (GTL) in all community/ public toilets for track feedback of users.
10. Information Education Communication (IEC) and Behaviour Change Communication (BCC).
11. Capacity building of ULB officials (under SBM) by attending national workshops/ Events/ Campaigns.
12. Ensuring Door to Door (D2D) garbage collection and all the ULB wards and all garbage collection vehicles to be equipped with GPS/Rfid system to track movement of vehicles.
13. Decentralised processing of waste to cut down hauling cost.
14. Cities should adopt zero-Landfill model and make cities garbage free.
15. No gap between waste generation and waste processing.
16. No Biodegradable waste to be disposed in Landfill, whereas maximum 5% of the total wet waste can be disposed in landfill with permission of the regulatory body. Rejects from Waste to Energy (WtE) and RDF should be disposed of in Sanitary Landfill (SLF).

### 8.4 Swachh Survekshan 2017

Swachh Survekshan 2017 targeted 500 AMRUT Cities, out of which 434 Cities actively participated. The Ministry of Housing and Urban Affairs (MoHUA) commissioned Quality Council of India (QCI) carry out assessment and rank ULBs over a predefined set of questionnaire defining Urban Sanitation and Solid Waste Management parameters. Indore was ranked as 'India's Cleanest City' under SS 2017 followed by Bhopal and Visakhapatnam (Vizag).

The overall weightage for ranking ULBs as per SS 2017 toolkit was 2000 marks. The overall assessments had 3 Parts (having different weightage individually) and the same has been depicted below with a pie diagram:

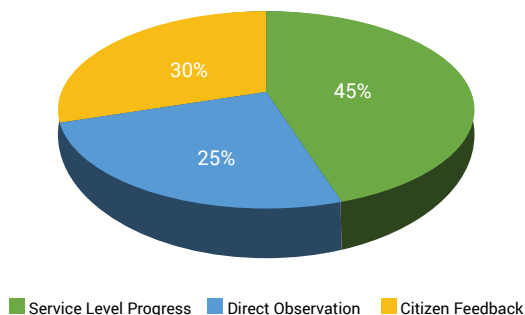
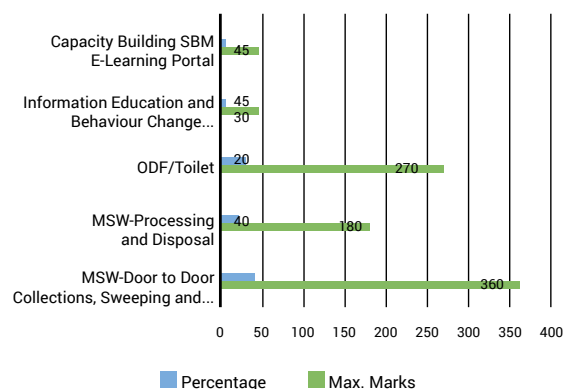


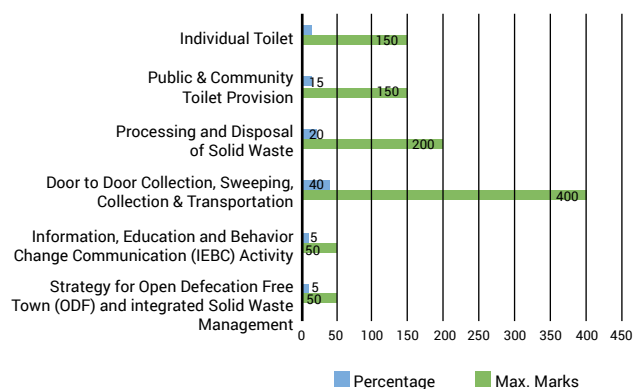
Fig. 8.4 Swachh Survekshan 2017: Overall Assessment

Fig. 8.2 The marking scheme along with no. of questions in each section of Part I

Service Level Progress (Part I Municipal Documentation)	Max. Marks	Per-centage	No. of Ques-tions
MSW- door to door collection, sweeping and transportation	420	40	11
MSW-Processing and Disposal	350	20	7
ODF/ Toilet	420	30	4
Information Education and Behaviour Change Communication	70	5	2
Capacity Building- SBM e-learning portal	70	5	6



**Fig. 8.5 Service Level Progress 2017**



**Fig. 8.6 Service Level Progress 2016**

Under direct observation, maximum weightage was 500 marks, which was bifurcated into observation and independent validation. Whereas, part 3 'Citizen Feedback' was comprised of 600 marks.

## 8.5 Swachh Survekshan 2016

In 2016 the first survekshan was conducted by the Quality Council of India (QCI) on the behalf of Ministry of Urban Development (MoUD), now known as Ministry of Housing and Urban affairs (MoHUA), which covered 73 cities, having a population of one million or more. The survekshan was divided into 3 parts, viz.,

1. Service level status data (1000 marks)
2. Independent observation data (500 marks)
3. Citizen Feedback data (500 marks)

During the assessment of 73 cities it was observed that all the cities hold a very varied level of cleanliness, hygiene and sanitation status. Moreover, one lakh citizens participated in the feedback survey under part 3, wherein, feedbacks were

**Fig. 8.3 The marking scheme along no. of questions in each section of Part 1 (Service level status data)**

Service Level Progress (Part 1 Municipal Documentation)	Max. Marks	Percentage
Strategy for open defecation free town (ODF) and Integrated Solid Waste Management	50	5
Information, Education and Behavior Change Communication (IEBC) activity	50	5
Door to door Collection, Sweeping, Collection & Transportation	400	40
Processing and Disposal of Solid Waste	200	20
Public & Community Toilet Provision	150	15
Individual Toilet	150	15

gathered by using IVR surveys, wherein 6 questions were asked from the citizens of the respective ULBs. Among the 73 cities, the top 3 winning cities were Mysore, Chandigarh and Tiruchirappalli.

# Annexures

## ANNEXURE-I SWACHH BHARAT MISSION EXPOSURE WORKSHOPS

### AGENDA : Field Trips

#### Field Trip Day I

Timings	Locations
8:00 a.m.	Departure from IHC
8:30 a.m.	Low water use Chemical Toilets by DUSIB at JJ cluster near Akshar Dam, New Delhi
9:15 a.m.	Ghazipur landfill site, Ghazipur, New Delhi
10:00 a.m.	Ghazipur WTE, Ghazipur, New Delhi
10:30 a.m.	Gulmeher – CSR supported Recycling Facility, New Delhi
12:00 noon	C & D Waste facility at Shastri Park, New Delhi
12:45 p.m.	BioBoxX Biomethanation at DMRC, Shastri Park, New Delhi
2:00 p.m.	Lunch at Akshardam Metro Station, Haldiram
3:00 p.m.	Decentralized Waste management at Miranda House, Delhi University
4:00 p.m.	Smart Toilets at Rafi Marg, New Delhi
5:00 p.m.	Composting plant in a Five Star Hotel – Le Meridien, New Delhi

#### Field Trip Day II

Timings	Locations
7:45 a.m.	Departure from IHC
8:00 a.m.	Door to door collection and Decentralized composting at Defence Colony, New Delhi
10:00 a.m.	Centralized Composting Plant at Okhla, New Delhi
11:30 a.m.	Decentralised Waste Management at Sector 21 A, Faridabad, Haryana
12:45 p.m.	Decentralized community based segregated composting by RWA, Regency Park II DLF, Phase IV, Gurugram, Haryana
1:30 p.m.	Lunch at Gurugram
3:00 p.m.	Decentralised Waste Management by RWA Vasant Vihar, New Delhi
4:00 p.m.	Decentralized waste processing at GPRA, New Motibagh, New Delhi
5:00 p.m.	TEAM Biomethanation at Delhi Gymkhana, New Delhi

## Ghazipur Landfill Site

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

#### 1. What is the total waste accumulated at this site?

- ☐ 4.7 million ton
- ☐ 5.2 million ton
- ☐ 4.9 million ton
- ☐ 7.0 million ton

#### 2. What is the quantity of waste received every day at the Ghazipur landfill site?

- ☐ 2500 TPD
- ☐ 2000 TPD
- ☐ 2700 TPD
- ☐ 3500 TPD

#### 3. What is the approximate area occupied by this landfill site (in ha)?

- ☐ 30.9
- ☐ 29.6
- ☐ 20.3
- ☐ 35

#### 4. Which of the following systems did you observe at the landfill site?

- ☐ Gas collection system
- ☐ Leachate collection and Processing system
- ☐ Methane gas based turbine to generate electricity
- ☐ None of the above

#### 5. The project demonstrated to you at the site is being monitored by which organization?

- ☐ GAIL
- ☐ SAIL
- ☐ UPES
- ☐ Don't Know

## Ghazipur Waste to Energy Plant

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

### 1. What is the total waste processing capacity of this plant (in tons)?

- ☐ 1300
- ☐ 1000
- ☐ 3000
- ☐ 4000

### 2. This plant has two parts. Which out of the following is correct out of the list?

- ☐ Processing plant & Power plant
- ☐ Processing plant & Main plant
- ☐ Power plant & Main plant

### 3. What type of air pollution control device/s is/are used at the waste to energy plant?

- ☐ Bag house filter
- ☐ Electrostatic precipitator
- ☐ Scrubber
- ☐ Catalytic convertor

### 4. What is the final BOD value of the leachate after being treated at the Effluent Treatment Plant (ETP)?

- ☐ 25
- ☐ 30
- ☐ 40
- ☐ 100

### 5. Which of the following coagulant/flocculant is used in processing the leachate at the ETP?

- ☐ Ferrous sulphate,
- ☐ Copper sulphate
- ☐ Methyl bromide
- ☐ Ferric chloride
- ☐ Don't Know

## **Gulmeher – CSR supported Recycling Facility, New Delhi**

Please answer the following questions using the following instructions

### **\* Instructions**

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

### **1. Gulmeher was started in**

- ☐ March, 2015
- ☐ May, 2013
- ☐ March 2013
- ☐ April, 2011

### **2. Which of the following products are made at this centre?**

- ☐ Handicraft products with Dried Flower Decoration
- ☐ Low Cost Sanitary Napkin Making Unit in partnership with NGO Akaar
- ☐ Dried flower Color Making
- ☐ Recycled Paper

### **3. How many people are being supported by this NGO?**

- ☐ 350
- ☐ 370
- ☐ 400
- ☐ 500

### **4. Gulmeher is -----?**

- ☐ Corporate Social Responsibility (CSR) Initiative
- ☐ Funded by some other NGO
- ☐ Self –sustaining unit
- ☐ None of the above

### **5. It was planned along with which of the following organizations?**

- ☐ Institute for Development Support
- ☐ World Health Organization
- ☐ Indian Institute of Planning and Architecture
- ☐ Don't Know

## C&D Waste Recycling Plant, Shastri Park, New Delhi

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

#### 1. What is the amount in tons of C&D waste that can be managed at this plant?

- ☐ 100
- ☐ 200
- ☐ 600
- ☐ 500

#### 2. Arranging the recycled products as per their selling price in the market in descending order which of the following is correct?

- ☐ Sand, Soil, Cloth, Plastic
- ☐ Cloth, Plastic, Sand, Soil
- ☐ Plastic, Soil, Cloth, Sand
- ☐ Don't know

#### 3. Which of these products could be utilized for conserving rain water (allowing water to percolate and reach the groundwater)?

- ☐ Pavement blocks
- ☐ Kerb stones
- ☐ Recycled Concrete aggregate
- ☐ Brick Pozzolana
- ☐ Concrete bricks
- ☐ Hollow bricks

#### 4. Which of the following is the maximum recovered product at this plant?

- ☐ Soil (Earth)
- ☐ Sand
- ☐ Brick mix aggregates
- ☐ Stone and concrete aggregates

#### 5. This plant is working on which model?

- ☐ BOOT Model
- ☐ PPP Model
- ☐ BOT Model
- ☐ None of the above

## Containerised Biomethanation, DMRC, Shastri Park, New Delhi

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

### 1. Which company/organization has set up this plant?

- ☐ Chintan
- ☐ Green Bandhu
- ☐ Green Brick Eco Solutions
- ☐ IL&FS

### 2. What type of biogas storage unit is installed here?

- ☐ Balloon type
- ☐ Dome type
- ☐ Floating dome type
- ☐ None of the above

### 3. What is the assumed operating temperature at this plant?

- ☐ 15-20 Degree Celsius
- ☐ 25-30 Degree Celsius
- ☐ 35-40 Degree Celsius
- ☐ Above 50 Degree Celsius

### 4. What is the total power utilized by this plant?

- ☐ 100 KWh/day
- ☐ 25 KWh/day
- ☐ 35 KWh/day
- ☐ 20 KWh/day

### 5. Biobox treats what kind of waste?

- ☐ Biodegradable kitchen, animal remains in abattoirs (slaughter house)
- ☐ Green plant waste, cow dung, plant leaf litter
- ☐ Crop residues, sugarcane waste
- ☐ Biomedical waste, C&D waste, plastic waste

## Decentralized Waste Management at Miranda House, Delhi University

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

#### 1. How does Miranda House, Delhi University manage solid waste within its campus?

- ☐ By installing Rapid Hybrid Technology Composting Plant
- ☐ By running Paper recycling unit and making recycled products
- ☐ By Collecting waste from canteen, gardens / lawns & hostel mess, at least twice a day
- ☐ By Producing energy from waste

#### 2. Miranda House Campus is producing ..... kg of compost per day.

- ☐ 10kg
- ☐ 60kg
- ☐ 50kg
- ☐ 85kg

#### 3. Which of the following machines are installed at Miranda House Campus for composting?

- ☐ Chip-Chopy Organic Waste Crusher or Shredder
- ☐ Eazy Squeezy De-hydrator.
- ☐ Rolimoli & Rolipoli, in-Vessel Aerobic Composting Systems.
- ☐ Excel composting System

#### 4. What types of recycling strategies are followed at Miranda House, Delhi University?

- ☐ From food waste to compost
- ☐ From MSW waste to energy
- ☐ From garden waste to Mulch
- ☐ From paper waste to paper

#### 5. Which of the following plants are installed within the Miranda House Collage Campus?

- ☐ Paper recycling plant
- ☐ Compost Plant
- ☐ Plastic Bottle recycling plant
- ☐ Solar Plant
- ☐ Hydroponic System

## Smart Toilets at Rafi Marg, New Delhi

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

#### 1. What is the cost of one unit of the Smart Toilet, observed at Rafi Marg?

- ☐ Rs. 12,000
- ☐ Rs. 20,000
- ☐ Rs. 25,000
- ☐ Rs. 30,000

#### 2. Which facilities are provided at Smart Toilet, Rafi Marg?

- ☐ Water ATM
- ☐ Sanitary Napkin Incinerator
- ☐ Vending Machine
- ☐ ATM
- ☐ Health Facilities

#### 3. Why Rafi Marg public toilet is called as Smart Toilet?

- ☐ The lighting of the toilets is managed by using solar power.
- ☐ 24\*7 water supply, Water ATM, clean, dust bins are provided, sewer line well functional.
- ☐ Vending machines for snacks and sanitary napkins.
- ☐ Toilet is locked all the time.

## Low water use Chemical Toilets at JJ cluster near Akshar Dam, New Delhi

#### 4. How many of Low water use Chemical Toilets are installed by DUSIB at de-notified JJ cluster near Akshardham?

- ☐ 12 toilets
- ☐ 50 toilets
- ☐ 20 toilets
- ☐ 10 toilets

#### 5. What is the cost of one unit of the self-cleaning bio-toilets, observed at JJ cluster, near Akshardham?

- ☐ Rs. 12,000
- ☐ Rs. 20,000
- ☐ Rs. 25,000
- ☐ Rs. 30,000

## In Vessel Composting at Le Meridien, New Delhi and Sector 21A Faridabad

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

#### 1. What kind of equipment is used for composting in Five Star Hotel – Le Meridien?

- ☐ Windrow Composting
- ☐ In Vessel Composting
- ☐ Rapid Composting Technology
- ☐ BioBoxX

#### 2. Which component is added for controlling moisture level of composting in In Vessel Composter?

- ☐ Saw Dust
- ☐ More organic waste
- ☐ Microbial Culture
- ☐ Soil

#### 3. How is Aerobic composting enhanced in the In Vessel Composter?

- ☐ By adding Bio-inoculum
- ☐ By adding saw dust/crushed dry leaves
- ☐ By manually turning the waste
- ☐ By electrically turning the waste inside the composter

#### 4. Why 40% of Saw Dust is added during composting at Five Star Hotel – Le Meridien?

- ☐ For controlling heat
- ☐ For increasing quantity
- ☐ For managing pH
- ☐ For controlling moisture

#### 5. In Sector 21A Faridabad, what challenges are faced by Humankind Foundation?

- ☐ Non-segregation of waste at source
- ☐ Lack of space for composting
- ☐ Ill treatment of waste collectors by house-holders
- ☐ Sale of compost

## Centralized Composting Plant at Okhla, New Delhi

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

### 1. Okhla Composting plant comes under which Model?

- ☐ A Private Enterprise
- ☐ A unit of South Delhi Municipal Corporation
- ☐ Public Private Partnership
- ☐ A NGO

### 2. Okhla Composting plant is processing ..... MSW.

- ☐ 400 tons/day
- ☐ 650 tons/day
- ☐ 500 tons/day
- ☐ 200 tone/day

### 3. How does Okhla Composting Plant help in Environment Sustainability?

- ☐ By Reducing Carbon Credits
- ☐ By Producing Waste to Organic Compost
- ☐ By producing Methane Gas
- ☐ By Producing Refuse derived fuel (RDF)

### 4. Okhla Composting Plant is associated with which organizations?

- ☐ Chintan
- ☐ IL&FS Environment
- ☐ Green Bandhu
- ☐ South Delhi Municipal Corporation

### 5. How much organic compost is produced from 500 tons of MSW per day at Centralized Composting Plant?

- ☐ 55 TPD
- ☐ 100 TPD
- ☐ 30 TPD
- ☐ 75 TPD

## Decentralized Community based Composting, DLF Phase I & IV, Gurugram

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

#### 1. What is the name of the NGO, which initiated Rapid Composting Technology in DLF Phase I and IV?

- ☐ Green Bandhu
- ☐ Vatavaran
- ☐ Centre for Science and Environment (CSE)
- ☐ Green Peace
- ☐ Kalpataru

#### 2. In DLF Phase I and IV, Green Bandhu mixes dry shredded leaf litter with crushed food waste for –

- ☐ For creating aerated condition during composting
- ☐ For increasing nitrogen in compost
- ☐ For maintaining temperature
- ☐ For reducing smell during composting
- ☐ For avoiding turning the compost too many times

#### 3. The unique features of SWM at Regency Park 2 at DLF Phase IV Gurugram is:

- ☐ Almost 100 percent of the households segregate waste into wet and dry waste
- ☐ The RWA collects the segregated waste from households separately in two bins
- ☐ The RWA with help from Green Bandhu composts all food waste and most green waste in a shed within their campus
- ☐ The RWA has a separate shed for dry waste and horticultural waste which are collected by waste collectors every day and taken outside the campus for recycling
- ☐ The RWA has a separate collection point for E-waste in their RWA office

#### 4. Cost of running SWM at Regency Park 2 at DLF Phase IV Gurugram is met through –

- ☐ Municipal Corporation of Gurugram funding
- ☐ The RWA meets cost through user charges
- ☐ The RWA meets cost through maintenance charges collected every quarter
- ☐ Cost is met through CSR funding

## Door to Door collection and composting at Vasant Vihar, New Delhi

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

#### 1. In which year did this waste management activity begin in Vasant Vihar?

- ☐ 2003
- ☐ 2005
- ☐ 2007
- ☐ 2010

#### 2. How many households are currently cooperating in this initiative?

- ☐ 500
- ☐ 700
- ☐ 900
- ☐ 1000

#### 3. Where does the waste collector segregate the collected waste?

- ☐ On his tricycle
- ☐ At the Dalao
- ☐ Doesn't segregate
- ☐ Don't know

#### 4. What is the name of the park you visited at Vasant vihar?

- ☐ Mahatma Gandhi Park
- ☐ Raja Ram Mohan Roy park
- ☐ Pandit Jawaharlal Nehru Park
- ☐ Shaheed Rajguru Park

#### 5. Which of the following activities were observed at the D-block park?

- ☐ Decentralized wet waste composting
- ☐ Leaf litter composting
- ☐ Rainwater harvesting
- ☐ None of the above

## Decentralised Waste Management at GPRA, New Moti Bagh, New Delhi

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

### 1. Which out of these technologies/methods of waste management did you observe at the GPRA, New Moti Bagh?

- ☐ Efficient door to door waste collection
- ☐ Efficient source segregation mechanism
- ☐ In-house sewage treatment plant
- ☐ Composting of wet waste and pelletization of horticultural waste
- ☐ Plastic to fuel technology

### 2. For what purpose was the treated waste water being used?

- ☐ Landscaping
- ☐ Cleaning
- ☐ Both of the above
- ☐ None of the above

### 3. How often is the testing of the treated water being done?

- ☐ Every 3 days
- ☐ Every 5 days
- ☐ Everyday
- ☐ Every week

### 4. Which of the technology is being used for treating the waste water?

- ☐ Moving Bed Bioreactor
- ☐ Simple Aeration
- ☐ Activated sludge process
- ☐ None of the above

### 5. Which company along with NBCC is managing this waste management facility?

- ☐ Green Planet Waste management Solutions
- ☐ Best of Waste
- ☐ Green Bricks Eco Solution
- ☐ Green Bandhu

## TEAM Technology, Gymkhana, New Delhi

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

### 1. What is the full form of TEAM?

- ☐ The Enhanced Acidifier and Methanation
- ☐ TERI's Enhanced Acidification and Methanation
- ☐ Timed and Enhance Acidification and Methanation
- ☐ Don't Know

### 2. TEAM Technology has been tested successfully used for which of the following wastes?

- ☐ Leafy waste, food waste, press mud, food -processing waste
- ☐ Tea waste, vegetable market waste, township waste
- ☐ C&D waste
- ☐ Hazardous waste

### 3. The leachate is fed into which of the following reactors?

- ☐ UASB reactor
- ☐ FBVC reactor
- ☐ ABMR reactor
- ☐ BMWC reactor

### 4. What percent methane is in the biogas produced by this technology?

- ☐ 50%
- ☐ 70%
- ☐ 60%
- ☐ 90%

### 5. The value of NPK is \_\_\_\_\_ in the digested waste (complete the sentence)

- ☐ High
- ☐ Low
- ☐ Moderate
- ☐ Don't Know

## Material Recovery Facility, Bhopura, Delhi

Please answer the following questions using the following instructions

### \* Instructions

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

### 1. The Bhopura MRF centre is managed by which NGO?

- ☐ Chintan
- ☐ Swachh
- ☐ Paryavaran
- ☐ Vatavaran

### 2. What was the process/pathway of plastic recycling at Bhopura MRF?

- ☐ Collection – Segregation – Shredding – Storage – Market
- ☐ Collection – Shredding – Market
- ☐ Collection – Segregation of bottles and caps separately – Shredding – Storage – Market
- ☐ None of the above

### 3. From where is this centre receiving waste?

- ☐ Hotels
- ☐ Hostels
- ☐ Households
- ☐ Industries

### 4. What is the size of the compost pit used at this plant?

- ☐ 3' X 6'X3'
- ☐ 2' X 3'X2'
- ☐ 4' X 2'X3'
- ☐ 6' X 3'X5'

### 5. CHINTAN has recently received which of the following awards?

- ☐ Waste Solutions Award, 2016
- ☐ Climate Solutions Award, 2015
- ☐ World Climate and Energy Benefit Award, 2014
- ☐ Don't Know

## **Integrated Solid Waste Management Facility at Narela - Bawana, Delhi**

Please answer the following questions using the following instructions

### **\* Instructions**

- ☐ This symbol is meant for single answers
- ☐ This symbol is meant for multiple answers

**1 How much total quantity of waste in TPD is processed by Integrated Solid Waste Management (ISWM) Facility at Narela - Bawana?**

- ☐ 3000
- ☐ 4000
- ☐ 6000
- ☐ None of the above

**2. What is the technology involved for compost process?**

- ☐ Aerobic Composting
- ☐ Anaerobic Composting
- ☐ Vermi Composting
- ☐ None of the above

**3. What is the pH value of the treated waste water obtained from Leachate Treatment Plant (LTP)?**

- ☐ 11 - 14
- ☐ 8 - 10
- ☐ 3 - 4
- ☐ 6 - 9

**4. What are the different types of waste processing facilities found at Narela - Bawana?**

- ☐ MRF
- ☐ Secured Landfill
- ☐ Power Plant
- ☐ Compost plant
- ☐ Leaf litter composting
- ☐ Rainwater harvesting
- ☐ None of the above

## ANNEXURE-II

Checklist for submission and scrutiny of DPR by  
Ministry of Housing and Urban Affairs (MoHUA).<sup>1</sup>

### Checklist For Submission And Scrutiny Of DPR (MUNICIPAL SOLID WASTE MANAGEMENT)

(to be filled in and certified by the highest city–level Officials, both technical and administrative, such as Chief Engineer/City Engineer/ Municipal Commissioner)

#### Instructions:

- The DPR shall be formulated as per the Manual on Municipal Solid Waste Management published by the Ministry and as per the Department procedures.
- DPR shall be technically sanctioned by the Competent Authority the State Govt./ULB before forwarding it to the Ministry.
- Each and every page has to be signed at the bottom by the officials.
- Each field has to be filled in appropriately as “yes”, “no”, “not required”, “not done”, “not used” etc. No field has to be left blank. Give explanatory comments wherever ‘no’ is indicated.
- Non- definite entries such as “will be done later”, “will be furnished later” etc. will not be accepted.

#### CERTIFICATE:

This is to certify that the undersigned have read the contents of the check list fully and have responsibly made the entries true to the best of knowledge and understanding. In case the information furnished in the check list enclosed is found to be incorrect for any reason, whatsoever, the undersigned may be held liable for disciplinary action as per applicable Government rules.

#### Certified that

- i. The designs and drawings have been approved by the Competent Authority.
- ii. The detailed estimates and cost estimates are as per the current schedule of rate and/or rate analysis and latest pro-forma invoices (current market rates).
- iii. The DPR has been technically sanctioned by the Competent Authority in the State Govt./ULB.

Signed:

Name:

Designation:

Signed:

Name:

Designation:

---

<sup>1</sup> <http://urban.bih.nic.in/Docs/CDP/Checklist-SWMG.pdf>

## Checklist For Submission And Scrutiny Of DPR (Municipal Solid Waste Management System)

S. No.	Description	Write 'Yes' or 'No' etc in the column below
		If Yes, give Page No./DPR volume reference. If No, reasons thereof
<b>3</b>	<b>General Components</b>	
3.1	Name of the town/city/District/State for which scheme has been formulated with name of the scheme  Name of the City/Town:  Name of the District:  Name of the State :  Name of the Scheme:	
3.2	Date of DPR appraised by State Level Nodal Agency (SLNA) and whether a copy of appraisal report (duly authenticated by the competent authority) has been forwarded with DPR.  Date of appraisal:  Name of the appraisal agency:  Original Estimated cost:  Appraised cost:	
	(e )Major comments/observations made by appraisal agency.	
3.3	Whether Administrative approval of State Government is obtained to implement the scheme immediately after approval of GOI and enclosed in DPR?	
3.4	Whether Project formulation justification (need for the project) has been furnished in DPR	
3.5	Whether linkages of this scheme have been established with ANY other municipal solid waste management (MSW) schemes being funded by the Central/State Govt./other agencies, if any. Please specify.	
3.6	Whether the compatibility between existing MSW system (if applicable) and proposed MSW system has been annexed in DPR	
3.7	Whether the map showing administrative and political jurisdiction has been given in DPR	
3.8	Whether the land use pattern of the city / town - Master Plan has been given in DPR	
3.9	Whether the DPR was authenticated by Competent Authority of State Govt./ ULB.	

S. No.	Description	Write 'Yes' or 'No' etc in the column below
		If Yes, give Page No./DPR volume reference. If No, reasons thereof
3.10	(A)Whether the Certificate of Land Acquisition / possession for setting up MSW Treatment Plant (MSWTP), landfill and MSW transfer stations by ULBs & Right of Way (ROW)/spots for setting up community MSW storage containers has been attached with DPR.	
	(B) If not, whether the action plan for acquiring the required land has been furnished in the DPR.	
3.11	Whether the proposals for setting up MSW treatment plants and landfill received clearance / consent from the State Pollution Control Board, Airport / Airfield Authorities, Flood Control/Ground water Management Authorities etc. Whether clearance for environmental impact assessment obtained for the proposed sanitary landfill site. If not, whether a status note and the date by which the clearance is expected to be received has been enclosed	
3.12	Whether the provision for separate electric feeder line to MSW treatment plant, landfill and transfer stations from HT line and an agreement between Electricity Deptt. and Urban Local Bodies (ULBs) has been furnished in the DPR	
3.13	Whether the commitment from Electricity Department for un-interrupted power supply is obtained	
3.14	Whether the Topographic map of the city/town/project area to scale -has been given in DPR / Zone wise Maps to scale showing all Streets	
3.15	Whether geo-technical (soil) investigation reports and bore hole logs for the site of MSW treatment plant and landfill has been furnished with DPR	
3.16	Whether Executive Summary of the project is enclosed in the DPR.	
<b>4</b>	<b>Engineering Components</b>	
4.1	a) Whether population pattern identification of urban / urban agglomeration and population projection has been adopted as per CPHEEO Manual and given in DPR i. Area of the city/town ..... Sq Km. ii. Extent of Project Area ..... Sq Km iii. No. of households (present) ..... nos iv. Population projection ..... lakhs v. 2001 Census ..... lakhs vi. 2011 Census .....% per year vii. Population Growth rate ..... lakhs viii Initial Stage (year of commissioning). ..... lakhs ix. Floating population, if any .....Lakhs x Design population including floating .....No. & % b) population ..... No. c) Whether basis for adopting tourist/floating pop documents annexed -----No. & % ..... No. Whether initial year has been taken as the likely year of completion of the project .....ulation has been described in the report and related	

S. No.	Description	Write 'Yes' or 'No' etc in the column below
		If Yes, give Page No./ volume reference. reasons thereof If DPR No,
	<p>xii.Total no. of vehicles for transportation of waste Total .....nos. Govt. ....nos. Private ..... nos. Total ..... nos.</p> <p>Whether the rationale for location of the transfer station and operating schedule of primary and secondary collection vehicles for synchronization has been calculated and attached with the DPR</p> <p>Whether the number of trips for each of the primary and secondary collection vehicles along with timing has been calculated and given in the DPR for calculating the number of vehicles required</p> <p>Whether the existing vehicles have been considered while calculating the additional vehicles required and whether such calculations form a part of the DPR.</p> <p>Whether the system of segregation at source has been considered and if yes, the design of vehicles for carrying the organic and recyclable waste separately has been incorporated and explained in the DPR.</p>	
4.5	<p>Details of ongoing project (Estimated cost) Rs..... Lakh</p> <p>i. Year of sanction</p> <p>ii. Funding agency &amp; funding pattern ..... iii. Population coverage .....</p> <p>iv. Infrastructure for collection, transportation has been envisaged or ..... MT/day not .....MT/day</p> <p>v. Capacity of compost plant ..... MT/Day &amp; Year vi.Capacity of sanitary landfill (please specify design period and qty. of waste disposed/day)</p>	
4.6	Please furnish the proposed major components and component-wise cost (Rs. In lakh)	
4.7	<p>a)Whether all components of MSW management system such as door to door collection, primary transportation, community/street side storages waste receiving pad, segregation/recycling facilities, MSW treatment plant and landfill have been designed as per the CPHEEO Manual and detailed drawings have been i.Design period Total design quantity of waste Bio-degradable waste and its percentage of total waste Recyclables and its percentage Construction &amp; demolition waste vi.Inerts and rejects and its percentage</p> <p>vii.No. of households proposed for door to door collection viii.No. of bins proposed for door to door collection</p> <p>b)Details of primary collection facilities proposed No. of bins proposed for primary collection Streets/tourist spot etc. Wheel-barrow (capacity in cum.) Tricycles (capacity in cum.) Auto rikshaws/tipper (capacity in cum.)</p>	<p>, secondary transport, transfer stations, bulk transport, n provided in the DPR. -----year -----MT/day -----MT/day...% -----MT/day ...% -----MT/day -----MT/day...% -----Nos. -----Nos. ....nos. ....nos. .... nos. ....nos. .....nos.</p>

S. No.	Description		Write 'Yes' or 'No' etc in the column below
			If Yes, give Page No./ volume reference. reasons thereof if DPR No,
	c) Details of Secondary collection and transportation Transfer stations -----No. Transportation vehicles (Refuse collectors, compacters, dumper placers) -----No. Standby provision for vehicles iv.Machinery proposed for mechanical sweeping of roads -----% -----No.  d)Details of the capacity of various treatment and disposal facilities Compost plant -----MT/day Sanitary land (5 years) -----MT/day RDF plant -----MT/day Other technologies -----MT/day Brick manufacturing -----MT/day Reusable material -----MT/day Total -----MT/day  Design of Leachate collection system furnished in the DPR Yes/No Whether the treated leachate effluent shall conform to the standards/ effluent discharge guidelines of the Pollution Control Board Yes/No Capacity of Leachate treatment facility ---MLD Technology proposed for leachate treatment .....		
4.8	Hazardous waste generated -----MT/day Any facility for hazardous waste treatment is available or not		
4.9	Whether Biomedical waste is separately collected and treated as per BMW Rules		
4.10	Whether the calculation for the requiremntn of number of primary and secondary transport vehicles has been shown along with route map to the scale and quantum of waste to be collected from each route in the DPR		
4.11	Whether the process Flow Diagram for entire MSW management system involving all components has been furnished in DPR		
4.12	Whether drawings to scale of the components such as landfill, transfer station, weigh-bridges, building, toilets etc., have been furnished in DPR		
4.13	Whether geometry of the land available for locating MSW treatment plant / landfill / transfer stations has been certified and furnished.		
4.14	Whether the MSW treatment process has been adopted using different proven technologies duly considering the temperature/climate existing in the city/town		
4.15	Whether the site of the proposed MSW treatment plant / landfill / transfer fa Master Plan of the town	cilities has been located as the	
4.16	Whether the provision of the land for MSW treatment plant / landfill / transfer facilities has been made as per 30 years requirement and future expansion in the DPR a)Total requirement of land (Pl also specify the design period) Landfill ----Ha Compost Plant ----Ha ----Ha		

S. No.	Description		Write 'Yes' or 'No' etc in the column below
			If Yes, give Page No./ volume reference. reasons thereof If DPR No.
	Transfer Station RDF Plant Total Land possession with Implementing Agency Whether Govt. land is yet to be transferred to the Implementing Agency and specifying time required to transfer.  Whether Private Land under acquisition and time required for acquisition Status of action initiated for transfer of Govt. land and acquisition of Private land (please specify)	----Ha ----Ha ----Ha ----Ha  -- Ha, ----months -- Ha, ----months	
4.17	Whether modular approach has been adopted to facilitate "addition" units to MSW treatment plants/ landfills at a future date, whenever required		
4.18	Whether Bill of Qualities (BOQ) and cost estimates of individual component of MSW management system prepared as per latest SOR and copy of latest Schedule of Rates (SOR) and Pro-forma invoices have been annexed with DPR. Prevailing SOR ---Year Market price ---Year Whether the authenticated document for various equipment/machinery is enclosed (invoice)  c)Whether provision has been made for IEC expenditure required for commissioning the new SWM system. If so, details thereof.		
4.19	Whether detailed drawing, estimation & detailed BOQ for ancillary works such as boundary wall / fencing, approach & internal road, electrification, buildings, water supply & drainage, site development / landscaping etc. has been provided in the DPR		
4.20	Whether provision for DG set has been made in the DPR to take care of interruptions in power supply, if any		
4.21	In case provision for DG set has been given in the DPR, whether the calculations to arrive at the capacity of the same has been mentioned in the technical statement		
4.22	Whether detailed PERT/CPM network showing implementation schedule has been furnished in DPR		
4.23	Whether Internal rate of return (IRR) / Economic rate of return (ERR) has been furnished in DPR		
4.24	Whether traffic diversion/ control arrangements for public and workers' safety, arising out of construction phase of MSW management works have been furnished in the DPR		
4.25	Whether Institutional and financial status of Project Executing Agency (PEA) has been reported in DPR		
4.26	Whether mechanism for marketing of compost/RDF has been tied Up with any agency Name of the agency with whom the marketing arrangement is tied up for compost and RDF ---		

S. No.	Description	Write 'Yes' or 'No' etc in the column below																																
		If Yes, give Page No./ volume reference. reasons thereof If DPR No,																																
	Annual Revenue (in Rs. Lakhs)  Existing (last 5 years)  Proposed (d)Whether the proposed tariff charges has different rates for different categories such as residential, commercial, establishments, hotels, restaurants, vegetable markets etc. if yes, whether these have been arrived at after adequate public consultation and if yes, whether summary of such consultation has been annexed to the DPR	1	2	3	4	5																												
4.28	<table border="0"> <tr> <td>Whether Service Level Benchmarking has been furnished in DPR. Please furnish S Sl. No.</td> <td>Indicators</td> <td>Benchmark</td> <td rowspan="8">After implementation of the proposed project</td> </tr> <tr> <td>Household Level Coverage</td> <td>100%</td> <td></td> </tr> <tr> <td>Efficiency in Collection of Solid Waste</td> <td>100%</td> <td></td> </tr> <tr> <td>Extent of Segregation of MSW</td> <td>100%</td> <td></td> </tr> <tr> <td>Extent of MSW Recovered</td> <td>80%</td> <td></td> </tr> <tr> <td>Extent of Scientific Disposal of MSW</td> <td>100%</td> <td></td> </tr> <tr> <td>Extent of Cost Recovery</td> <td>100%</td> <td></td> </tr> <tr> <td>Efficiency in Collection of SWM Charges</td> <td>90%</td> <td>8</td> </tr> <tr> <td colspan="3">Efficiency in Redressal of Customer Complaints 80%</td> <td></td> </tr> </table>	Whether Service Level Benchmarking has been furnished in DPR. Please furnish S Sl. No.	Indicators	Benchmark	After implementation of the proposed project	Household Level Coverage	100%		Efficiency in Collection of Solid Waste	100%		Extent of Segregation of MSW	100%		Extent of MSW Recovered	80%		Extent of Scientific Disposal of MSW	100%		Extent of Cost Recovery	100%		Efficiency in Collection of SWM Charges	90%	8	Efficiency in Redressal of Customer Complaints 80%							
Whether Service Level Benchmarking has been furnished in DPR. Please furnish S Sl. No.	Indicators	Benchmark	After implementation of the proposed project																															
Household Level Coverage	100%																																	
Efficiency in Collection of Solid Waste	100%																																	
Extent of Segregation of MSW	100%																																	
Extent of MSW Recovered	80%																																	
Extent of Scientific Disposal of MSW	100%																																	
Extent of Cost Recovery	100%																																	
Efficiency in Collection of SWM Charges	90%	8																																
Efficiency in Redressal of Customer Complaints 80%																																		
4.29	Whether Environmental and social problems (if applicable) has been furnished in DPR																																	
4.30	Whether provision has been made @ 0.5% of the project cost in the DPR for capacity building of ULBs for further O&M of the scheme after taking over the scheme from implementing agency. Please furnish the action plan for conducting capacity building programme. The action plan must specify specific actions such as the number of officials to be deployed in the project post commissioning, their designations, qualifications and training proposed to be given.																																	
4.31	Whether any PPP component involved in the DPR. Please specify the PPP components and funding pattern by Govt. and Private Party. Whether the options of method of operation of SWM collection i.e. departmentally or PPP mode has been considered and reasons for selection mentioned in the DPR. If PPP mode, whether the financial viability of the PPP has been calculated and attached with the DPR Whether key points to safeguard the interest of the department and the provision of regulation has been provided in case the PPP mode has been selected.																																	
4.32	Whether there is any association with the waste pickers organisations No. of waste pickers working in the town ..... Nos. Any plan to engage them in the door to door collection activities iv. No. of waste pickers proposed to be involved in the door to door collection ..... Nos.																																	
4.33	Whether Rehabilitation and Resettlement plan (if applicable) has been given in DPR																																	
4.34	Whether all the hard copies of the DPR furnished along with soft copies																																	
4.35	Period of completion of the project																																	

Signed:

Name:

Designation:

Signed:

Name:

Designation:

**This part to be filled-in by the Ministry**

Sl. No	Description	Remarks
1	Details of project area (State/District/City/Town)	
2	Whether the SLNA/SLSC recommendation is attached with DPR	
3	Project cost recommended by SLNA/SLSC	
4	Period of project implementation	
5	Date of receipt of first DPR	
6	Date of final acceptance of DPR	
7	Date of checklist confirmation	
8	Date of first information sent to the State Govt. on scrutiny of check list	
9	Date of receipt of DPR after reformulation (revision) if applicable	
10	Date of DPR sent to the Appraisal Agency (CPHEEO)	
11	Date of Comments / appraisal report of appraisal agency	
12	Date of comments conveyed by the Admn. Division to the State Govts. & ULBs for revision of DPR, if any	
13	Date of Receipt of Revised DPR for appraisal	

(Signature of Verifying Officer)

**NOTE:** The DPR should be forwarded to the Ministry along with the complete checklist duly filled in without which DPR shall not be processed and shall be returned to the State Government.

# References

[http://www.energynext.in/ghazipur-landfill-to-be-used-as-wte-plant/Okhla WT](http://www.energynext.in/ghazipur-landfill-to-be-used-as-wte-plant/Okhla%20WT)

<https://toxicswatch.files.wordpress.com/2012/04/twa-critique-of-the-reportcentral-pollution-control-board-on-waste-to-energy-incinerator.pdf>

<http://towmcl.com/content.aspx?MKey=20>

[http://www.nswaienvi.nic.in/National\\_news\\_Sept15/News24.aspx](http://www.nswaienvi.nic.in/National_news_Sept15/News24.aspx)

<http://indianexpress.com/article/cities/delhi/delhi-the-high-rise-garbage-landfills-2825046/>

<http://www.downtoearth.org.in/coverage/make-wealth-from-waste-47164>

<http://futureag.info/news/india-sets-up-waste-management-system-to-boost-composting/>

<https://www.lifepositive.com/from-trash-to-cash/>

<http://www.samhita.org/social-organisation/trash-to-cash/>

[http://www.ilsindia.com/pdf/2014/A\\_About\\_the\\_Company.pdf](http://www.ilsindia.com/pdf/2014/A_About_the_Company.pdf)

[http://cpheeo.nic.in/WriteReadData/Cpheeo\\_SolidWasteManagement2016/ Manual.pdf](http://cpheeo.nic.in/WriteReadData/Cpheeo_SolidWasteManagement2016/Manual.pdf)

<http://urban.bih.nic.in/Docs/CDP/DPR-Toolkit.pdf>

[http://moud.gov.in/pdf/57f1f2e1ac08aGUIDELINES%20 technology.pdf](http://moud.gov.in/pdf/57f1f2e1ac08aGUIDELINES%20technology.pdf)

<http://moud.gov.in/pdf/57f1e55834489Book03.pdf>

<https://gramener.com/qci/>



## **National Institute of Urban Affairs**

1st and 2nd Floor, Core 4B, India Habitat Centre, Lodhi Road, New Delhi - 110003, INDIA  
(+91 11) 24643284/24617517, (+91 11) 24617513. email: pdey@niua.org, niua@niua.org  
website: [www.niua.org](http://www.niua.org), [khub.niua.org](http://khub.niua.org)

