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Muncipal Solid Waste Management using Landfills in Hyderabad City

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***Abstract* - Municipal solid waste management (MSWM) is one of the major environmental problems. Improper management of municipal solid waste (MSW) causes hazards to inhabitants. Various studies reveal that about 90% of MSW is disposed of unscientifically in open dumps and landfills, creating problems to public health and the environment. In the present study, an attempt has been made to provide a comprehensive review of the characteristics, generation, collection and transportation, disposal and treatment technologies of MSW practiced in Hyderabad.Based on the discussions with Greater Hyderabad Municipal Commission (GHMC) officials and detailed survey, the total quantity of solid waste generated in the Hyderabad city is estimated to be around 4400 Tons Per day (TPD) excluding Construction and Demolition Waste (C&D Waste) which is about 650-700 TPD. The survey commissioned by GHMC showed that door to door collection was 72 per cent; garbage collection efficiency was 80 per cent.**

Key words : Municipal solid waste management (MSWM), Municipal solid waste (MSW), Greater Hyderabad Municipal Commission (GHMC), Tons Per day (TPD), Construction and Demolition Waste (C&D Waste)

1. INTRODUCTION

Over the last two decades rapid urbanization, change in life styles and rise in population has resulted in generation of huge quantities of Municipal Solid Waste (MSW). The quantity of MSW generated is much higher than the quantity collected, transported and disposed, leading to pilling up of uncollected waste in streets, public places and drains. Even the collected waste is mostly dumped on the outskirts of towns/cities and has created serious environmental and public health problems. Studies have shown that a high percentage of individuals who live near or on disposal sites are infected by gastrointestinal parasites, worms, and other pathogenic organisms. The insanitary methods adopted for disposal of municipal solid wastes are, therefore, a serious health concern. The poorly maintained landfill sites are causes of surface and groundwater contamination, and air pollution.

Plastic waste has emerged as one of the biggest challenges in municipal solid waste, leading to an acute problem of choking of rivers and drains, ruining the landscape and killing of cattle. Adding to this, the inert material coming from street cleaning, drain cleaning, construction, demolition and renovation are being mixed with the normal waste, aggravating the problems

2.INTEGRATED MUNICIPAL SOLID WASTE MANAGEMENT (ISWM)

Integrated solid waste management refers to generation, segregation, transfer, sorting,treatment, recovery and disposal in accordance with the MSW (M&H) Rules, 2000. This model is based on 4Rs-reduce, reuse, recycle and resource, and focuses on the three basic principles which are as under:

*Equity***:** All citizens are entitled to an appropriate waste management system for environmental health reasons
Effectiveness: the waste management model applied will lead to the safe removal of all waste
Efficiency: the management of all waste is done by maximising the benefits, minimizing the costs and optimizing the use of resources on sustainable basis.

The ISWM model depends on three basic concepts i.e. *lifecycle*, *waste generation* and *waste management.*
Details of these are presented below:

Lifecycle

Lifecycle assessment of a product from its production and consumption is in Figure - 1. The reduction in consumption, and utilization of discarded products within the production system as a substitute for new resources, can lead to reduced end-of-cycle waste generation; thus, less efforts and resources would be required for the final disposal of the waste. This concept is mostly applicable to industries.

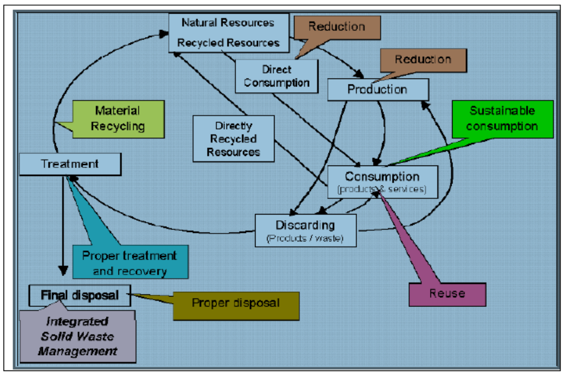

Figure 1-1: Lifecycle Assessment

3.WASTE GENERATION

Waste generation is from different sources such as domestic, commercial and industrial. This waste could be further classified as hazardous and non-hazardous waste. The former has to be segregated at source and treated for disposal in accordance with the regulations. 3R approach i.e. reduce, reuse and recycle is applicable both at source as well as at the different levels of solid waste management chain including collection, transportation, treatment and final disposal.

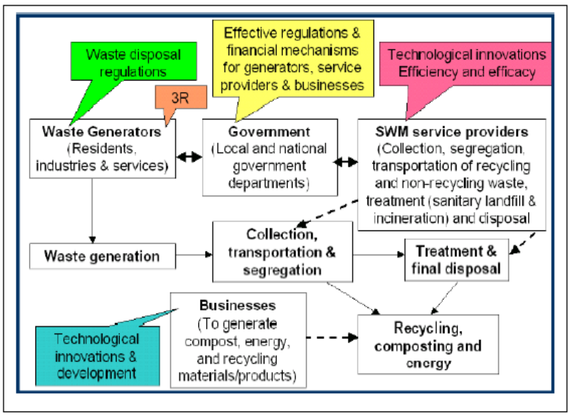

Figure 1-2: Waste Generation

It is depicted in Figure – 2 below which includes regulations and laws, institutions, financial mechanisms, technology, infrastructure, and role of various stakeholders in the solid waste management.

Waste management

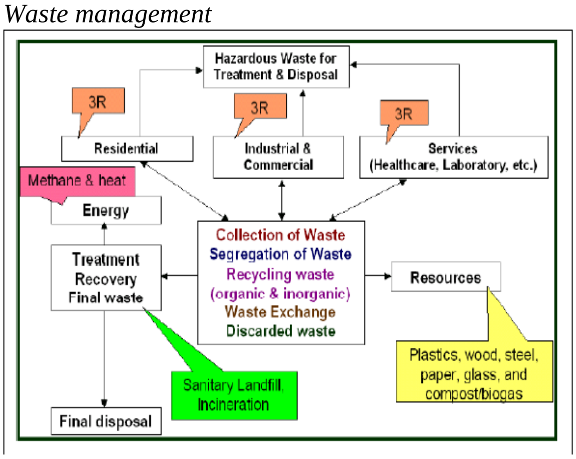

Figure 1-3: Waste management

Management systems may evolve over a period of time depending on the variations in solid waste, political and administrative structures, socioeconomic situation and geo-climatic conditions. Hence, it is useful to capture the evolving process with respect to laws,

Table 1 silent features of Hyderabad city

Area (2001)	172 sq. km
Area (2011)	638 sq. km (included added areas in 2007)
Census Population (2001)	36.11 lakhs (only MCH area)
Projected Population (2011)	83.89 lakhs (including population from added areas i.e. GHMC area)
Geographical Features	Altitude - 536 meter above mean sea level Latitude - 17.2o North Longitude - 78.3 o East
Climatic Features	Winter Temperature: Max 22oC, Min 12oC Summer Temperature: Max 40oC, Min 22oC Rainfall: (June to September): 89 cm Best season: June to February
Exports	Software, Basmati Rice, spices, medical transcription and oil exports.
Industries	Software industries, electrical fans, cooling systems, jewels, pharmaceuticals and automotive industries.
Famous Universities	Jawaharlal Nehru Technological University (JNTU), Osmania University, N.G. Ranga Agricultural University, Dr. B.R. Ambedkar University.
Airport	Rajiv Gandhi International Airport at Shamshabad, which is located 25 km from the city.
Regional Significance	Hyderabad is one of the India"s largest metropolises and the capital of the state of Telagana . Hyderabad is being located on the cross-roads of the rivers Krishna and Godavari in the Telangana. Regionally, Hyderabad lies on the convergence of National and state highways and trunk, air and rail routes. It is also recognized as the city of pearls and pearl ornament, silverware, lacquer bangles, kalamkari paintings and artifacts..

Total Waste Generation

The average daily waste generation from GHMC is around 5030 MT/day, with a per capita generation of about 599 gm. **Table 2** provides breakup of waste generation from various sources and**Figure 1.4**shows percentage distribution of waste generation from different sources.

Sl. No.	Type of Waste	Waste generated (MT/day)	Percentage Waste Composition (%)
1	Domestic Household waste	1870	37.18%
2	Commercial Establishments waste	350	6.95%
3	Hotels & Restaurants	666	13.24%
4	Institutional waste	125	2.48%
5	Parks and Gardens	69	1.38%
6	Street sweeping waste	325	6.47%
7	Waste from Drains	175	3.47%

Table 2:Waste Generation From Various Sources

Sl. No.	Type of Waste	Waste generated (MT/day)	Percentage Waste Composition (%)
8	Markets	479	9.52%
9	Temples	35	0.70%
10	Chicken, Muttpn, Beef, Fish stalls	164	3.26%
11	Cinema halls	15	0.30%
12	Function halls	88	1.74%
13	Hospitals	35	0.69%
14	Construction and Demolition waste	635	12.62%
TOTAL		5030	100.00

TABLE 3- TOTAL WASTE GENERATED

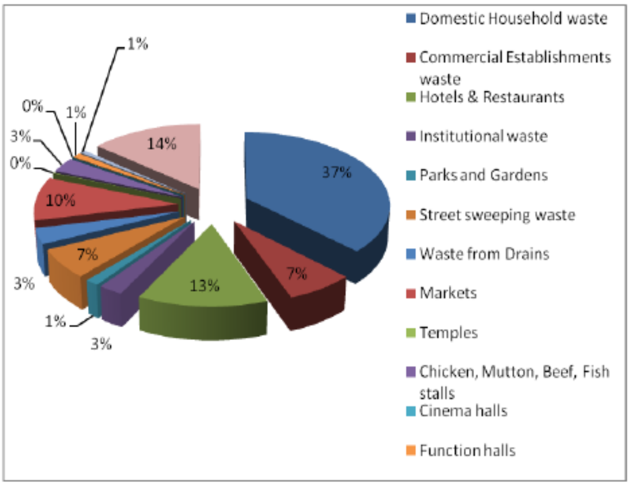

Figure 1-4: Sources Of Waste Generation In Hyderabad City

4. PHYSICAL ANALYSIS OF SOLID WASTE

Organic matter including food waste, market waste & leaves, ash, stones and fine earth with soil are the major constituents of the solid waste generated in Hyderabad. The composition of organic matter ranges from 39.17% to 64.57%, the composition of ash and fine earth ranges from 7.13% to 17.07% and the contribution of stones, debris and boulders constitutes a significant 0.71 % to 3.92 %.

4.1chemical Characteristics Of Msw

Chemical properties analyzed for MSW included moisture, Carbon content, Nitrogen, Calorific Value and heavy metals. Chemical properties of waste were analysed to make a decision on the most suitable waste processing technology. The moisture content of the tested samples was in the range of 31.73 – 59.24% and the calorific value ranges of 1250 – 2550 kcal/kg (dry waste). Carbon content is the indicator of the conversion of MSW into compost. Calorific Value is the indicator of suitability of waste for waste to energy technologies. The heavy metals are also well within the desirable ranges except Zinc. Detail chemical properties of waste are shown in the **Table**

Property	Range
Ph	6.24 – 7.15
Moisture Content, %	31.73 – 59.24
Carbon Content, %	7.60 – 15.6
Nitrogen mg/kg	4500 – 7200
Zinc, mg/kg	132 – 272
Lead, mg/kg	10 – 25
Nickel, mg/kg	1 – 6
Calorific Value, k.Cal/kg	1250 – 2550

TABLE1.6 CHEMICAL PROPERTIES OF MSW GENERATED IN GHMC

5. Waste collection

System	Description	Advantages	Disadvantages
SHARED: Residents can bring out waste at any time			
Dumping at designated location	Residents and other generators are required to dump their waste at a specified location or in a masonry enclosure.	Low capital costs	Loading the waste into trucks is slow and unhygienic. Waste is scattered around the collection point. Adjacent residents and shopkeepers protest about the smell and appearance.
Shared container	Residents and other generators put their waste inside a container which is emptied or removed.	Low operating costs	If containers are not maintained they quickly corrode or are damaged. Adjacent residents complain about the smell and appearance.
INDIVIDUAL: The generators need a suitable container and must store the waste on their property until it is collected.			
Block collection	Collector sounds horn or rings bell and waits at specified locations for residents to bring waste to the collection vehicle.	Economical. Less waste on streets. No permanent container or storage to cause complaints.	If all family members are out when collector comes, waste must be left outside for collection. It may be scattered by wind, animals and waste pickers.
Kerbside collection	Waste is left outside	Convenient. No	Waste that is left out may be scattered by wind, animals,

	property in a container and picked up by passing vehicle, or swept up and collected by sweeper.	permanent public storage.	children or waste pickers. If collection service is delayed, waste may not be collected or some time, causing considerable nuisance.
Door to door collection	Waste collector knocks on each door or rings doorbell and waits for waste to be brought out by resident.	Convenient for resident. Little waste on street.	Residents must be available to hand waste over. Not suitable for apartment buildings because of the amount of walking required.
Yard collection	Collection labourer enters property to remove waste.	Very convenient for residents. No waste in street.	The most expensive system, because of the walking involved. Cultural beliefs, security considerations or architectural styles may prevent labourers from entering properties.

6.Design criteria Sanitary Landfill

Sanitary landfill for GHMC has been proposed for the rejects from the waste processing facility and other inerts. Landfill has been designed for the average reject from the landfill from 2012 to 2014, which is approximately 800 TPD as per the proposed plan.

Quantity of rejects to be disposed = 800 tons/day
Bulk density of the rejects = 1 ton/m3
Volume of the rejects to be disposed = 800 m3/day

6.1 Landfill site specifications

Landfill consists of an area 13.00 acres / 55000 m2 at northern side of the Jawaharnagar site. The landfill capacities have been shown below.

Area at ground level = 54635 m2
Depth below ground level = 2 m
Area below ground level = 31329 m2
Height above ground level = 20 m
Area at the top = 1029 m2
Volume available = 624225 m3

6.2 Sanitary Landfill Facility Design Concepts

Landfill design involves development of concept, adoption of suitable procedure and safety considerations. Landfill is a typical combination of different component and each of these components has to be designed separately. For this process standard design procedure by CPHEEO Manual on Municipal Solid Waste Management, United States Environmental Protection Agency‟s Manual on Solid Waste Management (Subpart – D, Design Criteria) and Municipal Solid Waste (Management & Handling) Rules have been adopted. Design concepts for the following components have been developed,

Assessment of landfill volume and area required

- Landfill life
- Evaluation of concept development plan – Foot Print of Landfill Site
- Design of leachate collection system
- Design of liner system
- Assessment of landfill gas generation
- Design of landfill gas collection system
- Design of final cover system

6.3 Landfill Life

The landfill has been designed for a period of 10 years. Approximately 800 tons/day of inert matter comprising of silt, sand, rejects from each process line shall be disposed in the landfill.

6.4 Standard Design Requirements

For design and development of landfill recommendation from MSW Rules, 2000 have been adopted. Apart from that CPHEEO Manual and United States Environmental Protection Agency‟s Manual on Solid Waste Management (Subpart – D, Design Criteria) are also been referred to establish the design requirements.

Landfill Component	Requirement	Reference
Bottom Liner / Composite Liner	• A 90cm thick compacted clay or amended soil (amended with bentonite) of permeability not greater than 1X10-^{7} cm/sec • A HDPE geomembrane liner of thickness 1.5mm • A drainage layer of 300mm thick granular material of permeability not greater than 1X10-^{2} cm/sec.	MSW Rules, 2000
Final Cover	• Vegetative layer of 450mm thick with good vegetation supporting soil • Barrier layer of 600mm thick clay/amended soil with permeability 1 X 10-^{7}cm/sec • Gas venting layer of 450mm thick granular material with permeability 1 X 10-^{2}cm/sec	MSW Rules, 2000
Maximum Allowable Leachate Head with in Landfill	30 cm	USEPA's Manual on SWM (Subpart – D, Design Criteria)
Base Slope	2%	CPHEEO Manual
Cover Slope	Not steeper than 1:4	CPHEEO Manual

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6.5 Standard Design Requirements For Sanitary Landfill

Based on the above analysis and standard design consideration the profile of landfill has been finalised as follows;

Vegetative layer	0.45 m
Barrier layer of clay with permeability 1 X 10^{-7}cm/sec	0.60 m
Gas venting layer of granular material with permeability 1 X 10^{-2}cm/sec	0.45 m
Municipal Solid Waste	25 m
Drainage layer of permeability not greater than 1X10^{-2} cm/sec	0.30 m
HDPE Geomembrane liner (1.5 mm)	
Compacted Clay permeability not greater than 1X10^{-7} cm/sec	0.90 m

6.6 Design of Leachate Collection System

The primary function of Leachate Collection System is to collect and convey leachate out of the landfill unit and to control the depth of the leachate above the liner. The leachate collection system should be designed to meet the hydraulic performance standard of maintaining less than 30cm depth of leachate or head above liner, as suggested by USEPA Manual. Flow of leachate through imperfections in the liner system increases with an increase in leachate head above the liner. Maintaining a low leachate level above the liner helps to improve the performance of the composite liners.

The main components of leachate collection system are drainage layer and conveyance system. Leachate conveyance system is a network of pipes by which the leachate is collected through perforated HDPE pipes and collected in a sump. The drainage shall be provided as per the standards recommended by MSW Rules, 2000. The other design parameter which governs the leachate collection is the spacing between the pipes.

6.7 Spacing of Pipes

As suggested by USEPA Manual, the pipe spacing could be determined by the Mound Model.

In the Mound Model, the maximum height of fluid between two parallel drainage pipes is equal to,

$$h_{\max} = \frac{L\sqrt{c}}{2}\left[\frac{\tan^2\alpha}{c} + 1 - \frac{\tan\alpha}{c}\sqrt{\tan^2\alpha + c}\right]$$

Where, C = Q/k

hmax = Maximum Hydraulic Depth (30 cm)

L = Distance between the Pipes

k = Permeability of Drainage Layer (0.01)

Q = Inflow Rate for unit area

α = Slope (2%)

Inflow Rate for unit area Q = Total Leachate Generation/Total Area

Q = (964 m3/day) / (164664 m2) (*Note: Area of the landfill has been considered)

Therefore Q = 0.0058 m/day

k = 0.01 cm/sec = 8.64 m/day

Thus applying the values to the above equation;

L = 38.77 m

Factor of Safety = 2.5

Thus applying factor of safety L = 38.77 m / 2.5 = 14.5 (adopt 15 m)

7.LEACHATE COLLECTION SYSTEM

The leachate collection system is a network consisting, 160 mm diameter branch pipes at spacing of 15 m connected to 315 mm diameter header pipe. The higher diameter pipes are suggested to maintain the uniformity and to take care of clogging and algae growth. The pipes should be HDPE perforated pipes with sufficient strength (minimum 6 kgf) and should be safe from particulate and biological clogging and deflections. The header/ main trunk pipe shall be connected to leachate collection sump. The purpose of leachate collection sump is to collect the leachate from header pipes. The estimated lechate generated will be managed by leachate collection sump.

7.1Bottom Liner System

Leachate control by liner system within a landfill involves prevention of percolation of Leachate from waste in landfill to the subsoil by a suitable protective system (liner system).

The liner system is a combination of drainage layer and barrier layers. As per CPHEEO manual a competent liner system should have low permeability, should be robust and durable and should be resistant to chemical attack, puncture and rupture. A liner system comprises of combination of barrier materials such as natural clay, amended soils and flexible geomembrane.

As suggested by MoEF guidelines a composite liner of two barriers made of different materials, placed in immediate contact with each other provides a beneficial combined effect of both the barriers. The liner system suggested by MOEF is a geomembrane layer over clay or amended soil barrier. A drainage layer and leachate collection system is placed over the composite liner system.

The effectiveness of barrier layer basically depends on the hydraulic conductivity of the clay/amended soil liner and density of the geomembrane. The clay/amended soil liner is effective only if it is compacted properly and geomembrane liner is effective only if it has the density or mass per unit area (minimum thickness is specified) is sufficient enough against punctures.

The liner system for landfill site at Hyderabad is designed based on MoEF recommendations. As per MoEF "Construction of a non-permeable lining system at the base and wall of waste disposal site area. For landfill receiving residues of waste processing facilities or mixed waste or waste having contamination of hazardous material (such as aerosol, bleaches, polishes, batteries, waste oils, paint products and pesticides) minimum liner specification shall be a composite barrier having 1.5mm High Density Polyethylene (HDPE) geomembrane or equivalent overlying 90cm of soil (clay/amended soil) having permeability coefficient not greater than 1X10-7cm/sec."

Therefore for the landfill site composite liner of following specifications has been recommended complying Municipal Solid Waste (Management and Handling) Rules 2000.

- A 90cm thick compacted clay or amended soil (amended with bentonite) of permeability not greater than 1X10-7 cm/sec
- A HDPE geomembrane liner of thickness 1.5 mm
- A drainage layer of 300 mm thick granular material of permeability not greater than 10^{-2} cm/sec.

Main components of composite liner are clay/amended soil layer and geomembrane liner and performance of landfill largely depends on this liner system. Thus it is incumbent to design the liner system very accurately and perfectly.

Property			Typical Value
1	Thickness		1.5mm (60mil)
2	Density		0.94gm/cc
3	Roll Width X Length		6.5m X 150m
4	Tensile Strength		
	A	Tensile Strength at Yield	24kN/m
	B	Tensile Strength at Break	42kN/m
	C	Elongation at Yield	15%
	D	Elongation at Break	700%
	E	Secant Modulus (1%)	500MPa
5	Toughness		
	A	Tear Resistance (initiation)	200N
	B	Puncture Resistance	480N
	C	Low Temperature Brittleness	-94^{0}F
6	Durability		
	A	Carbon Black	62%
	B	Carbon Black Dispersion	A-1
	C	Accelerated Heat Ageing	Negligible Strength Changes after 1 month 110^{0}C
7	Chemical Resistance		
	A	Resistance to Chemical Waste Mixture	10% Strength Change Over 120 days
	b	Resistance to Chemical Reagents	10% Strength Change Over 7 days
8	Environmental Stress Crack Resistance		1500hrs
9	Dimensional Stability		2%
10	Seam Strength		80% or more (of Tensile Strength)

8. LANDFILL GAS MANAGEMENT

Landfill gas is generated as a product of waste biodegradation. In landfill sites organic waste is broken down by enzymes produced by bacteria in a manner comparable to food digestion. Considerable heat is generated by these reactions with methane, carbon dioxide, nitrogen, oxygen, hydrogen sulphite, carbon dioxide and other gases as the byproducts. Methane and carbon dioxide are the principle gases produced with almost 50 – 50 per cent share.

When methane is present in the air in concentrations between 5 to 15 per cent, it is explosive.
Landfills generate gases with a pressure sufficient enough to damage the final cover and largely have impact on vegetative cover. Also, because only limited amount of oxygen are present in a landfill, when methane concentration reach this critical level, there is a little danger that the landfill will explode. As suggested by CPHEEO Manual the gas management strategies should follow the following three plans,

1. Controlled Passive Venting
2. Uncontrolled Release
3. Controlled Collection and Treatment

Since landfill site at Hyderabad is supported by compost plant gas generation is anticipated to be very less. The principal components of landfill gas are Methane (CH4) and Carbon dioxide (CO2) and USEPA has identified another 47 type of toxicants and carcinogens liberate from the landfill. For landfill site at Jawaharnagar a passive gas venting system is proposed. To collect landfill gas about 220 gas vent are required.

9. DESIGN OF FINAL COVER SYSTEM

A final landfill cover is usually composed of several layers, each with a specific function. The surface cover system must enhance surface drainage, minimise infiltration, support vegetation and control the release of landfill gases. The landfill cover to be adopted will depend on the gas management system.

As recommended by the MoEF and CPHEEO the final cover system must consist of a vegetative layer supported by a barrier layer and gas vent layer. The final cover system proposed for landfill site at Jawaharnagar is based on the recommendations of MoEF and CPHHEO Manual. The final cover consists of the following components,

- Vegetative layer of 450 mm thick with good vegetation supporting soil
- Barrier layer of 600mm thick clay/amended soil with permeability 1 X 10-7cm/sec
- Gas venting layer of 450 mm thick granular material with permeability 1 X 10-2cm/sec

10. Summary of Design

This section of the chapter presents the summary of the design as worked out in the earlier sections. The details of design summary are presented in Table

Landfill Component	Design Specifications
Design Life of Cell	5 years
Area	49 .00 Acres
Maximum Leachate Generation	116.2 m^3 /day
Feeder Pipes Spacing Size	 15 m 160 mm diameter
Header Pipe Size	200 mm diameter
Feeder and Header Pipe Material	HDPE perforated pipes with sufficient strength
Liner System	• A 90cm thick compacted clay or amended soil (amended with bentonite) of permeability not greater than $1X10^{-7}$ • A HDPE geomembrane liner of thickness 1.5mm and with minimum density of 0.94 gm/cc • A drainage layer of 300 mm thick granular material of permeability not greater than $1X10^{-2}$ cm/sec.
Number of Gas Vents Required	

SUMMARY OF LANDFILL DESIGN

11. Landfill Closure, Cover and Slope Stabilization

The waste at all four dumping sites is accumulated non-uniformly with lots of undulations. At most of the locations there is no uniform pattern of the slope. It has been proposed that the landfills would be developed with a side slope of 1 (V): 3 (H). To stabilize the slope (top and side) and to close the landfill after filling suitable covering material would be provided discussed below.

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 dispose surface drainage, minimize infiltration and erosion and control the release of the landfill gas. REEL has proposed the surface cover design based on the objective and technical requirements of each cover component, keeping the mandatory requirements of as MSW rules in due consideration.

12. Surface Cover For Smaller Landfills

The proposed final cover for these three landfill sites is a simple cover layer as per CPHEEO guidelines, as passive venting is recommended here:

Top Soil: Vegetative layer made up of topsoil of thickness 45cm is proposed over the gas collection layer. The soil for this layer shall be transported from approved borrows pits suitable for growing vegetation and developing landscaping.

Gas collection Layer: A gas collection layer made up of granular soil of permeability coefficient (k) greater than 10-2 cm/sec of thickness 45 cm is proposed below the top soil.

Impervious Layer: The MSW rules specify only 60 cm of clay layer to prevent any kind of infiltration of water into the closed fill and escape of landfill gas into the atmosphere. This liner will act as a waterproof layer. Here, amended soil will be used as impervious liner comprising of soil added with 10% bentonite. On completion of the cover layer landscape would be developed over the closed landfill which will include green cover, shrubs, pathways, shelters with sitting space, etc.

12.1 Surface cover for dumpsite

The proposed final cover for landfill site is a composite cover layer as per
CPHEEO guidelines, as active landfill gas collection is recommended here:
Top Soil: Vegetative layer made up of topsoil of thickness 45cm is proposed over the gas collection layer. The soil for this layer shall be transported from approved borrows pits suitable for growing vegetation and developing landscaping

Drainage Layer: A drainage layer made up of granular soil of permeability coefficient (k) greater than 10-2 cm/sec of thickness 30 cm is proposed below the top soil. Top 15 cm will take care of drainage and in the bottom 15cm, the network of LFG collection pipes would be provided.

Impervious Layer: The MSW rules specify only 60 cm of clay layer to prevent any kind of infiltration of water into the closed fill and escape of landfill gas into the atmosphere. This liner will act as a waterproof layer. Here, amended soil will be used as impervious liner comprising of soil added with 10% bentonite. However, as per CPHEEO guidelines, additional layer of HDPE liner of 1.5mm thickness is also provided here. A separate gas collection layer has not been proposed in cover layer, as there shall be a network of pipes comprising of headers (dia. 16 cm) and feeders (dia 10 cm) to collect the landfill gas. On completion of the cover layer landscape would be developed over the closed landfill which will include green cover, shrubs, pathways, shelters with sitting space, etc

CONCLUSION

Landfills are part of an integrated system for the management of MSW. When carefully designed and well managed within the context of the local infrastructure and available resources, landfills can provide safe and cost-effective disposal of a city's MSW. Nevertheless, municipal landfills, whether controlled dumps or sanitary landfills, should not be treated as panaceas for deficiencies in the region's overall waste management needs. Landfills are not designed for the routine disposal of industrial or hazardous waste, used oil, or other special wastes. If they are consistently pushed beyond their design limits, landfills, like any other engineered system, will fail. Such failure can have dire consequences for human health and the environment as the landfill then degrades into a potentially toxic open dump.

An integrated MSWM system may prioritize its waste management options according to waste minimization, materials recovery/recycling, composting, incineration, and landfilling. Incineration is only a sound management practice under particular conditions. At present, these generally do not occur in MSWM systems with limited capital and technical resources. All the other components of the integrated approach can improve landfill operations and extend the life of the facility.

Waste minimization or source reduction focuses on reducing the quantity and potential toxicity of MSW destined for the landfill. This means less material to be handled throughout the MSW system with less risk.
Materials recovery and recycling reduces the amount of material to be disposed of and extends the life of the landfill. It also provides the additional benefit of reducing the consumption of raw materials.
Composting diverts organic matter from the landfill. This can reduce gas and leachate risks at the landfill and extend the life of the facility.

It is more cost-effective to perform these operations close to the site of waste generation. This reduces the cost of transporting the materials to the landfill and minimizes the difficulty of separating mixed wastes at the landfill.
Finally, as noted earlier, successful MSWM depends on adequate financing, enabling legislation, and a supporting institutional and policy environment. In many cases this will require changes in the way government institutions currently operate and will necessitate recognition of the importance of effective MSWM for a city's and country's sustainable development.

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