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TECHNICAL MANUAL FOR SOLID WASTE MANAGEMENT

KSWMP
KERALA SOLID WASTE MANAGEMENT PROJECT

TECHNICAL MANUAL FOR SOLID WASTE MANAGEMENT

SUCHITWA MISSION
LOCAL SELF GOVERNMENT DEPARTMENT KERALA



TECHNICAL MANUAL FOR SOLID WASTE MANAGEMENT

Suchitwa Mission
Local Self Government Department, Government of Kerala

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MESSAGE



Shri. M.B.Rajesh

Minister for Local Self Government Department,
Excise & Parliamentary Affairs

Solid waste management in Kerala continues to present significant challenges, characterized by complex issues and obstacles in implementing effective waste management facilities. Nevertheless, due to the persistent and dedicated efforts of the government, notable progress has been achieved in this area.

The Suchitwa Mission plays a critical role as a technical support agency for local bodies, and its 'Technical Manual for Solid Waste Management' is a testament to this effort. This manual is a comprehensive and invaluable resource that not only highlights the advancements we have made but also provides a clear path forward. The Suchitwa Mission's dedication to creating this manual is evident in the extensive effort put into compiling and presenting the information in a practical and accessible manner. It offers a thorough examination of the technologies currently used in solid waste management, along with the necessary policies and guidelines.

Officials will find this manual to be an exceptionally valuable reference for addressing technical challenges and improving waste management practices. While the release of this manual represents a significant achievement, it also underscores the ongoing need for continued effort. The work of the Suchitwa Mission remains essential in advancing sustainable and effective waste management systems in Kerala.

I sincerely hope this manual will prove beneficial to professionals and scholars in the waste management sector, enhancing practices and supporting the development of sustainable solutions for our state.

M.B.Rajesh

Message



Sarada Muraleedharan IAS

Additional Chief Secretary,
Planning & Economic Affairs and Waste Management

"Since the launch of the Government of Kerala's ambitious zero-waste campaign, 'Malinyamuktham Navakeralam,' in March 2023, there has been a noticeable shift towards finding immediate and practical solutions to Kerala's longstanding waste management issues. This campaign has catalysed a movement, bringing together communities, experts, and policymakers in a collective effort to transform the state's waste management landscape.

The release of this technical manual by the Suchitwa Mission marks a pivotal moment in this ongoing initiative. It is more than just a guide; it is a comprehensive resource designed to equip both professionals and the general public with the knowledge and tools needed to tackle the technical challenges of waste management. The manual's detailed guidelines and innovative strategies provide actionable steps that can be implemented at various levels, from individual households to larger municipal projects.

I hope that this manual will play a part in advancing the goals of the 'Malinyamuktham Navakeralam' campaign, enabling a more efficient and sustainable approach to waste management across Kerala."

Sarada Muraleedharan IAS

Message



Seeram Sambasiva Rao IAS

Principal Director, LSGD, Government of Kerala

Suchitwa Mission has done a remarkable job by publishing the technical manual on solid waste management. This comprehensive technical manual is a valuable resource that will greatly benefit both professionals and communities striving for sustainable practices. This will also act as a ready reference scripture for the officers in the Local Self Government Department for landing on decisions regarding various waste management topics, without much hassle. This can be also be proudly presented in front of other states of the country who are always keen to learn more about the Kerala model waste management.

Seeram Sambasiva Rao IAS

MESSAGE



Er. Sandeep K G

Chief Engineer, LID & EW, LSGD

As engineers, our contribution to the successful implementation of solid waste management projects is of paramount importance. The technical manual prepared and published by the Suchitwa Mission is a crucial resource designed specifically for professionals in our field. This comprehensive guide offers an in-depth exploration of the latest technologies, methodologies, and best practices in waste management, addressing the unique challenges we encounter.

By delving into the insights and practical solutions provided in this manual, engineers are equipped to enhance both the efficiency and effectiveness of their projects. The manual provides essential knowledge that enables us to navigate complex technical issues and implement solutions with greater precision and sustainability.

Moreover, this resource empowers us to align our work with the broader objectives of environmental stewardship and sustainability. It is not merely a guide but a transformative tool that will support us in achieving more innovative and impactful results in waste management. I am confident that this technical manual will become an indispensable part of our daily operations, helping us drive progress and contribute to a cleaner, more sustainable future for our state

Sandeep.K.G

Foreword



U. V. Jose IAS (Retd)

Executive Director, Suchitwa Mission

Occupying a central role in the state's waste management sector, Suchitwa Mission is dedicated to continuously updating and revitalizing its approach with cutting-edge concepts and technologies, reflecting the demands of our changing world. With a steadfast commitment to evolving alongside the latest advancements, the mission consistently integrates cutting-edge concepts and technologies to address the ever-changing landscape of waste management. In an era where artificial intelligence and virtual reality have reshaped our expectations, there is a growing demand for swift and effective solutions to complex challenges.

In response to this need, the Solid Waste Management wing of the Suchitwa Mission has meticulously developed and published this comprehensive technical manual. This manual stands as a curated repository of practical solutions, thoughtfully designed to support those dedicated to tackling the intricate issues within the waste management sector. It goes beyond serving as a mere guide; it is an essential resource that bridges the gap between expert knowledge and practical application.

By equipping both professionals and communities with actionable insights and strategies, this manual ensures that Kerala remains at the forefront of sustainable and responsible waste management practices, reinforcing the mission's role in fostering a cleaner, more efficient future.

U.V.Jose IAS (Retd)

PREFACE

Establishing waste recycling and processing facilities is crucial for promoting a healthy environment and ensuring sustainable waste management. These facilities help reduce the volume of waste sent to landfills, minimizing soil, air, and water pollution that results from improper waste disposal. By recycling and processing waste, valuable materials such as metals, plastics, etc are recovered and reused, conserving natural resources and reducing the need for raw material extraction. Additionally, recycling lowers greenhouse gas emissions by cutting down on energy consumption in manufacturing. Processing facilities for various waste streams, including biodegradable, electronic, and plastic waste, also support the development of a circular economy, where materials are continually reused, reducing environmental impact. This not only protects public health but also fosters long-term sustainability by promoting efficient resource use and reducing the environmental footprint of waste management.

This technical manual on solid waste management provides a comprehensive guide to various technologies and strategies for managing different categories of waste. It covers a wide range of waste streams, including biodegradable waste, plastic waste, electronic (e-waste), construction and demolition (C&D) waste, hair waste, domestic hazardous waste, legacy waste, refuse-derived fuel (RDF), and sanitary waste. The manual details sustainable solutions for each waste type, offering practical insights into collection, processing, and disposal methods. All the specifications provided in the manual are tentative for reference purpose and it can be customized based on the requirements of the project.

In addition to waste management technologies, the manual addresses the construction, and management of facilities such as modern slaughterhouses and crematoriums, with a focus on environmental and operational efficiency. It aims to equip field engineers and other professionals with the knowledge and tools needed to implement effective, sustainable waste management practices in line with regulatory and environmental standards. This resource is intended to support the development of resilient waste management systems that promote sustainability and public health.

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1 INTRODUCTION

1.1 SOLID WASTE

"Waste" refers to any material, substance, or byproduct that is discarded, unwanted, or no longer useful to its owner. Waste can come in various forms, including solid, liquid, or gaseous, and it can originate from residential, commercial, industrial, or institutional sources. Waste can be further categorized based on its composition, such as organic waste (e.g., food scraps, yard waste), recyclable materials (e.g., paper, plastics, metals), hazardous waste (e.g., chemicals, batteries), and so on.

According to SWM Rules 2016, "solid waste" means and includes solid or semi-solid domestic waste, sanitary waste, commercial waste, institutional waste, catering and market waste and other non residential wastes, street sweepings, silt removed or collected from the surface drains, horticulture waste, agriculture and dairy waste, treated bio-medical waste excluding industrial waste, bio-medical waste and e-waste, battery waste, radio-active waste generated in the area.

1.2 SOLID WASTE MANAGEMENT

"Waste management" encompasses the activities, processes, and strategies aimed at reducing, handling, treating, and disposing of waste in a safe, environmentally responsible, and cost-effective manner. This includes practices such as waste reduction and prevention, recycling and composting, treatment and disposal of hazardous waste, collection and transportation of waste, and the implementation of regulations and policies to govern waste management practices.

Effective waste management is essential for protecting public health, conserving natural resources, reducing pollution, and promoting sustainable development. It involves collaboration among governments, industries, communities, and individuals to minimize waste generation, maximize resource recovery, and minimize environmental impact throughout the waste lifecycle.

1.3 SEGREGATION OF SOLID WASTE

Source-level segregation of solid waste into biodegradable and non-biodegradable categories is a crucial step in achieving sustainable waste management practices, reducing environmental impact, and promoting resource efficiency.

Source-level segregation of solid waste into biodegradable and non-biodegradable categories is essential for several reasons:

1. **Effective Waste Management:** Segregation at the source enables the efficient management of solid waste by separating materials that require different treatment methods. Biodegradable waste, such as food scraps and yard waste, can be composted or anaerobically digested, while non-biodegradable waste, like plastics and metals, can be recycled or processed through other means.

2. **Resource Recovery:** Source-level segregation facilitates the recovery of valuable resources from waste streams. Biodegradable waste can be converted into compost or biogas, which can be used as organic fertilizer or renewable energy sources. Non-biodegradable waste can be recycled to produce new materials, reducing the need for virgin resources and minimizing environmental impact.

3. **Pollution Prevention:** Proper segregation of waste helps prevent environmental pollution. Biodegradable waste decomposes quickly, but when mixed with non-biodegradable waste in landfills, it produces methane, a potent greenhouse gas. Segregating biodegradable waste allows for controlled decomposition through composting or anaerobic digestion, reducing methane emissions.

4. **Landfill Space Optimization:** Source-level segregation reduces the volume of waste sent to landfills by diverting biodegradable materials for composting or energy recovery. This extends the lifespan of landfills and reduces the need for new landfill sites, which can be challenging to locate and environmentally damaging to establish.

5. **Cost Savings:** Effective waste segregation reduces the costs associated with waste management. Processing biodegradable waste through composting or anaerobic digestion is often less expensive than landfill disposal. Additionally, recycling non-biodegradable materials reduces the need for raw materials and energy-intensive manufacturing processes.

6. **Environmental Protection:** Proper waste segregation contributes to environmental protection by conserving natural resources, reducing energy consumption, and minimizing pollution. It promotes a circular economy where resources are reused, recycled, or recovered, leading to sustainable resource management and ecosystem preservation.

The segregation process in accordance with the Solid Waste Management Rules of 2016 should adhere to a three-bin system: one for biodegradable waste, another for non-biodegradable waste, and a third for domestic hazardous waste.



Figure 1.1 : Schematic representation of segregated waste storage bins

1.4 PROCESSING OF SOLID WASTE

Processing of solid waste involves various techniques and methods aimed at reducing the volume of waste, recovering valuable materials, and minimizing environmental impact.
Once waste is segregated, it can be processed using appropriate methods tailored to each waste stream:

1.4.1 Biodegradable Waste

Organic waste, including food scraps and yard waste is segregated from other waste streams and can undergo processing through the following methods.

Composting: Biodegradable waste is subjected to controlled decomposition in the presence of oxygen, resulting in nutrient-rich compost. Compost can be used as a soil amendment in agriculture and landscaping.

Anaerobic Digestion: Organic waste undergoes microbial digestion in an oxygen-free environment, producing biogas (mainly methane) and digestate. Biogas can be used as a renewable energy source, while digestate can be used as fertilizer.

Organism based composting: Organic waste is broken down by earthworms and microorganisms, resulting in nutrient-rich vermicompost.

1.4.2. Non-biodegradable Waste

Non-biodegradable materials, such as paper products, plastics, metals, glass, and specific types of paper that do not easily break down, are separated from biodegradable waste and can be processed using the following methods:

Recycling: Non-biodegradable materials are sorted, cleaned, and processed to manufacture

new products. Common recyclable materials include paper, cardboard, plastics, glass, and metals. Recycling conserves natural resources, reduces energy consumption, and minimizes waste generation.

Waste-to-Energy (WtE): Non-biodegradable waste can be incinerated to generate heat, electricity, or steam. Advanced incineration technologies minimize emissions and recover energy from waste.

Landfilling: Residual non-biodegradable waste that cannot be recycled or converted into energy is disposed of in engineered landfills. Proper landfill management practices, including waste compaction, covering, and monitoring, are essential to minimize environmental impact.

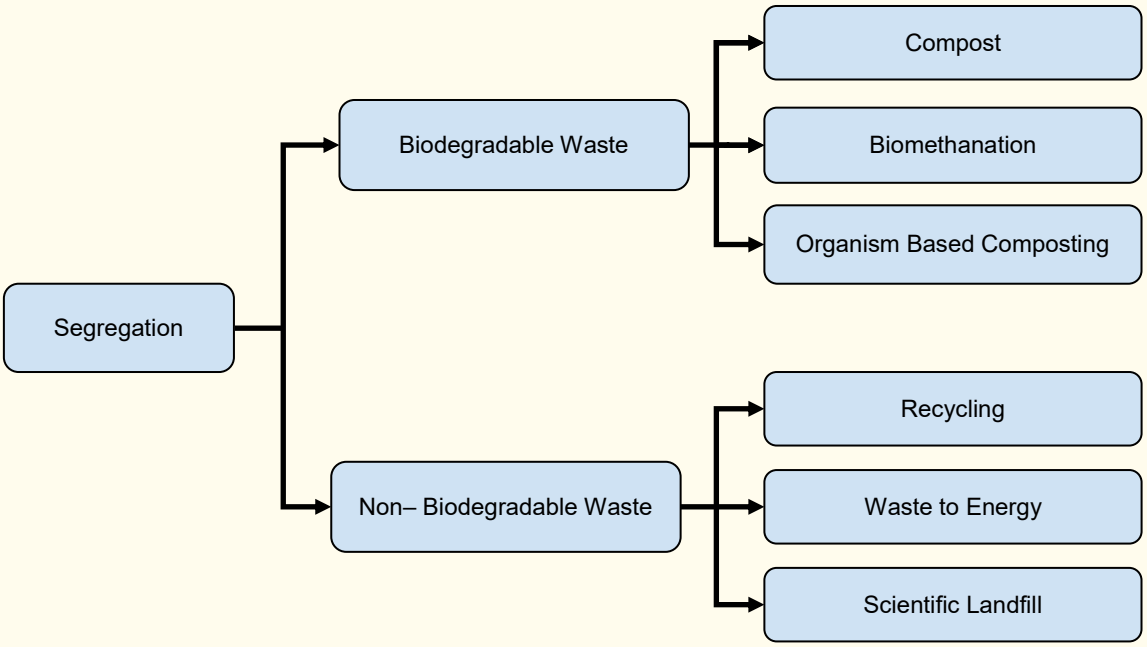


Figure 1.2 : Process flow of Solid Waste Management

Effective segregation and processing of waste into biodegradable and non-biodegradable streams help maximize resource recovery, minimize environmental impact, and promote sustainable waste management practices. It also facilitates the transition towards a circular economy where materials are reused, recycled, or converted into energy to minimize waste generation and conserve resources.

2 BIODEGRADABLE WASTE

Biodegradable waste specifically refers to organic materials that are capable of being decomposed by microorganisms into stable compounds. This category includes various types of organic matter such as food scraps, yard waste. Biodegradable waste can undergo natural decomposition processes, typically through composting or anaerobic digestion, ultimately resulting in the production of compost or biogas, which can be beneficially used in agriculture or energy generation.

Aerobic decomposition: The decomposition process occurs in the presence of air, where aerobic bacteria play a key role in breaking down complex organic matter into nutrients. This process primarily results in the production of carbon dioxide. Certain bacteria belonging to the Pseudomonas and Bacillus species contribute to aerobic degradation. The concentrated liquid generated from solid waste decomposition should be collected and disposed of in a scientific manner, so as to reduce groundwater contamination. Diluted leachate can be used as liquid fertilizer or microbial culture. Adequate leachate management provisions may be provided along with the biodegradable waste treatment units.

Anaerobic decomposition: The decomposition process occurs in the absence of air, where anaerobic bacteria play a crucial role in breaking down complex organic matter into nutrients. This process primarily results in the production of methane and carbon dioxide gases. Certain bacteria belonging to the Clostridium and Streptococcus species contribute to anaerobic degradation. Overflow water shall be treated in a septic tank soak pit system, so as to reduce groundwater contamination.

Operation and maintenance of bio waste: The efficient processing of biodegradable waste is crucial for environmental sustainability and requires a meticulous approach to operation and maintenance. To ensure the optimal functioning of waste processing plants, local bodies should consider outsourcing these responsibilities to specialized private operators. By engaging private players with expertise in managing and maintaining such facilities, local authorities can leverage advanced technologies and industry best practices that may not be available in house.

2.1 TECHNOLOGY OPTIONS AND SELECTION CRITERIA

Kerala has been making significant strides in source-level waste management through various decentralized initiatives. Source-level waste management involves handling waste right where it is generated, rather than transporting it to a central facility. This approach can significantly reduce the environmental impact and improve efficiency. Composting and Biomethanation are the main technologies involved in source level waste management. Decentralized waste management involves setting up small-scale facilities within communities to process waste, reducing the need for large, centralized waste management systems. The local body should choose the most suitable waste management solution based on the needs, taking into account the following factors:

- The characteristics, volume, and frequency of waste generation.
- The suitability, accessibility, and cost-effectiveness of available technology options in the area.
- The presence of skilled personnel, energy resources, operation and maintenance requirements, land availability, and other relevant factors.

Table 2.1: Technology options and selection criteria

Sl. No	Technology Options	Factors for Selection
Institutional Facilities		
1	**NADEP Composting**	✓ Low Capex ✓ Low maintenance ✗ Requires low raised roof. ✗ Difficult to handle. ✗ May attract flies and rodents. ✗ Cow dung required for microbial supply.
2	**Institutional Level Portable Bio Bins**	✓ It is mostly suitable for open terraced flats, institutions and housing colonies. ✓ Portable and Ready to install & operate. ✓ Increase in the number of bins can manage more quantities of waste. ✓ Pleasant order. ✓ Low capex. ✓ No Electricity required. ✓ No skilled labour is required. ✗ High moisture content bio waste shall be avoided. ✗ It's not easy to collect compost from bins.
3	**Aerobic Bin Composting Unit**	✓ All types of degradable waste including dead animals can be decomposed. ✓ Environment friendly. ✓ Dry leaves can be used as water absorbent. ✗ Non portable. ✗ High cost of construction and maintenance, required more space, continuous monitoring by skilled labourers required. ✗ Leachate shall be scientifically disposed of.

		✗ Pest/ rodent infestation ✗ Odour issues. ✗ Long composting duration ✗ Require skilled labourers for maintenance.
4	**Organic Waste Composting Machine**	✓ Easy and convenient. ✓ Required less space and time. ✓ Capacities from 10 - 250 kg per batch. ✓ Semi automatic and Fully automatic system available ✗ High installation and maintenance cost. ✗ Skilled labour is required ✗ Require power (3 phase) and water.
5	**In vessel composting**	✓ Capable of processing large amounts of waste in limited space. ✓ Waste can be continuously fed into the composting system. ✓ It can be used for producing high-quality compost in a controlled environment. ✗ It requires a larger investment upfront compared to other options which may be cost prohibitive. ✗ It can not be considered as a cost-effective solution.
6	**Rotating drum composting**	✓ Reduce the Composting plant ✓ Efficient and effective waste management solution ✗ Require skilled labourers for maintenance.
7	**Biogas Plant (Portable)**	✓ Green fuel ✓ Less space consumption, Portable ✓ Can digest waste with high moisture content ✓ Suitable for high water table areas ✓ Slurry is highly organic manure. ✓ Continuous feeding can be done ✓ Suitable for hot and wet climatic conditions. ✓ Very less maintenance is required. ✗ Not suitable for slow degrading bio waste.
Community level facilities		
8	**Windrow Composting**	✓ Suitable for large scale waste decomposing. ✓ Suitable for biowaste having a long decomposition period. ✗ High Capex and Opex ✗ Leachate management may cause issues ✗ Required heavy machineries ✗ Required skilled labours ✗ Required large space.

Community level facilities		
9	**Vermi-Composting**	✓ Eco-Friendliness ✓ Nutrient-rich compost ✓ Fast Reduction of waste ✗ Required high maintenance ✗ High initial setup costs ✗ Suitable for limited types of waste ✗ Highly sensitive because organism based ✗ Potential for odor
10	**Black Soldier Fly Composting**	✓ High moisture content waste can be treated. ✓ No odour issue. ✓ Nutrient-rich compost. ✓ Very fast conversion of biowaste. ✗ Skilled labour is required ✗ It is highly sensitive because organism based
11	**Biogas Plant (Fixed dome type)**	✓ Green fuel, commercial fuel consumption. ✓ Slurry is highly organic manure. ✓ Can digest waste with high moisture content. ✓ Continuous feeding can be done. ✓ Suitable for hot and wet climatic conditions. ✓ Low maintenance. ✗ High cost ✗ Not suitable for high water table areas. ✗ Required large space. ✗ Non portable. ✗ For large capacity, additional machinery, 3 phase connection, water supply etc are required.
12	**Compressed Biogas plant**	✓ Environment friendly. ✓ It is a renewable source of energy. ✓ Income can be generated on higher capacity plants. ✗ It can't work in all location ✗ Minimum viable capacity is above 20 TPD ✗ Capital cost is high.
13	**Dewatered Composting Unit**	✓ Easier to transport and store. ✓ Faster Bio- waste conversion. ✓ Reduce the amount of leachate produced during the composting period. ✗ Requires additional equipment and energy. ✗ Leachate from the squeezer shall be managed separately. ✗ High capex & Opex. ✗ Labor-intensive. ✗ Large area required.

2.2 AEROBIC COMPOSTING TECHNOLOGY

2.2.1. Institutional Level Portable Bio Bins

The decentralized solid waste management model for High rise apartments/ Gated communities, has today become a success and is being implemented across various cities in the state. The bio-waste collected in these bins are processed using bacteria solution to make bio-manure. The lidded waste bin is normally 6 feet long, 3 feet wide and 2.5 feet deep and is filled with bacteria bio-solution. An apartment housing 40 families will need two units at a time. Waste is deposited in a bin for 30 days. For the next 30 days, the second bin is used, giving time for the waste deposited in the first bin to turn into bio-manure. About 150 square feet is needed to install one unit. These bins can also be installed on the terrace of the apartment complexes. Processing Capacity: 20 kg/day, Approx. Cost: Rs. 60,000 - 70,000/-.



Figure 2.1 : Institutional level portable bio bins

2.2.1.1. Operation & Maintenance

Operating and maintaining a portable Bio bin composting system at an institutional level involves several key steps to ensure efficient and effective composting as follows:

1. **Placement:** Position the Biobin in a well-ventilated area, away from direct sunlight and heavy rainfall to maintain optimal conditions.
2. **Loading:** Add organic waste materials such as food scraps, garden waste, and other biodegradable materials. Ensure a good mix of green (nitrogen-rich) and brown (carbon-rich) materials to balance the compost. The waste collected by the workers is deposited on layers of husk or sawdust at the base. The Diluted bacteria solution (inoculum) is then sprayed on top of it to kick-start a biological reaction.
3. **Aeration:** The Biobin system is designed to keep the compost aerobic. Regularly check the aeration system to ensure it is functioning correctly, as this helps in reducing odors and

and speeding up the composting process.

4. **Moisture Control:** Maintain the right moisture level. The compost should be as damp as a wrung-out sponge. Add water if it's too dry or add dry materials if it's too wet.
5. **Temperature Monitoring:** Monitor the temperature of the compost pile. It should ideally be between 55-65°C (131-149°F) to ensure effective decomposition and pathogen kill.
6. **Regular Inspection:** Check the Biobin regularly for any signs of damage or malfunction. Ensure that the aeration system, lids, and other components are in good working condition.
7. **Turning the Compost:** Although the Biobin system is designed to minimize the need for turning, occasional mixing can help in maintaining uniform decomposition.
8. **Pest Control:** Ensure the bin is sealed properly to prevent pests. If pests become an issue, check for gaps or openings and seal them.
9. **Cleaning:** Clean the Bio-bin periodically to prevent the buildup of residues that can attract pests or cause odors.
10. **Harvesting Compost:** Once the compost is ready, it can be harvested and used for grow-bag agriculture in the apartment or can be used in farmlands directly.

2.2.2. NADEP Composting

The NADEP (Narayan Devrao Pandripande) composting method is a sustainable technique that utilizes a diverse range of organic materials, including crop residues, weeds, forest litter, and kitchen waste. By layering these materials in a composting pit, the NADEP Composting method creates a balanced mix of carbon-rich and nitrogen-rich components.

Through the natural process of decomposition, microorganisms break down the organic matter, resulting in a nutrient-rich fertilizer. This eco-friendly approach not only reduces waste but also enhances soil fertility, improves plant health, and promotes sustainable agriculture. The NADEP composting method offers a cost-effective alternative to traditional farmyard manure, making it an excellent choice for organic gardeners and farmers.

Material Selection: Collect a diverse range of organic materials, including crop residues, weeds, forest litter, and kitchen waste. These materials will provide a balance of carbon-rich (brown) and nitrogen-rich (green) components.

Honeycombed walls: Constructing a NADEP compost pit with honeycombed walls, measuring 3 meters in length, 1.8 meter in width, and 1 meter in height above the ground, provides an ideal environment for efficient composting.

Composting Process: Over time, microorganisms will break down the organic materials within the pit. The compost pile will shrink in size, turn dark, and emit an earthy aroma. This indicates the decomposition and maturation of the compost.

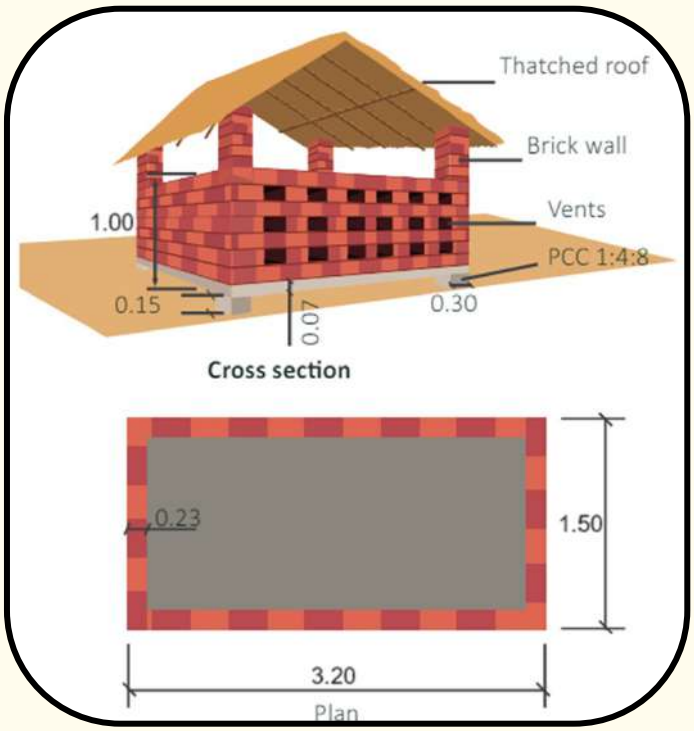


Figure 2.2 : NADEP Compost

2.2.2.1. Design Considerations

Density of biodegradable waste = 500 kg/m³

Retention time = 30 days

30% of waste reduction will be considered due to leachate and volatile gas removal.

- Incoming waste per day = 100 kg/day
- Inoculum (Cow Dung) needed per day = Appox.10%(*Qty will vary based on the nature of inoculum used) of waste generation

  = 10 kg/day
- Total Incoming waste quantity for 30 days = 100 x 30 = 3000 kg
- Total Inoculum needed for 30 days = 10 x 30 = 300 kg
- Total waste + inoculum for 30 days = 3300 kg
- Corresponding waste volume in m³ = 3300/500 = 6.6 m³
- Volume of composting tank required, considering 30% waste volume reduction

  = 6 .6 x 0.7 = 4.62 ≅ m³
- Considering the depth of tank is 1 m
- Area of the tank = 4.62/1 = 4.62 m^2

- Size of tank needed = 3.08 x 1.50 x 1.00 m
- Recommended size = 3.20 x 1.50 x 1.00 m
- No. of tanks needed = 2 nos
- Therefore the **Size of NADEP compost is 3.20 x 1.50 x 1.00 m** for treating 100 kg of biowaste per day.

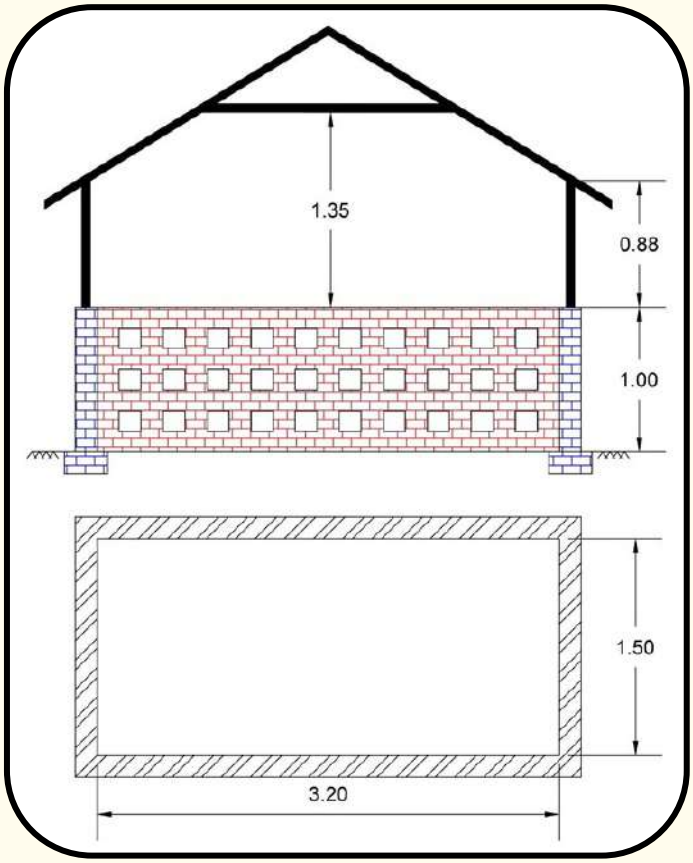


Figure 2.3 : Section and Elevation of NADEP compost

2.2.2.2. Operation and Maintenance

Preparation: Construct a rectangular brick tank with ventilation holes. The tank should be about 10 feet long, 6 feet wide, and 3 feet high.

Layering: Start with a layer of coarser materials like twigs or straw at the bottom to allow for proper drainage and aeration. Alternate layers of carbon-rich and nitrogen-rich materials, ensuring each layer is moist but not waterlogged.

Moisture Management: Maintain the right moisture and temperature of the compost pile by periodically checking. It should be moist like a wrung-out sponge. Ensure the compost pile is moist but not waterlogged. The ideal temperature is between 50-60°C. If it becomes too dry, water the pile lightly to keep the composting process active.

Covering: Cover the compost pit with a tarp or breathable material to retain moisture, maintain

temperature, and protect the pile from excessive rain or drying out.

Aeration: Turn the compost pile every 15-20 days to ensure proper aeration and decomposition.

Pest Control: Keep the compost pile covered to prevent pests and rodents.

Harvesting: The compost will be ready in about 4-5 months. It should be dark brown, crumbly, and have an earthy smell. Harvest the compost by carefully removing the top layer and using the matured compost in your garden or agricultural fields.

Cleaning: After harvesting the compost, clean the tank and prepare it for the next batch.

2.2.3. Aerobic Ferro Cement Composting Units (Thumboormuzhi Model)

The composting unit includes a box-like structure with Ferro cement panels which can be easily removed and fixed in the channel . It helps in breakdown of organic waste by microorganisms in the presence of oxygen. Layers of cow dung, carbon source and waste materials are subjected to composting in presence of oxygen. The temperature rises rapidly in the waste to almost 70 ˚C, the peak temperature with pathogens. An aerobic compost bin, under the correct conditions, creates a lot of heat; this can kill all sorts of seeds and pathogens. An efficient aerobic compost bin does not emit foul ammonia like smell. An aerobic compost bin reduces the biomass to usable compost quicker than its anaerobic counterpart.



Figure 2.4: Aerobic bin at St. Peters HSS, Kurumpanadom, Madapally, Kottayam

2.2.3.1. Technical Aspects

Aerobic cluster is an eco-friendly waste management system consisting of two units. Each unit is a 120 cm x 120 cm x 120 cm ferro cement bin with airspace and grooves utilizing bacteria consortium from cow dung and carbon source from dry leaves and paper bits with a roof to prevent rain water during monsoon. 6'' layer of fresh cow dung as the first layer with 6" layer of

dried leaves provided the carbon source for the bacteria to flourish, above that another six inch layer waste is converted into compost. If dry leaves/ cow dung is not available, microbial culture shall be sprayed at each interval to ensure microbial colony.

The core temperature built up in this layering is 70 - 75 ˚C which prevents the breeding of flies and parasites. Moreover due to aerobic functioning no putrid smell is there. About 562 kg waste can be managed in a bin. We can get compost with carbon nitrogen ratio 20 - 30% after 45 days. Adequate drainage facility for collecting and safe disposal of leachate should be provided. If any non biodegradable waste is coming to the composting plant it should be cleaned and transferred to the nearest material collection facility. Leachate pipe shall be cleaned regularly. For 0.02 TPD capacity unit approx. cost is Rs. 2.5 - 3 Lakhs (for shed, bins). Area required is 1 cent.

2.2.3.2. Design Considerations

Density of biodegradable waste = 500 kg/m³.

Retention time = 45 days

30% of waste reduction will be considered due to leachate and volatile gas removal.

For one unit (2 bin) of Aerobic bin,

- Volume of a bin = 1.2 x 1.2 x 1.2 = 1.728 m³
- Volume of waste that can be treated in a bin excluding of cow dung/inoculum = 1.512 m³
- Volume of waste that can be treated in a bin considering 30% volume reduction
  = 1.512/ 0.70 = 2.16 m³
- Density of waste = 500 kg/m³
- Waste can be treated in a bin (in kg) = 500 x 2.16 = 1080 kg
- For Retention time 45 days = 1080/45 =24 kg/day
- For one unit (i.e. 2 bins) 24 kg of biodegradable waste can be treated per day.
- Leachate collection facility shall be provided. Collected leachate can be used for agriculture purposes after dilution or may be used in the unit itself for accelerating the composting process.

If any waste other than biowaste is coming to the bio waste management unit, it shall be handed over to the MCF units.

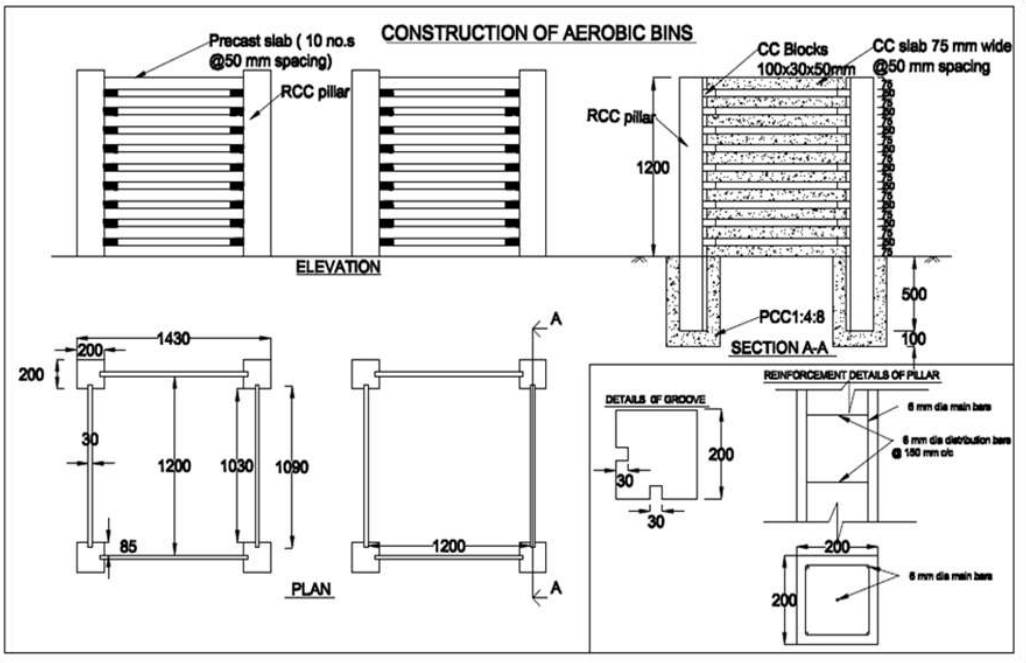


Figure 2.5: Plan, Section and Elevation of Aerobic Bin Composting Unit



Figure 2.6: Aerobic Compost unit of Chittur, Thathamangalam Municipality, Palakkad

2.2.3.3. Operation and Maintenance

1) A 6 inch layer of fresh cow dung/inoculum is laid as the first layer.
2) A layer of dry leaves is laid on top of the cow dung layer.
3) Above that 6 inch layer waste is added and inoculum containing enzymes made from cow dung is sprayed, this fastens composting.
4) Alternately, one layer of dried leaves and waste sprayed with inoculum is repeated till the bin is filled.
5) Once the first bin is filled, start using the second bin. By the time the second bin is filled the

contents in the first bin will turn into compost. Then dry it in drying beds.

6) Care should be given to clean the leachate drain pipe before feeding the next batch.
7) Always ensure that non bio waste is strictly not mixed with the waste fed to the bins.
8) Once the first bin is filled, start using the second bin. By the time the second bin is filled the contents in the first bin will turn into compost. Then dry it in drying beds.
9) Care should be given to clean the leachate drain pipe before feeding the next batch.
10) Always ensure that non bio waste is strictly not mixed with the waste fed to the bins.

2.2.4 Organic Waste Converter Machine (Mechanical Composting)

Organic waste converters are machines that are used to convert organic waste into valuable compost that can be used for organic farming activities. Converters are actually self-contained systems designed to perform a variety of functions such as waste shredding or crushing, dewatering and mixing. Residential Estates, Restaurants, Food Canteens, Shopping Malls, Educational Institutes, Municipal Corporations, Vegetable Markets, Fish Markets, Military Bases, Naval Bases, and Temples are among the beneficiaries of the organic waste converter technology. The composting techniques and capacities of converters differ. Some may have a high-tech automated shredder that may also be utilized as an accessory with various organic waste converter types. It shreds and dewaters organic waste, eventually reducing its volume by 70% to 80%. These generate practically dry, odourless organic waste that may be composted further in an organic waste converter. It is entirely automated and simple to use. It requires less space because all operations take place in the same unit and curing is done in vertical arrangements. The composting process is monitored and managed electronically hence it requires less manpower and may be operated by untrained persons.



Figure 2.7: Organic Waste Converter Machine

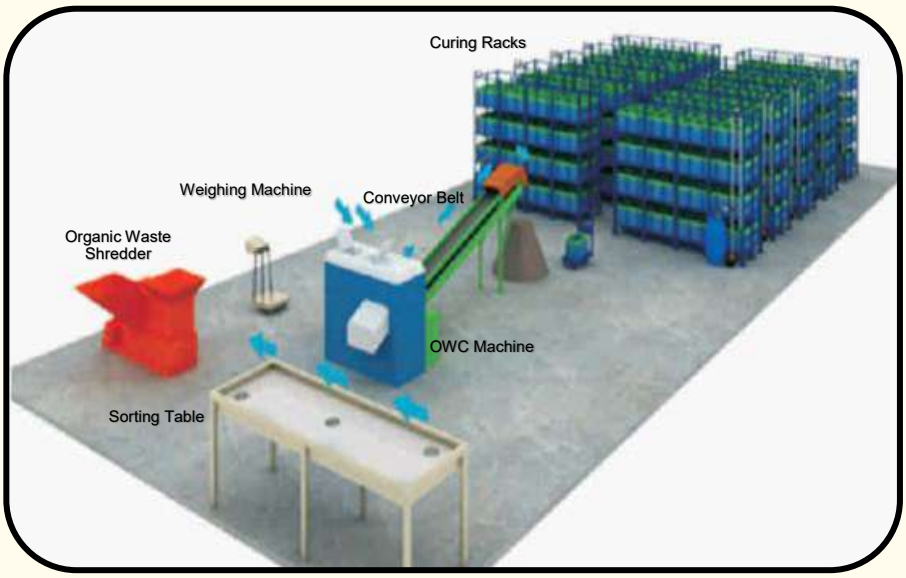


Figure 2.8: Layout of an Organic Waste Converter Machine

2.2.4.1. Technical Aspects

It consists of an organic converter machine and pre-compost curing units. The organic waste is shredded and mixed with effective microorganisms within the unit, which reduces 60% moisture and the volume is minimized. The volume-reduced component is set for curing for 10 -15 days to convert the same into matured compost. It requires less space than conventional composting methods. The matured compost is sieved, weighed, and packed for sale. For a basic model with a curing rack of capacity 240 Kg/day,

- 2 units of electricity is required, for a fully automatic model of capacity 500 Kg/day,
- 30 - 35 units of electricity is required for processing waste.

Projects may be implemented as procurement projects, subject to availability of infrastructure, adequate space for installation of machines and 3 phase AC power supply as mentioned in the below table.

Model plant is working at Thrissur Sakthan Market**.**

Capacity : 200 - 1000 kg/day,

Approx. cost : Rs. 2,00,000 - 10,00,000/-. Ready to install prefabricated units.

2.2.4.2. Infrastructure and Specifications

i. Bio-waste converting machines of appropriate capacities-available sizes are 10/25/50/125/250/500 Kg per batch. 3 batches per hour and 7 to 8 hrs of operation is suggested per machine.

ii. Plastic baskets 20 kg capacity. Number as required for curing of 10 days waste basis.

iii. Rack for stacking plastic baskets filled with semi-treated waste with humidity control arrangements.

iv. A room of size 3 m x 4 m for (base model machine) installing the machine.

v. A well ventilated space for keeping the rack with baskets.

vi. Power connection for bio- waste converting machine 4 KW to 10 KW 3 phase

vii. Bioculum, saw dust, water connection etc.

viii. The higher size plants will have an extra double shredder (25 kg batch and above) and conveyor belt for unloading the waste from the machine to the basket for capacities of 125 and 250 kg batch as part of the package.

2.2.4.3. Operation & Maintenance Protocols

- The segregated bio- waste mixed with inoculum powder at the rate of 1 gram per kg of waste is loaded into the Bio-waste converting machine.
- If the waste is dry, mix the inoculum in water at the rate 1 kg in 30 litre of water and then add to the waste in liquid form. If the waste is soggy, add a small quantity of saw dust to reduce the water content.
- Run the machine for 15 minutes.
- Unload the semi-treated waste into the basket kept under the machine .
- Shift the basket with the waste to the cooling rack.
- The cooling rack is to be located in a covered space with adequate ventilation arrangements.
- Keep watching the moisture content of the waste to remain 40 %.
- Excess water is drained out and water sprayed in the mist form to the waste kept in the cooling rack to adjust its moisture content .
- Waste is converted into compost in a period of 10 to 15 days.

2.2.5. Windrow Composting

Windrow composting is a centralised aerobic composting system, commonly proposed at community level. Generally windrow composting is opted for composting Bio waste of minimum 1 tonne and above.

2.2.5.1. Infrastructure Requirements

a) **Waste Receiving yard :** A platform for secondary segregation of the biowaste received.

b) **The compost pad :** A platform has to be constructed with an appropriately designed combination of RCC and PCC. The compost pad shall have a slope of about 1% to drain the excess water (storm water or leachate) from the windrows into a leachate collection tank. The leachate tank is placed in the lowest corner of the compost pad area.

Factors to be considered in the location and design of the composting pad:

- The base has to provide a barrier to prevent the percolation of leachate and/or nutrients to

the sub-soil and groundwater.

- The surface has to facilitate equipment movement even during wet weather conditions.
- The surface area has to accommodate waste for 5 weeks, with sufficient room for equipment to maneuver and an area to establish a static pile for curing compost.

c) **Curing/ Maturity yard**: Screened material coming out of the coarse segregation section requires further maturation and moisture control for producing a product that is beneficial for plants and soil. The curing piles are placed either in a storage area or covered area for a minimum duration of 2 weeks. In general, the area needed for the curing process is one quarter of the size needed for the windrow/composting process.

d) **Leachate Tank**: Leachate generated during composting varies with seasons. This leachate can be used for agriculture purposes after dilution or may be used in the unit itself for accelerating the composting process.

e) **Store :** A minimum of 90 days compost storage space and 30 days inoculum storage space shall be provided.

f) **Office Room :** An office space shall be provided within the premises with toilet restroom facility for the workers.

2.2.5.2. Machinery Required

- **Waste conveyor:** For a secondary segregation and uniform feeding to the shredder a conveyor with adequate length shall be provided.
- **Waste Shredder:** Shredder for reducing the size of items of bigger size into uniform size.
- **Loader:** Tractor mounted front-end loaders or pay loaders are used to deliver the pre-processed feedstock to form windrows. They can be used for site maintenance, piling the cured compost and loading the finished compost product into trucks or trailers for sale in the market.
- **Windrow Turner:** Generally, pay loaders (wheel or tracked) or tractors with hydraulic attachments are used to scoop the material from one windrow to make a new pile in an adjacent location on the compost pad, while placing and mixing the material. Other equipment such as front end loaders/ windrows re-shifters may also be used for turning windrows.
- **Screener:** A trommel screen is desired at the end of the curing process to screen the finished compost for a suitable particle size. This will remove any larger undesirable items and will fluff up the finished product to ensure a suitable compost quality.
- **Weighing platform:** Daily incoming waste shall be weighed and logs shall be maintained at the office. The matured compost shall be weighed and packed with a bag sealer machine.
- **Bagging machine:** Bulk supply of compost is usually through 50 kg bags.

2.2.5.3. Design Factors

- Windrows are typically trapezoidal in the cross section. The average windrow shape is between an oval and trapezoidal. A factor of 0.66 is assumed to estimate windrow volumes (Volume = Height x Width x Length x 0.66)

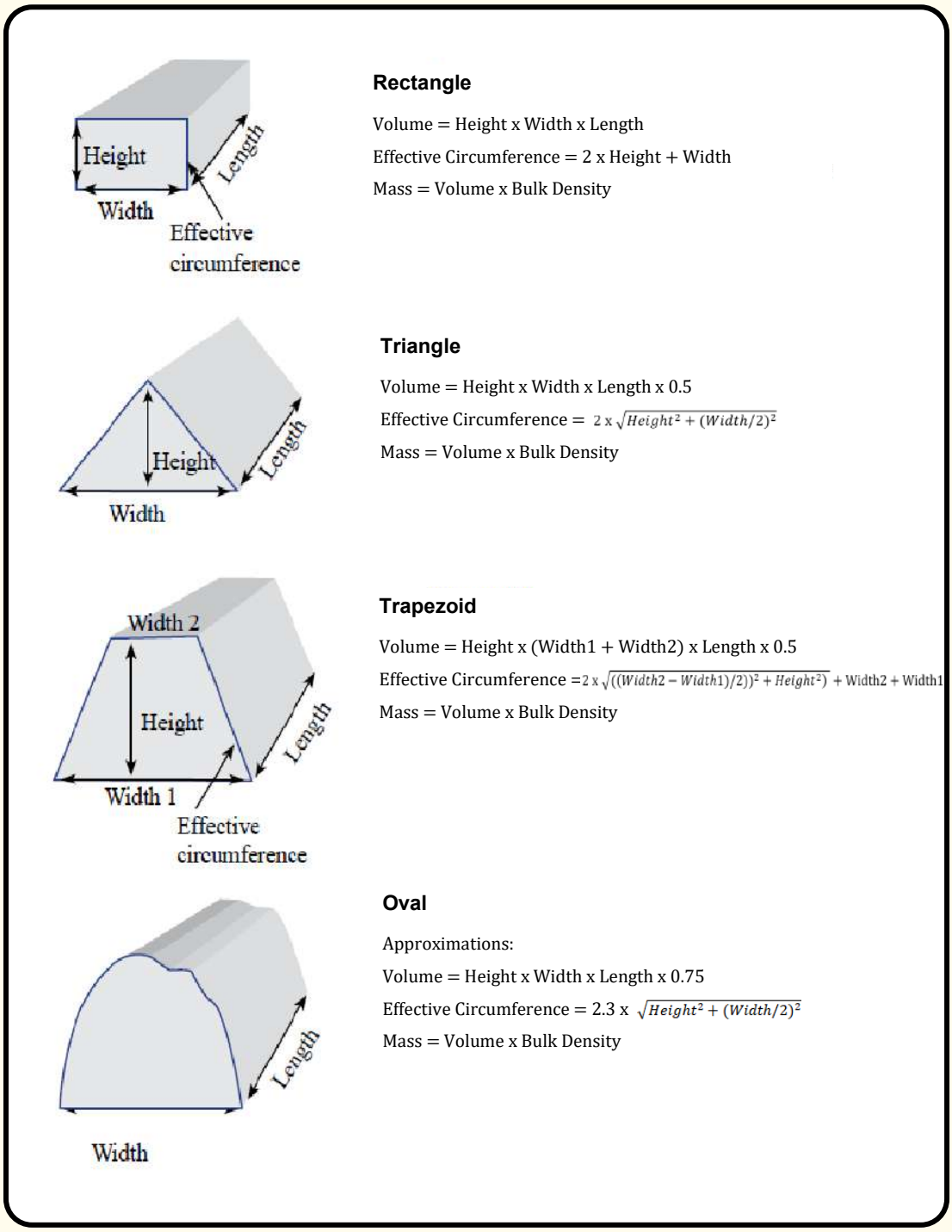


Figure 2.9: Windrow Design

- Typically windrows can vary from 6 to 10 feet in height and 6 to 10 feet wide at the base.
- The space between windrows should be sufficient for movement of the windrow turning machine to be employed in the plant. Normally it is 1 - 3 meters.

- Windrow dimensions should allow conservation of heat generated during the composting process while also maintaining diffusion of air to the deeper portions of the windrow.

2.2.5.4. Design of 3 TPD Windrow Compost

Design Considerations

- Density of MSW- 500 Kg/m^3.
- Retention Time – 25 days.
- 30% waste reduction will be considered due to leachate and volatile gas removal.
- The shape of the windrow is oval.
- Density of compost from windrow is 420 Kg/m^3
- Density of compost is 340 Kg/m^3
- Leachate generation is taken as 400 litres per ton

1) **Design of Receipt platform**

Total biodegradable waste per day = 3000 Kg/day

Density of biodegradable waste = 500 Kg/m3

Volume = Total biodegradable waste per day/ Density of biodegradable waste

= 3000/500 = 6 m^3

Height of the waste in receipt platform= 0.333 m

Area = Volume/ Height of the waste in receipt platform

= 6/0.333 = 18 m^2

L x B = 6 x 3 m

2) **Area for Receipt conveyor**

L x B = 2 x 5 m

3) **Area for Shredding machine**

L x B = 2 x 2 m

4) **Design of Windrows space**

Total biodegradable waste per day = 3000 Kg/day

Qty of inoculum (5 % of waste qty) = 150 kg

For 25 days retention time total waste to be handled in windrow = 3150 x 25 =78750 Kg

Volume = Waste to be handled in windrow/ Density of waste

= 78750/500 =157.5 ≅ 158 m^3

As per GO (MS) No. 73/2011/LSGD; dated 01-03-2011 the size of the windrow is limited to a maximum of 2m width and height 1.5 m.

Considering the shape of windrow is oval the volume of windrow needed is

Volume = Height x Width x Length x 0.66

Length of Windrow = Volume / (Height x Width x 0.66)

= 158 / (1.5x2x0.66)

= 79.79 ≅ 80 m

Windrows each bay = Total Length/ No. of bays = 80/26 = 3 m

L x B = 3x 2 m # 26 Nos

5) **Design of Maturity Bay**

Digested compost from windrow (as per the Chapter XIV - Composting - Ministry of Housing and Urban Affairs, quantity of compost is much lesser than the input & is normally around 50% of daily incoming waste) =3000 x 50% = 1500 Kg/day.

As per GO (MS) No. 73/2011/LSGD; dated 01-03-2011 the maturity bay is for stacking min 30 day's partially treated waste from the windrows. Sieve the compost and move the output to the designated maturity yard and keep it in a heap of 3m for a period of 30 days or till the compost is fully matured.

After screening for 30 days =1500 x 30 = 45000 Kg

Density of compost from windrow = 420 Kg/m^3

Volume required = 45000/420 =107.14 ≅ 110 m^3

Height of heap is 3 m

Therefore Area for Maturity bay = 110/3= 36.66 **=** 37 m^2

6) **Area for Rotary Sieve**

L x B = 7 x 2.5 m

7) **Area for platform balance**

L x B = 2x 2 m

8) **Design of store**

As per GO (MS) No. 73/2011/LSGD; dated 01-03-2011 the storage space with locking arrangements to stack mini 90 days production.

Compost generation per day = 900 kg

Compost generation for 90 days = 900 x 90=81000 Kg

Density of compost = 340 Kg/m^3

Volume required =81000/340 = 238.23≅ 238 m^3

Height of heap is 3 m

Area required = 238/3 = 79.33 ≅ 80 m^2

Size of Compost Shed = 10 x 8 m^2

9) **Design of Shed for Anaerobic bay, Storing inoculum and Non bio waste**

a) Anaerobic Bay

Anaerobic bays cater for slow decaying bio-degradable waste of approximately 5% of the daily waste input for a period of 90 days.

Slow decaying bio-degradable waste per day	= 5% total waste
	= 3000 x 0.05 =150 Kg
For 90 days	= 150 x 90 = 13500
Density of partially treated waste	= 420 Kg/m^3
Volume required	= 13500/420 = 32.141≈32m^3
Height of the tank	= 1.5 m
Area required	= 32/1.5 = 21.33 ≅ 22m^2

As per GO (MS) No. 73/2011/LSGD; dated 01-03-2011 plants of 2 ton and above provide twelve bays each of adequate size

For 12 bays = 22/12 = 1.83 ≈ 2 m^2

L x B x H = 2 x 1 x 1.5 m 12 Nos

b) Inoculum Store

Inoculum needed for 25 days = 3750 Kg

Density of inoculum = 340 Kg/m^3

Volume required = 3750/340 = 11.029 m^3 = 11 m^3

Height of heap is 3 m

Area required = 11/3 = 3.66 ≅ 4 m^2

c) For Non bio waste

1% of total waste i.e., 1% of 3 Ton = 30 Kg/day

Storing for 30 days = 30 x 30 = 900 Kg

Density of Non bio waste = 250 Kg/m^3

Volume required= 900/250 = 3.6 m^3

Stack Height = 2 m

Area required = 3.6/2 = 1.8 ≈ 2 m^2

Area Required = Anaerobic bay + Inoculum store + Non bio waste

= 22 + 4 + 2 = 28m^2 say 30m^2

Shed for Anaerobic bay, Storing inoculum and Non bio waste = 30 m^2

10) **Office cum restroom with washing area**

As per GO (MS) No. 73/2011/LSGD; dated 01-03-2011 an office space of appx 3mx3m and workers rest room of appx 3mx3m along with one toilet each for men and women, a washroom for women in the same block for the plants of capacities3 ton/day to 5 ton/day. In the case of 1 ton and 2 ton plants one rest room with two toilets. For higher size plants which are above 6 ton size and above additional 10 sqm of rest room area per 5 ton of additional capacity each. Separate buildings for office and rest room in higher size plants.

Area required = 42 m^2

11) **Guard Room**

As per GO (MS) No. 73/2011/LSGD; dated 01-03-2011 a guard room of size 2.1mx 2m at the entrance to the plant complex for watch and ward staff in plants of capacity 3 ton and above.

LxB = 2.1x 2m

Area required = 4.20 m^2

12) **Water supply**

As per GO (MS) No. 73/2011/LSGD; dated 01-03-2011 a 1000 litre water tank for plants 1 ton and 2 tons capacities 2000 litres up to 5 ton /day capacity plant, above the roof of office cum restroom .Additional 1000 litres capacity per increase of 2 Ton.

Water supply = 2000 Litres

13) **Design of Leachate Collection tank**

Total waste per day = 3 TPD

Leachate generation per ton = 400 litres per ton

Total leachate generation = 1200 KLD = 1200m^3/day

Detention period = 8 hrs

Volume of tank = 36 m^3

Effective depth of tank = 2 m

Area required = 36/2 = 18 m^2

L x B x H= 9 x 2 x 2+0.3 freeboard

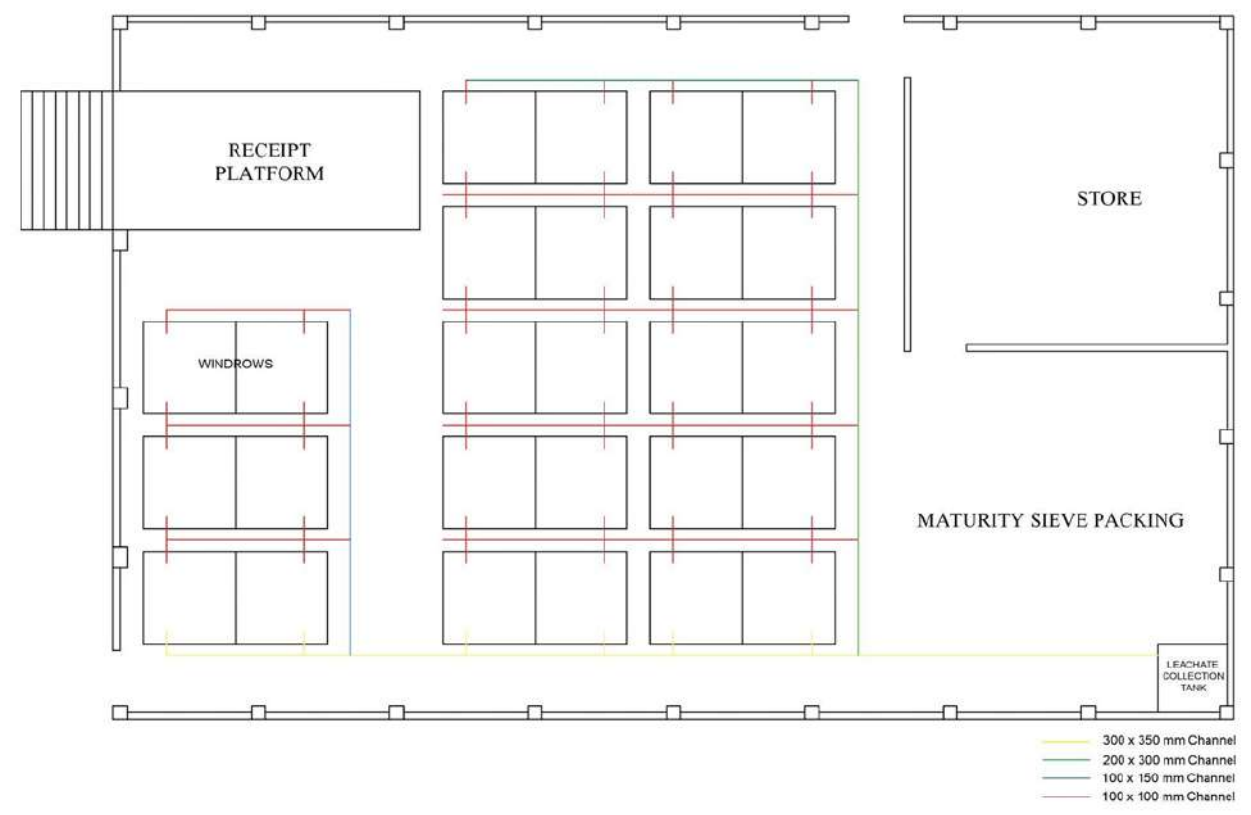


Figure 2.10: Layout of a windrow compost shed

2.2.5.5. Operation and Maintenance Protocols

The pre-processed MSW is transferred onto the compost pad (platform) into windrows by means of bucket loaders or by manual labour, depending on the size, shape, and spacing of windrows.

1. The outer layers of piles are moved to inner layers by turning the windrows once every week for 5 weeks, high temperatures within the windrow (55 to 65 °C) sanitize the material. During the rainy season turning shall be done at an interval of 3 - 4 days.

2. Each windrow should be allowed to stay on the compost pad for 25 days and at the end of the 25th day the compost is ready for sieving. Each windrow should have a flag board depicting the age of the waste.

3. Fresh incoming waste is always depicted by “Age 1”. The numbering on the window changes from Age 1 to Age 2 on the second day; Age 2 should be changed to Age 3 on the third day and so on.

4. Each windrow may be turned manually or mechanically. This turning process has to be done every 5th day. Hence, only those windrows having a flag board showing Age 5, 10, 15 and 20 should be turned.

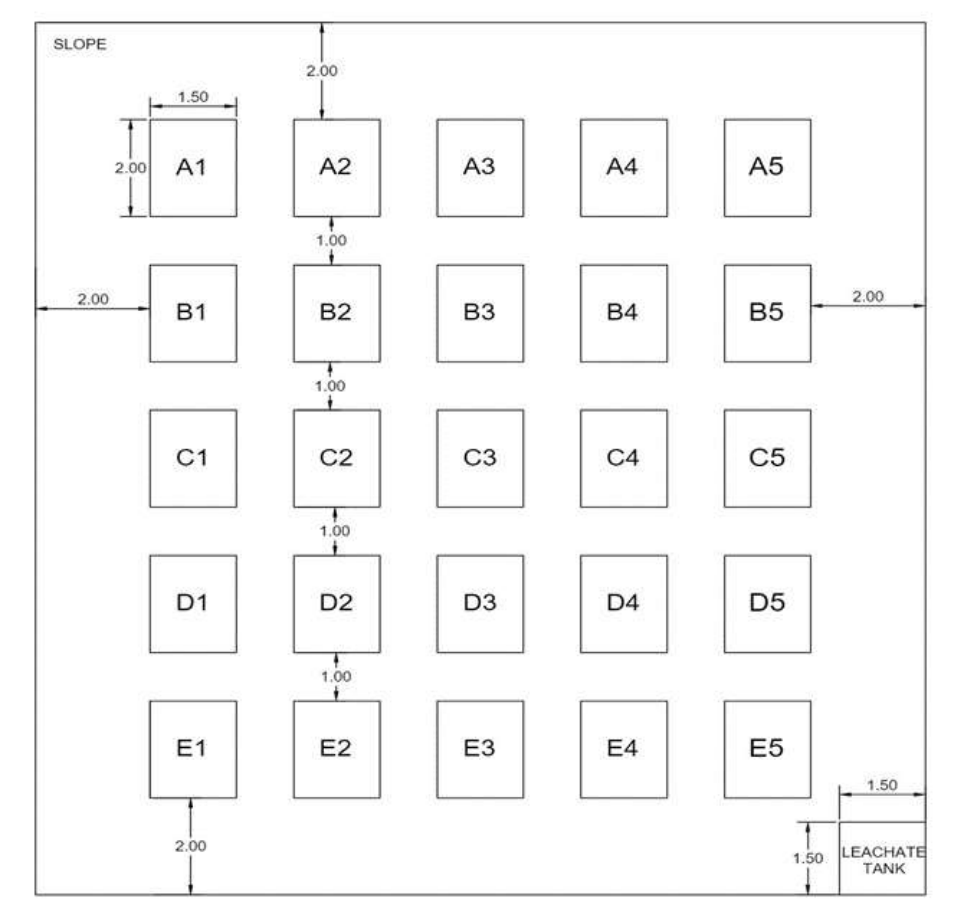


Figure 2.11: Chart showing arrangement of windrow

5. Leachate stored in the leachate tank should be sprinkled during the turning process to maintain the moisture content of the waste. Figure below shows a quick and simple method to test moisture content.

6. Temperature should also be monitored and maintained within 55 - 60 °C.

7. On the 25th day, the compost is successively sieved through a two stage screening system of 35 mm followed by 16 mm. Screened material coming out of this section is uniform in texture but contains semi-solid organic compost, which requires further stabilization. The rejects from the 35 mm screen are sent to the RDF and the 35 mm – material is sent to the

16 mm screen. The rejects from the 16 mm (16 mm+) screen are to be put back on the windrow.

8. The curing piles are placed either in a storage area or covered area for a minimum duration of 30 days. The degree of maturity is determined through either oxygen uptake or carbon dioxide production rate. (Determination of maturity is explained in Municipal Solid Waste Management Manual of CPHEEO)
9. Compost Refinement: At the end of the composting phase, the material usually contains 30 to 35% moisture.

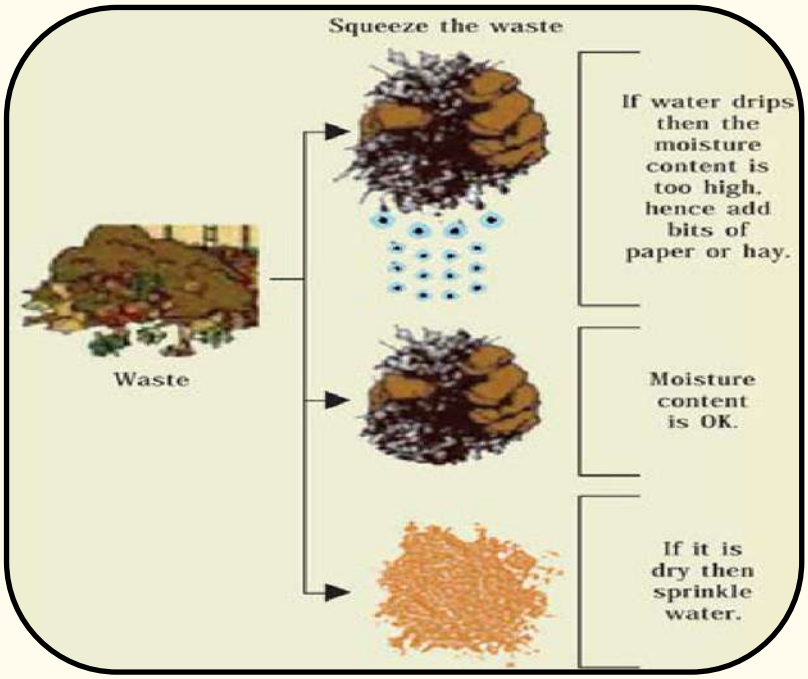


Figure 2.12: Moisture Content Test

10. The composting is normally taken to be complete when the active decomposition stage is over and the C/N ratio is around 20:1. The refinement section also consists of a feeder conveyor and a trommel with 4mm perforations.
11. The screened product which is less than 4 mm is passed through ADS (air density separator or de-stoner) to remove sand and grit. Then the compost can be put in bags and stored for sale. The remaining material greater than 4 mm in size should be put on top of the fresh incoming waste heap, to speed up the process of composting and for absorbing excess leachate.
12. The residue material from the ADS is inert laced with fine organic material. This should be kept out of the composting stream. The finished product is dark brown with an earthy smell, fragile and rich in organic matter content and nutrients. The matured compost quality shall be analyzed and packed for selling.



Figure 2.13: Windrow Composting

Model plants are working in Attingal Municipality and Kozhikode Corporation.

2.3 ORGANISM BASED COMPOSTING TECHNOLOGIES

2.3.1. Vermi Composting



Figure 2.14: Eudrilus Eugeniae Worms



Figure 2.15: Vermi Composting

2.3.1.1. Infrastructure

Shed of steel structure with light weight roofing and cement concrete flooring, of suitable size with PVC fencing wire mesh / net protection above 80 cm high parapet wall, on all sides to prevent birds, mouse, dogs etc, to house the following provisions :

a. Receipt/segregation platform 50cm high (raised floor) for spreading one day's waste and segregating the non- biodegradable items if any

b. Windrow compost bays each of 1.5 m to 2 m width of required length to treat the waste

for a period up to 20 days. Each bay stacks one day's waste .In smaller plants one bay may cater for more than one day's waste.

c. Space for shredding.

d. 28 numbers of masonry pits (tanks) having a width of 1m and depth 0.5 m and of sufficient length each to accommodate one day's waste duly treated for a period of 15 to 20 days in the windrow compost bays. Bottom of the tank to have adequate slope to drain the leachate. A water channel of size 5 cm x 7 cm around the vermi pits to prevent entry of ants.

e. Adequate space around for the movements of men and materials

f. Space for placing the sieve, storing the sieved manure, weighing machine, packing the manure in polythene bags and stitching the same

g. Store with locking arrangements for storing 90 days production

h. 50 mm PVC pipe under the floor to drain the leachate from vermi tanks to the draining channel and the draining channel below the floor level with cast iron removable covers flush with the floor, to drain the leachate that comes out from vermi tanks and windrow bays to the leachate collection tank.

i. Lighting at the rate of 12 W CFL per 12 sq.metre area

2.3.1.2. Other Miscellaneous Items

a. Office and restroom with toilet and wash area

b. Water storage and supply system

c. Cow dung storage tank

d. Nursery tank for worms

e. Septic tank with soak pit to treat leachate and the sewage

f. Minor tools like, chopper, showels, spade, wheelbarrows, baskets, buckets - 2 sets for 250 kg capacity and additional one set each for additional 250 kg capacity each.

g. Surgical hand gloves and boots for staff - 2 pairs each per staff.

h. Coconut husk, cow dung, sack, cloth, wire mesh protection for vermin pits, Eudrillus eugeniae worms

2.3.1.3. Mechanical Equipment's/Machineries

a. **Shredder :** Manual shredder for plants up to 500 kg/day and mechanical one for plants of 1 ton and above

b. **Leachate pump :** A sludge pump with open impeller 1 hp portable on wheels to pump out

out the leachate from the leachate collection tank.

a. **Manual rotary sieve :** A manually operated rotary sieve suitable to pass up to 6 mm size particles

b. **Weighing Machine/ Platform balance :** A platform weighing machine ranges up to 300 kg.

c. **Bag sealing machine :** A portable bag stitching/ sealing machine operating on single phase 230 V supply for sealing the filled up bags.

2.3.1.4. Standards

1. Eudrillus eugeniae worms 50 worms each per sq.ft area in each tank.
2. Moisture content of waste 40 - 55%
3. Temperature 20 - 30°C
4. In a 250 kg/day plant, one vermi tank for 2 to 3 days' waste and in higher capacity plants one vermi tank each for one day's waste.

2.3.1.5. Specifications

1. Compost Shed

a) *Foundation/basement:* RCC column with RR masonry in cement mortar 1:6, 50 cm plinth height above average ground level filled up with approved earth/ red soil duly rammed in layers.

b) *Floor :* with cement concrete 1:2:4 using 20 mm metal 75 mm thick and plastered with cement mortar 1:3, 12mm thick one coat and finished smooth by hand trowel. Bottom of the vermi tanks will have the same specification of flooring. Platform surface will have a richer specification of 1:1.5:3 cement concrete.

c) *Wall :* 80 cm high single brick wall all around. PVC fencing mesh of minimum thickness 2 mm and aperture not more than 30 mm x 30 mm, on angle iron frame work over the wall up to the bottom of the tie beam (size 30 cm x 20 cm to be provided between the columns on both the sides of the shed) on the sides and up to the roof level on the front and backsides to prevent birds, mice etc..

d) *Roof :* 0.25 mm thick powder coated sheets over angle iron trusses and purlins. Slope on two sides with side height 3.2 metre above the plinth level. Half cut PVC 110 mm diameter pipes /suitable gutter along the eve edge with proper slope and adequate number of down pipes 110 mm PVC to drain the rain water.

d) *Doors :* On the front wall, a double shutter hinged door of suitable size (3 m x 2.8 m) with a ramp for unloading waste from the vehicle into the receipt platform. And a normal door of size 1.2 m wide and 2.1 m height for movement of men and other materials in and out of the shed.

f) *Store :* in one corner of the shed and the outer walls of the shed on the store side be constructed with bricks instead of PVC mesh. Internal partition between the shed area and the store with 2.5 metre brick wall and PVC mesh on angle iron frame work above the wall. Ventilators on the outer walls.

g) *Vermi (tanks) pits:* Brick work and cement plastering with 1:3 cement mortar, Total depth of the pit of 50 cm, 40 cm above the finished floor level and 10cm below the finished floor level The concealed PVC pipe embedded inside the floor will connect the leachate flow with the leachate channel all around. Sufficient space around the tanks (pits) for easy access. A water channel of size 7 cm x 5 cm around the pits to prevent ants.

2. Office cum Restroom

An office space of approx. 3mx3m area and workers restrooms of approx. 3 m x 3 m area along with one toilet each for men and women ,a washroom for women in the same block for the plants of capacities 1000 kg/day to 2000 kg/day. In case of smaller plants of 250 kg/day and 500 kg/day a single room of size 3 m x 3 m with toilet and wash room as office cum restroom. Random rubble masonry foundation, brick wall, and RCC slab roof construction.

3. Guard Room/Gate

A guard room of size 2.1 m x 2 m area at the entrance to the plant compound for watch and ward in case of 1000 kg and above capacity plants. In case of smaller plants, guards can use the office cum restroom during night hours. Gate fabricated out of MS grill duly painted mounted on gate pillars.

4. Electricity

An LT connection from EB, distribution board/meter box in a weather proof feeder pillar box mounted on a pole inside the compound, service connections to all the buildings. Sufficient security lights with fluorescent/ CFL lights on the outer walls of the buildings with brackets. Post top lantern lights on the gate pillars. Street lights on poles were considered necessary.

5. Water Supply

A 1000 litre capacity PVC water tank above the roof of office cum restroom up to 1 ton capacity and 2000 litre tank for 2 Ton plant. Ground sump and mono block pump where required.

6. Roads/Compound Wall

Roads with width of 3 m and side berms 50 cm each on both sides and a compound wall with random rubble masonry foundation and cement concrete blocks to a height of 6 ft as required at site and the cost be added separately. Typical layout of a vermi compost plant showing the vermi shed, office cum restroom wash areas, cow-dung cum nursery tank shed, guard room, roads and green belt.

7. Green Belt

A green belt of minimum width of 3 m be provided all around the plant compound inside the walled area. It is recommended to plant “ Mahagony “plant on the outer row, Bamboo/

walled area. It is recommended to plant " Mahagony "plant on the outer row, Bamboo/ Aryaveppu on the second row and flowering plants/ shrubs like Chemparathi/Arali/Mandar/ Mulla be planted on the third row and maintained to increase the aesthetic value of the plant complex.

8. Rain Water Harvesting

Rain water harvesting as per norms as an optional item

2.3.1.6. Operation & Maintenance Protocols

1. Segregate the waste on receipt and cut oversized items to size of less than 5 cm either manually or by using a shredder machine. Remove and dispose of the non-biodegradable waste for recycling /final disposal.
2. Treat the waste initially in windrows for a period of 15 to 20 days or more as per the nature of the waste. Height of stack not to exceed 1.5 m in windrows. Windrows shall be turned once in four to five days to the next bay and break the windrows when ready for feeding to vermi tanks.
3. Base layer with coconut husks for one or two layers with cow dung powder will be placed in the vermi tanks (This layer be renewed annually). Place the worms on the base layer and the partially decomposed waste from the windrows be spread over it.
4. Thickness of the waste layer should not be more than 30cm at a time. Sprinkle cow dung mix on the waste and moisture content shall be maintained as 40 - 55%.
5. Introduce fresh waste in the consecutive portion of the same tank /consecutive tanks on successive days.
6. Sprinkle cow dung powder along with the waste.
7. Protect the tank from mice, rats and ants by covering it with a PVC coated net bend to shape and welded to an aluminium/steel frame with a handle.
8. Keep the waste covered by wet clothes/sack pieces. Moisture contents of the waste to be maintained as 40- 55% by sprinkling water over the cloth. Temp shall be in the range 20-30°C
9. Avoid over sprinkling of water and stagnation of water at the bottom of the tank
10. Tank should not be exposed to direct sun or rainfall.
11. Prevent introduction of excessive hot, sour, and oily substances. Bones, flesh & fibre can be placed as interlayers within the soft waste layer.
12. Heap the compost with worms within the tank under light for two days and remove the compost from the top and use the worms at the bottom for further composting.

13. Stop watering 3 - 4 days prior to removing the compost from the tank.

14. Allow compost to dry in shade prior to sieving.

15. Compost taken out should not be dried under sunlight.

16. Renew the base layer annually.

17. Engage appropriate no of labourers for operating the plant

18. Collection of washouts from the tank in the final stages of composting for vermi wash.

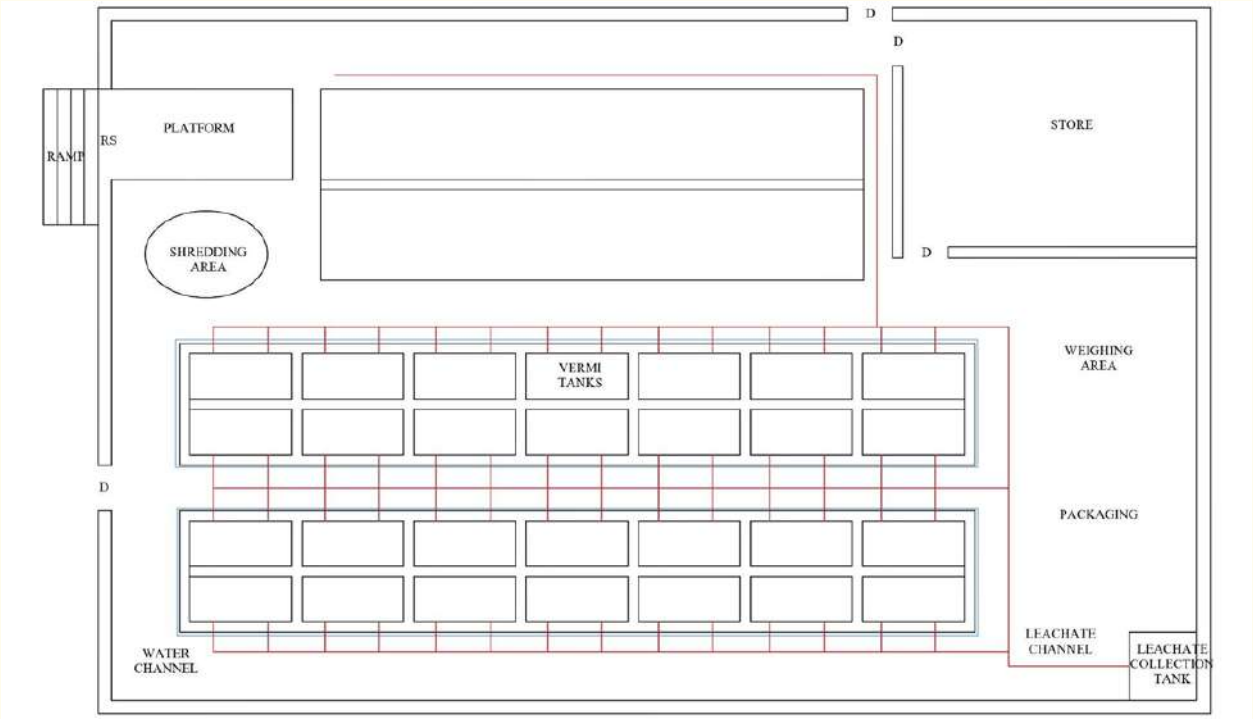


Figure 2.16: Layout of Vermi Compost Plant

2.3.2. Black Soldier Fly Composting

This system consists of a BSF rearing unit, waste receiving and pre-processing unit and BSF waste treatment unit. MSW collected is shredded and fed to BSF and the end product is organic manure. BSF helps to reduce the wet waste into 80% of its weight. It will take 15 to 20 days for BSF rearing. After 15 days, larvae will be removed for breeding to continue the cycle and the next batch of larvae will be produced. It can be used as feed to poultry, fisheries, pets and piggery. Flies will live only for 5 days and then they are also fed to larvae. The capacity is scalable, construction cost depends upon the facility and area. The by-products formed are: Live larva, dried larva, BSF Oil, BSF Meal. Secretion of BSF, called FRASS, is used as an ideal organic fertilizer for soil. The projects can be done in PPP mode or DBOT method. The agencies capable of doing the projects have been empaneled by Suchitwa Mission.

Model plants are working in Palakkad municipality and Cochin corporation.



Figure 2.17: Black Soldier Fly Composting

Capacity : 10 ton

Approx. cost : 50 Lakhs (Inclusive of sheds & Machineries)

Area required : 50 cents

Installation time : 2 months time

2.3.2.1. Infrastructure Requirements

A BSF farm usually presents various sections, each dedicated to a phase of the workflow and life-cycle of the insect. These are:

1. Breeding area: Breeding area, allowing plenty of room and optimal conditions for the insects to lay eggs.
2. Hatching area/nursery: Hatching area/nursery, where eggs hatch over several days onto a nutritious starter feed and emerge as juvenile BSF 'Seedlings'
3. Waste processing area: Waste processing areas, where organic waste is processed into a porridge like sludge ideal for fast BSF processing
4. Growing area: Growing area, where the seedlings can feed on the waste substrate and mature to adult larvae
5. Post-processing area: Post-processing area, where the larvae are neutralised, sieved from their frass an then go on for drying, defatting and grinding depending on the product requirement of the factory.

Necessary machinery or equipment usually fall into three main categories:

1. Waste-processing equipment, to prepare the substrata that will feed the insects
2. Controlled environment equipment, to maintain optimal environmental conditions (such as 70% humidity and 27 degrees Celsius heat) given that BSF thrive in tropical climates
3. Post-processing equipment, like dryers, shredders or oil-pressers, to kill and prepare the insects to be sold as alternative protein.

2.3.2.2. Operation and Maintenance

Here are some key points for the operation and maintenance (O&M) of a BSF composting system:

Breeding: Love cages are usually used for BSF breeding. Double layer covering shall be provided to the breeding unit.

Container Selection: For large scale operation, choose a container with a minimum depth of 6 inches to provide enough space for the larvae.

Feeding: Provide a balanced diet, avoiding just one or two inputs. The recommended feeding rate is 1.7- 2.0 kgs of material per day as a thin layer of 5-10 cm for 10,000 maggots. Regularly feed the larvae with a variety of organic waste materials such as food scraps, manure, and plant matter.

Moisture Management: Keep the compost moist but not waterlogged. 60-75 % water content in waste is admissible. Use substrates like coconut coir or coffee grounds to help maintain moisture.

Temperature: The optimal temperature at which BSFL consumes their food is around 95 °F The minimum temperature for survival is 32 °F for no more than four hours, whereas the maximum temperature allowing survival is 113 °F. The larvae will become inactive at temperatures less than 50 °F and temperatures higher than 113 °F, where their survival decreases dramatically. The best range of temperature for the larvae to pupate is from 77 to 86 °F. For mating purposes, the optimal temperature is around 82 °F.

Humidity: The optimal humidity at which BSFL consumes their food is around 65%. The rate of weight loss for the BSFL increases with decreasing humidity. The optimal humidity for black soldier fly mating is around 30 to 90 percent. It is very important to monitor humidity for captive rearing and breeding.

Larvae Harvesting: Provide a sloped edge or pipe with channel at the top of the container to allow larvae to exit when they are ready to pupate. Clean and dry the collected larvae or pupae in a dryer unit or oven. The dried larvae can be used as pet feed.

Compost Harvesting: The compost can be harvested in as little as 15 -20 days from the container. Pile the harvested compost in a shade to a minimum period of 10-15 days for compost curing and drying.

Odor Control: Ensure proper aeration inside the shed. Wind driven turbo air ventilators may be provided and care should be given for avoiding overfeeding to prevent anaerobic conditions.

2.4 ANAEROBIC BIOMETHANATION TECHNOLOGY

Anaerobic bio methanation, also known as anaerobic digestion, is a process where organic materials are broken down by microorganisms in the absence of oxygen to produce biogas, which primarily consists of methane (CH_2) and carbon dioxide (CO_2). This technology is widely used for waste management and renewable energy production. In this process Specialized microorganisms, particularly methanogens, convert organic matter into biogas. The process occurs in an anaerobic (oxygen-free) environment, typically within a digester. It involves four main stages: hydrolysis, acidogenesis, acetogenesis, and methanogenesis. This technology is particularly relevant for sustainable waste management and renewable energy initiatives, aligning well with your interest in environmental sustainability and waste management practices.

Design Considerations

Considerations

Density of biodegradable waste-	= 500 Kg/m³
Per capita waste generation	= 300gm/day
Per Capita biodegradable waste generation	= 77% of total waste generation
	= 231 gm/day
Retention time	= 45 days

Total solid (TS) is estimated at 20%

Volatile Solid (VS) estimated at 80% of TS

Optimum mixing ratio 1:1

Based on literature, the size of a digester is 75% while the gas holder is 25%.

For example

No. of Households - 250 nos

Population - 250 x 4 = 1000 nos

Per capita biodegradable waste generation = 231 gm/day

Total quantity of solid waste generation = 1000x 231 = 231000 gm = 231kg

For 45 days retention time, waste qty = 231x45 = 10395 kg

volume of solid waste = 10395/500 = 20.79 m^3

The solid waste is mixed with equal qty of water - volume ratio of 1:1

Volume of water to be added in 45 days, = 20790 ltrs

Total volume of tank = Volume of waste + Vol. of water

= 20.79 + 20.79 = 41.58 = 42 m^3

Volume of digester tank = 21 cum

Volume of gas holder tank

Based on literature, the size of a digester is 75% while the gas holder is 25%. Thus, gasholder size is calculated as follows:

42 m3 x 25% = 10.5 cum = Say 11 cum

Biogas plant Size = 42+11 = 53 cum, say 55 m^3

2.4.1. Fixed Dome Type Biogas Plant

The Deenbandhu model was developed in 1984. Schematic diagram of a Deenabandhu biogas plantentire biogas programme of India as it reduced the cost of the plant half of that of KVIC model and brought biogas technology within the reach of even the poorer sections of the population. The cost reduction has been achieved by minimizing the surface area through joining the segments of two spheres of different diameters at their bases. The Deenbandhu biogas plant has a hemispherical fixed-dome type of gas holder. The dome is made from prefabricated ferrocement or reinforced concrete and attached to the digester, which has a curved bottom. The slurry is fed from a mixing tank through an inlet pipe connected to the digester. After fermentation, the biogas collects in the space under the dome. It is taken out for use through a pipe connected to the top of the dome, while the sludge, which is a by-product, comes out through an opening in the side of the digester. About 90 percent of the biogas plants in India are of the Deenbandhu type. The capacity of the biogas plant to be mentioned in terms of the loading rate (ie, maximum quantity of waste to be fed in kg per day).



Figure 2.18: Biogas Plant

2.4.1.1. Infrastructure

1. Pre-processing room with space to accommodate the pulverizing machine and an inlet mixing chamber to mix the pulverized waste. A platform outside with an extended roof to receive the waste.

2. Inlet mixing cum feeding tank constructed near to the digester, with locking arrangements for feeding the waste to the digester.
3. Inlet devices with PVC pipe of diameter 150 mm one from the inlet mixing chamber for the pulverized waste located inside the pre-processing room to the common inlet mixing cum feeding tank located outside near the digester and another inlet pipe from this outside feeding tank to the digester.
4. Digester with reinforced cement concrete with brick masonry lining on both sides and having the following;
    a. Bottom slope of the digester shall be 1 in 8 for easy withdrawal of sludge.
    b. Outlet opening with 200 to 300 mm diameter.
    c. Outlet (balancing) tank with cement concrete/brick masonry lining on both sides having a free board of 30 cm.
5. Pumps of screw type or submersible type or external chemical process type for pumping water, slurry and sludge.
6. Pre-digester tank for increasing the efficiency of main digester/digesting of slow digesting items in plants of capacity 1 ton and above
7. A Pulverizing machine /Shredder for reducing the size of items of bigger size into uniform size and mixing the same with water inside the mixing tank (No1) provided in the pre-processing room.
8. Pre-filter tank with four number of chambers in series with baffle walls in between to reduce the load on the septic tank.
9. Septic Tank - soak pit system for treatment and disposal of effluent from biogas plants.
10. Rubber hose for conveying gas 20 mm dia min 40 meters long, moisture trap, H2S scrubber, pressure blower, fire arrestor, regulator and a gas stove to spend the gas.
11. Control panel for monitoring / operation.

Notes

a. All metal parts to be coated with epoxy primer and epoxy enamel for avoiding corrosion.
b. All masonry tanks to be coated with epoxy or other corrosion resistant coating.
c. Plant to be established in a place fully exposed to sunlight and away from drinking water sources.
d. Gas utilisation for heating /cooking purpose
e. A balloon storage facility for storage of at least ¾ th of bio gas generated in a day. 1/4th quantity of the gas produced in a day is stored inside the gas holder chamber of the digester itself.
f. Provide a water heater working on biogas with necessary safety arrangements and be

mounted on the wall of the pre-processing room to heat the water before mixing with the waste input, along with necessary plumbing.

g. Provision of gas measuring meter to supply gas to the nearest house-hold/commercial establishments on cost.

h. Solar water heater for making hot water to mix with the water to maintain the temperature where considered necessary in plants of 1000 kg/day capacity and above.

Additional facilities include;

I. Facility for utilizing the electricity generated for operating equipment in the plant / lighting the plant area.

II. Facility for flaring of excess gas with automatic or semi automatic flame ignition.

III. Facility for Biogas cleaning for removal of water vapour and H_2S concentration to 100 ppm or less.

IV. Facility for flaring of excess gas with automatic or semi automatic flame ignition.

V. Facility for Biogas cleaning for removal of water vapour and H_2S concentration to 100 ppm or less.

2.4.1.2. Standards

1) Minimum 45 days waste retention time

2) Particle size of waste not to exceed 20 mm

3) Rubber hose of ¾ to 1 1/2 inch diameter with maximum length of 40 m for conveyance of biogas

4) All PVC pipe of class 4 kg/cm2

5) Rubber hose, stove and control valve with ISI mark

2.4.1.3. Specifications

1. Pre-processing room

a. *Foundation/basement :* Random rubble masonry with cement mortar 1 in 6 , filled up with approved earth/ red soil, concrete belt 5 cm thick PCC 1:4:8, plinth height minimum 50 cm above the ground level.

b. *Floor :* Cement concrete 1:4:8 using 40 mm metal 75 mm thick and plastered with cement mortar 1:3, 12mm thick one coat and finished smooth by hand trowel.

c. *Superstructure :* Single brick wall 23 cm thick with cement mortar 1:6, plastered with 12mm thick 1:4 cement plaster finished smooth with hand trowel on both sides. Steel windows on all four sides. Snowcem painting on the external walls and dry distemper on

internal walls. Metal parts to be given synthetic enamel 2 coats over a primer coat.

d. *Platform /doors :* A platform of adequate size outside the pre-processing room, sides open, under the same roof with a ramp of size 2mx1m to unload the waste on arrival at the plant site. Door with opening of 1.2 metre wide on the platform side, another door 1m wide for entry of operating staff.

e. *Inlet mixing chamber :* Of suitable size to unload the mixed /pulverized waste, constructed out of brick work duly plastered on both sides on one corner of the room. The inlet device of PVC/cement pipe to connect the bottom of the inlet tank to the inlet chamber located near to the digester.

f. *Roof :* RCC slab 1:2:4, 10 cm thick, over which water tank and the gas balloon are placed. Provide steel rings 3 each on the soffit of the slab projections outside the enclosed room for tying up the gas balloon with Manila ropes/belts.

g. *Light /control panel :* Lighting with CFL 15 W, suitable control panel with power points for pulverizer, slurry pump etc.

2. Inlet mixing cum feeding tank

Constructed out of brick masonry plastered with cement mortar 1 in 3 circular in shape with locking arrangements near to the digester. The inlet device from the inlet mixing chamber feeds the pulverized waste into this tank and the normal waste which doesn't need any pulverizing is directly fed to this. This tank acts as the feeding tank to the digester.

3. Pre-Digester

Pre Digester tank is to digest slow digesting waste at the rate 5% of the total waste for a period of 90 days. Brickwork duly plastered with 1:3 cement mortar finished fair with hand trowel. This is to be provided in the plants of more than 1 Ton per day.

4. Digester

Digester tanks are designed with 40 days waste capacity duly mixed with equal amounts of water.

a. *Foundation /bottom :* RCC 1:1/2 :3 15 cm thick for plants up to 600 kg/d plant and 20 cm thick for plant of capacity 800 kg and above over a layer of PCC 1:4:8, 15cm thick over random rubble masonry with cement mortar 1:8 thickness 40 cm. Digester cylindrical shape, bottom with a slope of 1:8, for easy flow of slurry. Top hemispherical shape to accommodate the gas generated. The gas holder contains 25% of the gas generated in a day.

b. *Side walls and top :* 15/ 20 cm RCC 1:1 ½ :3 wall, brick lining 10 cm, on both the sides. Roof slab RCC 15/20 cm thick with brick lining 10 cm thick inside. Walls to be plastered and finished with 12mm thick cement mortar 1:3. Reinforcement details are shown in Sketch No 14. The whole digester is constructed below the ground level.

a. *Outlet opening :* 200/300 cm circular opening for the slurry to move into the outlet balancing tank.

b. *Outlet balancing tank :* Out balancing tank of the same specification of the digester tank as explained above.

5. Pre-filter

Pre filter, brick construction plaster 12mm thick 1:3 cement mortar, with four chambers in series separated by RCC baffle walls. The slurry from them balancing tank to be pumped into the first chamber where it passes through the baffle walls and comes out from the last chamber and flows into the septic tank. Certain amount of sludge gets deposited in this pre filter which is to be removed periodically. Provision of pre-filters reduces the load on the septic tank.

6. Septic tank and soak pit

Septic tank of 3 compartments with maximum of 1.7 m depth and L:B:H ratio of 7.5:2.25:1.2. The soak pit bottom is paved with bricks,sides of honeycomb brickwork inside filled up with brick jelly. Vent pipe is not necessary.

The soak pit bottom is paved with bricks, sides of honeycomb brickwork inside filled up with brick jelly. Vent pipe is not necessary.

7. Water Tanks

PVC water tanks of required capacity be placed on the roof of the plant room. In case there is no space on the roof as a gas balloon may occupy the full area a separate staging with brick pillars will be constructed to place the water tank. Ground sump and monoblock pump as required.

8. Mechanical equipment's

a. *Pulverizer :* A 3 hp 3 phase pulverizer 300 kg/hour rating for plants up to 1000 kg/day and 5 hp 400 kg/hour rating for higher capacity plants .Cutting blades on single shaft, belt driven enclosed pulverizing chamber ,hopper loaded ,fixed with 3 phase motor, suitable for wet grinding.

b. *Slurry pump :* Slurry pump open impeller type 1 hp for pumping the slurry out of outlet chamber into the pre-filter tank mounted on a portable base with wheels and flexible hoses on the suction and delivery sides.

c. *Biogas balloon :* High tenacity polyamide fabric matrix impregnated with compatible polymer on the inside for the gas stored and on outside with hypalon weather abrasion and UV resistance. Balloons are placed above the roof of the pre-processing room. This may be tied up with the roof by means of Manila rope and sleeves around.

2.4.1.4. Operation and Maintenance Protocols

1. Start up by adding cow dung and equal quantity of water
2. Waste feeding after chopping and mixed with water in the ratio 1:1
3. Daily feeding of easily degradable waste in slurry form or solid waste mixed with equal quantity of water
4. Limit the quantity of daily waste feed below the designed capacity
5. Maximum particle size of waste shall be 20 mm
6. Daily removal of slurry in to Septic Tank - Soak Pit system
7. Clean the inlet chamber after each feeding and keep it Closed.
8. Prohibited to feed wastes of slow degrading nature like straw, soil, egg shells, fibrous materials like banana leaves, coconut shells, coconut coir , pseudo stem etc. These are put into a pre-digester for pre-digestion.
9. Feeding of toxic substances like fungicides, insecticides, pesticides, detergents, and infectants like phenyl, Dettol etc. are prohibited.
10. Mix the substrate or rotate the drum at least weekly to prevent scum formation.
11. Skilled Manpower for Operation of the Plant.
12. AMC with the executing agency/ supplier for a period of 2 years after installation and initial capacity building period of six months shall be done.

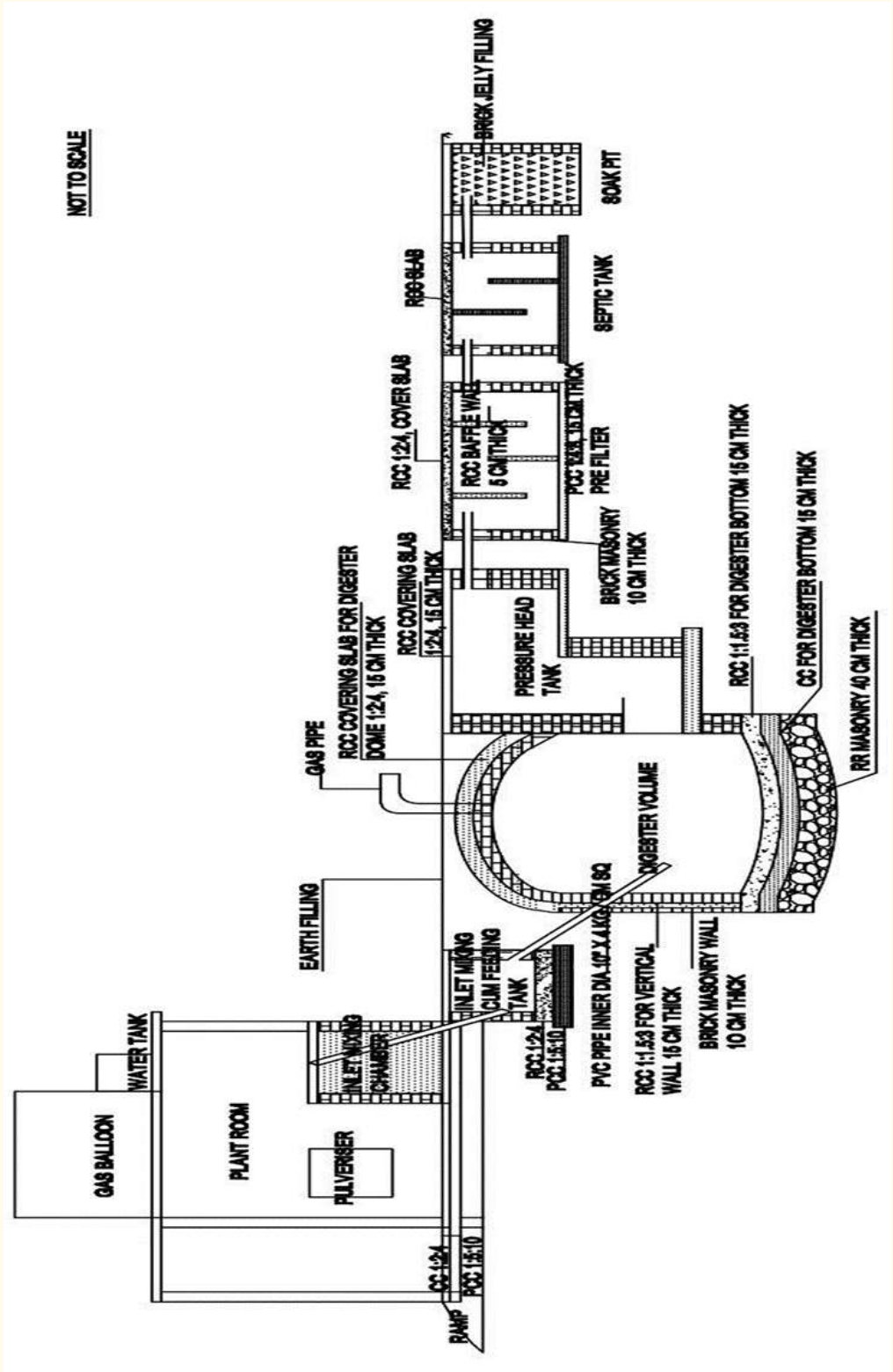


Figure 2.19: Sectional Elevation of Biogas plant

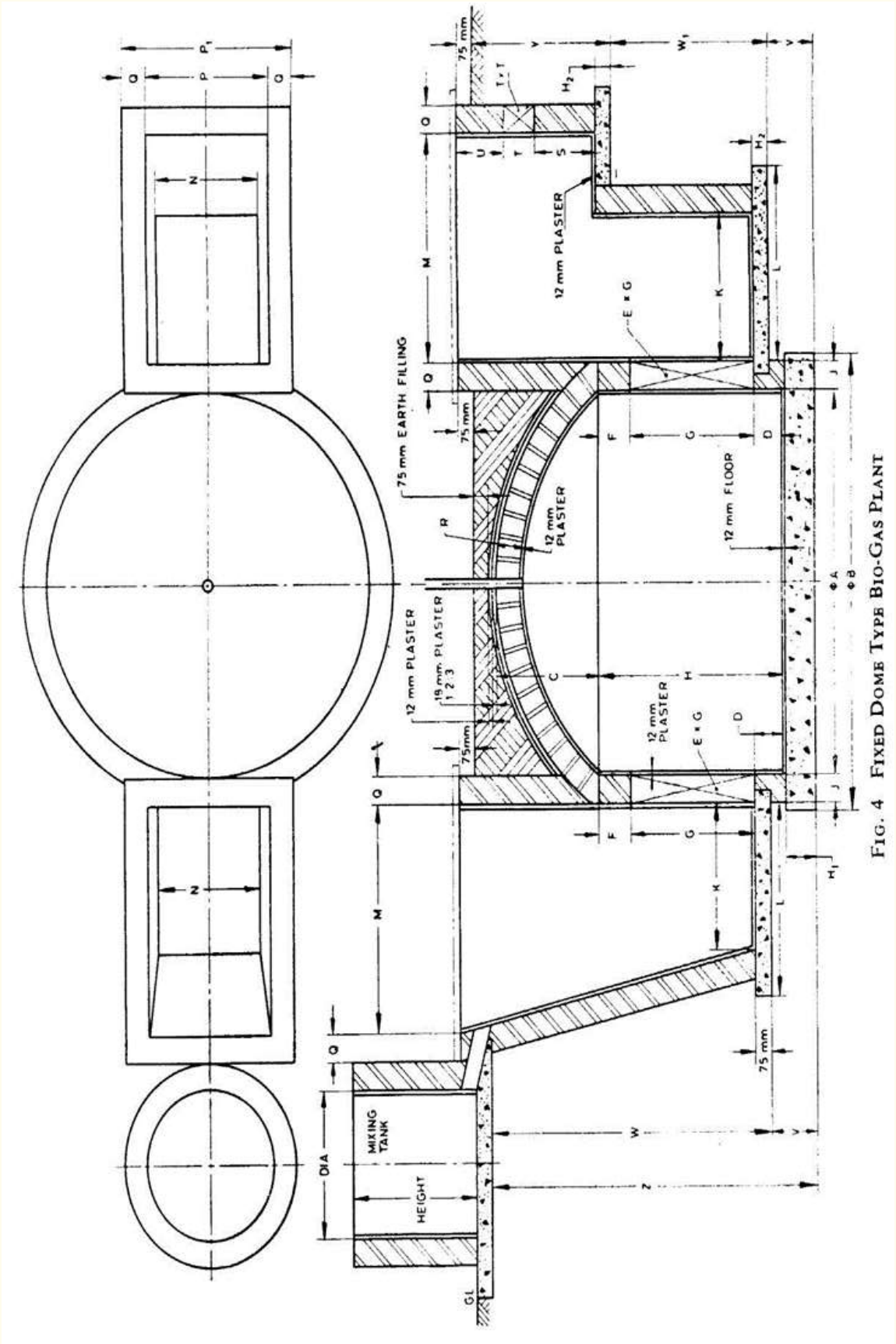


FIG. 4 FIXED DOME TYPE BIO-GAS PLANT

Figure 2.20: : Fixed Dome type biogas plant

2.4.2. Compressed Biogas Plant

Biogas is produced by digestion with the help of anaerobic microorganisms inside an anaerobic digester, biodigester or bioreactor. Biogas can be compressed after the removal of carbon dioxide and hydrogen sulphide, in the same way as natural gas is compressed to CNG. CBG produced can be used to power motor vehicles. A consistent feed of good quality segregated biowaste is essential for the sustainability of this model. These types of projects can be done as DBO projects or through PPP Mode.

Capacity : 20 TPD (Minimum viable capacity)

Approx. cost : Rs. 4 Cr.

Area required : 20 TPD - 1 acre

Installation time : 6 months time



Figure 2.21: 100 TPD CBG at Pune Municipal Corporation

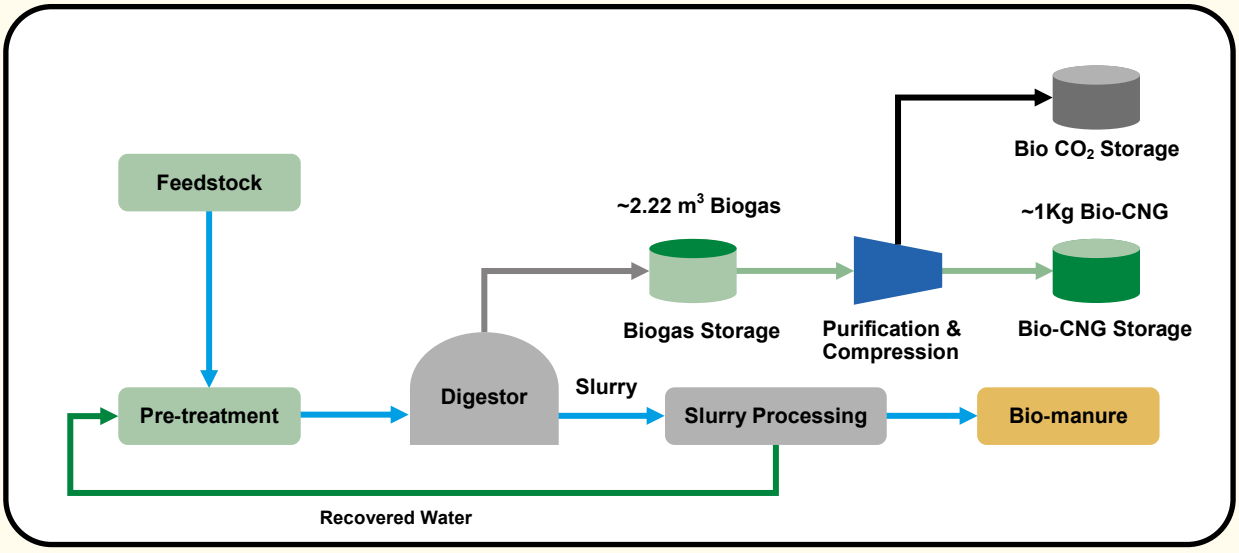


Figure 2.22: Process of producing and storing compressed biogas

The Bio-Gas generated is purified to remove hydrogen sulphide (H_2S), water vapour and compressed as Compressed Bio Gas (CBG), which has more methane content. Hydrogen Sulphide scrubber and water scrubber should be installed for the removal of such undesirable gases.

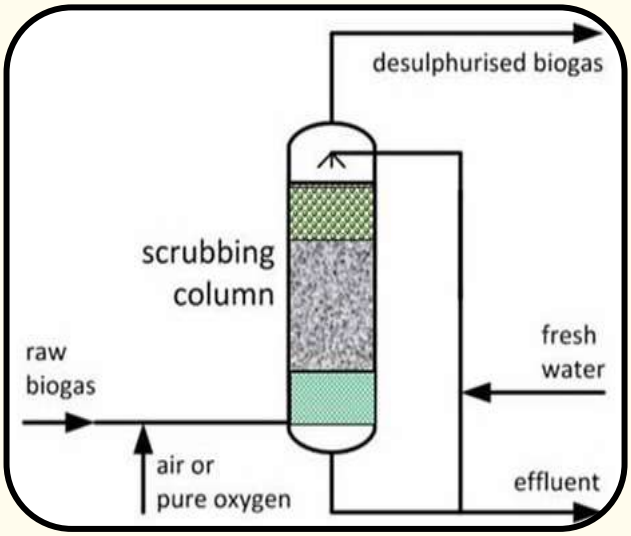


Figure 2.23: Working of Hydrogen sulphide scrubber

The purified biogas can be bottled in CNG cylinders and also can be used for the generation

2.4.3. Nisargruna Biogas Plant

NISARGRUNA Biogas plant is an anaerobic biodegradable waste management unit. It requires very little space for its machinery installation.

It offers “Zero garbage and Zero effluent“ and provides high quality manure and methane gas. It reduces the duration of degradation. About 70% of Water can be recycled at the end of the process. It can decompose kitchen/market waste, grass, gobar (animal dung), dry leaves, animal carcasses, effluent sludge etc. BARC technology transferred agency, who is interested to execute works in kerala – M/s SNL Bioenergetics.

Capacity : 1 TPD

Space : ~ 100 m^2

Manpower : Two unskilled persons

Power supply : 3 phase AC

Water Supply : 1.2 kL for one tonne plant/day

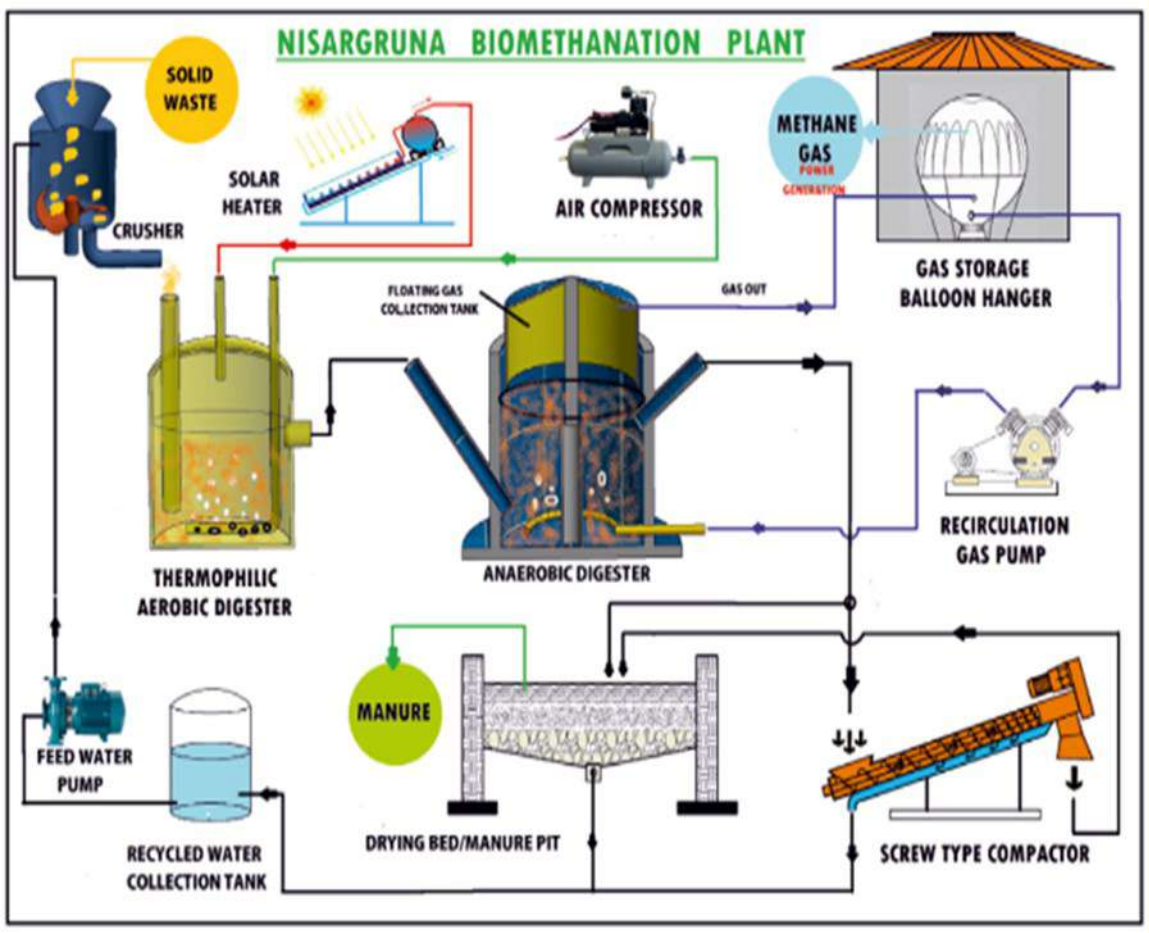


Figure 2.24: Layout of Nisargruna Biogas Plant

2.4.3.1. Advantages

Decentralized processing of biodegradable wastes Generation of 60 - 80 m of biogas from 1 MT of waste, which can produce about 90-120 KWH power. Generation of good quality manure (about 80 kg/day from a 1 MT/day plant). Prevents methane escape to the atmosphere, thereby helping reduction of global warming. Contribution to Swachh Bharath mission of Government of India.

2.4.3.2. Biodegradable wastes that can be processed in a NISARGRUNA plant

Waste/uneaten food from households, restaurants and industrial canteens Vegetable wastes from vegetable markets and kitchens , Shredded paper , Abattoir waste, especially cattle intestinal materials ,Cattle dung and night soil, Green lawn cuttings, algal/plant material removed from water bodies etc.

Green agro wastes (should be finely chopped before processing)

Certain materials are to be strictly avoided : Coconut and egg shells, Coconut coir, feathers, hair

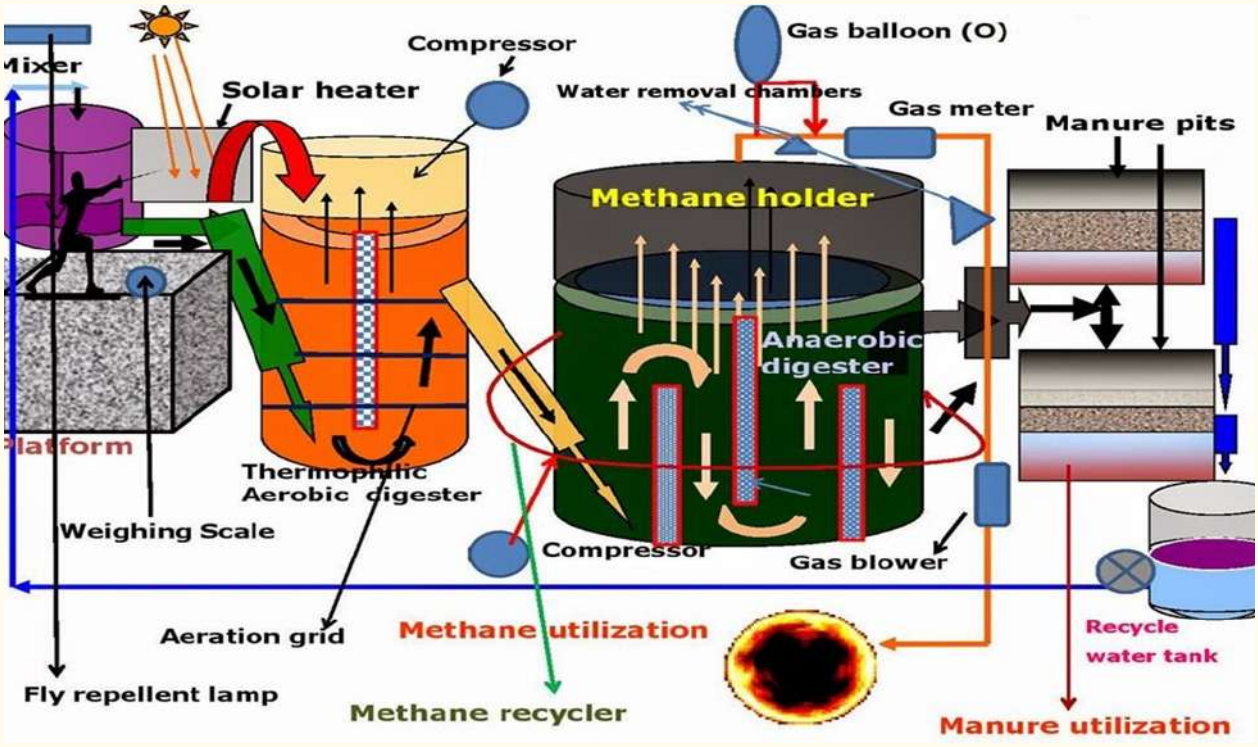


Figure 2.25: Working of Nisargruna Biogas Plant

2.4.4. Compact Helical Biodegradable Waste Converter

In order to manage the biodegradable waste generated in smaller housing societies, restaurants, a novel, compact helical shaped waste converter has been developed at the Nuclear Agriculture & Bio-Technology division of BARC. It is a helical shaped digester made from low cost PVC pipes, System requires very limited space for construction. Design saving major cost of construction and MS dome required for conventional designs. Design suitable for mounting on wheels/vehicle for processing waste from different societies/residential complexes. Design has inbuilt capacity for biogas recycling for methane enrichment. Design suitable for understanding different process parameters online, sampling from different locations, understanding the role of bacteria in the process etc. The compact helical shaped waste converter suppliers have been approved by BARC. These kinds of projects do not require technical sanction, these can be done as procurement projects. This is a low cost technology. This can also be used as a portable unit, attached to vehicles.

This system is particularly beneficial for small-scale waste management and can significantly contribute to sustainable waste processing practices.

Capacity : 10 kg/day and 100 kg/day

Space : 400 sq. ft. area (20 ft. x 20 ft.)

Power supply : 3 phase AC

Water Supply : 1.2 kL for one tonne plant/day



Figure 2.26: Layout of Compact Helical Biodegradable waste Converter

2.4.4.1. Design Features

1) **Helical Shape:** The digester is designed in a helical shape using low-cost PVC pipes. The helical design ensures that the waste moves through the system in a spiral path, which increases the contact time with microorganisms. This design maximizes the surface area for microbial activity and enhances the efficiency of waste breakdown. and efficiency of the decomposition process.

2) **Material and Construction:** The use of PVC pipes makes the system lightweight, durable, and cost-effective. The helical structure can be easily assembled and disassembled, which is beneficial for maintenance and transportation.

3) **Aeration and Mixing:** The design includes mechanisms for aeration and mixing, which are crucial for maintaining aerobic conditions. Proper aeration prevents the formation of anaerobic zones that can cause odors and slow down the composting process.

4) **Biogas Collection:** The design includes the capability for biogas recycling, which enriches methane content and can be used as a renewable energy source. The system is equipped with a biogas collection unit that captures the methane produced during the decomposition process. This biogas can be used as a renewable energy source for cooking or heating.

5) **Leachate Management:** The design includes a leachate collection system to manage the liquid by-products of composting. This prevents contamination of the surrounding environment and allows for the leachate to be treated or reused.

6) **Mobility:** It can be mounted on wheels or a vehicle, allowing for easy transportation and processing of waste from different locations.

7) **Online Monitoring:** The system allows for online monitoring of process parameters, enabling better control and optimization of the composting process.

2.4.4.2. Benefits

1) **Compact Size:** The system is compact and suitable for small spaces, making it ideal for housing societies, restaurants, and small establishments.
2) **Decentralized Processing:** Reduces the need for transporting waste to central processing facilities, saving on transportation costs and reducing carbon footprint.
3) **Cost-Effective:** The use of readily available materials such as PVC pipes and fibers, eliminate the need for expensive construction materials like MS domes make it a cost-effective solution hence it is an affordable option for many communities.
4) **Scalability:** Suitable for processing varying amounts of waste, from as little as 10 kg to 100 kg, making it adaptable to different needs. The system can be scaled up or down based on the amount of waste generated. This makes it suitable for a variety of settings, from small households to larger communities or institutions.
5) **Renewable Energy Production:** The biogas produced can be used as a clean energy source, reducing reliance on fossil fuels and contributing to energy sustainability.
6) **High-Quality Output:** Produces good quality compost and biogas, which can be used as fuel and manure to improve soil health and support sustainable agriculture.

2.4.4.3. Operation & Maintenance

1) **Loading:** Organic waste is loaded into the helical digester. The system can handle varying capacities, making it adaptable for different scales of waste generation, such as 10 kg, 25 kg, 50 kg, or 100 kg.
2) **Aeration:** The helical structure promotes natural aeration, which is essential for aerobic decomposition. This helps in maintaining the right oxygen levels for microbial activity.
3) **Initial Breakdown:** The helical design ensures that the waste is evenly distributed and mixed, which is crucial for the initial breakdown of organic material.
4) **Temperature Control:** The system retains heat generated during decomposition, which accelerates the composting process.
5) **Methane Enrichment:** The system is designed to recycle biogas, enhancing methane production. This biogas can be used as a renewable energy source.
6) **Gas Collection:** The produced biogas is collected and can be utilized for various applications, such as cooking or electricity generation.
7) **Regular Inspection:** Check for any blockages or mechanical issues in the helical structure and ensure all components are functioning correctly.
    a) Mechanical Parts: Regularly inspect mechanical components like motors and gears to ensure they are functioning smoothly.

b) Helical Structure: Check for any blockages or wear and tear in the helical structure. This ensures continuous and efficient operation.

8) **Cleaning:** Periodically clean the system to prevent the buildup of residues that could hinder the composting process.

9) **Residue Removal:** Periodically clean the system to remove any residues that might accumulate and hinder the composting process.

10) **Component Cleaning:** Clean the PVC pipes and other components to prevent clogging and ensure smooth operation.

11) **Component Replacement:** Replace any worn-out parts, such as PVC pipes or mechanical components, to maintain the efficiency of the system.

12) **Wear and Tear:** Replace any worn-out parts promptly to maintain the system's efficiency. This includes PVC pipes, mechanical parts, and any other components that show signs of wear.

2.4.5. Advanced Waste to Energy - Biourja Modular Biogas Plants

The Biourja system is a high-rate dry anaerobic digestion system. It digests biowaste and produces clean bio-CNG (biogas which contains high percentage of methane). The gas can be directly used for cooking and thermal applications. It can also be used with a gas engine for power generation. The post-digested liquid is used as a fertilizer. The projects can be done in PPP mode or DBOT method. The agencies capable of doing the projects have been empanelled by Suchitwa Mission.

Pilot plant established in Perinthalmanna Municipality (2 TPD).

Capacity : 2 TPD

Approx. cost : Rs. 80,00,000/-

Area required : 2 cents

Installation time : 2.5 months



Figure 2.27: Biourja modular Biogas plant

2.4.6. NIIST Model Biogas Plants

This biogas plant model was developed and patented by NIIST - National Institute for Interdisciplinary Science & Technology (CSIR-NIIST), and is suitable for household-level and gated communities. The plant is designed to efficiently convert organic waste into biogas and organic manure.



Figure 2.28: NIIST Model Biogas plant

These plants use machinery for grinding the feed, mixing, and boosting the feed to the digestor to ensure maximum biogas production. Unlike traditional biogas plants, this model does not require water for the digestion process, making it suitable for areas with water scarcity. The process is working on dry digestion principle (Solid content >15%, and Volatile solid loading >5 Kg/Cub M) in plug flow type bioreactor operating in parallel. That can manage and handle normal issues with anaerobic digesters. The major highlight of the process are-

- No fresh water addition into the digester.
- No fresh water addition into the digester.
- No fresh water addition into the digester.
- The Volatile solid reduction >90%, so the slurry is highly stable without any odour.
- The slurry can be used as organic manure.

The total biogas produced (~80 Cubic meter) can be recovered as Power (~1.5 Kwh per cubic meter), which can be used for local lighting and operation of the plant. The capacity varies from 50 kg/day - 1000 kg/day. Small capacities (50 Kg/day) of similar systems are most ideal for canteens, marriage halls, schools, apartments, housing colonies, etc. These units can treat any food waste (both cooked and uncooked including egg shell, lemon, onion peel, etc. These compact digester units are portable, and occupy small space for installation. The area requirement for a 50 kg/day capacity biogas plant is about 2.5 m2; about 9000 L/day biogas yield is expected.

The cost of the plant varies depending upon the capacity of the unit.

Capacity : 0.05 - 1 TPD

Approx. cost : Rs. 1,00,000 - 10,00,000/-

Installation/operation cost and ROI for a 50 kg/day unit

- Fabrication & Installation cost : Rs. 4,00,000 (Profit margin & GST not included) (MS + inside FRP coated)
- Biogas from 50 kg food waste/day : 10000 L/day
- LPG equivalent : 4.5 kg/day
- Rs equivalent : 380/day (@85 Rs/kg)
- Biogas value per year : Rs. 1,35,000
- Operational cost/year : Rs. 3500 (<1 kwh/day)
- Maintenance/replacements : Rs 10,000
- Biogas value - OpEx/year : Rs 1,24,000 (Value of manure not accounted)
- Return period : 3.2 years (Plant life minimum 10 years)



Figure 2.29: Machineries in a MIIST model Biogas plant

2.4.6.1. Advantages

- Compact size, Minimum space requirement for installation
- No freshwater consumption
- It can take any food waste
- Scalable to accommodate more food waste
- Less slurry out, highly stable, the can be used as manure
- Even large units can be portable

- Yields more biogas with higher methane content (~200 Lit/kg food waste)
- The burden of periodical disposal of too watery discharge slurry
- No vector problems

2.5 NEW TECHNOLOGY OPTIONS

2.5.1. Mechanized - Aerated Windrow Composting Unit

It is a mobile cum decentralized treatment system suitable for handling bio waste from markets and bulk waste generators. Bio waste is crushed and mixed with microbes within the mobile organic waste converter unit so as to prepare a pre-compost with reduced moisture content. Then it is transferred into a decentralized treatment unit and forms an aerated windrow heaps to convert the waste into compost. The very low quantity of leachate generated is used for maintaining the moisture content in the windrow heaps, so no leachate is produced out of the system. The projects may obtain technical sanction from the respective technical committees in accordance with the financial limitations established for this purpose as per GO.(Rt) 1688/2023/LSGD) dated August 19, 2023.**Model Plant is working at Adichanalloor GP, Kollam District.**



Figure 2.30: Schematic representation of Mechanized Aerated Windrow Composting Unit

Mechanical Equipment's

a. Organic waste converter
b. Wheelbarrow
c. Air blowers
d. Bag sealing machine

Capacity	:	1 - 1000 kg/Day (for 1 tons)
Batch Size	:	250 kg
Approx. cost	:	Rs. 15,00,000/-
Area required	:	50 cent land
Installation time	:	2 months

Mechanized aerated windrow composting is a popular method for large-scale composting. Here are some of the pros and cons:

Pros

1. **Efficiency:** The mechanized process significantly speeds up composting, producing high-quality compost in a shorter time frame compared to traditional methods.
2. **Space Utilization:** Aerated windrows make excellent use of space, reducing the footprint needed for composting facilities.
3. **Odor Control:** The aeration process helps in controlling odors, making it suitable for urban or densely populated areas.
4. **Scalability:** This method can handle large volumes of organic waste, making it ideal for municipal or industrial composting.
5. **Quality of Compost:** The combination of aeration and turning produces high-quality compost with dried finer particles and richer color.

Cons

1. **Initial Investment:** The setup cost for mechanized aerated windrow composting can be high due to the need for specialized equipment and infrastructure.
2. **Operational Costs:** Ongoing costs for maintenance and operation of the machinery can be significant.
3. **Technical Expertise:** Requires skilled personnel to manage the process effectively, including monitoring temperature, moisture, and aeration levels.
4. **Energy Consumption:** The mechanized process can be energy-intensive, which may offset some of the environmental benefits.

2.5.2. Dewatered Composting System

The Dewatered composting system can be used to manage biodegradable waste from markets, institutions etc, which is having higher particle size and high moisture content. Dewatering composting is a process that involves the removal of excess water from organic waste before composting. The biodegradable waste is chopped into 10 to 20 mm size and fed into the dewatering system. 30 to 40 % of water content is reduced from bio waste. The blended bio waste is filled in the plastic trays and left for composting for another 12 to 15 days. Dewatered waste is blended with a bacteria consortium to enrich the microbial action and with a bio culture to retard the growth of worms. The compost is crushed, sieved and packed for selling. The leachate collected from the unit shall be treated in a biogas plant associated with this unit. The projects may obtain technical sanction from the respective technical committees in accordance with the financial limitations established for this purpose as per GO(Rt) 1688/2023/LSGD) dated August 19, 2023.

Model plant is working at Wadakkanchery Municipality.



Figure 2.31: Dewatered Composting System

Mechanical Equipment's

a. Shredder
b. Screw press
c. Conveyor belt
d. Leachate pump
e. Trolley
f. Bag sealing machine

Capacity : 3 TPD

Approx. cost : Rs. 75 Lakhs (for sheds and machineries)

Area required : 400 Sq ft for processing + 1000 Sqft for curing (Maximum 8 Cent of land)

Installation time : 3 - 6 months time

Pros

- Dewatering reduces the weight and volume of organic waste, making it easier to transport and store.
- Faster Bio- waste conversion.
- The process of dewatering can help to reduce the amount of leachate produced during composting, which can be harmful to the environment.
- Dewatered composting can produce a high-quality compost that is rich in nutrients and beneficial for soil health.

Cons

- Dewatering requires additional equipment and energy, which can increase the cost of composting.
- The process of dewatering can be time-consuming and labor-intensive.
- Large area required compared with Biogas plant of equal capacity

2.5.3. In-Vessel Composting Units

This is a type of biomass converter, that converts the bio waste into nitrogen-rich compost to be used in the agricultural or biofuel sector. In-vessel composting is a method of composting that involves the use of a closed container to compost organic waste. This system is very suitable for treating institutional level biowaste. Favourable conditions for breaking down organic waste by the actions of microorganisms is ensured in this system. The composting process occurs within the rotating drums/ vessels. Electricity is required for the operation (turning of unit) of this unit. The projects may be executed as procurement work.



Figure 2.32: In Vessel Composting Units

Capacity	: 500 - 1500 kg/Day
Batch Size	: 25 -75 kg
Approx. cost	: Rs. 3,00,000 - 15,00,000/-
Area required	: 10 m^2/unit
Installation time	: Ready to install prefabricated units.

Pros

- Capable of processing large amounts of waste in limited space.
- Waste can be continuously fed into the composting system.
- It can be used for producing high-quality compost in a controlled environment.

Cons

- It requires a larger investment upfront compared to other options which may be cost prohibitive.
- It can not be considered as a cost-effective solution.

2.5.4. Rotating Drum Composting

Rotating/ Rotary Drum Composting is a decentralized composting technique that provides agitation, aeration, and mixing of the substrate to produce mature and stable compost. the microbial digestion of food and other organics occurs in an aerated enclosed cylinder (the vessel or drum). The Rotary Drum Composter reduces composting time to 2 - 3 weeks. Consistent rotation of the compost and the side air vents allow the organic waste to remain in contact with oxygen, while the drum retains heat. It requires very little space of 3 x 3 ft. The rotating drums can be run by manual as well as motorized. For 60 kg/Day capacity drums, it will cost around Rs. 1,20,000/-



Figure 2.33: Rotating Drum Composting

For Processing Capacity : 500 kg/Day

Approx. Cost: Rs. 1,10,000/-

Drum composting has several advantages and disadvantages as follows;

Pros

1. **Faster Composting:** The frequent turning of the drum provides better aeration, which speeds up the composting process.
2. **Odor Control:** Since the compost is enclosed, it helps in controlling odors better than open compost piles.
3. **Pest Prevention:** The sealed design keeps pests like rodents and insects out.
4. **Ease of Use:** Turning the drum is generally easier than manually turning a compost pile with a pitchfork.
5. **Compact Design:** Drum composters are often more compact and can fit into smaller spaces, making them suitable for urban gardening.

Cons

1. **Cost:** Drum composters are typically more expensive than traditional compost bins due to their design and moving parts.
2. **Maintenance:** They can be harder to maintain, especially larger models which can be difficult to turn when full.
3. **Compost Quality:** The compost produced might not be as rich as that from traditional methods, as the rapid process might not allow for complete breakdown of materials.

2.6 MICROBIAL CULTURE/ INOCULUM

2.6.1. Rapid Composting Inoculum

A single microbe (cellulolytic fungus) based formulation has been developed by Nuclear Agriculture & Biotechnology division of BARC for decomposition of biodegradable wastes like kitchen/ market waste, dry plant matter including coconut leaves, straw/agricultural residue and flower waste from temples. Its application shortens the degradation time(required for natural processes, depending on the type of biomass) to a few weeks. The compost generated in this process has high carbon content which will be beneficial in enriching organic matter-depleted soils. The projects can be done as procurement projects, through BARC technology transfer agencies, who are interested in executing works in Kerala (M/s Social Theta).

Capacity : 1 TPD (Minimum)

Approx. cost : Rs. 8 lakhs

Area required : 100 Sq.m.

Manpower : 1-2 skilled/unskilled workers



Figure 2.34: Composting of coconut leaves in pit : Initial stage after shredding (a), Composted coconut leaves after 55 days (b and c)

Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies

Table 2.2: Indicative criteria for selection of appropriate technology or combination of technologies

CRITERIA	AEROBIC COMPOSTING	VERMICULTURE	BIOMETHANATION
TECHNICAL CRITERIA			
Facility Location	To be located as per the buffer zone criteria mentioned below.	To be located as per the buffer zone criteria mentioned below.	To be located as per the buffer zone criteria mentioned below.
Buffer Zone (No Development Zone)	500 m for facilities dealing with 100 TPD or more of MSW 400 m for facilities dealing with 75–100 TPD of MSW 300 m for facilities dealing with 50–75 TPD of MSW 200 m for facilities dealing with 10–50 TPD of MSW No buffer zone for facilities dealing upto 5 TPD of MSW No buffer zone for decentralised plants handling less than 1 TPD of MSW (but adequate environmental controls are required)		
Natural Environment	Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation.	Composting in coastal/ high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation.	
Land Requirement	For 300 TPD of segregated/ pre-sorted MSW: 5 ha of land including buffer zone is required.	For 20 TPD of segregated/ pre-sorted: 1.25 ha.	For 300 TPD of segregated/ pre-sorted MSW: 2.5 ha of land is required.
Waste Quantity which can be managed by a single facility.	500 TPD	1 TPD to 20 TPD. Higher capacities can also be planned if adequate land is available along with other necessary arrangements.	1 TPD at small scale to 500 TPD at larger scale
Requirement for Segregation prior to technology	High	Very high	Very high

Rejects	About 30% including inerts if only composting is done.10 15%* rejects with RDF, if located in the same plant	About 30% including inerts*	About 30% from mixed waste*
Potential for Direct Energy Recovery	No	No	Yes
Technology Maturity	Windrow composting technique is well established	Community scale projects are successful	Feasibility for biodegradable waste is proven. In case of mixed waste, appropriate pre-sorting has to be carried out.
FINANCIAL CRITERIA			
Indicative Capital Investment	Typically 15-20 Cr for 500 TPD plant	1 Cr. per 20 TPD	Typically 75-80 Cr for 500 TPD plant
Market for product/ By-Product	Quality compost compliant with FCO 2013 has a good market. IPNM Task Force (vetted by Supreme Court, 1 Sep 2006) has Recommended co-marketing of 3-4 bags of compost with 6-7 bags of inorganic fertilizer.	Good market potential in urban and rural areas. However it is not adequately explored for bulk marketing	So far, there is no appropriate system for pricing biogas. The system of pricing according to kerosene equivalent puts biogas at a disadvantage. At present, there is lot of interest in conversion of biogas into automotive fuel by stripping CO2. In this case, equivalent pricing with power/CNG again puts biogas at a disadvantage because of scale of economy.

MANAGERIAL CRITERIA			
Labour Requirement	Labour intensive	Labour intensive	Less labour intensive
Predominant skills for Operation and Management	Technically qualified and experienced, and semi-skilled staff.	Technically qualified, experienced and semi-skilled staff.	Technically qualified and experienced staff.
ENVIRONMENTAL CRITERIA			
Concerns for toxicity of product	The final product is generally applied to soil and used as manure. Can contaminate the food chain if compost is not meeting FCO norms.	The product is generally safe as worms cannot endure significant contamination of raw materials. FCO Standards are to be met with.	The final product is generally applied to soil as a soil conditioner. Can contaminate the food chain if compost is not meeting FCO norms.
Leachate Pollution	Potential exists. Varies with the climate of area and seasonal variation. In relatively dry seasons, leachate can be recirculated into the windrow to contain loss of nutrients and also pollution potential. In high rainfall areas, the windrows need to be covered either temporarily or permanently to control leachate generation. However, the design of the shed should be such that good natural ventilation is maintained.	Insignificant quantities at low waste volumes per vermi-pit.	High if not treated appropriately

Atmospheric pollution	Low (dust, aerosol etc.). Odour issues.	Low. Odour issues.	Low. Leakage of biogas. Odour issues
Other	Fire and safety issues to be taken care of	Fire and safety issues to be taken care of	Fire and safety issues to be taken care of

2.7 COLLECTION & TRANSPORTATION SYSTEM



Figure 2.35: Schematic representation of segregation, collection & transportation system

The collection and transportation of biodegradable waste to processing facilities is a critical component of waste management systems, ensuring that organic materials are efficiently handled and processed. This process typically involves setting a collection frequency that balances operational efficiency with community needs, often ranging from daily to bi-weekly pickups depending on the volume and type of waste generated. Specialized collection vehicles, such as those equipped with sealed compartments to prevent odors and contamination, are essential for transporting biodegradable waste. These vehicles are designed to handle organic materials safely and hygienically, minimizing the risk of spillage and environmental impact. In addition to the physical logistics, effective routing strategies and real-time tracking systems can optimize collection routes, reduce operational costs, and improve service reliability. Regular maintenance of these vehicles and adherence to strict sanitation protocols further ensure that the waste collection process remains efficient and environmentally friendly, paving the way for successful waste processing and recycling efforts.

A. Vehicles with IoT Based Monitoring Tool



Figure 2.36: IOT based monitoring and weighing tool



Figure 2.37: IoT enabled smart vehicle

The Auto tippers would be IoT-enabled smart vehicles with weighing capabilities and generator identification. The other features are

- Sensors to capture the waste quantity and GPS trackers will be fitted in the vehicle.
- It enables weight-based tariff fixation, leading to the successful implementation of the “3R” principle.
- The system can be retrofitted to any collection vehicle making it SMART.
- There is no loss of time in acquiring the operational parameters.
- The system can be adopted in all types of waste collection vehicles including Pushcarts
- Waste should be carried in covered vehicles. Vehicles must be adequately covered to ensure waste from not falling or spilling while transporting.

B. Bio CNG Vehicles



Figure 2.38: CNG Goods Carrier

LMVs fueled by Bio CNG can be used in the primary collection. If Bio CNG is produced from the local body level Bio CNG Plant could be used as fuel, thereby reducing the fuel cost involved in transportation. The vehicles will act as mode of forward linkage of the Bio CNG Produced. Hence, the continuous processing cycle of waste could also be ensured. Also, the reduction in Carbon emission is expected to attract carbon credits

C. E-Vehicles



Figure 2.39: Electric Goods Carrier

User friendly E-vehicles would help to improve the collection of waste with the help of existing HKS Workers (minimal training required). Narrow lanes can be covered. The availability of subsidies in E-Vehicle Procurement and establishment of more charging stations would improve the service level of C&T.

Payload Capacity : 500 kg; Approx. Cost : Rs. 5,00,000/-

D. Diesel Vehicles



Figure 2.40: Diesel fueled Goods Carrier

Small collection vehicles such as tricycles and bullock carts can discharge their waste into these trucks. The vehicles are provided with lifting mechanisms to discharge the waste from stationary containers located at the source of generation. Hilly regions often have steep gradients, narrow roads, and winding paths. In hilly regions, waste collection poses unique challenges due to the rugged terrain, seasonal variations, and socio-economic factors. Diesel engines are known for their high torque output, making them suitable for hilly terrains. The ability of diesel vehicles to climb steep gradients and handle heavy loads is crucial for waste collection trucks navigating uphill roads



Figure 2.41: Diesel fueled Waste Collection Truck

E. Portable Stationary Compactors



Figure 2.42: Portable stationary compactor and truck mounted hook loader

The stationary compactors can be adopted in places where the secondary transportation of waste is needed. Waste collected by small vehicles can be transferred to large vehicles for the transportation of waste to the processing facility.

F. Garbage Compactor

A garbage compactor truck is used for the safe and efficient collection of waste. The advanced level of features for loading, compacting and transportation make the collection process easy and efficient.



Figure 2.43: Garbage Compactor with truck

Estimated Approx. Cost : Rs. 12,00,000/- (Capacity: 14 Cubic Meter)

The rear loading compactor shall be mounted on a suitable 16 Ton GVW chassis. The compactor shall comprise three main parts.

1. The body and Ejection Barrier
2. The Hopper and compaction hydraulic unit at rear body.
3. The bin lifter Mechanism.

1. **The Body and Ejection Barrier**

A.The Body :

- With optimum volumetric capacity of 14 cu.m, the body is constructed from high tensile steel ST 52, “one piece” rolled side sheets reinforced by front and rear stiffeners, pressed integrated channels and ‘keel’ type floor. The Rear entry floor plate is constructed from Hardox 450.
- The Cylindrical appearance of Body shape not only gives improved aesthetics but increases body capacity by 1 - 1.5 Cu.m per body size.
- Body manufactured from one piece rolled and pressed steel sides that extend body life and also increase the efficiency of the entire body concept and provide ready space for signage.
- The Keel shaped Body floor, fitted with under - floor sump and floor channels ensure 100% of leachate collection in the floor sump at the front of the body. It also ensures clean discharge of solid waste.

B. Refuse Ejection Barrier

- Ejector Barrier plate is manufactured from high tensile abrasion resistant Hardox 450 steel and formed in such a shape gives smooth and unobstructed discharge of garbage.
- Heavy duty Ertalon LFX self lubricated guides allow the barrier to move smoothly along the rail, provided within the body.
- Multi - stage double acting telescopic hydraulic cylinder and its geometrical mounting gives efficient ejection and retraction travels, without any side load on sliding guides.

2. Packing Mechanism

The packing system will consist of two moving plates: the packing plate and the sweeping plate. The packing plate will travel angular track, and at the end of the stroke, sweeping plate will be activated and clean the hopper, at the end of its travel, packing plate start it’s reverse travel and start compressing the refuse into the body. It’s called one complete cycle of compaction.

- Proven two plate fabricated packer / sweeper design. Manufactured out of high tensile abrasive resistance Hardox 450 steel.

- Packing mechanism slides in integrated side channels and provided with low friction self lubricating Ertalon LFX guides.
- Heavy duty and well corresponding hydraulic cylinders ensure the efficient sweeping and packing cycle, within a nominal cycle time of 23 seconds.
- We provide 3 stage compaction enabling better compaction ratio

A. Hydraulic System

- PTO Mounted Close Coupled standard Gear pump delivers 82 LPM at 1000 RPM.
- Body mounted Oil Tank which optimizes the mounting space, equipped with Return Line Filter, Breather, level indicator and shut-off Valve
- Full flow 10 micron return line filter controls contaminant levels.
- Engine speed is maintained by the electro-pneumatic throttle control system automatically, when hydraulic power consumption increases.
- Electro - pneumatic operated spool valves control all system functions separately, with inbuilt dump valve for retraction process.
- Automatically adjusted high and low pressure system, gives efficient and smooth working of the system and protects the system from over stress and obtains better fuel efficiency.
- Inverted fitment of Sweeping Cylinder with spherical bearings, protects the piston rod from direct contact of acidic waste/garbage.
- Heavy duty inverted packing Cylinders mounted outside the hopper, gives more clearance in Hopper loading area and protects the piston rod from direct contact of acidic waste/ garbage.
- Roof mounted Hopper/Tailgate lift Cylinders, get well protected from accidental damage. Double check valves give extra safety in case of hose failures.

B. Electrical System:

- Fully integrated logical system and printed circuit board located on the body in a IP66 weatherproof panel.

C. Hydraulic Cylinder:

- Heavy duty double acting inverted sweeping cylinders fitted with maintenance free spherical bearings - 2 nos.
- Heavy duty double acting inverted packing cylinder mounted outside the hopper, clear of the loading area - 2 nos.

- Roof mounted heavy duty double acting hopper lift cylinder - 2 nos.
- Heavy duty double acting cylinders for bin lifting - 2 nos
- Heavy duty multi stage double acting telescopic cylinder for ejection plate - 1 no.
- Maximum no. of cylinders is 09 nos (Double acting).

3. Bin Lifter

- The bin lifter will be made from a lightweight conventional steel structural framework.
- Bolt on connection with tail gate and has a relatively short rear overhang
- Reduced effective rear axle load, delivering significant payload advantage
- The bin lifter shall be suitable to lift the standard DIN containers of size 120, 240, 600 & 1100 Ltrs. (120 Ltrs & 240 Ltrs. of HDPE & 1100 Ltrs of Steel)
- The length of bin lifter shall be minimum 1.40 meter
- Two double acting hydraulic cylinders (one on each side) shall be provided for lifting the bins.
- Bin lifter arms shall be supplied with DIN arms
- A safety valve shall be provided to avoid sudden descent of the bin lifter in case of failure of hydraulic pressure.

A. Tailgate:

The tailgate shall be provided with a hydraulic bin lifter which shall be suitable to lift standard DIN containers of size 120, 240, 600 & 1100 ltrs. The entire compaction system shall be operated at designed speed with auto throttle.

- Optimized 2.4 m^3 swept volume capacity, resulting in fewer packing cycles giving high rate of packing garbage and also gives benefits of reduced wear, minimize fuel consumption, time & noise.
- Full 1.9 m uncluttered loading width facilitates bulky material to be packed.
- Low rave rail height of 1.05 m facilitates manual loading and versatile bin - lift mounting.
- Tailgate sides are made up of high tensile abrasive resistant Hardox 450 steel and formed with an integrated guide channel to guide the packing mechanism.
- Integral full height body/Hopper seal fitted to prevent liquid leakage from bottom edge and Hopper sides.
- Reduced overhang for improved weight distribution and maneuverability. Rear overhang

shall be within the RTO norms i.e. 60% of the wheelbase of the chassis.

OTHER EXTRA FITMENTS

- Two Footsteps will be provided one each on left and right side at the rear & two hand bars one on each side at the rear side shall be provided for the equipment operators to stand and travel when the compactor is moving.
- One large flashing light will be provided in the front in the centre at the highest point so as be seen clearly
- Two emergency stop switches will be provided on either side of the body to instantly stop the operation in case of emergency.
- A level indicator will be provided to indicate hydraulic oil level in the tank
- The Vehicle will be provided with a reverse horn so that it gives the indication at the time of reversing.
- Arrangement will be provided to get an indication as soon as the garbage contained reached its maximum. Arrangement shall also be provided to stop the operating cycle as soon as the Compactor is full.

2.8 SPECIFICATIONS FOR VEHICLES & MACHINERIES

2.8.1. Vehicle Specification

2.8.1.1. Bio CNG Vehicle Specification

Fuel Type	:	CNG
Load Capacity	:	619 kg
Overall Width	:	1493 mm
Wheel Base	:	2125 mm
Overall Length	:	3230 mm
Overall Height	:	1818 mm
Maximum GVW	:	1250 kg
Min. Ground Clearance	:	195 mm
CNG Tank Capacity	:	5.6 kg
Battery	:	12 V, 32 A
Maximum Net Power	:	7.30 kw / 4750 RPM
Engine Displacement	:	236.2 CC
Maximum Net Torque	:	16.5 Nm / 3500 RPM
Gradeability	:	18 %
Brake	:	RH Foot Operated
Hydraulic	:	Drum
Payload Capacity	:	500 Kg
Approx. Cost	:	Rs. 3,00,000/-

2.8.1.2. E-Vehicles

Battery & Power		
Battery Type, Voltage	:	Lithium ion, 48 V
Battery Capacity Rated	:	8 kWh
Peak Power	:	9.55 kW @ 3500 rpm
Peak Torque	:	45 Nm

Transmission Type	:	PT gear with differential (Integral)
		Suspension & Brakes
Front	:	Helical spring with damper
Rear	:	Rubber spring with damper
Steering	:	Handlebar type
Brake Drum & Rear)	:	Brake hydraulically actuated (Front
Tyre	:	4.5 – 10″
Dimensions		
Wheelbase	:	2100 mm
Overall Width	:	1490 mm
Overall Length	:	3315 mm
Overall Height	:	1770 mm
Minimum Ground Clearance	:	220 mm
Cargo Box Dimensions (LxWxH)	:	1830 mm x 1400 mm x 285 mm
Weights		
Gross Vehicle Weight (With Batteries)	:	975 kg
Payload	:	506 kg
Performance		
Top Speed	:	45 km/h
Typical Driving Range (On Road)	:	90 ± 5 kms
Gradeability	:	17 %
Home Charger Type	:	48 V / 3000 W Off-board charge
Charge Duration	:	3 hours, 45 mins

2.8.1.3. Vehicles with IoT Based Monitoring Tool

Gross Vehicle Weight	:	1.2 Ton
Warranty	:	1 Years
Fuel Type	:	Diesel
Material	:	MS
Surface Finish	:	Color Coated
Usage	:	Widely used for collecting garbage
No of Wheels	:	3

2.8.1.4. Portable Refuse Stationary Compactors

Product Description

Truck Mounted Hook Loader for Lifting the Garbage Compactor and unloading the garbage

Estimated Approx. Cost : Rs. 11,50,000/- (Capacity: 10.50 Cubic Meter)

Crane Type : Hook Loader

Max Lifting Capacity : 10-15 ton

Model : HL -16

Jib Length : Telescopic Jib

Capacity : 10 to 16 Ton

Mounting : Vehicle Mounted

Power Source : Hydraulic

Usage/Application : For Lifting Portable Compactor

Portable Refuse Stationary Compactor

Capacity : 10.50 cubic meter

Automatic Grade : Automatic

Cycle time for Crusher : 48 (Second)

Compaction force : 360 (KN)

Minimum Order Quantity : 01

2.8.1.5. Garbage Compactor

Estimated Approx. Cost : Rs. 12,00,000/- (Capacity: 14 Cubic Meter)

Specification of Truck Mounted Garbage Compactor 14 Cu. m capacity

A) MATERIAL FOR BODY

Sl. No	Description	Specification
1	Material	High Strength Steel, Yield Strength, 340 N/Sq. mm – ST5
2	Roof Panelling	4 mm
3	Side Panelling	4 mm
4	Floor Thickness	5 mm
5	Rear Cross Bar Thickness	75 x 40 x 6 mm

B) MATERIAL FOR TAILGATE

Sl. No	Description	Specification
1	Material	Special High Strength steel Min Yield 1200 N/Sq.mm – Hardox 450
2	Side Panelling Thickness	7 mm
3	Rear Side Hopper Plate Thickness	7 mm
4	Hopper Bottom	7 mm
5	Superstructure member thickness	6 mm

C) EJECTOR SYSTEM

Sl. No	Description	Specification
1	Ejector Plate Materials	High Strength Steel, Yield Strength 340 N/Sq. mm – ST 52 with bottom portion from special high strength steel of min. yield 1200N/Sq.mm – Hardox 450
2	Pads	Etalon LFX Bearing

D) HYDRAULIC SYSTEMS

Sl. No	Description	Specification
1	Power Take Off (P.T.O)	Preferably Vehicle Manufacturers
2	Hydraulic pump pressure	Min. 170 kg per CM Square
3	Packer plate Hyd Cylinder stroke	548 mm
4	Packer plate Hyd Cylinder Internal Diameter	100 diameter
5	Tailgate Hyd Cylinder Internal Diameter	70 diameter
6	Tailgate Hyd. Cylinder stroke	726 mm
7	Bin lifter Cylinder internal diameter	80
8	Bin lifter Cylinder stroke	250 mm
9	Carrier plate Cylinder internal diameter	110

10	Carrier Plate Cylinder stroke	670
11	Ejector Cylinder	Telescopic type
12	Ejector Cylinder No. of stages	04
13	Ejector Cylinder internal diameter	140
14	Ejector Cylinder stroke	3455
15	Hydraulic Cylinder	Hyva / Wipro / Dantal Make
16	Hyd. Valve	Dual flow Vane pump
17	Oil Capacity	125 Litres
18	Size of suction filter	140 microns
19	Size return line filter	10 microns
20	Size of Ejector Plate	920 x 1740 x 2000
21	Cycle duration for Bin lifter	25 seconds
22	Duration of Ejection	28 seconds
23	Pump and PTO mounting	Directly coupled without any intermediate shaft

2.8.2. Machineries Specification

2.8.2.1. Organic Waste Shredding Machine



Figure 2.44: Single Shaft Organic Waste Shredder Machine

Shredding Capacity	: 1-500 kg/hr
Shredding Machine Type	: Double Shaft
Automation Grade	: Semi-Automatic
Size	: 1000 x 600 x 1200 mm
Metal Rotary Sieving Machines, Vessel Height	: 1000 mm, 400 mm
Usage/Application	: Industrial
Flow Rate	: 2000-3000 m^3/hr
Vessel Diameter	: 400 mm
Vessel Height	: 1000 mm
Material	: Metal
Automation Grade	: Automatic
Media Quantity	: 100 kg
Frequency	: 50 Hz

2.8.2.2. Platform Weighing Scale



Figure 2.45: Platform Weighing Scale

Material	: S.S Top
Size	: 400 x 400 mm
Capacity	: 100 kg
Type	: Mechanical platform scale, mechanical machine
Accuracy	: 10 g

2.8.2.3. Bagging Machine



Figure 2.46: Bagging Machine

Automatic Grade	: Automatic
Drive Type	: Electric
Voltage	: 400 Volt (v)
Price	: 390000.00 INR (Approx.)

2.8.2.4. Grinder (Pulverizer) Machine



Figure 2.47: Pulverizer Machine

Capacity	: 500 kg/hr
Operation Mode	: Automatic
Electricity Connection	: Single Phase
Motor Power	: 2 HP
Voltage	: 240 V
Frequency	: 50 - 60 Hz

2.8.2.5. Hydrogen Sulphide Scrubber/ Water Scrubber



Figure 2.48: Biogas Scrubber

Type	: H_2S Scrubber
Usage/Application	: Biogas
Capacity	: 3000 m^3/hr
Voltage	: 415 V
Material	: Mild steel
Power	: 180 kW

2.8.2.6. Metallic Rotary Sieving Machine



Figure 2.49: Metal Rotary Sieving Machines

Capacity	: 500 kg/Hr
Flow Rate	: 3000 m^3/hr
Type Of Machine	: Rotary Sieving Machine
Usage/Application	: Industrial
Material	: Metal
Brand	: Vaam Engineering
Frequency	: 50 Hz

2.8.2.7. Windrow Turner



Figure 2.50: Windrow Turner

Width (m)	2.3	2.4	2.5	2.6	3.0
Height (m)	0.6 - 0.8	0.7 - 0.9	0.8 - 1	0.8 - 1.1	0.9 - 1.2
Stack spacing (m)	0.8 - 1	0.8 - 1	0.8 - 1	0.8 - 1	0.8 - 1
Power	R4102-48KW/65HP	R4102-60KW/80HP	R4108-75KW/100HP	4108/75-80 KW/115HP	6105/-110KW/140HP
Biggest speed (r/min)	2200	2400	2400	2200	2200
Rated power speed (r/min)	2200	2200	2200	2200	2200
Driving speed (m/min)	10 - 50	10 - 50	10 - 50	10 - 50	10 - 50
Working speed (m/min)	6-10	6-10	6-10	6-10	6-10
Processing capacity (m^3/ h)	500 - 700	700 ~ 1000	700 ~ 1100	1000 ~ 1200	1000 ~ 1500
Overall size (m)	3.4 x 2.6 x 2.75	3.5 x 2.6 x 2.75	3.6 x 2.6 x 2.8	3.8 x 2.7 x 3.0	4.2 x 2.7 x 3.0

3 NON-BIODEGRADABLE WASTE

Non-biodegradable waste is a type of waste that cannot be broken down into its base compounds by microorganisms, air, moisture or soil in a reasonable amount of time. It includes items like paper, plastic, rubber, leather, Styrofoam, glass and metals etc.

The ideal approach for decreasing non-biodegradable waste is to refuse, reduce, reuse, and recycle.

Refuse - Refuse single use plastics like packaging materials, bags, straws etc. and use alternatives. For e.g. Carry a reusable bag, water bottle, use reusable or returnable containers etc.

Reduce - Reduce means to use less and NOT waste. Reduce the use of harmful, wasteful, and non-recyclable products.

Reuse - Reuse items instead of buying new ones. For every item that can't be refused, reduced, try reusing or repurposing it.

Recycle - Recycling means reprocessing of waste materials for use in new products

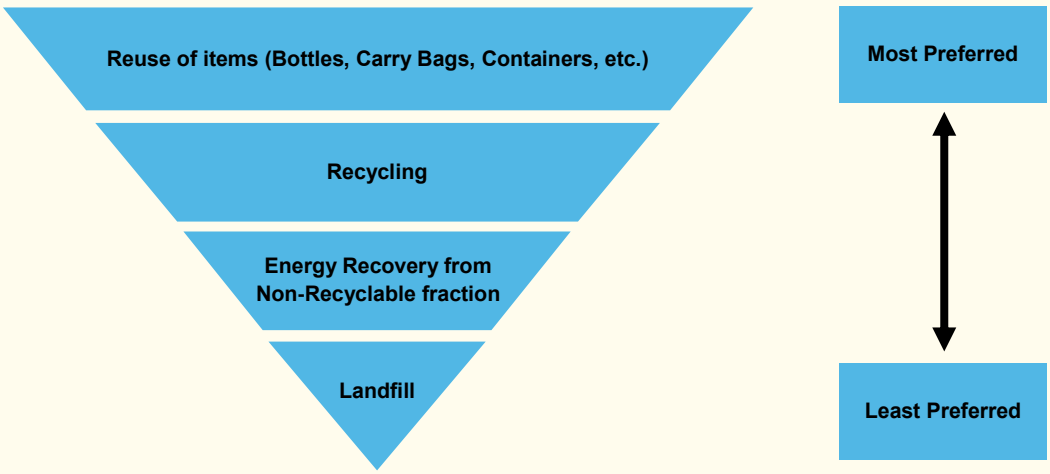


Figure 3.1: Non-biodegradable waste management hierarchy

Problems Caused by Non-biodegradable Waste

- If non-biodegradable waste is left untreated and disposed of improperly, it can deeply affect the environment.
- Leads to uncontrolled landfills that may cause an unhygienic environment, leading to diseases among the people residing nearby.

3.1 NON-BIODEGRADABLE WASTE MANAGEMENT IN KERALA

In Kerala, non-biodegradable waste undergoes separation from bio-waste at its source and is collected either by Haritha Karma Sena or private agencies. It is then transported to Material Recovery Facilities where it undergoes segregation. Following this, the segregated waste is taken by agencies to deliver recyclable materials to recycling units or processing plants, while Reject Waste is directed to cement factories for use as fuel.

3.1.1. Key considerations in planning

Population: An essential aspect to account for in a city's solid waste management planning is the determination of the necessary facilities and their respective spatial requirements, which are determined according to the area's population.

Waste quantification and characterization: Quantifying waste is pivotal, as it directly influences the capacity of the processing facility. This quantification involves multiplying the population by the waste generation rate per capita. Waste characterization analysis is also necessary due to the variability in solid waste composition observed across different locations.

Man power: Adequate staffing must be guaranteed for consistent waste collection from various sources and for the effective sorting of waste at the Material Recovery Facility.

Transportation facility: Adequate transportation facilities are essential to ensure the smooth and timely transportation of collected waste to the processing facility, minimizing any potential delays or the need for interim waste storage along the way.

Interim Storage Facilities: In cases where it is not possible to transport collected waste to the processing facility on the same day as collection, interim storage facilities are necessary to store it safely without environmental impact. These facilities should be strategically planned considering the area's topography, population density, and available transportation infrastructure.

Processing facility: Local authorities need to designate land for the processing facility, ideally situated close to major waste generation sources. Sufficient space and appropriate facilities must be provided to ensure the efficient operation of the processing facility.

Transportation Plan: Local bodies are responsible for developing a comprehensive transportation plan for the efficient management of non-biodegradable waste, ensuring that it is effectively transported from households or mini Material Collection Facilities (MCFs) to central MCFs. This plan should be meticulously designed to optimize the waste collection process and prevent any waste from being left on streets. Key elements of the plan will include determining the appropriate frequency for waste collection from various wards, tailored to the volume and type of waste generated in each area. The plan should specify the type and capacity of vehicles needed for waste collection, such as those equipped with sealed compartments to prevent spillage and contamination. Additionally, the plan should incorporate routing strategies to streamline collection routes, reduce transportation costs, and enhance service efficiency. Real-time tracking and monitoring systems can further improve the management of waste transportation, ensuring that all collected waste reaches the central MCFs in a timely and sanitary manner. By adhering to these guidelines, local bodies can ensure a cleaner urban environment and a more effective waste management system.

Lifting Plan: The lifting plan, developed by forward linkage agencies, is a crucial strategy for managing the efficient transfer of baled plastic wastes and rejects from Material Collection Facilities (MCFs) to recyclers and cement companies. This plan is designed to ensure that the waste is collected and transported in a timely manner, preventing overflows and maintaining the operational efficiency of the MCFs. It should detail the specific frequency of waste collection from each MCF, aligning with the volume of waste generated and the capacity of the facilities. The plan must be formulated to ensure that waste is removed from the MCF before it reaches full capacity, thus avoiding potential issues such as contamination, spillage, or operational disruptions. By implementing a well-coordinated lifting schedule, forward linkage agencies can optimize waste handling processes, minimize environmental impacts, and support the smooth operation of both MCFs and recycling or processing facilities. This proactive approach helps maintain cleanliness at MCFs and ensures that waste is efficiently directed to appropriate end-use applications, such as recycling or cement production, thus contributing to a more effective and sustainable waste management system.

Forward linkages are the connections established with facilities and industries for processing of recyclable waste materials and for co-processing of non-recyclable waste materials.

Necessary authorization: Prior to establishing a processing facility, it is essential to obtain the requisite approvals from the appropriate authorities. For instance, permission must be sought from the State Pollution Control Board if the capacity of the Material Recovery Facility exceeds 5TPD.

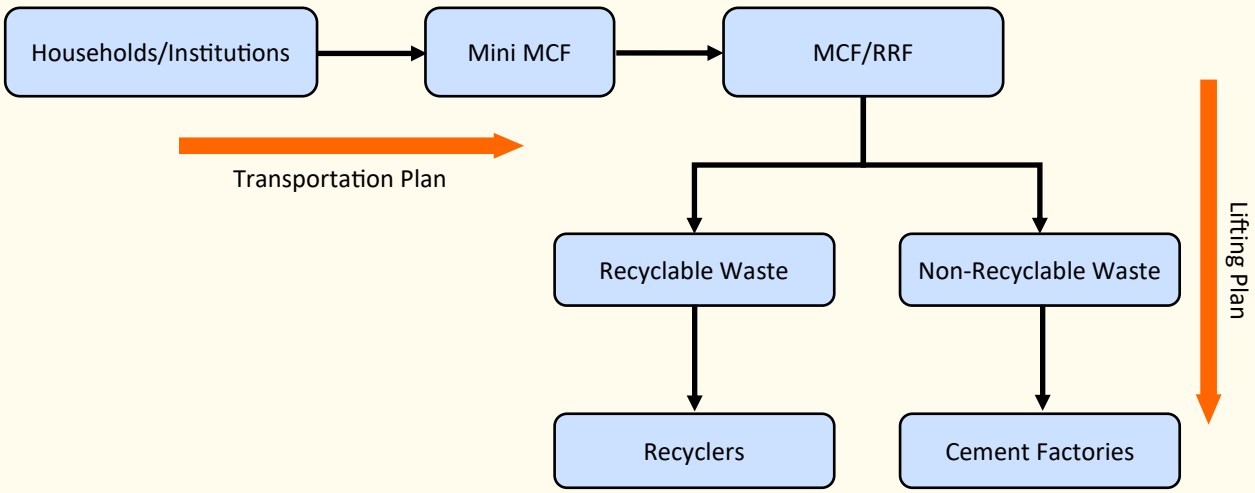


Figure 3.2: Process flow of non-biodegradable waste

3.2 APPLICABLE RULES

- Solid Waste Management Rules, 2016.
- Plastic Waste Management Rules, 2016 and its amendments.
- The fire protection and safety requirements for storage buildings are covered under Chapter-7 of the National Building Code of India published by the Ministry of Housing and Urban Affairs.
- Kerala Municipal/ Panchayat Building Rules, 2019 and its amendments.
- G.O.(Rt)No.113/2021/LSGD dated, 16/01/2021- Regarding fire and safety measures to be adopted in the MCF.
- Circular No. PCB/T4/115/97 dated 2/5/2018 - Pollution Control Board Circular regarding categorization of industries based on pollution potential.

3.3 PROJECTS UNDER NON-BIODEGRADABLE WASTE MANAGEMENT

Non Biowaste management is crucial because it doesn't disappear on its own. It sticks around for hundreds of years, causing harm to the environment, wildlife, and even human health. The notable projects under non-biodegradable waste management are aimed at collecting, sorting, and recycling plastic waste to reduce landfill and environmental pollution. These projects aim to reduce the environmental impact of non-biodegradable waste and promote sustainable waste management practices.

3.3.1. Bottle Collection Booth

- The initiative primarily focuses on establishing designated collection points in strategic locations such as bus stations, tourist spots, pilgrim centers, institutions, and markets for the collection of PET bottles.
- This effort aligns with the government's broader objective of enhancing cleanliness and promoting a plastic-free environment at tourism destinations and major sensitive points across the state.
- By providing accessible and convenient collection points, the initiative aims to discourage the common practice of littering plastic bottles, which often leads to environmental degradation.
- These booths can be customized in terms of design and materials to suit the specific needs and preferences of the facility.
- The entrance of the bottle booth should be narrowly sized, slightly larger than the bottle itself, to deter the disposal of non-bottle waste. A large, lockable opening at the bottom should be provided to facilitate the collection of bottles during clearance.
- It is preferable to place the booth in a monitored location to prevent the surrounding area from becoming cluttered with various types of waste discarded by the public.



Figure 3.3: Bottle Booths

3.3.2. Drop Box

- Drop box is primarily aimed at catering to the transient population in tourist destinations, heritage sites, religious areas, etc., facilitating the collection of segregated waste at designated spots.
- Each drop box will feature multiple compartments equipped with sensors for different materials such as glass, metal, bottles, plastic, paper etc.
- The capacity of drop boxes at specific locations will be determined based on demand.
- These drop boxes can also be positioned at the entrances of Material Recovery Facilities (MCFs), with users charged a fee. This allows households not serviced by the Haritha Karma Sena to dispose of their waste at the drop box.
- An effective monitoring system must be implemented for the facility.



Figure 3.4: Drop Box

3.3.3. Mini MCF

- This serves as a temporary storage facility for non-biodegradable waste gathered from households and institutions by the Haritha Karma Sena before its transfer to the Material Recovery Facility (MCF).
- It is advisable to establish mini MCFs in each ward to streamline material transportation at frequent intervals.
- The capacity of the Mini MCFs shall be determined based on the amount of waste to be stored and the frequency of waste clearance from the facility.
- A Transportation Plan should be devised to link all these Mini MCFs to the Main MCF, with the local body ensuring the proper collection of waste from these Mini MCFs.
- Measures must be taken to prevent waste overflow within the Mini MCFs and discourage dumping of waste around the facility.
- Proper monitoring system shall be ensured for the facilities



Figure 3.5: Mini MCF

3.3.4. Container Mini MCF

- Used shipping containers can be repurposed as Mini MCFs or storage units for segregated wastes like cloth, leather items, metal, e waste etc., as per the Waste Collection Calendar, thus conserving storage space in the MCF.
- They are easy to install and can be positioned in vacant roadside areas. Additionally, they can be relocated if road development projects are underway.
- Due to their ease of installation and potential for relocation, these facilities should be promoted.
- Adequate ventilation and doors will be essential features of these containers to ensure proper air circulation.
- Adequate foundation should be prepared before positioning the container.

Table 3.1: Specifications of 20-Foot and 40-Foot Dry Containers

Dry Container Type	Exterior Dimensions (L x W x H)	Interior Dimensions (L x W x H)	Material	Average Weight
20-Foot Container	20' × 8' × 8' 6"	19' 4" × 7' 9" × 7' 10"	Corrugated Steel (Stainless or Corten steel)	1.8 to 2.2 tons
40-Foot Container	40' × 8' × 8' 6"	39' 6" × 7' 9" × 7' 10"	Corrugated Steel (Stainless or Corten Steel)	3.5 to 4.2 tons



Figure 3.6: Container MCF at Kochi Corporation

3.3.5. Material Collection Facility (MCF)

Non-biodegradable waste gathered via door-to-door collection by the Harithakarmasena is delivered to the Material Collection Facility. Here, the collected waste undergoes cleaning and sorting to achieve more precise categorization, including plastics, paper, metal, textiles, glass, and glass bottles, among others, based on the type of waste. Plastics are further segregated according to their specific types, such as Poly Ethylene Terephthalate (PET), High Density Polyethylene (HDPE), Poly Vinyl Chloride (PVC), Low Density Polyethylene (LDPE), High Molecular HDPE (HM), PolyPropylene (PP), Extended Polystyrene (Thermocol), and miscellaneous items like Multi Layer Plastics (MLP).

As local bodies adhere to a monthly collection calendar for non-recyclable waste, which includes domestic hazardous waste, items such as chappals/shoes, rexine bags, medicinal strips/bottles, unused medicines, syringes and needles, electronic hazardous waste like tube lights, CFLs, broken CDs, picture tubes, unused paint, paint drums, thinners, etc. are sorted into recyclable and non-recyclable waste upon arrival at the MCF.

Subsequently, the segregated wastes are collected from the MCFs by agencies sanctioned by the local authority. Recyclable wastes are then transported to authorized recycling facilities to be transformed into raw materials for the production of new goods, while non-recyclable waste are directed to cement factories for use as fuel.

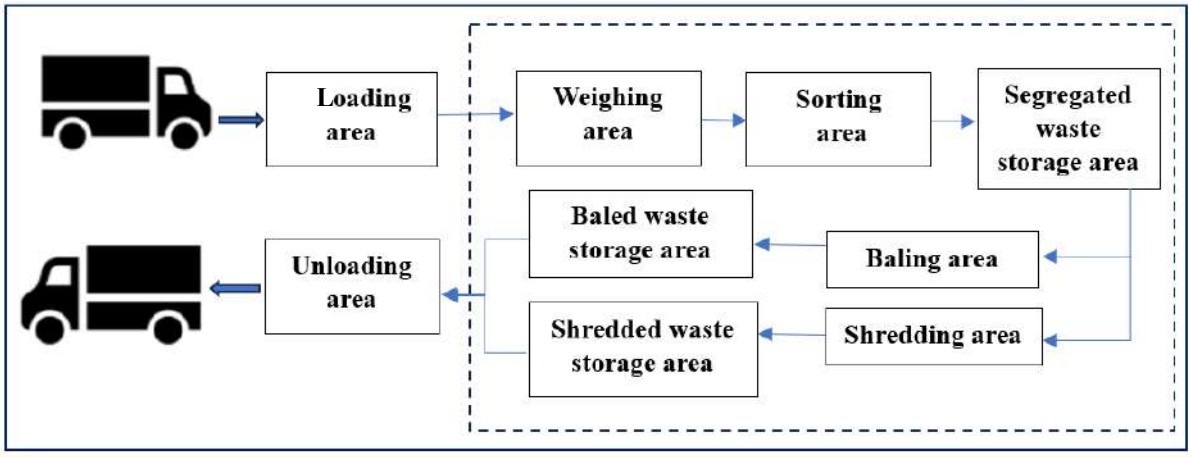


Figure 3.7: Process Flow Chart

3.3.6. Resource Recovery Facility (RRF)

The Solid Waste Management Rules 2016 mention the term Material Recovery Facility (MRF) for the storage, type-based segregation, sorting and recovery of recyclables from various components of waste and forward transfer to the recyclers, co-processing facilities and final disposal sites. The Solid Waste Management Policy 2018 issued by the State Government states that Resource Recovery Facilities will be established in urban region of 20 sq km area or in a cluster of panchayats (say one in each Block Panchayat) for sorting and facilitating reuse and recycling of waste materials including e-waste and domestic hazardous waste.

In practice, Resource Recovery Facilities (RRFs) serve as the third tier of decentralized waste management. Non-biodegradable waste collected by the Haritha Karma Sena (HKS) is initially transported to MCFs, where sorting and segregation based on waste type occur. The segregated waste designated for recycling, non-recyclable combustible waste for co-processing, and lower-quality plastic waste less than 50 microns in size for shredding are then forwarded to the resource recovery facility.

These days, MCFs are also functioning as RRFs since they are equipped with shredding machines, and waste is directly transported from MCFs to processing units, bypassing the need for RRFs. Therefore, the facilities required for RRFs can be considered the same as those in MCFs.

3.3.6.1. Design and Construction of MCF/RRF

- As MCFs/RRFs play a crucial role in the local body's non-biodegradable waste management system, it is vital that they should be properly designed, constructed, and operated to ensure effective waste management.
- The construction of MCFs/RRFs must adhere to the Siting Criteria outlined by the Pollution Control Board (PCB) as per Circular No. PCB/T4/115/97 dated 2/5/2018.
- These facilities should be situated in close proximity to existing roads that are wide enough to accommodate heavy vehicles, including fire engines.
- The size of the MCF/RRF area will be determined based on the volume of waste to be managed and the frequency of waste clearance.
- LSGIs, lacking sufficient space in their existing MCFs/RRFs, must establish additional facilities to fulfill their requirements.
- Adequate height should be provided at the loading and unloading areas.
- The use of a Baling machine must be mandated in all MCFs/RRFs as it enhances waste handling capacity, optimizes area utilization within the facility, and facilitates easy transportation.
- The flooring should be resistant to abrasion and capable of bearing heavy vehicle traffic loads.
- Sufficient ventilation must be ensured through rooftop air ventilation or turbine roof vents.
- The incorporation of a mezzanine floor is recommended for improved space utilization.
- The size of the front door should be determined based on the dimensions of the machinery to be installed in the MCF/RRF and to facilitate easy movement of waste and vehicles, if necessary.

- Strong foundations must be provided to support the machinery.
- Wall-mounted provisions for fixing electrical circuit boards/panels should be incorporated into the building.
- Labels or sign boards for cabins, storage racks, and utility areas are essential.
- Adequate capacity storage cabins/racks should be installed to accommodate segregated waste.
- A drop-in facility for the public to directly deposit non-biodegradable waste at the MCF/RRF should be included.
- If necessary, forklifts for stacking and unstacking baled waste should be provided.
- Proper lighting must be installed inside the facility.
- The building's height should allow for sufficient ventilation.
- Additionally, aesthetics should be considered to ensure the building is visually pleasing.

3.3.6.2. Components of MCF/RRF

- Waste receiving or tipping area: The MCF/RRF should have adequate space to accommodate the incoming waste
- ***Segregation/ sorting area:*** Sufficient area within the facility should be designated for sorting and segregating waste according to its type.
- ***Segregated material storage area:*** Storage area for storing the segregated material.
- ***Space for machineries:*** Space should also be allocated for the installation of machinery such as weighing machines, conveyor belts/sorting tables, baling machines, shredding machines, etc.
- Separate toilet facilities for ladies and gents.
- Dress changing Room
- Rest/ Dining room (Openings shall be given towards outside)
- Store room for tools and equipment's
- Office room
- CCTV having night vision
- Water connection
- Three phase electric connection for machineries

- Compound wall and gate
- Vehicle parking area
- Green belt should be provided on the periphery which should be protected by fences
- Fire fighting facilities as per requirement.

Table 3.2: Components of MCF/RRF

Functional Area	Description
Tipping area	Incoming waste dumping area
Segregated storage	Storage of segregated, unbaled waste
Baled waste storage	Storage space for baled material
Machinery area	Weighing machine + Sorting table/ Conveyor belt + Baling machine + Shredding machine
Utility area	Office space
	Toilets (separate for men and women)
	Store room
	Changing/ Dining/ Restroom
Passage	Area for passage (taken as 20% of total area)
Unloading/ Loading	Vehicle Parking for Unloading/ Loading area (not included in built-up area)

3.3.6.3. Safety Aspects

- 'Fire Protection and Fire Safety Requirements' (Chapter 7) published by MoHUA shall be complied with while designing the MCF/RRF building.
- Fire Risk Assessment/ Fire audit of the facilities shall be conducted at regular intervals. However, the following minimum requirements shall be ensured at MCFs/RRFs

  a) 3 Nos of 6 Kg ABC type fire extinguisher (Dry Chemical Powder).

  b) 3 Nos 4.5 Kg CO_2 type fire extinguisher.

  c) 6 Nos of 9 litre fire buckets filled with sand.

  d) A minimum 1000 litre capacity overhead water tank with pressure pump to be installed for fire emergencies.
- As per Kerala Municipal/ Panchayath Building Rules, MCFs/RRFs can be considered as a storage building (H category) based on the functions.
- LPG or kerosene usage inside the MCF/RRF is strictly prohibited.
- Open burning and smoking are prohibited within the premises.
- Waste clearance must occur at appropriate intervals, to prevent waste accumulation and dumping in the yard.
- The operation of machinery and firefighting equipment should be regularly monitored, and maintenance should be conducted as needed.
- Fire safety sign boards with red backgrounds and white lettering, illuminated by battery lighting, should be installed.
- Fireproof door/window panels and shutters must be provided to prevent fire accidents.
- The use of wooden furniture inside the MCF should be minimized to mitigate fire safety risks.

3.3.6.4. Machineries Required

Table 3.3: Machineries Required

Sl. No.	Items
1	Trolley
2	Sorting Table
3	Conveyor Belt
4	Baling Machine
5	Deduster /Dust Remover
6	Shredding Machine
7	Fork Lift
8	Weighing Machine
9	Turbo Air Ventilator
10	Weigh bridge
11	Fire Extinguisher

3.3.7. Sample Area calculation of MCF/RRF (For reference only)

(a) Calculation of waste generation

Let P be the forecasted population of the LSGI, based on average growth rate of district;

$$P_n = Po[1 + (r/100)]^n$$

where, P_n - population (predicted) after 'n' number of years

Po - last known population

r - population growth rate = (increase in population/initial population) * 100 (%).

n - number of years between Po and P_n

As per SWM policy 2018, per capita waste generation per day = Avg. 300gms

Dry waste generation per person per day = 300 x 18% = 54 gm /day

Total Dry waste generated per day = P_n x 54 gm/day

Total Dry waste generated per day in Kg (W) = 1.15* x (P_n x 54)/1000

*An additional 15% will be included for floating population and commercial establishments.

Let, waste clearance frequency be **15 days***.

(*frequency of waste clearance from MCF and density of waste may vary based on the nature of waste and facilities available at concerned LSGIs)

Therefore the Waste that can be handled in MCF (W_7) = 15 x W

(b) Calculation of Area of MCF/RRF

1) Area required for stacking of incoming waste (A_1)

The area required for stacking of incoming waste is based on a 100 kg/m³ density, 1.5 m stacking height, and a waste quantity for 2 days. The formula for calculating the area is:

A_1 = Waste quantity for 2 days/ (Stacking height x Density)

= 2400kg/(1.5m x 100Kg/m^3) = 16m^2

2) Area required for segregation and processing, including machinery area (A_2)

This area is provided for machinery such as the weighing machine, conveyor belt, baling machine, deduster, and forklift. Based on the space required for this machinery,

A_2 = 39m^2

3) Area required for storage of segregated unbaled waste (A_3)

The area required for unbaled waste storage is calculated similarly to the incoming waste, using a 100 kg/m³ density and 1 m stacking height. Assume the waste quantity for 2 days is 2400 kg

A_3 = Volume of waste/ (Stacking height x Density)

$$\mathbf{A_3} = 2400\text{kg}/ (100\text{kg/m}^3 \times 1\text{m}) = 24\text{m}^2$$

4) Based on the baling machine specifications, the density of baled waste is assumed to be 250 kg/m³.

5) Volume of baled waste produced (V)

The volume of baled waste is calculated as:

$$V = \text{Total waste to be baled}/ \text{Density of baled waste}$$

Assuming that the total waste to be baled is 18,135 kg as per projected population

$$V = (18.134 \times 1000)/250 = 72.54\text{m}^3$$

6) Area required for storage of baled waste (A_4)

The area for baled waste is calculated using the stacking height and the volume (V) from the previous step. The formula is:

$$\mathbf{A_4} = V/\text{Stacking height}$$

Assuming a 2 m stacking height with the help of a forklift ,

$$\mathbf{A_4} = 72.54\text{m}^3/2\text{m} = 36.27\text{m}^2$$

7) Area for Passage (A_5)

The area for movement and passage within the MCF is generally assumed to be 20% of the processing area. The processing area includes A_1, A_2, and A_3:

$$\mathbf{A_5} = 20\% \times (A_1+A_2+A_3+A_4)$$
$$= 0.20 \times (16+39+24+36.37)$$
$$= 23\text{m}^2$$

8) Area required for utilities (A_6)

The area required for utilities such as office rooms, dining/rest rooms, toilets, and personal item store is fixed at, $\mathbf{A_6} = 25\ \text{m}^2$

Total area required for MCF, $A = A_1 + A_2 + A_3 + A_4 + A_5 + A_6$

$$= 16+39+24+36.27+23+25 = \mathbf{163m^2}$$

$\mathbf{A_1}$ = Area required for stacking of incoming waste

$\mathbf{A_2}$ = Area required for segregation and processing (including machinery area)

$\mathbf{A_3}$ = Area required for storage of segregated unbaled waste

$\mathbf{A_4}$ = Area required for storage of baled waste

$\mathbf{A_5}$ = Area for passage

$\mathbf{A_6}$ = Area required for utilities (office, dining/rest room, toilets, store, etc.)

Note: For ease of calculation, an Excel-based tool is available on our website. This tool allows users to input variables such as waste quantity, stacking height, and density to automatically calculate the required areas for stacking, machinery, and storage.

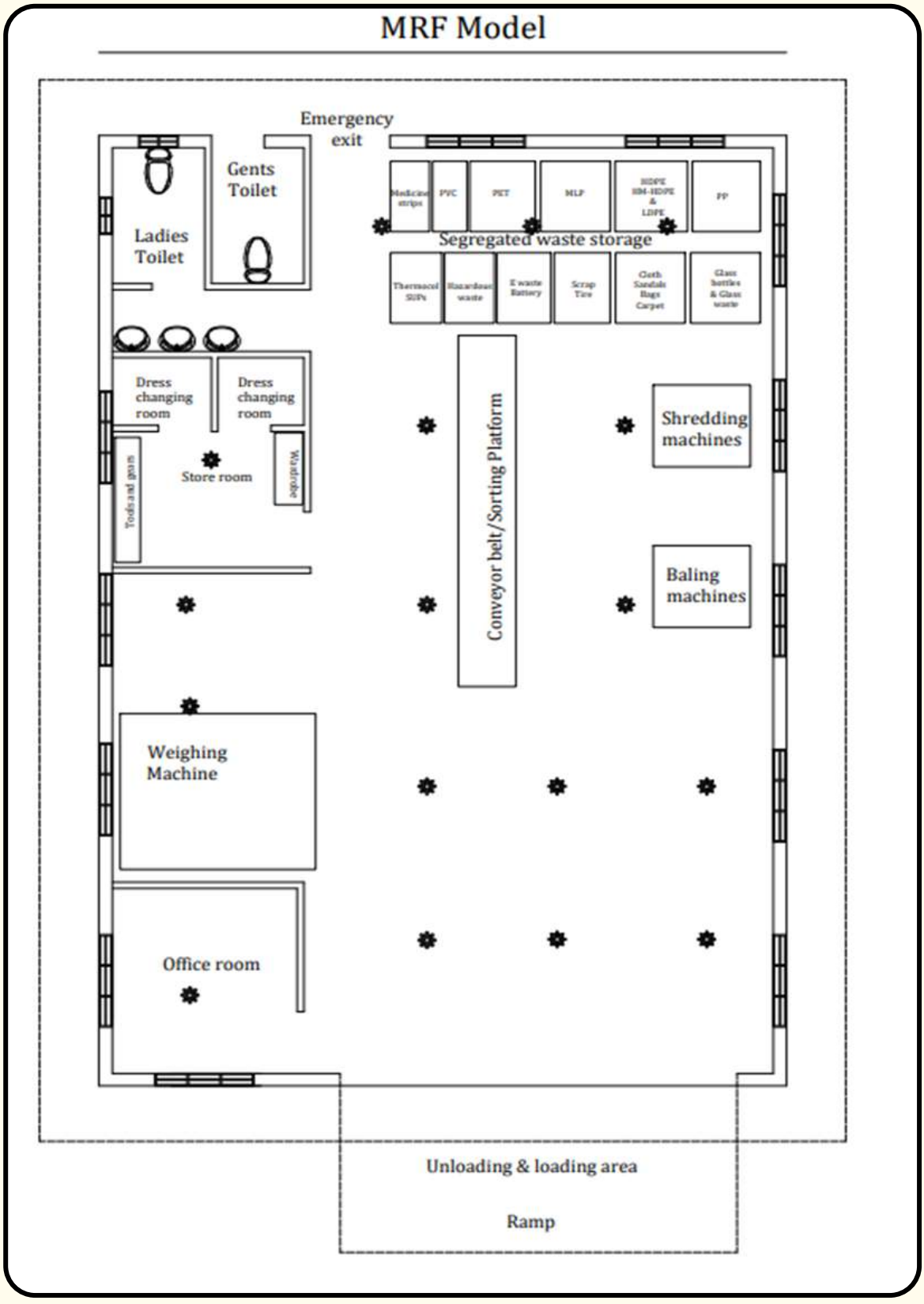


Figure 3.8: Conceptual Layout of MRF



Figure 3.9: Conceptual Front View of MCF/RRF



Figure 3.10: Conceptual Inside View of MCF/RRF



Figure 3.11: Conceptual Layout of MCF/RRF

3.3.8. Green Facilitation Centre (GFC)

The Green Facility Center (GFC) is designed to serve as a communal space offering the public access to various waste management devices, products, alternatives to plastic bags, inoculum, recycled products, and a wide range of waste management-related services.

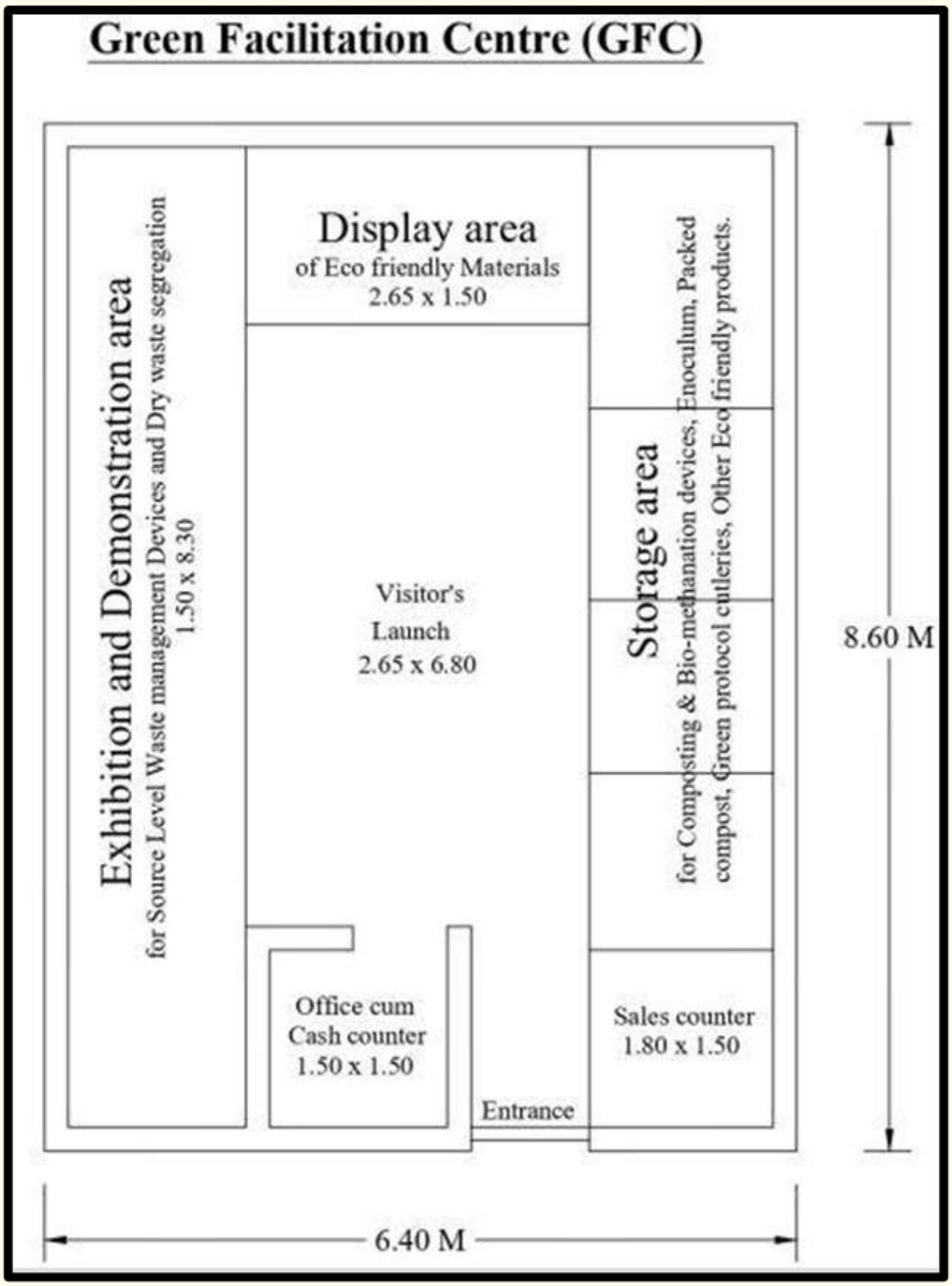


Figure 3.12: Layout of GFC

3.4 UPCYCLING UNITS

Upcycling, also known as creative reuse, involves the transformation of by-products, waste materials, or unwanted products into new materials or products perceived to have greater quality, such as artistic or environmental value.

- This process contributes to achieving three of the 5Rs: Reduce, Repurpose, and Reuse.
- It represents a creative and innovative approach to revitalizing old or unwanted products and materials by adding value to them.
- By refurbishing or repurposing materials or products to create something of higher quality or value, upcycling gives old or unwanted materials a second life, thereby reducing pollution and waste.
- Upcycling can be carried out at MCF or RRF

Local bodies can establish upcycling units in collaboration with Kudumbasree to generate income for workers and reduce the amount of waste that needs to be managed. Additionally, the local body and Kudumbasree can jointly establish a local marketing facility to promote and sell the upcycled products.

3.4.1. Materials that can be upcycled

- Plastic
- Glass
- Industrial waste
- Clothing and textiles
- Aluminium
- Cardboard and paper
- Wood
- Rubber

3.4.2. Upcycling Ideas

3.4.2.1. Clothing & Textiles

Clothing and textiles leave a significant environmental footprint due to the extensive energy, water, and polluting chemicals required for their production. The rise of fast fashion, characterized by inexpensive and trendy clothing, contributes to the generation of a substantial amount of clothing and textile waste. Disposing of old or unwanted clothes or textiles is harmful to the environment, particularly because the supply chain often lacks ethical practices. Upcycling clothing and textiles offers significant environmental benefits, as it allows for the reuse and transformation of these materials into new and valuable products, thereby reducing

waste and lessening the strain on environmental resources.



Figure 3.13: Upcycling of clothes

3.4.2.2. Furniture

Furniture typically has a long lifespan, but various factors can shorten it, such as relocation or the desire for new pieces. Many individuals opt to purchase new furniture because they feel their current pieces no longer suit their decor or are considered outdated. However, rather than buying new furniture, it can be upcycled with ease.



Figure 3.14: Upcycling of furniture

3.4.2.3. Common Household Items

Many common household items, including cardboard, paper, aluminum, plastic, and glass, are recyclable. However, they can also undergo upcycling to extend their lifespan. Through upcycling, these products can be creatively repurposed and enhanced, providing economical and innovative solutions.



Figure 3.15: Upcycled Common Household Items

3.4.2.4. SWAP & Repair Shops

- Swap shop is a simple public platform or outlet where reusable products are not of use for one individual family can be considered and given to another or exchanged.
- Swap shop will be an open platform for the public like a barter system or a free exchange that builds up social relationships.
- Repair shops in waste management are places where broken or damaged items are repaired and reused instead of being discarded.
- Repairing items is a great way to reduce waste and save money.
- Swap shops and repair shops can be set up at the same place where the damaged products are repaired and can be sold or exchanged at the same place. In swap, shops a nominal amount can be charged from the customer for the item sold.



Figure 3.16: Swap Shop

3.5 RECYCLING UNITS

Recycling involves collecting and processing materials that would otherwise be discarded as trash, transforming them into new products. This practice offers numerous benefits to communities, economies, and the environment. It's essential to prioritize recycling for materials that cannot be reduced or reused. Recycling contributes significantly to environmental preservation by decreasing the demand for natural resources needed for manufacturing new products. Additionally, recycling helps conserve energy, making it a vital component of sustainable living.

To recycle the waste collected by local bodies, plants can be established in a Public-Private Partnership (PPP) model. Alternatively, the segregated waste can be directly provided to existing recycling plants in the private sector on a tipping fee basis. This approach allows for the efficient management of waste while leveraging the expertise and resources of both the public and private sectors.

3.5.1. Plastic Recycling

Plastic is a widely used and valuable material in modern society, emphasizing the importance of maximizing its lifespan. Reusing and recycling plastics as much as possible can reduce the necessity to produce new plastic items. Plastic recycling involves converting plastic waste into new products, offering numerous benefits such as reducing reliance on landfills, conserving resources, and safeguarding the environment from plastic pollution and greenhouse gas emissions.

The majority of plastic recycling is mechanical, involving melting and reshaping plastic into alternative items. However, this process may lead to molecular-level polymer degradation. Additionally, plastic waste must be sorted by colour and polymer type before processing, which can be complex and costly. After sorting, the plastic undergoes washing, shredding, and further sorting at a reprocessing facility. Eventually, the plastic is melted and extruded into new

new recycled plastic pellets.

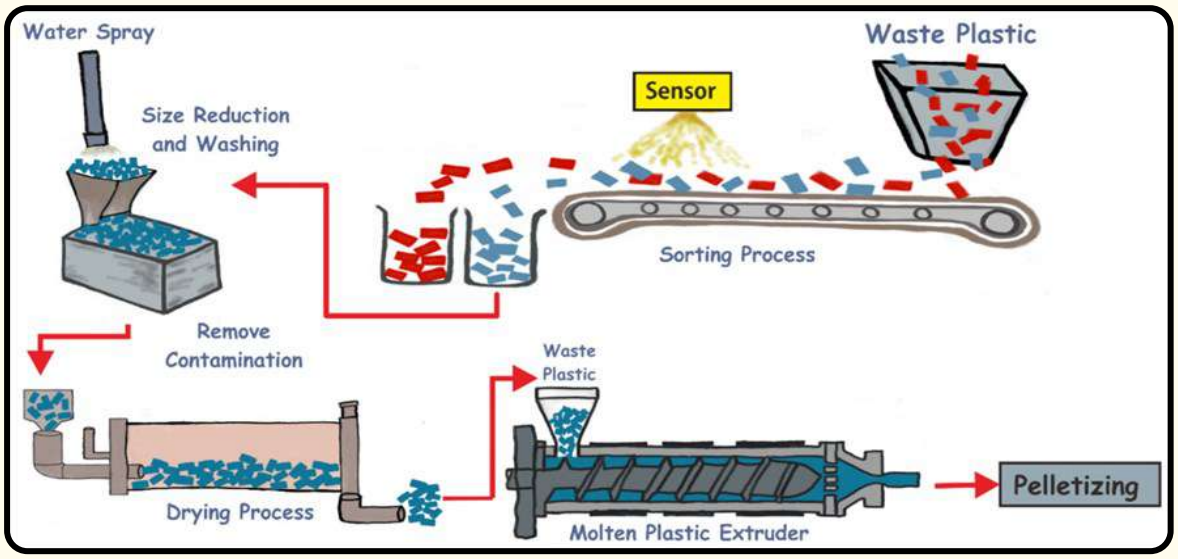


Figure 3.17: Plastic pelletization process

Indeed, there are various innovative technologies utilized for reusing plastics beyond traditional recycling methods:

Depolymerization: This process breaks down plastic into its original monomers, which can then be used to create new plastic products or other chemicals.

Plasma Pyrolysis Technology: Plasma pyrolysis involves using high-energy plasma to break down plastics into simpler molecules, which can be further processed into fuels or other chemicals.

Road Construction: Certain types of plastics, particularly single-use plastics, can be incorporated into asphalt mixes for road construction, improving road durability and reducing plastic waste.

Pavement Blocks: Plastics can be transformed into durable pavement blocks, offering a sustainable alternative to traditional concrete or clay bricks.

These technologies offer promising avenues for reusing plastics and reducing their environmental impact. Each method has its unique advantages and challenges, and their adoption depends on factors such as local infrastructure, regulations, and market demand.

3.5.2. Paper Recycling

Paper recycling is the method through which waste paper is transformed into new paper products. This process generally involves mixing used or old paper with water and chemicals to break it down. The mixture is then chopped up and heated, further breaking it down into strands of cellulose, an organic plant material, forming what is known as pulp or slurry. The pulp is strained through screens to remove any remaining plastic, especially from plastic-coated paper. Next, the pulp is cleaned, de-inked to remove ink, bleached, and mixed with

water before being shaped into new recycled paper products.

3.5.3 Metal Scrap Recycling

Metal scrap recycling is a well-established business sector. Metals like iron, steel, aluminium and copper are highly recyclable and have good market value. In the recycling process, the sorting ensures that different types of metals, such as brass, steel, and aluminum, are appropriately segregated into separate piles. After sorting, the scrap metals undergo shredding into smaller pieces, facilitating easier melting. This crucial step reduces the time required for melting and results in fewer emissions during the burning process, thus enhancing the eco-friendliness of recycling. The shredding process produces small scraps of metal, which are then conveyed into a high-temperature furnace for melting. Depending on the metal's melting point, this process can take anywhere from a few minutes to several hours. The intense heat eventually transforms the metal scraps into molten metal, which can be easily molded into new products.

3.5.4. Glass Recycling

Glass is 100% recyclable and can be used to make new bottles, jars, or other glass products. Starting a glass recycling business involves collecting glass bottles from various sources and processing them into cullet (crushed glass). Cullet is then sold to glass manufacturers who use it as raw material. With the increasing emphasis on reducing single-use plastic bottles, the demand for recycled glass is expected to rise.

3.6 MACHINERIES AND EQUIPMENT REQUIRED IN MCF/RRF

3.6.1. Baling Machine

Table 3.5: Specifications of Baling Machine

SL. NO	PARTICULARS	DESCRIPTIONS
1	Automation Grade	Automatic
2	Capacity	25 tonnes
3	Cylinder	Single Cylinder 140mm x 80mm @3000 psi
4	Oil Tank Capacity	250 litres
5	Bale Size	600mm x 600mm x 600-900mm
6	Chamber Size	600mm x 600mm x 1500mm
7	Bale Weight	50-75 kg

8	Cycle Time	10-15 min per bale
9	Power	5-10 HP
10	Controls	Push Button Operated, Electrically Controlled
11	Production Capacity	1000-1500kg/8 hr. shift
12	Feed Type	PET, HDPE, LDPE, MLP, Paper, Clothes, Bag, Chappal
13	Bale Ejection (Preferable)	By opening the front door and operating bottom plate
14	Hydraulics Safety	Hydraulic relief valves are provided against overloads
15	Electrical Safety	Overload switches are provided against overloads
16	Surface Finish (Preferable)	Powder Coated
17	Operation (preferable)	Control Panel
18	Manuals	Soft and hard copies
APPROXIMATE COST		**Rs. 5,30,000/-**



Figure 3.18: Baling Machine

3.6.2. Shredding Machine

Table 3.6: Specifications of Shredding Machine

SL. NO	PARTICULARS	DESCRIPTIONS
1	Capacity	1000 kg in 8 hours
2	Size of the shredded plastic	0.6-2.36 mm (As per IRC SP:98-2013 standard)
3	Feeding hopper	Fully insulated
4	Motor capacity	15 HP -20 HP
5	Motor	Make: ABB/SIEMENS/SCHNEIDER Flame proof, Efficiency of motor should comply with IE-3 rating conforming to IEC 60034-30 standard and nameplate to be provided confirming to IS 12615-2011
6	Control panel	Suitable size of contactor, overload relay, control & power fuses, Power & Control terminals, start / stop push buttons with lock facility & ammeter to match the motor size & rating
7	Other Features	• Bearing should be from reputed brands such as NTN/SKF • Noise control features • Easy adjustment of blades • Energy Efficient
8	Manuals	Soft and hard copies
9	Blade grinding machine	2 HP
10	Weighing Machine	Electronic Operated
APPROXIMATE COST		**Rs. 8,50,000/-**



Figure 3.19: Shredding Machine

3.6.3. Dust Remover

Table 3.7: Specifications of Dust Remover

SL. NO	PARTICULARS	DESCRIPTIONS
1	Drum diameter	915 mm (perforated casting)
2	Drum length	2100 mm
3	Drum cover diameter	1200 mm
4	Machine output	120 – 200 kg/hr
5	Rotor	Dynamically balanced
6	Rotor type	Blender cum impactor
7	Main motor	15 HP, 1440 rpm
8	Overall machine size (indicative	1200 X 2550 X 1350 mm
9	Machine frame	Heavy framed structure
10	Weighing Machine	Electronic Operated
APPROXIMATE COST		**Rs. 2,40,000/-**



Figure 3.20: Dust Remover

3.6.4. Conveyor Belt

Table 3.8: Specifications of Conveyor Belt

SL. NO	PARTICULARS	DESCRIPTIONS
1	Conveyor Length:	20 feet
2	Belt	900mm*5mm thickness PVC Belt
3	Motor	2 HP
4	Capacity	500 Kg per hour
5	Belt speed	**5 ft/min to 30 ft/min**
6	Head Roller	Dia 165 mm MS Pipe
7	Gear:	Worm gear with speed reduction
8	Control Panel:	Powder coated with on / off control
9	Color	Green / black
10	Weighing Machine	Electronic Operated
APPROXIMATE COST		**Rs. 700000 + GST**



Figure 3.21: Conveyor Belt

3.6.5. Platform Trolley

Table 3.9: Specifications of Platform Trolley

SL. NO	PARTICULARS	DESCRIPTIONS
1	Foldability of Handle	No
2	Type of Wheel Movement	Front Fixed & Rear Swivel Castors
3	Warranty, Years	1
4	Load carrying capacity (kg)	50-100
5	Handle	Yes
6	Availability of Railing above the Shelves	No
7	Weight of Trolley	10 kilogram
8	Numbers Of Wheels	4
9	Width, cm	30-40
10	Finishing of surface edge	Free from sharp edges and rounded edge/corner
11	Gauge of Frame	10
12	Caster Material	Plastic
13	Caster Diameter	3 Inch
14	Powder Coating on Metallic Frame	Yes

15	Material Grade	SS202
16	Gauge of Sheet	14
17	Height, cm	40-50
18	Quality of Paint on the Trolley must be in accordance with latest IS for paints	Yes
9	Foot Brake facilities	No
10	Length, cm	50-60
APPROXIMATE COST		**Rs. 5000 + GST**



Figure 3.22: Platform Trolley

3.6.6. Sorting Table

Table 3.10: Specifications of Sorting Table

SL. NO	PARTICULARS	DESCRIPTIONS
1	Material	Stainless Steel
2	Color	Silver
3	Edge Type	Rounded
4	Condition	New
5	Material grade	SS 304
6	Surface	Powder coated
7	Size	6x3 feet (As per requirement)

8	Other Features	• Aesthetic design • Rugged construction • Excellent performance • Low maintenance • Resistant to corrosion • High tensile strength • Dimensional accuracy • Superior finish
9	Warranty	1 Year
APPROXIMATE COST		**Rs. 45000 + GST**



Figure 3.23: Sorting Table

3.6.7. Fork Lift

Table 3.11: Specifications of Fork Lift

SL. NO	PARTICULARS	DESCRIPTIONS
1	Length To Fork Face	8.4ft in.
2	Overall Width.	3.8ft in.
3	Overall Height	7.12ft in.
4	Wheelbase	5.33ft in.
5	Ground Clearance	6.3in.
6	Height To Top Of Overhead Guard	7.09ft in.
7	Max Fork Height	10.81ft in.
8	Turning Radius	7.06ft in.
9	Lifting Height	3200- 4000 mm
APPROXIMATE COST		**Rs. 8,00,000 + GST**



Figure 3.24: Fork Lift

3.6.8. Weighing Machine

Table 3.12: Specifications of Weighing Machine

SL. NO	PARTICULARS	DESCRIPTIONS
1	Weighing Capacity	5 kg to 1000 kg
2	Accuracy	100 Grams
3	Minimum Weighing Capacity	200 grams
4	Platform Size	Minimum 1000 mm x 1000 mm, Height minimum 50 mm
5	Dimensions	1050*1030 mm
6	Display Type	Digital
7	Scale body Material	Mild Steel Rust Proof Powder Coated
8	Weight of Machine	Maximum 45 Kilograms
9	Power supply	230 V AC +-10%, 50 Hz
10	Power Consumption	10 Watt
11	Powered By	Mains and Battery
12	Battery Back up	In Built upto 40 Hours
13	Battery Type	Rechargeable
14	Warranty	1 Year
15	Warranty Type	Service Warranty
APPROXIMATE COST		**Rs. 55,000 + GST**



Figure 3.25: Weighing Machine

3.6.9. Handheld Weighing Scale

Table 3.13: Specifications of Handheld Weighing Scale

SL. NO	PARTICULARS	DESCRIPTIONS
1	Maximum Weighing Capacity	Up to 100 Kg
2	Accuracy	10 Grams
3	Minimum Weighing Capacity	50 grams
4	Display	Red double side display
5	Modes	Liter and Piece Counting
6	Overload Protection	Mandatory
7	Operating temperature	0 to 50^0 C
8	Powered By	Mains and Battery
9	Battery Backup	In Built up to 40 Hours
10	Battery Type	Rechargeable
11	Warranty	1 Year
12	Warranty Type	Service Warranty
APPROXIMATE COST		**Rs. 9,000 + GST**



Figure 3.26: Handheld Weighing Scale

3.6.10. Turbo Air Ventilator

Table 3.14: Specifications of Turbo Air Ventilator

SL. NO	PARTICULARS	DESCRIPTIONS
1	Material	Stainless Steel
2	Material Grade	SS316
3	Air Volume	298-1100 m3/h
4	Diameter	24 inch
5	Floor Area Covered	500 Sq. Ft
6	Minimum no. required	2
APPROXIMATE COST		**Rs. 5000+ GST**



Figure 3.27: Turbo Air Ventilator

3.6.11 Weigh Bridge

Table 3.15: Specifications of Weigh Bridge

SL. NO	PARTICULARS	DESCRIPTIONS
1	Structure	Electronic Scale
2	Display Type	LCD
3	Sensor	Digital Scale
4	Installation	Weighbridge
5	Automation	Automation
6	Weighing Method	Static Truck Scale
APPROXIMATE COST		**Rs. 20 to 25 lakhs plus GST**



Figure 3.28: Weigh Bridge

3.6.12. CCTV with Night Vision Mode



Figure 3.29: CCTV with Night Vision Mode

Table 3.16: *CCTV with Night Vision Mode* (Specification 1)

SPECIFICATION 1		
SL. NO	**PARTICULARS**	**DESCRIPTIONS**
1	Electronic Shutter	1s to 1/1,00,000 s
2	Minimum Illumination Color mode	0.001 lux @ F1.6 or better
3	B/W	0 lux with IR illumination on
4	S/N Ratio	≥ 55 dB
5	Auto Adjustment + Remote Control of Image settings	Brightness, Sharpness, Contrast, Saturation, Hue, White Balance, Exposure Control, Backlight Compensation, Gain Control, 3DNR, HLC, Defog, EIS, Scheduled Profile Settings, Video Title and Time Stamp Overlay
6	Wide Dynamic Range	True WDR 120 db or better
7	Day/Night Mode	With IR Cut Filter
8	IR Cut Filter	Automatically Removable IR-cut filter
APPROXIMATE COST		**Rs. 1,00,000 + GST**

Table 3.17: *CCTV with Night Vision Mode* (Specification 2)

SPECIFICATION 2		
SL. NO	**PARTICULARS**	**DESCRIPTIONS**
1	5MP Bullet IP Camera with 2.7~13.5mm	Motorized Lens or higher
2	Video Compression	H.265+/ H.265/ H.264
3	Video Resolution & Streams	At least 2 streams, one stream with 2592x1944 or better and another at HD (1920 x 1080) resolution
4	Frame Rate	2592x1944 >= 15FPS & 1920x1080 @ 25/30FPS
5	Image Sensor	1/2.8" Progressive scan CMOS or better
6	Lens Type	Varifocal Motorized with Remote Focus & Zoom
7	Lens	2.7~13.5mm
APPROXIMATE COST		**Rs. 1,00,000 + GST**

Table 3.18: *CCTV with Night Vision Mode* (Specification 3)

SPECIFICATION 3		
SL. NO	**PARTICULARS**	**DESCRIPTIONS**
1	Local Storage	Provision for SD Card / NVME / EMMC storage should be there
2	Audio	Full duplex, line in and line out, G.711/ G.726, External microphone input, External line output, Built-in Mic
3	Protocol	IPv4, IPv6, HTTP, TCP/IP,UDP/IP, DHCP, NTP/SNTP, RTSP, DNS, DDNS, FTP, UPnP, ONVIF Profile S, G&T
4	Security	User Authentication, IP Address Filtering, RTSP Authentication & RTSP over SSL (RTSPS)
5	Alarm	I/O Minimum 1 Input & 1 Output contact for 3rd party interface
6	Operating Conditions	-20 °C ~ 60 °C
7	Network Interface	RJ 45, 100 Base TX
APPROXIMATE COST		**Rs. 1,00,000 + GST**

Table 3.19: *CCTV with Night Vision Mode* (Specification 4)

SPECIFICATION 4		
SL. NO	**PARTICULARS**	**DESCRIPTIONS**
1	Local Storage	Provision for SD Card / NVME / EMMC storage should be there
2	Audio	Full duplex, line in and line out, G.711/ G.726, External microphone input, External line output, Built-in Mic
3	Protocol	IPv4, IPv6, HTTP, TCP/IP,UDP/IP, DHCP, NTP/SNTP, RTSP, DNS, DDNS, FTP, UPnP, ONVIF Profile S, G&T
4	Security	User Authentication, IP Address Filtering, RTSP Authentication & RTSP over SSL (RTSPS)
5	Alarm	I/O Minimum 1 Input & 1 Output contact for 3rd party interface
6	Operating Conditions	-20 °C ~ 60 °C
7	Network Interface	RJ 45, 100 Base TX
APPROXIMATE COST		**Rs. 1,00,000 + GST**

Table 3.20: *CCTV with Night Vision Mode* (Specification 5)

SPECIFICATION 5		
SL. NO	**PARTICULARS**	**DESCRIPTIONS**
1	Casing	IP66/IP67, IK10, NEMA 4X or higher
2	Power	PoE IEEE 802.3af/ PoE+ IEEE 802.3at and 12VDC/24AC/24VDC
3	Certification	CE, FCC, RoHS, BIS, IP66/67
4	General Security	OEM of the camera should not be blacklisted in India or anywhere globally for security reasons from any organization including ONVIF.
5	IR Illuminator	Internal IR Illuminator with range of 60 meters based upon requirement of site/focus/area of interest.
6	Humidity	10-95% RH (Condensing)
APPROXIMATE COST		**Rs. 1,00,000 + GST**

3.7 VEHICLES

3.7.1. Tricycle with Containers

Table 3.21: Specification of Tricycle with Containers

SL. NO	PARTICULARS	DESCRIPTIONS
1	Usage	For garbage carrying
2	Height	18 inch
3	Size	3 Wheel
4	Material	MS, Plastic
5	Capacity	4 to 6 containers with 40 to 60 liters capacity
APPROXIMATE COST		**Rs. 25,000 + GST**



Figure 3.30: Tricycle with Containers

3.7.2. E- Auto

Table 3.22: Specifications of E-Auto

SL. NO	PARTICULARS	DESCRIPTIONS
1	Variant	Pickup
2	Vehicle Category	L5N
3	Vehicle roof type	Hand Panel
4	Payload – Kg	550
5	Dimensions - Length x Width x Height - mm	3100 x 1460 x 1762
6	Turning Radius - m	3.05
7	Vehicle Kerb Weight - Kg	445
8	Vehicle GWW - Kg	995
9	Gradeability - Degree	7
10	Battery Type, Voltage - V	Lithium-ion 48 V
11	Battery Capacity (Installed) - Kwh	737
12	Charging Time at Standard Conditions	3 Hr 50 Min
APPROXIMATE COST		**Rs. 4,00,000 + GST**





Figure 3.31: E- Auto

3.7.3. Light Motor Vehicle (Mini Truck) with Hydraulic Tipping Containers

Table 3.23: Specifications of Light Motor Vehicle

SL. NO	PARTICULARS	DESCRIPTIONS
1	Max Speed	10- 70 Km/H
2	Model	QEE TP
3	Truck Type	Tipper
4	Material	MS
5	Volume	1000 - 3000L
APPROXIMATE COST		**Rs. 7,00,000 + GST**



Figure 3.32: Mini Truck

3.7.4. Refuse Compactor

Table 3.24: Specifications of Refuse Compactor

SL. NO	PARTICULARS	DESCRIPTIONS
1	Collection Hopper	14 Cum Volumetric capacity
2	Structure	ISMC 100 x 50 MM Channel
3	Material	Mild Steel Plates of IS 2062 GRADE
APPROXIMATE COST		**Rs. 45,00,000 + GST**



Figure 3.33: Refuse Compactor

3.8 OTHER WASTE MANAGEMENT TECHNOLOGIES

3.8.1. Mechanized Road Sweepers

Road sweeping is essential to keep our streets clean and reduce the accumulation of various materials on road surfaces. Regular sweeping helps minimize the amount of debris entering stormwater systems, thereby reducing the risk of localized flooding, especially during periods of heavy rainfall. By keeping roads debris-free, street sweeping plays a crucial role in preventing accidents and slip-and-fall incidents. Removing loose debris, gravel, and litter helps maintain proper traction, thereby preventing hazardous conditions that could lead to accidents.

Urban local bodies face challenges in maintaining cleaner and safer roads, particularly concerning the accumulation of fine sands near the center median and road sides. This accumulation poses a significant threat to two-wheeler riders who must navigate through it with extra caution. Manual sweeping of these sand mounds by conservancy workers is insufficient, as constant vehicle movement often redistributes the sand back onto the road, making it difficult for motorists, especially two-wheeler riders, to maintain balance.

Truck-mounted sweepers, also known as City Sweepers, offer an effective solution to this challenge faced by Municipal Corporations. These sweeping units, mounted onto trucks, are equipped with auxiliary engines to control their functions. They provide efficient sweeping of roads, ensuring cleaner and safer conditions for motorists to commute



Figure 3.34: Mechanized Road Sweepers

3.8.2. Mechanized Beach Sweepers

Most of the beaches in Kerala is facing serious threats posed by the large amount of waste deposited on the shore day by day. The macro and micro plastic pollution in oceans, often referred to as microplastics, is a growing environmental concern. As an effective solution that can eradicate this issue, beach cleaning machines can be brought in place. This is a German-made surf rake machine that costs more than 30 lakhs. A tractor that costs more than 8 lakhs was also introduced which is essential for the working of the beach cleaning surf rack machine. Using the surf rack machine system, the soil is scooped up to a depth of 30 cm from the surface passed through a special screen in the machine, and sieved. In this way, the sand is cleaned and is deposited back on to the beach and the waste is deposited in a special chamber in the surf rake. These will be deposited and disposed of in the specified area.

Table 3.25: Specifications of Mechanized Beach Cleaning Machine

Vehicle length	3,302 mm
Vehicle Width	1,753 mm
Vehicle Height	1,702 mm
Operating Width	1,219 mm
Operating Depth	Up to 10 cm
Hopper Capacity	0.4 m^3
Cleaning Speed	Up to 7 km/h
Hopper Dump Type	Hydraulic
Hopper Dump Height	1,524 mm
Tractor Requirements	30-45 HP, 3 point hitch and 540 PTO



Figure 3.35: Beach Cleaning Machine of Kollam Municipal Corporation

4 ELECTRONIC WASTE

E-waste, or electronic waste, refers to discarded electrical or electronic devices such as computers, mobile phones, televisions, printers, refrigerators, and other gadgets that have reached the end of their useful life. These devices often contain valuable components such as gold, silver, and copper as well as hazardous materials like lead, mercury, cadmium, and brominated flame retardants, which can be harmful if improperly managed.

This chapter describes the systematic and scientific management of E-waste. The objectives of e-waste management includes :

1. **Prevent environmental pollution:** Proper recycling and disposal reduce the release of toxic substances into the air, soil, and water, protecting ecosystems.
2. **Safeguard human health:** Safe handling prevents exposure to hazardous chemicals that can cause health issues, including respiratory problems, organ damage, and cancers.
3. **Conserve resources:** Recovering valuable materials like metals reduces the need for mining and helps conserve natural resources.
4. **Promote sustainable development:** By recycling e-waste, we reduce landfill use and support a circular economy, where materials are reused and repurposed.
5. **Extended Producer Responsibility (EPR):** The EPR mechanism lays emphasis on producers' responsibility for environmentally sound management of E-waste and promotes the establishment of an efficient E-waste collection mechanism, through buy-back and take-back systems.

Safe e-waste management ensures that electronics are disposed of in an environmentally responsible manner, minimizing harm and maximizing resource recovery.

4.1 APPLICABLE RULES

1. E-Waste (Management) Rules, 2022.

   E-Waste Management Rules, as amended from time to time.

The Ministry of Environment, Forest and Climate Change (MoEFCC) has notified the E-Waste (Management) Rules, 2022 on 2nd November, 2022 under the Environment (Protection) Act, 1986 (29 of 1986);. These rules will replace E-waste (Management) Rules, 2016 and effective from 1st April, 2023. These rules will launch a new Extended Producer Responsibility (EPR) regime for e-waste recycling.

These rules shall apply to every manufacturer, producer, refurbisher, dismantler and recycler involved in manufacture, sale, transfer, purchase, refurbishing, dismantling, recycling and processing of E-waste or electrical and electronic equipment listed in Schedule I of the E-Waste (Management) Rules, 2022 , including their components, consumables, parts and spares which make the product operational.

However these Rules shall not apply to -

(a) waste batteries as covered under the Battery Waste Management Rules, 2022;

(b) packaging plastics as covered under the Plastic Waste Management Rules, 2016;

(c) micro enterprise as defined in the Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006); and

(d) radio-active wastes as covered under the provisions of the Atomic Energy Act, 1962 (33 of 1962) and rules made there under.

Highlights of mandates under the E-Waste (Management) Rules, 2022 are listed below:

- All the manufacturers, producers, refurbishers and recyclers are required to register on the portal developed by CPCB.
- No entity shall carry out any business without registration and also not deal with any unregistered entity.
- Manufacturer, producer, refurbisher and recycler require registration through online portal.
- As per Schedule I of E-Waste (Management) Rules, 2022, 106 Electrical and Electronic Equipment (EEE) has been included under EPR regime.
- Producers of notified EEE, have been given annual E-Waste Recycling targets based on the generation from the previously sold EEE or based on sales of EEE as the case may be. Target may be made stable for 2 years and starting from 60% for the year 2023-2024 and 2024-25; 70% for the year 2025-26 and 2026-27 and 80% for the year 2027-28 and 2028-29 and onwards.
- Management of solar PV modules /panels/ cells added in these rules.

- The quantity recycled will be computed on the basis of end products, so as to avoid any false claim.
- Provision for generation and transaction of EPR Certificate has been introduced.
- Provisions for environment compensation and verification & audit have been introduced.
- Provision for constitution of Steering Committee to oversee the overall implementation of these rules.
- Under the E-Waste Management Rules, provision for reduction of hazardous substances in manufacturing of Electrical and Electronic Equipment (EEE) has been provided. It mandates that every producer of EEE and their components shall ensure that their products do not contain lead, mercury and other hazardous substances beyond the maximum prescribed concentration.
- The E-Waste (Management) Rules also provide for recognition and registration, skill development, monitoring and ensuring safety and health, of workers involved in dismantling and recycling of E-waste.
- These rules regulate the management of electronic waste, or e-waste, focusing on the recycling and reduction of hazardous substances used in electronics. Similar to the Plastic Waste Management Rules, they incorporate principles of EPR, requiring manufacturers to facilitate the collection and recycling of electronic waste. Producers of electronic goods must establish collection facilities (working closely with local bodies and private authorized agencies), provide financial assistance for collection and further channelisation of waste to authorized recyclers/refurbishers, create EPR plans detailing their e-waste management strategies, and obtain authorization from KSPCB.
- As per the rules, the producers are required to fulfil their Extended Producer Responsibility (EPR) obligations assigned to them through online purchase of EPR Certificates from registered Recyclers of E-Waste only. Further, as per the provisions laid in the Rules, the Central Pollution Control Board shall generate an EPR certificate through Portal in favour of registered Recyclers. The quantity eligible for generation of EPR certificate shall be based on the quantity of E-Waste recycled by the Recyclers.
- The registered recyclers have to upload details of the quantity of E-Waste procured/ collected, recycled, and end products produced and sold on the E-Waste EPR Portal. Based on the information uploaded on the Portal, EPR certificates will be generated in favour of the recycler by CPCB through the Portal. The certificates shall be subject to environmental audit by the Central Pollution Control Board or any other agencies authorised by the Central Pollution Control Board in this regard.

- Following are the guidance on the generation & transfer of the EPR certificates/credits for e-waste recyclers.
    - ♦ To ensure sequential submission/ upload of invoices with respect to procurement of raw material (e-waste – item code wise) and sale of end products.
    - ♦ Sequence of procurement dates and sales dates are to be maintained.
    - ♦ (Note: Oldest date needs to be provided first, and sequence needs to be maintained).
    - ♦ To maintain records of the quantity of E-Waste collected/procured, processed/ recycled and end product sold as per the forms on the EPR Portal along with the invoices & other details.
    - ♦ To ensure correctness of data w.r.t. E-Waste collected/procured, processed/recycled and sold end product.
    - ♦ To generate ERR certificates/ credits based on the quantity of e-waste recycled and the quantity of end products sold.
    - ♦ To upload invoices with respect to procurement of e-waste and sales of end products by the recycler. The end product sales invoices have to be GST-linked.
    - ♦ To make available all records for verification or audit as and when required.
    - ♦ To follow all the instructions/guidance as available on the EPR Portal as data edition/ deletion will not be allowed in case EPR certificate generation and transaction has been done by the recycler.
    - ♦ To file annual and quarterly returns in the laid down form on the portal on or before the end of the month succeeding the quarter or year, as the case may be, to which the return relates.
    - ♦ To ensure that the fractions or material not recycled in its facility is sent to the respective registered recyclers or/and authorised treatment storage disposal facility (TSDF).
    - ♦ The validity of the extended producer responsibility (EPR) certificate shall be for two years from the end of the financial year in which it was generated and the expired certificate automatically extinguished after the period unless extinguished earlier as per the provisions of these rules.
    - ♦ The details provided by the producer and registered recycler shall be cross-checked on the portal.
    - ♦ In case of any difference, the lower figure shall be considered towards the fulfilment of the extended producer responsibility (EPR) obligation of the producer.

- The procedure for the generation of an EPR certificate involves the following steps:

  i. To provide information on the quantity of E-Waste Procurement data (in tonnes) and upload copies of corresponding invoices.

  ii. To provide production details in terms of End Products based on the quantity of E Waste recycled from the quantity of procured E-Waste as at (i) above.

  iii. To generate EPR credits in the form of four end products i.e. Gold, Iron, Copper & Aluminum

  iv. To enter the quantity of end products sold.

  v. To upload GST-linked sales invoice corresponding to the end product sold

  vi. To generate an EPR Certificate in the denomination of 0.01, 0.001, 0.1, 0.5, 1, 10, 50, 100, 500, 1000.

  vii. To sell EPR certificates to producers for fulfilment of their EPR obligations.

4.2 TERMS USED IN E-WASTE MANAGEMENT

Dismantler means any person or entity engaged in dismantling of used electrical and electronic equipment into their components and having authorisation from concerned State Pollution Control Board or Pollution Control Committee as per the guidelines of the Central Pollution Control Board;

E-retailer means an individual or company or business entity that uses an electronic network such as internet, social media, telephone or any other media, to sell its goods;

Extended producer responsibility (EPR) -The EPR mechanism emphasizes producers' responsibility for environmentally sound management of E-waste and promotes the establishment of an efficient E-waste collection mechanism, through buy-back and take-back systems. It means responsibility of any producer of electrical or electronic equipment as given in Schedule-I for meeting recycling targets as per Schedule-III and Schedule-IV, only through registered recyclers of e-waste to ensure environmentally sound management of such waste;

Manufacturer means a person or an entity or a company as defined in the Companies Act, 2013 (18 of 2013) or a factory as defined in the Factories Act, 1948 (63 of 1948) or Small and Medium Enterprises as defined in the Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006), which has facilities for manufacture of electrical and electronic equipment as specified in Schedule-I;

Orphaned products means non-branded or assembled electrical and electronic equipment as specified in Schedule-I or those produced by a company which has closed its operations.

Producer means any person or entity who, -

(i) manufactures and offers to sell electrical and electronic equipment and their components or consumables or parts or spares under its own brand; or

(ii) offers to sell under its own brand, assembled electrical and electronic equipment and their components or consumables or parts or spares produced by other manufacturers or suppliers; or

(iii) offers to sell imported electrical and electronic equipment and their components or consumables or parts or spares; or

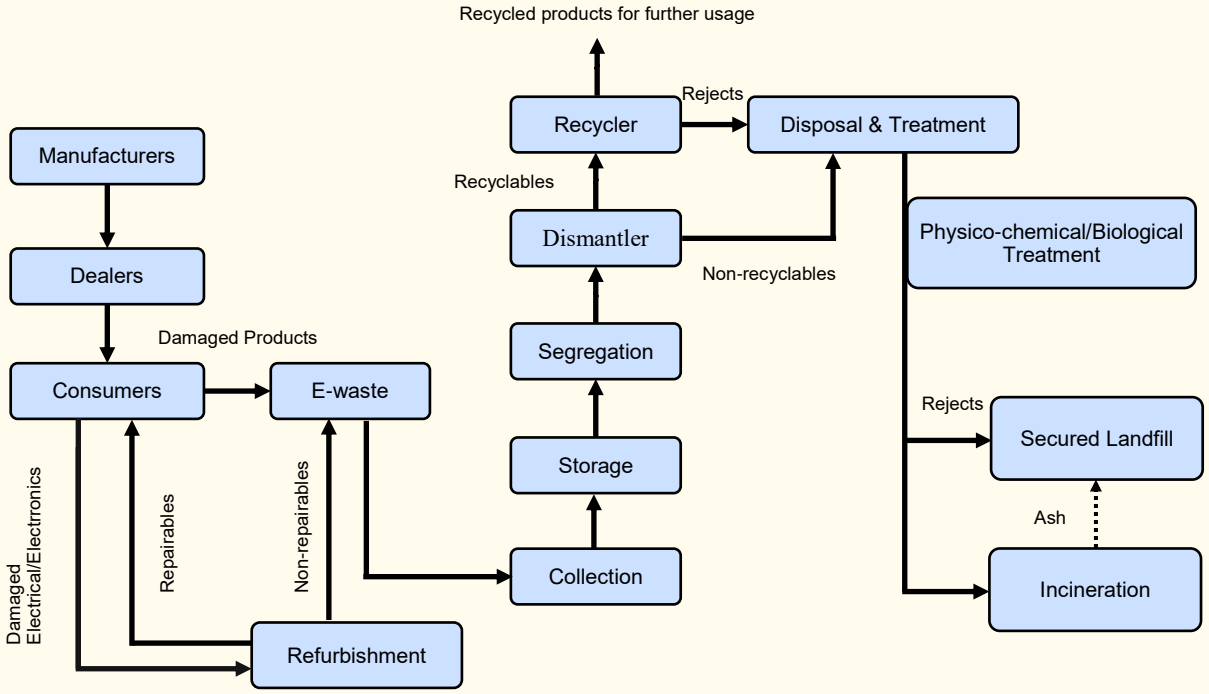
(iv) who imports used electrical and electronic equipment; irrespective of the selling technique used such as dealer, retailer, e-retailer, etc.;

Recycler means any person or entity who is engaged in recycling and reprocessing of waste electrical and electronic equipment or assemblies or their components or their parts for recovery of precious, semi-precious metals including rare earth elements and other useful recoverable materials to strengthen the secondary sourced materials and having facilities as elaborated in the guidelines of the Central Pollution Control Board made in this regard;

Refurbisher means any person or entity repairing or assembling used electrical and electronic equipment as listed in Schedule-I for extending its working life over its originally intended life and for same use as originally intended, and selling the same in the market;

4.3 E-WASTE MANAGEMENT PROCESS FLOW

The flow diagram of overall E-waste management process is shown below :



(The diagram depicts the waste management angle and the EPR mechanism as mentioned in the E-waste rules shall apply at various stages wherever applicable)

Figure 4.1: Flow Diagram for E-waste Management

4.4 RESPONSIBILITIES OF STAKEHOLDERS

4.4.1. Responsibilities of Local Bodies

a) To ensure that e-waste if found to be mixed with Municipal Solid Waste is properly segregated, collected and is channelized to registered recycler or refurbisher.

b) To ensure that e-waste pertaining to orphan products is collected and channelized to registered recyclers or refurbishers.

c) To facilitate setting up e-waste collection, segregation and disposal systems.

d) Conducting training sessions to develop capacities of the urban and rural population.

4.4.2. Responsibilities of State Government

a) Department of Industry in State or any other government agency authorised in this regard by the State Government, to ensure earmarking or allocation of industrial space or shed for e-waste dismantling and recycling in the existing and upcoming industrial park, estate and industrial clusters;

b) Department of Labour in the State or any other government agency authorised in this regard by the State Government shall:

- ensure recognition and registration of workers involved in dismantling and recycling;
- assist formation of groups of such workers to facilitate setting up dismantling facilities;
- undertake industrial skill development activities for the workers involved in dismantling and recycling;
- undertake annual monitoring and to ensure safety & health of workers involved in dismantling and recycling;

c) State Government to prepare an integrated plan for effective implementation of these provisions, and to submit an annual report to the Ministry of Environment, Forest and Climate Change.

4.4.3. Responsibilities of CKCL

Clean Kerala Company Limited (CKCL) is authorized by the State Government to collect E-waste from various institutions within the State. As per G.O. No. 3326/LSGD dated 17.10.2017, non-hazardous e-waste to be collected by CKCL from Govt/non-govt/ public sector institutions by paying the generator Rs.10/kg and hazardous e-waste to be collected from Govt/non-govt/ public sector institutions by charging the generator Rs.40/kg (this rate is subjected to amendment as decided by the Govt from time to time). The list of e-waste falling into both categories as detailed in the G.O. is attached as annexure.

4.4.4. Responsibilities of Manufacturers

All manufacturers shall have to

a) obtain EPR registration from Central Pollution Control Board through the portal developed by CPCB,

b) collect e-waste generated during the manufacture of any electrical and electronic equipment and ensure its recycling or disposal

c) file annual and quarterly returns in the laid down form on the portal on or before end of the month succeeding the quarter or year, as the case may be, to which the return relates.

4.4.5. Responsibilities of Producers

The producer of electrical and electronic equipment listed in Schedule I shall be responsible for-

(1) registration on the portal

(2) obtaining and implementing extended producer responsibility targets as per Schedule-III and Schedule-IV of said Rules through the portal

(3) creating awareness through media, publications, advertisements, posters or by any other means of communication;

(4) file annual and quarterly returns in the laid down form on the portal on or before the end of the month succeeding the quarter or year, as the case may be, to which the return relates.

4.4.6. Responsibilities of Dealers

(1) If a dealer has been assigned the task of collecting e-waste on behalf of the producer, they must collect the e-waste from customers and deliver it to the designated dismantler or recycler specified by the producer.

(2) In adherence to the producer's Take Back System or Deposit Refund Scheme, the dealer, retailer, or e-retailer must reimburse the depositor of e-waste accordingly.

(3) It is mandatory for every dealer to guarantee the safe transportation of generated e-waste to authorized dismantlers or recyclers. Stringent measures must be implemented to prevent any environmental damage during the storage and transportation of e-waste.

4.4.7. Responsibilities of Bulk Consumers

Bulk consumers of electrical and electronic equipment listed in Schedule I shall ensure that e-waste generated by them shall be handed over only to the registered producer, refurbisher or recycler.

4.4.8. Responsibilities of Consumers

a) Consumers are strictly prohibited from disposing of e-waste in the environment and are required to deposit it only at designated collection points established by the local body or hand it over to authorized collection agents appointed by the local authorities. In many localities, the Haritha Karma Sena undertakes the collection of e-waste from households and institutions according to a scheduled system.

b) For end-of-life intact fluorescent and other mercury-containing lamps, it is advisable to pack them securely to prevent breakage during storage and transportation before handing them over.

4.4.9. Responsibilities of the Refurbishers

All refurbisher shall have to-

a) register on the portal;

b) collect e-waste generated during the process of refurbishing and hand over the waste to registered recycler and upload information on the portal;

c) ensure that the refurbished equipment shall be as per Compulsory Registration Scheme of the Ministry of Electronics and Information Technology and Standards of Bureau of Indian Standards framed for this purpose;

d) file annual and quarterly returns in the laid down form on the portal on or before the end of the month succeeding the quarter or year, as the case may be, to which the return relates.

4.4.10. Responsibilities of the Recyclers

All recyclers shall have to, -

a) register on the portal;

b) ensure that the facility and recycling processes are in accordance with the standards or guidelines laid down by the Central Pollution Control Board in this regard from time to time;

c) ensure that the fractions or material not recycled in its facility is sent to the respective registered recyclers;

d) ensure that residue generated during recycling process is disposed of in an authorised treatment storage disposal facility;

e) maintain record of e-waste collected, dismantled, recycled and sent to registered recycler on the portal and make available all records for verification or audit as and when required;

f) file annual and quarterly returns in the laid down form on the portal on or before the end of the month succeeding the quarter or year, as the case may be, to which the return relates;

g) accept waste electrical and electronic equipment or components not listed in Schedule-I for recycling provided that they do not contain any radioactive material and same shall be uploaded on the portal;

h) create awareness through media, publications, advertisements, posters or by such other means of communication;

i) account for and upload information about any non-recyclable e-waste or any quantity which is not recycled and disposed of;

j) take help of dismantlers for recycling purposes. Provided that it shall be the responsibility of recycler to ensure proper material flow to and from those dismantlers and the dismantler shall give dismantled material to registered recycler only and maintain record of the same.

4.5 COLLECTION CENTRES

a) Collection centres or points play a vital role in the proper channelization of e-waste.

b) These centres have the responsibility to collect and store e-waste and then transfer it to authorised dismantlers or recyclers.

c) Only those collection centres specified in the Extended Producer Responsibility (EPR) authorization of the producers can operate. This includes collection centres established by dismantlers, recyclers, or refurbishers, provided they have agreements with producers. If a collection centre serves multiple producers, all such producers must include this information in their EPR application.

d) Collection centres are required to collect e-waste on behalf of producers, including waste from orphaned products. Those established by producers can be managed by their Producer Responsibility Organizations (PROs) or by dismantlers and recyclers with agreements with the producers.

e) Collection points or bins can be located at designated areas such as residential complexes, office buildings, commercial areas, retail outlets, educational institutions, and community organisations. These points should be part of the producer's collection and channelization plan.

f) Mobile collection vans can also be utilised for door-to-door collection of e-waste from individuals, institutions, and small enterprises. These vans should be linked to collection centres and, if provided by producers, should be included in their EPR plan.

g) Material collected at these centres should only be sent to authorised dismantlers and recyclers,except for used fluorescent and other mercury-containing lamps, which may be sent to Treatment, Storage, and Disposal Facilities (TSDFs) if recyclers are not available.

4.5.1. Facilities Required at E-waste Collection Centres

The collection centre must adhere to the provisions outlined in the e-waste management rules and comply with the conditions specified in the Central Pollution Control Board (CPCB) guidelines. Here are the key requirements for a collection centre:

Accessibility: The centre should be well connected by roads and accessible for large trucks to facilitate transportation.

Storage Area: The storage area should be covered to protect the E-waste from external elements.

Segregation: E-waste must be segregated into different categories and stored separately.

Weighing Equipment: The centre should have weighing equipment to accurately measure each delivery received and outgoing, with records maintained accordingly.

Handling Procedures: It's crucial for collection centres to securely store the e-waste until it is transferred to authorised dismantlers or recyclers. This ensures that the e-waste remains properly managed and does not pose any risks to human health or the environment.

Special Handling for Certain Items: CRTs, LCD/LED/Plasma TVs, and fluorescent and other mercury-containing lamps should be stored securely to prevent damage or breakage.

Record-Keeping: Detailed records of e-waste collected and handed over must be maintained.

Management of Hazardous Materials: If refrigerators and air conditioners are stored, the centre should have adequate facilities to manage leakage of compressor oils, coolant/ refrigerant gases (such as CFCs/HCFCs), and mercury from lamps. This may involve the use of dry sand, absorbent pads, stabilising chemicals, etc., for subsequent transfer to Treatment, Storage, and Disposal Facilities (TSDFs).

Fire Safety: The collection centre must have adequate fire-fighting arrangements and emergency exit routes.

Preservation of End Use: Loading, transportation, unloading, and storage of e-waste and end-of-life products should not compromise their potential for reuse after refurbishing or recycling.

Storage of E-waste: Every manufacturer, producer, refurbisher and recycler may store the e-waste for a period not exceeding one hundred and eighty days and shall maintain a record of sale, transfer and storage of e-wastes and make these records available for inspection and the storage of the e-waste shall be done as per the applicable rules or guidelines for the time being in force. Provided that the Central Pollution Control Board may extend the said period up to three hundred and sixty-five days in case the e-waste needs to be specifically stored for development of a process for its recycling or reuse.

Transportation: Transportation of e-waste shall comply with the e-waste management rules and CPCB guidelines.

Adherence to these guidelines ensures proper management of e-waste while minimising environmental and health risks.

4.6 DISMANTLING PROCESS

The dismantling of electrical and electronic equipment involves manual separation and segregation of components. It occurs on a dedicated table with a dedusting system comprising suction hoods connected to cyclones, bag filters, and chimneys for safe dust venting. Workers utilise tools like screwdrivers, pliers, and wire cutters, along with personal protective gear. Components such as batteries, Printed circuit boards (PCBs), toner cartridges, and plastic are removed and stored securely for transport to recyclers. Dismantled parts may undergo size reduction for transportation ease, with plastics directed only to registered recyclers. Noise and dust controls are essential during this process. Dismantlers are barred from shredding PCBs, lamps, or performing certain processes like leaching or heating. Special care is needed for hazardous materials like PCB-containing capacitors. Facilities must manage spills and store dismantled parts securely. Premises for dismantling require waterproofing, storage space, and separate containers. Directly usable components are sent to refurbishers, while others go to recyclers based on their nature and hazards.

4.6.1. Space Requirements for Dismantlers

A dismantler needs space for storage of electrical and electronic equipment up to 180 days, for process of dismantling and volume reduction and space for storage of dismantled and segregated material and free space for movement and office/ administration and other utilities. It is estimated that a minimum of **300 square metres area for a dismantling capacity of 1 T/ day** is required for storage of raw material, segregated material, dismantling operations and office/ administration & other utilities **(Ref- CPCB Guidelines on Implementation of E-Waste (Management) Rules, 2016)**.

4.6.2. Responsibilities of the Dismantler

It shall be ensured that the facility and dismantling processes are in accordance with the standards or guidelines prescribed by the Central Pollution Control Board from time to time.

4.7 RECYCLING PROCESS

Recycling facilities for e-waste are essential for sustainable management, and they can employ various processes including dismantling, shredding, and metallurgical operations. These facilities must comply with regulations and have adequate pollution control measures in place. For CRTs, special procedures are required to contain harmful substances, while LCD and Plasma TVs demand a sealed vacuum dismantling platform. Recovering resources, especially precious metals, is prioritised. Fluorescent lamp recycling units must adhere to strict guidelines for mercury handling, emission control, and waste disposal. Maintaining records of collection, recycling, and waste management is essential for accountability and environmental monitoring.

4.7.1. Space Requirement for Recyclers

As a general rule, a recycler of capacity of **1 Ton per day shall require a minimum of 500 square metres area**. Authorisation to recyclers may be preferred if they have a minimum operational capacity of 5 MT/day with an area of about 2500 square metres.
(Ref- CPCB Guidelines on Implementation of E-Waste (Management) Rules, 2016).

4.7.2. Types of Machinery Required at a Recycling Facility



Dust Collector



Wire Stripping Machine



Hard disk and PCB Shredder



Non-ferrous Melting Furnace



Air Compressor



CRT Cutting Machine

Figure 4.2: Machineries required at the recycling facility



Compressor Recovery Table



Gas Recovery Machine



Oil Extraction Table



Automatic Compressor Cutting Machine



Vertical Drilling Machine



Horizontal Bandsaw Machine

Figure 4.2: Machineries required at the recycling facility

4.8 ACCIDENT REPORTING

Where an accident occurs at the facility processing e-waste or during transportation of e-waste, the producer, refurbisher, transporter, dismantler, or recycler, as the case may be, shall report immediately to the concerned State Pollution Control Board about the accident through telephone and e-mail.

4.9 MANAGEMENT OF SOLAR PHOTO-VOLTAIC MODULES OR SOLAR PANELS

1) Every manufacturer and producer of solar photo-voltaic modules or panels or cells shall

   a. ensure registration on the portal;

   b. store solar photo-voltaic modules or panels or cells waste generated up to the year 2034- 2035 as per the guidelines laid down by the Central Pollution Control Board in this regard;

   c. file annual returns in the laid down form on the portal on or before the end of the year to which the return relates up to year 2034-2035;

   d. ensure that the processing of the waste other than solar photo-voltaic modules or panels or cells shall be done as per the applicable rules or guidelines for the time being in force;

   e. ensure that the inventory of solar photo-voltaic modules or panels or cells shall be put in place distinctly on portal;

   f. comply with standard operating procedure and guidelines laid down by the Central Pollution Control Board in this regard.

2) Recyclers of solar photo-voltaic modules or panels or cells shall be mandated for recovery of material as laid down by the Central Pollution Control Board in this regard.

5 CONSTRUCTION & DEMOLITION (C&D) WASTE

The rapid urbanization in the State has led to the construction of numerous civil structures, both new constructions and renovations of existing ones. The new ones are either constructed in new premises or after demolishing an existing building. These activities generate substantial quantities of material waste known as Construction & Demolition (C&D) Waste.

"**Construction and Demolition Waste**" means the waste consisting of building materials, debris and rubble resulting from construction, re-modeling, repair and demolition of any civil structure.



Figure 5.1: Civil structure demolition activity leading to C&D waste generation

Benefits of Construction and Demolition Waste Processing

1. Resource Conservation: Processing construction and demolition (C&D) waste allows for the recovery and reuse of valuable materials such as concrete, wood, metal, and glass, reducing the need for virgin resources.

2. Reduced Landfill Use: By recycling C&D waste, the volume of debris sent to landfills is significantly reduced, extending landfill life and reducing the environmental impact of waste disposal.

3. Energy Savings: Recycling materials like steel and concrete consumes less energy compared to producing new materials, leading to lower greenhouse gas emissions and reduced energy consumption in construction processes.

4. Cost Efficiency: Recycled materials are often more cost-effective than new ones. Waste processing can also reduce disposal costs and create revenue streams from the sale of recovered materials.

5. Environmental Protection: Proper processing of C&D waste helps prevent land, water, and air pollution, minimizing the environmental footprint.

5.1 APPLICABLE RULES

1) Construction and Demolition Waste Management Rules 2016, as amended from time to time.

The major components of C&D waste, as outlined in the 2017 CPCB guidelines, are listed below.

Table 5.1 : Major Components of C&D Waste as per CPCB guidelines, 2017

Components	% of Components
Cement Concrete	36%
Bricks Masonry	31%
Soil, Sand and Gravel	23%
Steel (from RCC, door/window frames, roofing support, railings of staircase, etc.)	5%
Bitumen (In road excavations)	2%
Timber/wood (especially demolition of old buildings)	2%
Stone (marble, granite, sandstone)	1%

5.2 CURRENT SCENARIO

Currently, reusable C&D waste materials such as steel, window and door frames, wood, roofing tiles, etc generated in the State are collected by various scrap dealers. Additionally, a significant portion of concrete waste is utilized for ground leveling activities and road construction. However, there have been reports of C&D wastes being illegally used to fill up water bodies and wetlands around urban centers to create land for real estate development. Such practices pose environmental hazards and need to be addressed through proper waste management and enforcement of regulations.



Figure 5.2: C&D waste illegally dumped at roadsides

5.3 QUANTIFICATION OF C&D WASTE

Quantification of C&D waste is a primary requirement for managing the waste. Various approaches which can be considered for quantifying the C&D waste generation are listed below:

a. Activity-wise C&D waste quantification

Based on a study conducted by 'Technology Information Forecasting and Assessment Council', New Delhi (TIFAC), activity-wise C&D waste generation is as follows:

i. 40-60 kg per sq.m of C&D waste will be generated during **new construction,**

ii. 40-50 kg per sq.m of C&D waste will be generated during building **repair,**

iii. 300-500 kg per sq.m of C&D waste will be generated during the **demolition** of buildings.

ii. During the demolition of buildings, approximately 300-350 kg of C&D waste is generated per square meter.

b. Local Self Government wise C&D waste quantification

10% of total Municipal Solid Waste generated in the Local Self Governments may be taken as the approximate quantity of C&D waste generation for planning purposes (Ref-SOP- KSPCB

No. PCB/HO/SEE-3/TECH/139/2022 dated 04/04/2022). However, LSGIs shall be responsible for carrying out the C&D waste quantification in their jurisdiction. The Study on “Construction & Demolition Waste Generation and Management- Kozhikode” conducted by the LSGD Planning Kozhikode, could be taken as a pointer to the quantity of C&D Waste being generated in various districts in the State. The methodology followed in the report could be adopted for further studies on the quantitative estimation of C&D Waste generation in Kerala.

The study estimated the generation of C&D waste as follows:

i. During new construction, approximately 20-30 kg of C&D waste is generated per square meter.

ii. During the demolition of buildings, approximately 300-350 kg of C&D waste is generated per square meter.

Similar studies should be conducted before establishing C&D waste processing plants to characterize the waste and assess the quantity of each category. However, in the absence of local body/district-specific data, the TIFAC estimate may be adopted to quantify C&D waste generation.

5.4 COLLECTION CENTRES

The Local Self-Government Institutions (LSGI) shall identify and determine the locations of collection centers and shall facilitate the collection of Construction and Demolition (C&D) waste from non-bulk generators by establishing designated collection centers within a reasonable distance, allowing generators to transport and deposit the waste conveniently.

a. Categories

i. Local Body owned units: Collection centers owned and operated by the Local Self Government Institutions (LSGIs) at the local level.

ii. Cluster level centers in districts: Collection centers established at the cluster level within districts to serve multiple local bodies.

iii. PPP model unit: Collection centers established under a Public-Private Partnership (PPP) model, where both public and private entities collaborate in the operation and management of the unit.

iv. Private owned unit: Collection centers owned and operated by private entities for the collection and processing of C&D waste.

b. Site Selection Criteria

Identified C&D waste collection centers must be adequately fenced, demarcating a minimum area of 100 sq m for the facility (as per the Garbage Free City rating criteria of SBM Urban, 50 sq m is required). It is imperative to ensure that debris and dust from the collection centers do not adversely affect neighboring communities. Additionally, existing dumpsites should not be

repurposed as C&D waste collection centers. If areas adjacent to existing dumpsites are to be utilized for C&D waste collection, measures must be taken to prevent the mixing of waste at any instance. However, dumpsites, after undergoing remediation, can be repurposed for the scientific management of C&D waste.

c. Location

Collection centres should be strategically established at regular intervals to ensure that non-bulk generators of C&D waste do not need to transport debris over distances exceeding 5 km. Alternatively, this distance may be determined by the concerned Local Self Government Institutions (LSGIs) based on the C&D waste generation potential of the area. LSGIs may also choose to implement mobile collection units to facilitate smooth C&D waste collection operations as needed.

d. Facilities required at collection centres

- Collection centres shall have a weighing bridge, C&D waste unloading area and segregated waste storage facility with roofing.
- C&D waste collected shall be segregated at the collection centres in the designated areas with clear separation or in separate storage bins into the following categories: Concrete, soil, steel, wood, plastics, bricks & mortar, paper (eg: paper sack cement bags), electrical items and metallic items.
- Storage of C&D waste shall be in a permanently enclosed area wherever possible or else in a fenced area with a roofing facility.
- Adequate number of water sprinkling arrangements shall be provided in the collection centers to mitigate the dust generated.
- The unloading area shall be enclosed appropriately (using green net or other means) to prevent dust pollution during unloading operations.
- **SOP - Siting requirements and pollution control measures** in construction & demolition waste processing plants by Kerala Pollution Control Board No. PCB/HO/SEE-3/ TECH/139/2022 dated 04/04/2022 shall be adhered to.
- Required pollution control measures are to be adopted at the collection centers as specified in the CPCB Guidelines on Environmental Management of C&D wastes.

5.5 TRANSPORTATION MECHANISM

C&D waste collection/transportation mechanism may be of the following types:

i. **LSGI owned**

ii. **Private owned**

The required C&D waste collection/transportation mechanism-including the capacity of vehicles, staff strength, equipment/machinery needed for collection operations shall be adequate to meet the assessed C&D waste generation of the concerned local bodies. Whether an in-house mobile collection facility is to be provided or it may be an on-call private service facility to be decided by the concerned local bodies.

C&D waste transporting agencies must maintain a manifest in the format provided in Annexure I of the C&D guidelines. Transport operations should be conducted without causing any disturbance to the public. All environmental norms and safety precautions specified in the CPCB guidelines on environmental management of C&D waste, KSPCB SOP, C&D waste management Rules, and MVD guidelines must be strictly followed during C&D waste transportation.

Proper transportation of C&D waste includes, but is not limited to, the following conditions:

a) Transportation from collection centers to processing facilities should be carried out regularly to prevent the accumulation of C&D waste at the collection facility.

b) C&D wastes should be transported in covered vehicles to prevent fugitive dust emissions.

c) Vehicles should have various compartments/arrangements to prevent mixing of waste, or only non-mixing types of waste should be transported during each trip.

d) Vehicles engaged in C&D transportation should be fitted with GPS tracking facilities for monitoring purposes.

e) C&D waste management operations should avoid peak times from 8 AM to 11 AM and 3 PM to 8 PM to minimize traffic disruption.

5.6 C&D WASTE PROCESSING

The secondary transportation to the centralized C&D waste processing plant may be taken up by the ULB or third party or processing facility management agency. In addition, the bulk generators/service providers can directly transport their C&D waste to the processing facility as per their waste management plan by paying the required charges to the local authority.

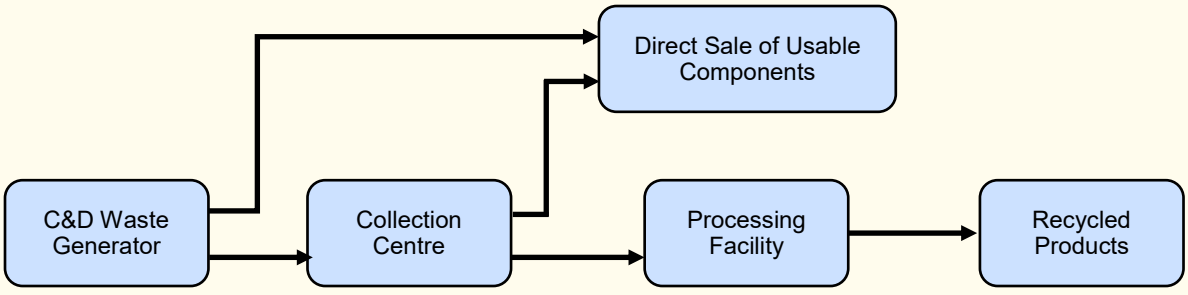


Figure 5.3 : C&D waste management process outline

C&D waste processing facilities can be established through the following methods:

i. Local Self Government Owned

Processing plant owned, operated and maintained by the Local Self Government. As setting up a C&D waste processing plant demands huge financial investment, it is better to involve private participation.

ii. PPP Model

- In this model, the construction and operation cost shall be shared by the local body and private investors. The processing or recycling plant shall be large enough to last for a minimum 20-25 years. The collection centres of C&D waste shall be pre-approved by the LSG. The primary sources of benefits are disposal fees/Tipping fee and from the sale of recycled products. The price of recycled materials has to be lower than that of primary virgin materials. This gives a strong motivation to buy the recycled materials. LSG may give a buy-back assurance to the plant owner that it will use a certain percentage of the recycled materials in its various projects. Notification for user charges for C&D processing shall be fixed by the LSG in consultation with the agency.
- **Minimum waste assurance**: Local body shall ensure that the bidder will be the sole agency responsible for collection of C&D Waste in the project area.

iii. Private Owned - Facility owned and operated by the private party.

C&D processing facility in the State shall comply with the following conditions:

a) Minimum area of at least 1 hectare is preferred for C&D plant (because of its similarity to crusher units). However, considering the non-availability of adequate land, a thumb rule of one acre per 100 tons/day may be taken as the minimum requirement. ie, for a 200 tons/ day plant, an area of two acres is required and 75 tons/day plant area of 75 cents is required. However, in no case, the minimum area shall be less than 75 cents, however small the capacity is.

b) The non-availability of C&D waste due to improper collection/transportation/enforcement of law can adversely affect the economical functioning of the C&D waste processing plants. C&D plants may not be needed in all the districts since in some districts the waste generation may be low. Hence, one common C&D waste processing plant may be sufficient for multiple districts.

c) There shall be no residence/public building/place of worship within 100m of the processing facility. A minimum setback of 10m shall be available on all sides.

Existing quarries/ crusher units can be utilized for processing C&D waste as these units are already having installed machinery and with some alterations, the same can be made suitable for processing C&D waste. Hollow brick manufacturing units, paver brick manufacturing units etc may be involved in C&D waste processing activities to ensure forward linkage. This will

lead to easier and timely setting up of C&D processing facilities in the State.

5.6.1. Operation of Plant

Processing facilities are equipped for carrying out crushing, screening as well as purification to separate the contaminants. In the usual construction waste processing plant, concrete wasteis fed into the hopper and then crushed in a crusher (jaw or horizontal impact crusher) resulting in particle size reduction from 400mm to less than 80mm. The under 80mm size particles are discharged into grizzly feeder (vibrating feeder) through conveyor and then into log washer (intensive washing in an inclined washer {sloped} using shaft and paddles) for removal of plastic/wood/ silt/clay and then sorted in vibrating screens to generate particles in the size range 80mm –20mm, 20mm – 8.5mm and < 8.5mm. The under 8.5mm particles are then sent to the cyclone separator to separate into two fractions of size 0.75mm – 3.75mm & 3.75 – 8.5mm. Processing methodology may vary from that mentioned above. However, the aim in all processing technology is to crush the concrete waste into uniform aggregates of specified size.

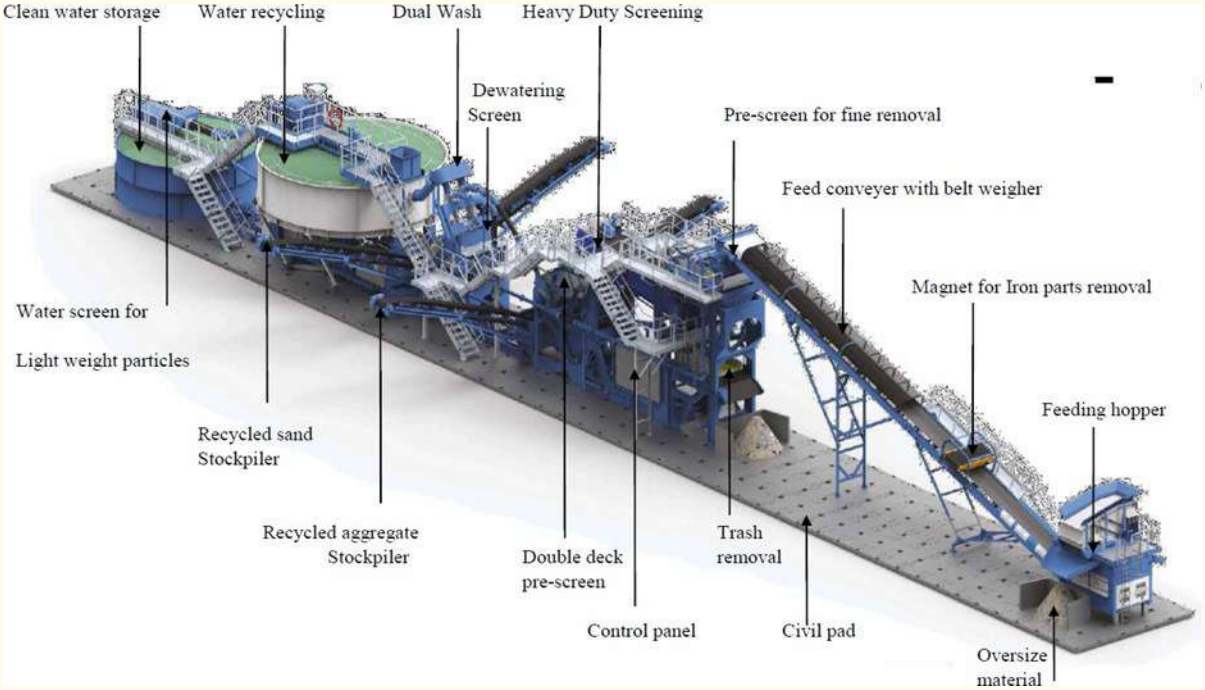


Figure 5.4 : Indicative C&D Processing Plant Flow

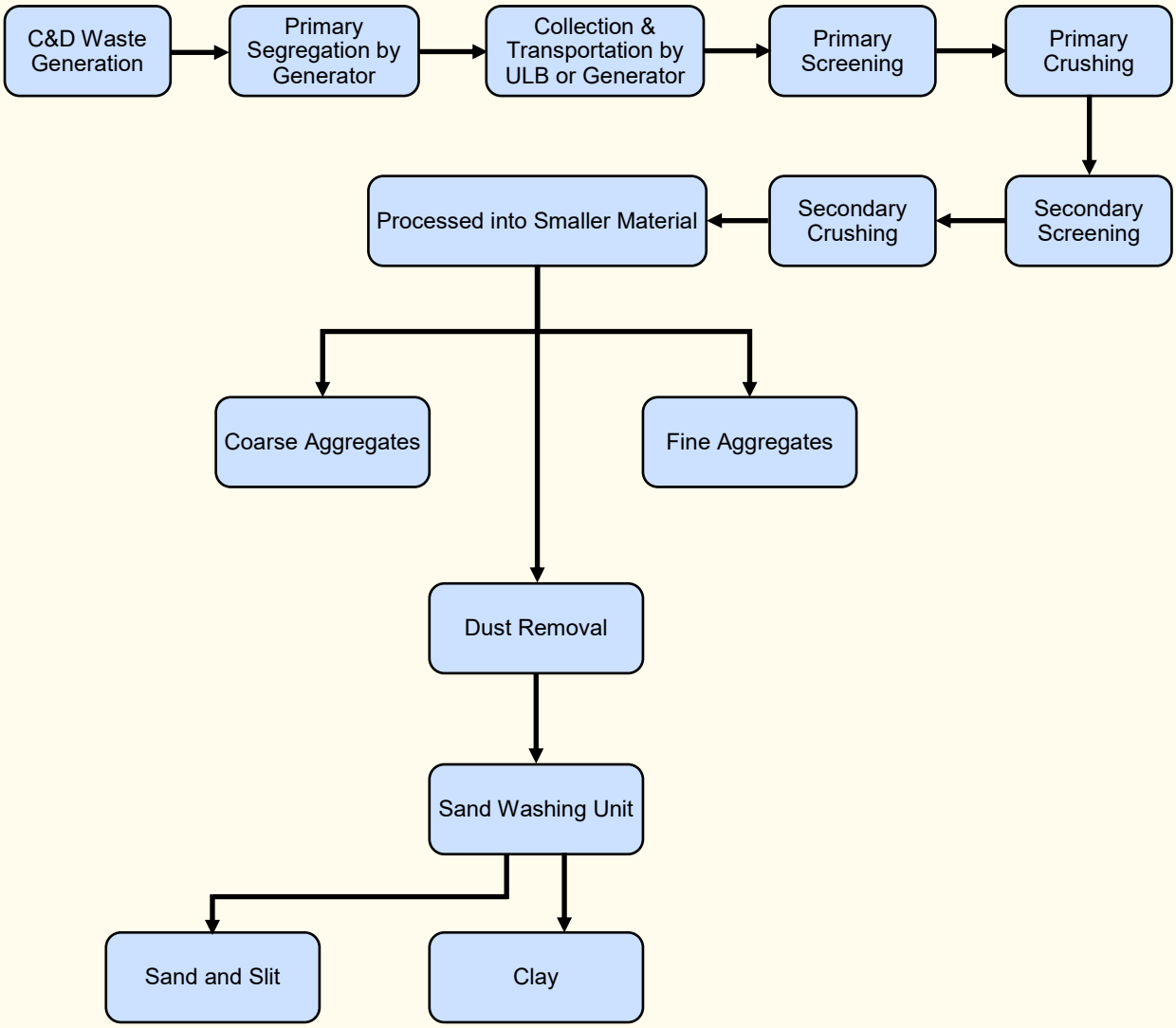


Figure 5.5 : Steps involved in C&D Waste Processing

*The above outputs from the C&D processing facility can be used to manufacture various concrete products as detailed in the later sections of this document

5.6.2. Components of the Plant

The processing facility shall consist of the following components

i) Compound Wall / Fencing Arrangements

ii) Weigh bridge at entry/exit gate

iii) C&D waste unloading platform

iv) Sorting/Segregation Area

v) Conveyor belt to the crusher plant

vi) Crusher plant

vii) Wet Processing Plant

viii) Screening Mechanism to screen various size of aggregates

ix) Processed Material Storage Area

x) Material Testing / Administrative block buildings

5.6.3. Processing Facility - Features

i) Processing or recycling site shall be fenced or hedged and provided with proper gate to monitor incoming vehicles or other modes of transportation.

ii) The crushing plant shall be fully enclosed in a brick/concrete walled building

iii) Adequate water storage facilities and water sprinkling and dust suppression systems have to be provided in the plant.

iv) The waste received, the waste processed, the products and the rejects shall be correctly quantified using weighbridge.

v) The owner of the facility shall prepare annual reports as per the prevailing rules and submit to the local bodies & the PCB.

vi) There shall be earmarked areas for parking vehicles and carrying out vehicle cleaning operations.

vii) The approach and or internal roads shall be concreted or paved so as to avoid generation of dust particles due to vehicular movement and shall be so designed to ensure free movement of vehicles and other machinery

viii) Utilities such as drinking water and sanitary facilities (preferably washing/bathing facilities for workers) and lighting arrangements for easy landfill operations during night hours shall be provided and Safety provisions including healthinspections of workers at landfill sites shall be carried out.

ix) Provision of storm water drains to prevent stagnation of surface water

x) Fire protection equipment and other facilities as may be required shall be provided.

xi) Provision for the prevention of noise pollution from processing and recycling plant

xii) Provision for treatment of effluent if any, to meet the discharge norms as per KSPCB standards

xiii) Work Zone air quality at the Processing or Recycling site and ambient air quality at the vicinity shall be monitored.

xiv) The measurement of ambient noise shall be done at the interface of the facility with the surrounding area, i.e., at plant boundary.

xv) A vegetative boundary shall be made around Processing or Recycling plant or site to strengthen the buffer zone.

xvi) Pollution control measures as specified in the CPCB Guidelines on Environmental Management of C&D wastes shall be adhered to.

xvii) SOP- Siting requirements and pollution control measures in construction & demolition waste processing plants by Kerala Pollution Control Board No. PCB/HO/SEE-3/ TECH/139/2022 dated 04/04/2022 shall be adhered to. Pollution control measures to be adopted at a processing facility shall be as per PCB guidelines and include the following measures:

- Adequate number of sprinklers & dust suppression systems shall be provided.
- A minimum water storage facility of 10,000 litres per day shall be provided.
- Facilities for treatment of wash water including settling tank and sludge drying facilities for the sludge settled in the settling tank shall be provided.
- Green belt with suitable species of trees/curtain plants shall be provided within and along the boundary of the premises.
- Fire fighting/protection equipment may be provided on the site.

5.6.4. Equipments used in Processing Plant



Figure 5.6: Aggregate Washing System



Figure 5.7: Screener

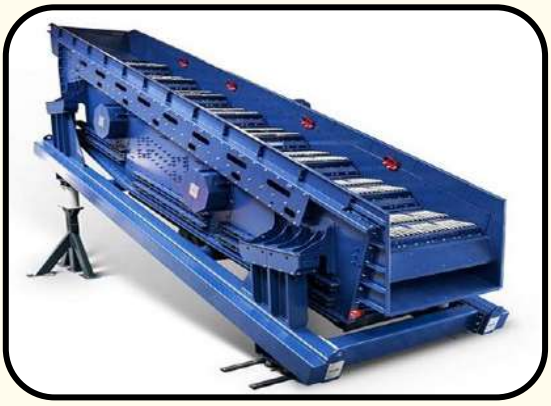


Figure 5.8: Screener



Figure 5.9: Sand Washing System– Bucket Wheel

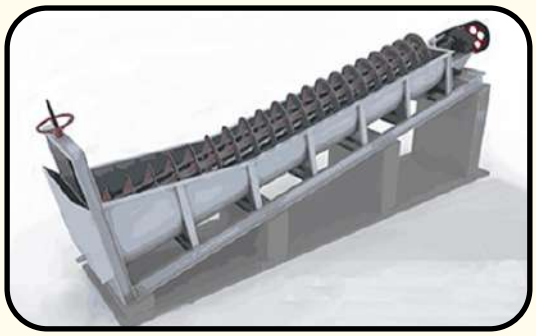


Figure 5.10: Sand Washing System- Spiral



Figure 5.11: Thickener



Figure 5.12: Hydroclone



Figure 5.13: Filter Press

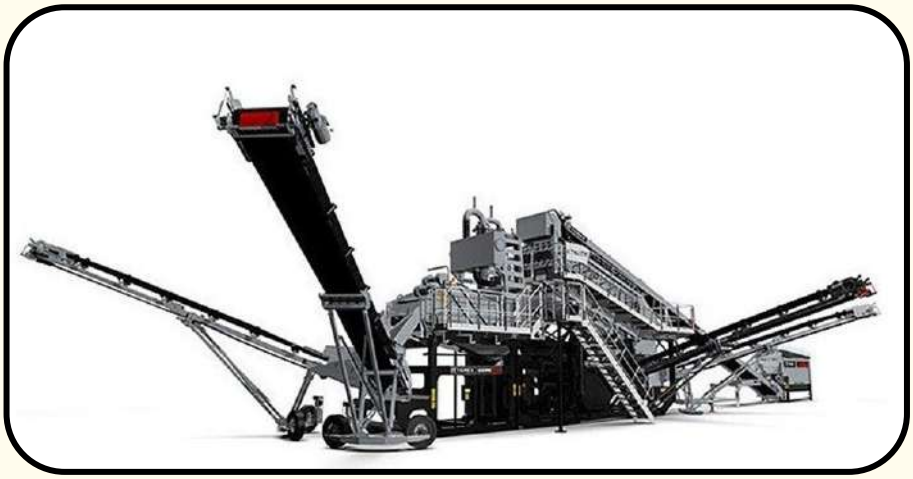


Figure 5.14: Washing System

5.7 DIFFERENT METHODS FOR C&D WASTE PROCESSING

C&D waste can be processed through Wet and Dry Processing Methods. As in the name indicates that the wet process needs water to clean the aggregates wherein dry, air is used.



Figure 5.15 : Dry Processing & Wet Processing

5.7.1. Advantages of Wet Processing Over Dry Processing

- Wet waste processing increases dust control when compared with dry processing.
- Wet processed aggregates have good bonding strength when used in cement concrete when compared with dry processed aggregates since the existing dust in the pours is wiped away.
- Wet waste processing increases noise reduction when compared with dry processing
- Material Recovery percentage for wet processing is higher than dry processing
- The water used in Wet processing can be recycled with minimal mechanisms

5.8 THE DIRECT PRODUCT OF RECYCLING OF C&D WASTE

The need for use of virgin raw materials for construction can be reduced as most part of the C&D waste can be recycled to make value added products and secondary raw materials thus Resource Recovery and saving critical resources.



Figure 5.16 : Recycled aggregates from C&D waste

i. **Fine aggregate -** The produce of C & D waste processing i.e. fine and coarse aggregates are good materials for road construction. Road stretches have been already constructed in India using these materials.

ii. **Recycled Concrete Aggregates** - It is derived from concrete after requisite processing of different sizes (5-10 mm, 10-20 mm, 20-40 mm or as required)

iii. **Recycled Aggregates** - It is made from C & D waste, which may comprise concrete, brick, tiles, stone, etc. of different sizes (5-10 mm, 10-20 mm, 20-40 mm or as required)

iv. **Manufactured soil** - The manufactured soil is quite suitable for landfill, landscaping as a substitute of excavated soil. Fine and coarse aggregates are ready raw materials for Ready Mix Concrete plants and construction sites. The manufactured soil is also a good substitute for soil for construction of road and fly over embankments. It saves precious topsoil.

The resultant crushed aggregates can be used as follows:

80mm	–	20mm	: Road works
20mm	–	8.5mm	: Concreting other than for load bearing structures.
8.5mm	–	3.75mm	: As plaster sand
3.75mm	–	0.75mm	: Machine sand (M sand).

5.9 VARIOUS BY PRODUCTS THAT CAN BE MANUFACTURED USING RECYCLED C&D WASTE

i. Tetrapods and other similar structures which can be used for coastal protection (As Kerala is having long coastline, the demand for bulk materials to be used in coastal protection is high and C&D waste recycled products can substitute enormous quantity of natural materials in this aspect)

ii. Bricks, blocks, tiles, hollow bricks, wall tiles.



Figure 5.17 : Recycled Concrete blocks and pavers

iii. Pavers, kerb stones;
iv. Park benches, drain covers, planters, compound wall, fence post, tree guards, tree pit covers, manhole covers, underground cable covers, precast boundary wall panels, poles, etc.

5.10 QUALITY CONTROL

C&D waste recycled product use shall be according to the following specifications/guidelines:

A) IS: 383(2016) Indian Standard COARSE AND FINE AGGREGATE FOR CONCRETE – SPECIFICATION. Utilisation of C&D waste permitted in various concrete works by IS: 383(2016) are as below:

Table 2 : C&D waste utilisation permitted in various concrete works

C & D Waste BIS IS : 383	Plain Concrete	Reinforced Concrete	Lean Concrete (< M15 grade)	Extent of Utilization
Recycled Concrete Aggregate (RCA)	25%	20% (only up to M25 grade)	100%	as Coarse Aggregate
Recycled Aggregate (RA)	nil	nil	100%	as Coarse Aggregate
Recycled Concrete Aggregate (RCA)	25%	20% (only up to M25 grade)	100%	as Fine Aggregate

B) Indian Road Congress has permitted the use of produce of C&D waste processing and has issued IRC: 121-2017 “Guidelines for use of construction and demolition waste in road sector”. The manufactured soil is also a good substitute for soil for construction of road and flyover embankments. It saves precious topsoil. Using processed C&D waste for road construction has the following advantages:

a. Mitigates shortage of raw materials such as coarse aggregates, bitumen, sand, etc., bridging the demand supply gap.

b. Usually it is available closer to the site, especially for construction within or near a city where C&D waste processing facilities can be set-up, thus saving transportation cost for the aggregates.

c. Conservation of natural resources such as river sand, stone aggregates, etc.

d. Saving land required for dumping of C&D waste by its recycling and usage.

5.11 MANDATORY USE OF C&D WASTE PRODUCTS

As and when a C&D waste recycling plant is commissioned in a district and recycled products are available within 100 km from construction site, it shall be mandatory for below listed construction activities to use specified percentage of available building construction materials manufactured from recycled C&D waste.

a. All Government constructions including shall mandatorily use at least 20 percent of recycled C&D waste products.

b. All renovation projects involving demolition, even in the private sector, shall mandatorily use at least 20 percent of recycled C&D waste products.

5.12 C&D PLANTS IN INDIA

1) BURARI, New Delhi

India's first plant for recycling of C&D waste has been commissioned during 2009 at 10 acre site at Burari, Jahangirpuri in North Delhi by Infrastructure Leasing & Financial Services (IL&FS) under an agreement with North Delhi Municipal Corporation. The plant was initially set up to process 500 tpd (tonnes per day) C&D waste. Processing of 1200 tpd was achieved during 2014 and Delhi Pollution Control Committee has awarded the permission to expand the capacity to 2000 tpd.The products being manufactured at this facility are sand, coarse aggregate, Ready Mixed Concrete (RMC), bricks, blocks, curb stones, pavement blocks, hollow bricks etc.

2) SHASTRI PARK, New Delhi

Second plant in Delhi for recycling of C&D waste has been commissioned at Shastri Park in East Delhi at 2.5 acre site to process 500 tpd C&D waste. The plant has been built in partnership with IL & FS, which would run it for 15 years before transferring it to EDMC.

3) AHMEDABAD, GUJARAT

Ahmedabad Enviro Projects Pvt. Ltd. (AEPL) has commenced a 100 tonne per hour capacity plant for recycling of C&D waste in phase wise manner from December, 2013. The plant is fully operational since June, 2014 and is located at Pirana, Ahmedabad.

4) VIKHROLI , MUMBAI

Godrej Construction have commissioned a C&D waste processing plant at Vikhroli during early 2017 to manufacture 36,000 blocks and 54,000 pavers per day by using the produce of processed C&D waste.

SPECIAL WASTE

6 POULTRY WASTE

"Poultry" refers to live birds belonging to domestic fowls, turkeys, geese, ducks, guinea-fowls, pheasants, and quails. Poultry waste encompasses various byproducts of poultry farming, including chicken waste such as feathers and deceased chickens.

6.1 POULTRY MEAT STALL

A "poultry meat stall" refers to establishments such as shops, outlets, or other business premises designated for the slaughter, handling, and sale of poultry meat. These stalls are required to adhere to infrastructure standards, as well as sanitary and hygiene regulations outlined in the guidelines specified in GO (Ms) No. 227/2021/LSGD -GUIDELINES FOR LICENSING POULTRY MEAT STALLS AND POULTRY WASTE RENDERING PLANTS. Owners of poultry meat stalls are obligated to comply with the rules and responsibilities stipulated in the aforementioned government order.

Furthermore, poultry stalls are mandated to obtain a licence from the Localbody and enter into agreements with authorised rendering plants. Poultry waste generated on their premises must be disposed of by delivering it to authorised rendering plants in accordance with regulatory requirements.

6.2 QUANTITY OF WASTE GENERATED

Table 6.1 : Quantity of Waste Generated

Type of Animal	Waste Generation (% of Total Body Weight)	Breakdown of Inedible Components
Large Animals	27%	-
Small Animals	17%	Bones: 8%, Blood: 1%, Intestine : 5-6%
Poultry	25%	Inedible Waste : 25%

(Ref-KSPCB Revised Standard Operating Procedure for Rendering Plants no. PCB/HO/SEE3/TECH/ 80 / 2019 dated 10/11/2021.)

6.3 MANAGEMENT OF POULTRY WASTE

The management of poultry waste generated at the meat stall involves daily transportation of the waste to rendering plants that have been approved by the District Level Facilitation Monitoring Committee (DLFMC). This process ensures that the waste is properly disposed of and processed in accordance with regulatory standards and environmental guidelines.

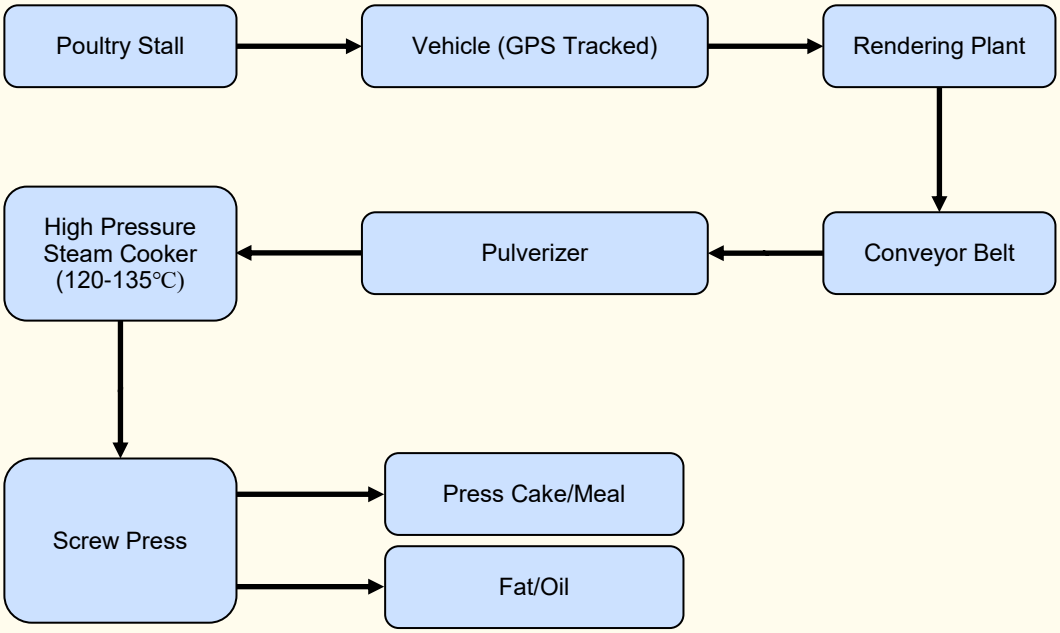


Figure 6.1: Poultry waste management process flow

6.4 RENDERING PLANTS

Rendering plants specialise in processing various waste materials, including bone, lard, tallow, and slaughter wastes from animals and chickens. At a rendering plant, these raw materials are subjected to a series of processes aimed at converting them into useful products.

One of the main products obtained from rendering plants is protein meals. During the rendering process, the raw materials undergo cooking and extraction methods that separate the protein-rich components from the waste materials. These protein meals, which contain valuable nutrients, can be used as ingredients in animal feed and other applications. By transforming animal and chicken waste into protein meals, rendering plants contribute to sustainable waste management practices and the production of valuable resources for various industries.

6.4.1. Rendering Plant Process

In the rendering plant, the raw material (animal/chicken waste) is transferred to a conveyor and discharged into a magnetic separator for removal of ferrous materials. It is then pulverized to uniform particle size and then treated in a cooker to temperature in the range 120^0C to 135^0C with adequate pressure based on the capacity of the cooker. At this temperature, the moisture gets evaporated and fat separates from bone and protein.

Dehydrated slurry of fat & solids is discharged from the cooker. It is then sent to the screw press where the solid's fat content is reduced to 10-12%. The solids that bypass the screw conveyor are returned to the cooker. The solids discharged from screw press are called press cake and are used for making the meal. Fat removed from the screw press is discharged into the centrifuge which removes the impurities in the fat. As per KSPCB SOP DATED 10.11.2021, for poultry, waste pre breaking is optional and can directly be taken to the cooker through conveyor. Fat press is also optional, as the poultry meal with fat is preferred for using it as a feed ingredient.

There are other rendering processes also like microbial fermentation of waste using steam. Some units used dryers instead of cookers (or a combination of drying & cooking) and then pressed and milled to obtain the meal while the fat from the press is decanted/centrifuged to obtain tallow.

All the animal matter wastes such as inedible offal, tissues, meat trimmings, waste and condemned meat, bones etc. can be processed in the rendering system. The main constituents of animal matter are fat, water and solids. The objective of the rendering process is to physically separate the fat, the water and the solids. This is effected by heating and rupturing connective tissue of individual fat and muscle cells so that raw fat and other material bound within is freed. In rendering, fat recovered is used for industrial purposes, such as soap and greases. Fat recovered from flesh of healthy parts can also be used for edible purposes. Solid portion, which is known as meat meal or bone meal, is utilised for the manufacture of stock feed and fertilisers. Rendering is carried out in dry rendering or wet rendering plants. In both the processes, large pieces such as heads, bones etc are reduced in size by shredders or other machinery. Large soft offals are also cut to size before processing.

6.4.1.1. Wet Rendering

The name wet rendering is applied where the raw material is processed with added water or condensate derived from steam. The wet-rendering tank is usually a vertical, cylindrical boiler, having a cone-shaped bottom, with a gate valve outlet.

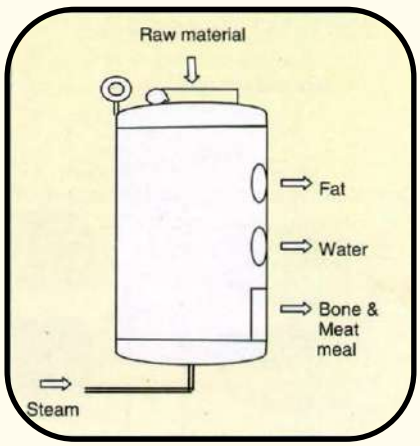


Figure 6.2: Typical batch-type wet rendering plant.

At the top of the tank there is a manhole through which raw material is loaded, and also a valve through which obnoxious gases escape without reducing the pressure. Steam is injected from the bottom of the tank. Several draw-off cocks on the side of the tank, at different levels, enable the fat and water to be removed .

After the raw material is loaded, the manhole is tightly closed and steam is let into the mass. The steam pressure used will vary with the material. The higher the pressure, the quicker the disintegration. For this reason, large plants often render the offal at a pressure of 4 kg/cm^2. However, high pressure may reduce the quality of the material, especially of the fat. For this reason, a pressure of 3 kg/cm^2 is usually maintained in the tank.

The time required to disintegrate the tissue and free all the fat varies from four to six hours, depending on the character of the offal. After cooking is completed, the contents of the tank are allowed to settle for about two hours.

After settling, clean divisions are formed between the digested material, water and fat. The fat, having the lowest specific gravity, will be on the top, the sludge and solids having the high specific gravity will be at the bottom. The center will be occupied by water. Gradually the pressure is reduced to that of the atmosphere, and then the water and fat are ready to be drawn off through the side cocks. If the fat level is below a cock, the level can be raised as required by addition of water. After the fat and tank water have been removed, the gate valve is opened and the digested mass of meat and bones is taken out. At this stage the mass may contain up to 55 percent moisture and about 15 percent fat which can be dried in the dryer to obtain meat meal or bone and meat meal.

For large operations, integrated continuous rendering plants are used. An integrated rendering plant consists of a pre-breaker, metal detector, fat separator, dryer and hammer mill. Total yield of bone and meat meal by wet rendering system is about 30 percent of raw material weight and tallow about 10 percent.

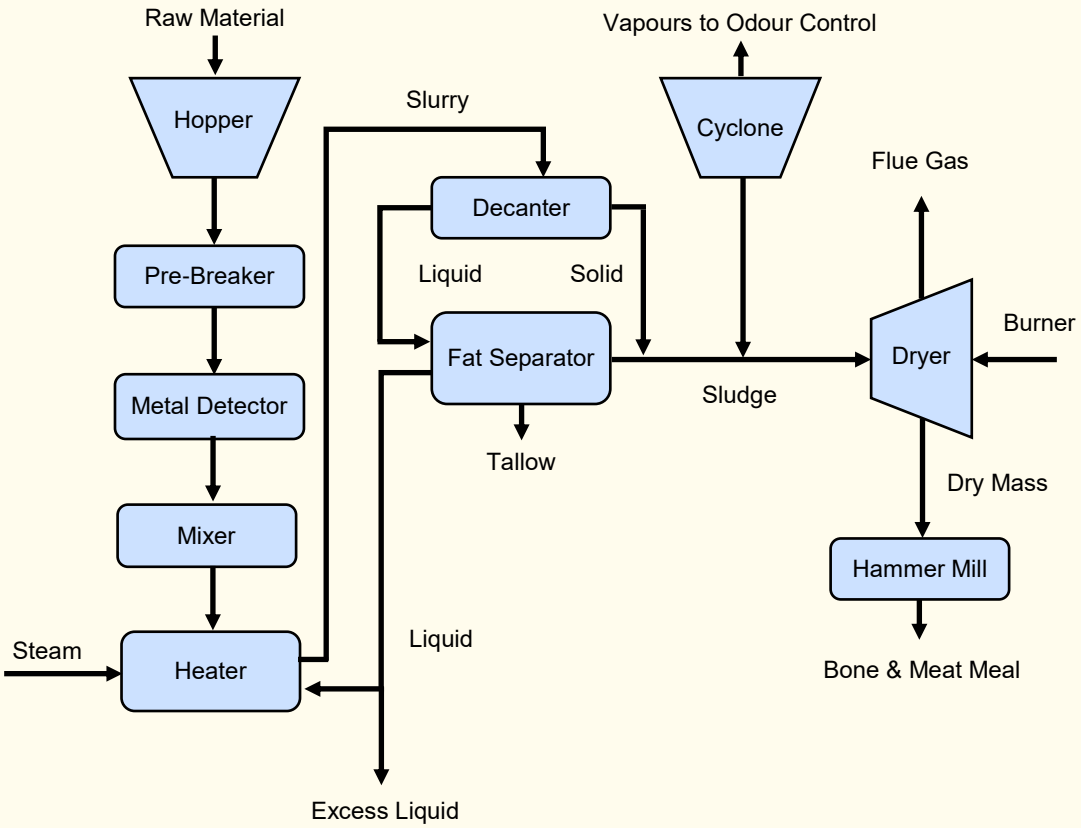


Figure 6.3: Schematic diagram of an integrated wet rendering plant

6.4.1.2. Dry Rendering

In this process, all the unwanted moisture is eliminated from wastes without the loss of any nutrient by using a specially designed cooker. The dry rendering cooker is a horizontal steam jacket equipped with a set of agitators, which keep the material in continuous motion. The steam is applied to the jacket only and not to the material to be . processed, as in wet rendering.

The material remains in the cookers for about 4 to 5 hours in most plants. Steam pressure in the cooker jackets usually ranges from 3 to 4 kg/cm2. The dry heat transmitted from the steam jacket to the raw material converts the moisture present in the material into steam, which gradually builds up the internal pressure of the cooker. This pressure, combined with agitation, disintegrates the material and breaks down the fat cell. Dry rendering therefore works on steam pressure developed from the moisture contained in the raw material itself, and not as in wet rendering, from the pressure created by injected steam.

In the wet-rendering process, the fat floats on top of the liquid and is separated out. In dry-rendering, the fat is released from the fat cells but is still dispersed throughout the material. The fat in the solids may be removed by either a hydraulic press or by using a centrifugal turbine fat extractor.

As seen from the above, the whole process, i.e., sterilisation, digestion, and drying, take place in a cooker only. Therefore, there is no loss of nutrients. The dry rendering process allows approximately 20 percent higher yield than the wet-rendering, as the water containing water-

soluble extractives and proteinous suspended matter is not discarded.The dry rendering plants have units such as metal detector, pre-breaker, cooker, fat extractor and hammer mill.

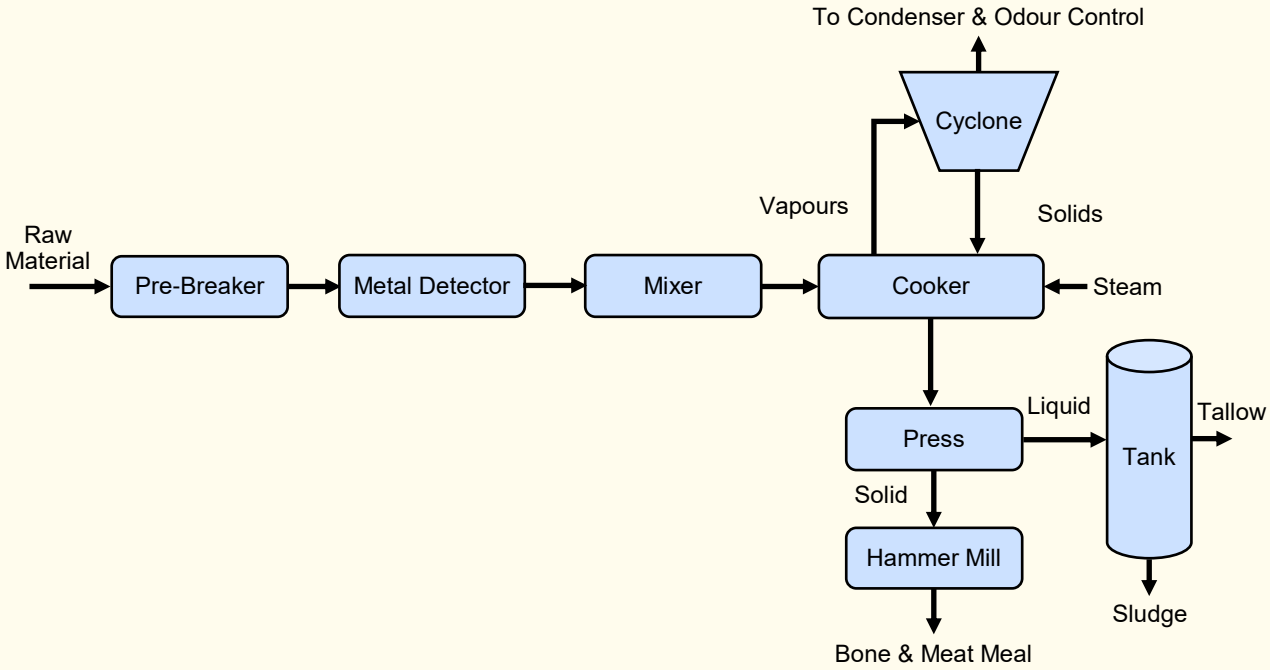


Figure 6.4: Schematic diagram of a typical dry-rendering plant

6.5 DISTRICT LEVEL FACILITATION AND MONITORING COMMITTEE

District Level Facilitation And Monitoring Committee (DLFMC) shall be constituted in each district to regulate the operation of Poultry Waste Rendering Plants based on the quantum of waste generated and to ensure that such facilities are meeting the prescribed design and standards of operation within the respective district/area of jurisdiction.

The structure of the committee shall be as follows;

- District Collector-Chairman
- District Co-ordinator, Suchitwa Mission - Convener
- District Co-ordinator, Haritha Keralam Mission - Member
- Regional Joint Director (Urban) in charge of the district - Member
- Deputy Director of Panchayats- Member
- Representative of Kerala State Pollution Control Board- Member
- Representative from Food Safety Department - Member
- Technical expert nominated by Suchitwa Mission - Member

6.5.1. Establishment of Rendering Plants

Rendering plants shall be established through private agencies after getting approval from DLFMC.

6.6 DUTIES OF RENDERING PLANT OWNERS

Rendering plant owners are required to adhere to the Standard Operating Procedure (SOP) set forth by the Kerala State Pollution Control Board (KSPCB) for the collection, transportation, storage, and processing of poultry waste. This includes following the guidelines outlined in the agreement with poultry meat stalls to ensure the efficient and timely management of poultry waste.

Daily, rendering plant operators must collect poultry waste from the designated meat stalls and transport it to the rendering plant without fail. Once at the plant, they should store and process the waste according to the SOP provided by the KSPCB.

Additionally, rendering plant owners are responsible for fulfilling their obligations as per the agreed-upon terms with the poultry meat stalls. This may include maintaining proper documentation, adhering to environmental regulations, and ensuring the safe and responsible disposal of poultry waste.

Rendering plants must have NOC from the following institutions

- Local Self Government Institutions (LSGI)
- Kerala State Pollution Control Board (KSPCB)
- District Level Facilitation and Monitoring Committee (DLFMC)
- Factories and Boilers Department
- Food and Safety Department

6.7 POLLUTION CONTROL MEASURES

The following are the essential requisites of a rendering plant from pollution angle as per the KSPCB Revised Standard Operating Procedure for Rendering Plants no.PCB/HO/SEE3/ TECH/80/2019 dated 10/11/2021.

1. Rendering Plants can be operated only with the consent of the Pollution Control Board. It is taken under the Red Category.

2. There should be a setback distance of minimum 10 m on all sides from the side walls of the plant to the plot boundaries on all sides.

3. The minimum distance to the existing nearest residences and other existing institutions/ establishments shall be 100 m.

4. A Rendering Plant should have a good network of waste (raw material) collection & transportation systems. It should have a good fleet of vehicles specially designed for the purpose.
5. The vehicles used for the purpose should be closed and refrigerated inside so that foul smell is contained during transportation. For rendering plants collecting waste from within a 20 km radius, refrigeration is not insisted.
6. Vehicles should have a fully closed chamber with stainless steel lining.
7. The vehicles should be GPS tagged and should take the shortest route to the plant so that the waste material is conveyed to the plant in the shortest time. In case of non-refrigerated storage and transport of offal, it should reach the rendering plant within 4 hours of generation. As there are practical difficulties in transferring the waste within 4 hours, a freezer facility is preferred.
8. The unit should maintain a complete register for recording the movement of each vehicle. Vehicles should be affixed with stickers "Slaughter wastes to Rendering plants" and address with contact number of the rendering plant. The vehicle should have a uniform colour code to identify the vehicle. The rendering plant owner should arrange immediate removal of waste in the case of breakdown of vehicles during transportation. All vehicles and offal containers must be washed with hot water or with mild soap solution, on every delivery.
9. The feeding area to the raw material holding tank shall be fully enclosed so that complaints due to odour are prevented.
10. Processing should be done as quickly as possible on receipt of raw material. Enclosed areas with freezer facilities shall be provided if storage of raw material is required. Capacity of the cold storage tank should be the capacity of the rendering plant per day. If due to breakdown, the storing capacity is 100%, then further receipt of raw materials shall be stopped and waste distributed to other rendering unit with prior information to the concerned Pollution Control Board office & LSGI.
11. The Rendering Plant should essentially have a system for collection of odorous gases generated at various points in the plant. The odorous gases thus collected shall be treated in an odour control system like bio-filter, carbon filters or scrubber system. Gas Incinerators (heating the exhaust gas to 850^0C) are the best option to destroy odour. The incinerated gases can be let out through exhaust pipes at roof level of the building in which it is installed.
12. The odour level at I m from the boundary of the unit shall be below detectable level when measured with Olfactometer.
13. A typical rendering plant generates waste water from the following sources: vehicle

equipment, serum water from blood processing etc. This results in wastewater with high BOD (of the order of 250-750m9/l), oil & grease (of the order of 150-l000mg/l), COD of the order of 1000-4000 mg/l). It may also contain high concentration of ammoniacal nitrogen and very high concentration of coliform bacteria. Hence Effluent Treatment Plant of primary, secondary (including UASB followed by aerobic treatment) & tertiary treatment (including disinfection) is highly essential.

14. Precautions are to be taken like netting /fencing the area to prevent the entry of birds/stray dogs/rodents in the premises.
15. Green belt (preferably herbal) should be created by planting canopy trees around the plant.
16. Good practices like packaging, labelling and correct storage of products shall be ensured. Storage facility for keeping product should be provided for at least 7 days production.
17. Should have a predetermined maintenance schedule of equipment to ensure that all the equipment's are functional with maximum possible efficiency.
18. Raw material that is suspected of being contaminated with chemical hazardous substances such as used- mineral oils and other potential sources of high levels of PCB or dioxin must not be used to make rendered products that may be used as animal-feed ingredients.
19. Spillages should be cleaned up without delay. Any spillages of cooked material should be considered to be contaminated and be reprocessed through the heat treatment.
20. Floor sweepings or material dislodged from equipment during cleaning should be collected and reprocessed through the heat treatment.
21. Records of receipt of raw materials should be maintained and should include date of receipt, supplier name & quantity and shall be produced to the Board officials for verification on demand.
22. Records of despatch of finished materials should be maintained and should include date of despatch, destination of products, customer name & quantity and shall be produced to the Board officials for verification on demand.
23. Rendering is an approved technology for processing slaughter waste, Dumping, land filling, digestion in biogas, are not permitted.
24. Waste generated in each district should be quantified. No waste should be transported from one district to another for processing, except in following cases and subject to the approval of the District Level Facilitation & Monitoring Committee (DLFMC).

    a. Rendering plant situated in a different district is at a shorter distance than the plants in the same district.

b. Rendering plants in the same district is not having sufficient capacity.

c. In cases of breakdown of plants.

d. In other cases, as per approval of concerned DLFMC's (District Level Facilitation & Monitoring Committee).

e. Under any circumstances, waste should not be transferred to other states.

25. Provision for washing the bins/trays should be provided at the site.

26. ETP should have sufficient capacity for processing wash water (generated during washing of vehicles carrying waste) too.

27. The district level facilitation monitoring committee (DLFMC) constituted as per the Hon'ble NGT order in O.A no.606 of 2018 shall monitor the activities. In case of transfer of waste to different districts the DLFMC of both the districts are to be alerted.

28. Unauthorised waste collection should be stopped. For this, DLFMC shall monitor the activities.

29. In the case of carcasses of stray animals, littered on road side, or other public places, the nearest rendering unit shall process such carcasses after informing the concerned local body.



Figure 6.5: High pressure steam cooker in a rendering plant



Figure 6.6: Powdered output after rendering operation



Figure 6.7: Rendering plant setup at Mattannur, Kannur

SPECIAL WASTE

7 SANITARY WASTE

Sanitary waste as per the Solid Waste Management Rules, 2016 means wastes comprising of used diapers, sanitary towels or napkins, tampons, condoms, incontinence sheets, and any other similar waste. Safely managing sanitary waste is essential to protect public health and the environment. Sanitary waste can carry harmful pathogens and bacteria that pose a risk of disease transmission if improperly handled. Safe disposal prevents contamination of water bodies, soil, and air, reducing the risk of spreading infections and harmful pollutants. Proper management also ensures the protection of waste workers who handle these materials, minimizing their exposure to health hazards. Moreover, it supports hygiene and cleanliness in communities, contributing to a healthier and more sustainable living environment.

Sanitary products can be classified into three: Non-compostable disposable products, Compostable products and Reusable products. Of this, compostable means compostable under specified testing facilities and reusable means clothes, menstrual cups etc that can be reused.

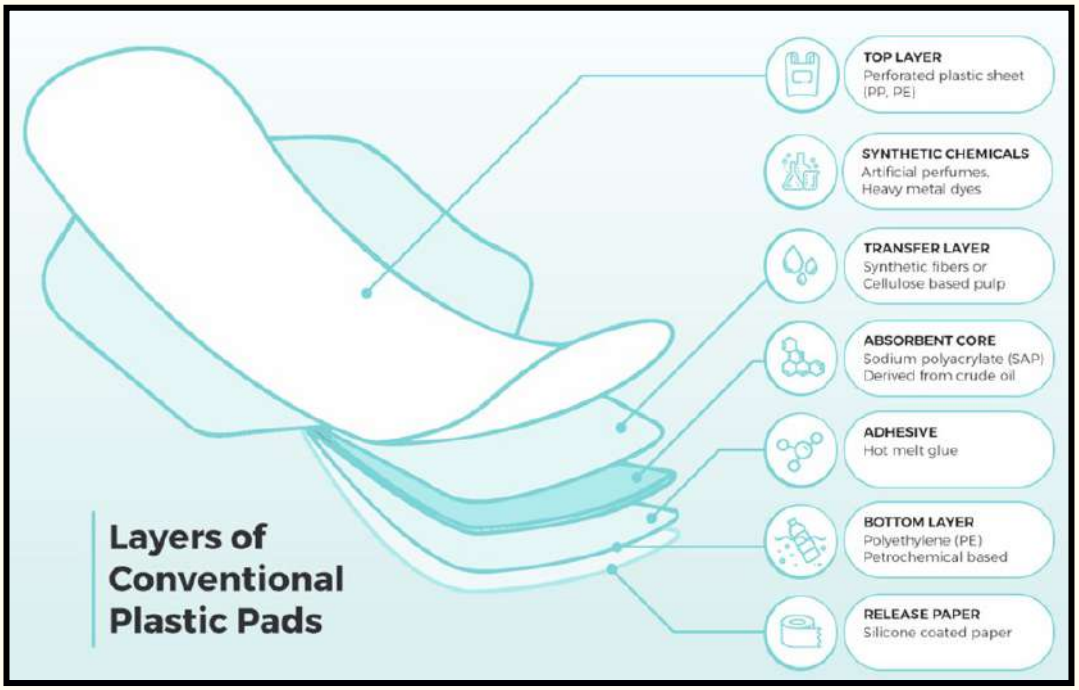


Figure 7.1: Components of a Non-Compostable Sanitary Napkin



Figure 7.2: Reusable Menstrual Cups

7.1 APPLICABLE RULES & GUIDELINES

1. Solid Waste Management Rules, 2016.
2. Guidelines for Management of Sanitary Waste, CPCB - 2018.
3. Guidelines for Bio-medical Waste Incinerator (Revised Draft), CPCB - 2017
4. Bio-Medical Waste Management Rules, 2016

7.2 WASTE QUANTIFICATION

The following methodology may be adopted for the quantification of sanitary waste generated in a local body. Major sources of sanitary waste generation in a region are

a. Palliative care patients

i. Let the no. of palliative care patients using diapers be 'a'

ii. Assuming an average 3 diapers are used per day per patient

iii. Taking the approximate weight of a wet adult diaper as 400 g

iv. Total waste generated per day **(w1**)= a x 3 x 400 g

b. Children less than 5 years old using diapers

i. No of children less than 5 years using diapers: 'b'

ii. Assuming an average 4 diapers are used per day per child

iii. Taking the approximate weight of a wet child diaper as 250 g

iv. Total waste generated per day **(w2)** = b x 4 x 250 g

c. Adolescent girls and women

i. Usually, used sanitary napkins and tampons are generated for 6 to 7 days each month

ii. No of adolescent girls and women using sanitary pads: 'c'

iii. Assuming an average of 3 pads are used per day per person during the menstruation cycle.

iv. Taking the approximate weight of the wet pad as 15 g

v. Total waste generated per day during menstrual cycle **(w3)** = c x 3 x 15 g

The used masks generated at houses must be collected in a yellow-coloured non-chlorinated plastic bags and sent to common bio-medical waste treatment storage and disposal facilities (BMWTSDF) or community-level sanitary waste incinerator facilities for safe disposal.

Estimation of the weight of used masks (generated from houses), condoms and any other similar waste

Assuming 5% of the total population uses 2 masks daily

1. Taking per piece mask approximate weight as 4gm
2. Total weight of used mask waste generated per day,

   (m) = 5 % population x 2 x 4 g

3. Assuming that an equal quantity of condoms and any other similar waste is generated = (**m)**
4. Therefore, the approximate weight of used masks (from houses), condoms and any other similar waste generated per day **(w4)** = 2 x (m) g

Table 7.1: Daily Disposal Capacity of Community-Level Sanitary Waste Incinerators

Capacity of community-level sanitary waste incinerator	The approximate **number of** sanitary waste that can be disposed of per day (taking the weight proportion of sanitary pads: baby diapers: adult diapers from a region as 15:60:25)		
	Sanitary Pads	**Baby Diapers**	**Adult Diapers**
500 kg/day	5,000	1200	300
1 Tonnes/day	10,000	2400	625
2 Tonnes/day	20,000	4800	1250
5 Tonnes/day	50,000	12000	3125

Once the waste generation for an area is quantified, the collection and transportation plan needs to be worked out. The following methodology may be adopted while designing sanitary waste collection and transportation plans for an area.

7.3 COLLECTION AND TRANSPORTATION

The responsibility for collecting, storing, and disposing of sanitary waste falls to Local Self-Government Institutions (LSGIs) in accordance with the Solid Waste Management (SWM) Rules, 2016. To promote awareness, LSGIs must conduct Information, Education, and Communication (IEC) programs to educate residents on the importance of source segregation and hygienic handling of sanitary waste. Safe disposal of sanitary napkins at institutions can be facilitated using Pollution Control Board (PCB)-approved devices. For community-level sanitary waste management, collection bags should be distributed to all sources of sanitary waste within the local body to support segregated collection.

The collection process may be managed by a dedicated Harita Karma Sena (HKS) team or assigned private agencies. Workers handling sanitary waste must use personal protective equipment (PPE) such as gloves and masks. Collection routes should be based on the estimated waste generation in the area, and each team should consist of a driver and a collection personnel, along with a designated waste collection vehicle. Receipts should be provided to waste generators at the time of collection, and collected sanitary waste must be directly transported to double-chambered incinerators for incineration. Data on sanitary waste collection and processing should be maintained by both the processing facility and LSGIs, with regular reporting to the Kerala State Pollution Control Board (KSPCB).

To create an effective collection and transport system, the following steps are recommended:

1. Enumeration of Generators: Identify the households and institutions producing sanitary waste, including items like sanitary pads, adult diapers, and baby diapers.
2. Frequency Assessment: Determine how often sanitary waste is generated from each source. For example, used sanitary napkins and tampons are usually generated for 6 to 7 days each month, whereas diapers are generated daily.
3. Regular Collection: Sanitary waste must be collected regularly from identified sources.
4. Provision of Collection Bags: Provide non-chlorinated plastic bags to sanitary waste generators to facilitate safe collection.
5. Route Planning: Develop a designated collection route to cover all waste-generating units efficiently.
6. Use of Covered Vehicles: Utilize dedicated vehicles with GPS tracking and proper sealing mechanisms to contain odors during transport.

7. Prompt Disposal: Transport collected sanitary waste directly to the disposal facility as soon as possible.
8. Weighing and Record-Keeping: Weigh the collected waste and log it in the accounting system before incineration.

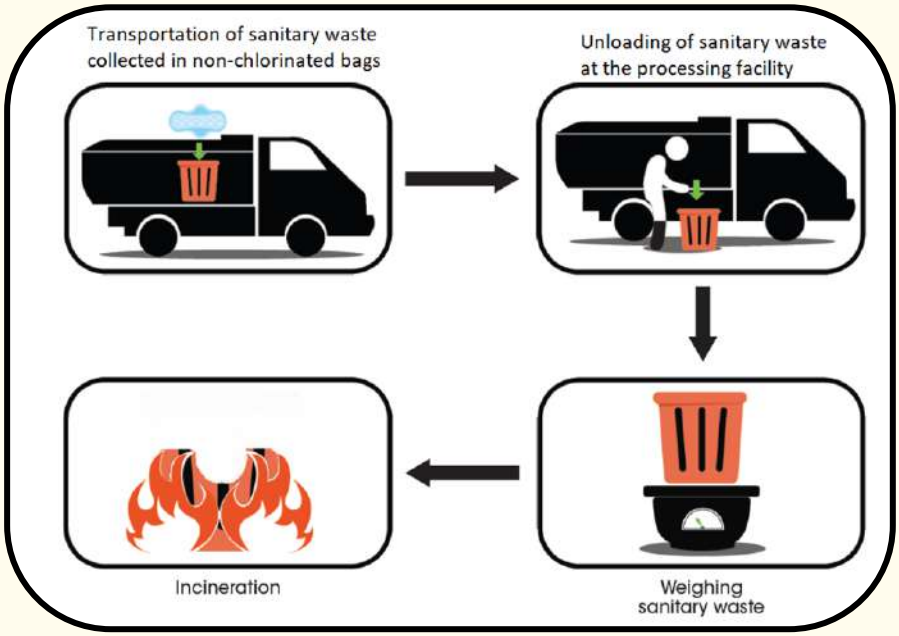


Figure 7.3: Sanitary Waste Transportation

7.3.1. Collection Bags

To ensure safe handling and disposal of sanitary waste, **"non-chlorinated"** plastic collection bags need to be supplied. As per SWM Rules, the bags shall be supplied by the Producers or Brand Owners for safe collection. These bags shall allow the sanitary waste to be disposed of directly into the waste disposal chamber for incineration, without the need to open the bags, thereby minimizing human contact with the waste.



Figure 7.4: Sanitary Waste Collection Bag & Bin

7.3.2. Usage of Haritha Mithram App or Other Mobile Applications

Sanitary waste has a distinct characteristic in that it is not generated daily. Used sanitary napkins and tampons are typically produced for 6 to 7 days each month during the menstrual cycle, whereas adult and infant diapers are generated daily. Consequently, daily waste collection may not be feasible. To overcome this challenge, a solution involving mobile apps, such as the Haritha Mithram App or similar applications, can be implemented to streamline waste collection and management.

These apps can function as a tool to notify or alert authorized sanitary waste collection agencies regarding the waste generation. This allows the collection team to plan the collection route. In the initial phase, before a dedicated mobile app is developed, this system can be implemented using WhatsApp groups. WhatsApp provides a convenient platform for communication and coordination, enabling authorized collection agencies to receive timely alerts and updates about waste generation and collection requirements. This approach ensures efficient waste collection without the need for regular physical checks and serves as a practical interim solution until a dedicated mobile application is launched.

7.4 PROCESSING AND DISPOSAL

7.4.1. Institutional-level Sanitary Waste Incinerator

Institutional-level sanitary incinerators are used to dispose of sanitary pads generated at the institutional level such as hostels, schools, colleges, offices etc.

Only PCB-approved devices shall be used for this and an annual maintenance contract (AMC) shall be entered into for its proper operation. These shall be installed close to toilets and the vent pipe shall be installed as per KSPCB norms.



Figure 7.5: Institutional level sanitary pad incinerator (indicative figure)

Specifications of institutional level electric incinerators for managing sanitary waste as per CPCB guidelines are as follows:

Table 7.2 : Specifications/ Pollution Control Norms

Electric Incinerators (Institutional Level)	
Type of waste that can be processed: Sanitary Napkins **Where to Use:** Girls toilets, Community toilet complexes, Malls, Society Complex etc.	• Ensure complete burning of napkins. • Ensure instant disposal in a scientific and hygienic way with fully automatic way and burn completely. • Burns 150 to 200 napkins/day, can be programmed for cycles/ day • Self-disposal by user by directly putting into the incinerator. • Ash generation should not exceed more than 5% per napkin • Ash should be collected in a separate tray and ensure stacked on that tray. • Auto power & thermal cut-off and automatic temperature maintenance should be there for the safety of the user. • Inside refractory lining should have excellent heat retention to avoid thermal loss. • The residence time for gaseous products in the combustion chamber shall be designed to be at least 2 seconds to ensure complete combustion. • The emission from incinerators shall comply with the General Emission Standards mentioned under Standard for Incineration section in SWM Rules, 2016.

7.4.2. Community-level Sanitary Waste Incinerator

For community-level sanitary waste disposal facilities, a double chamber-based thermal process is recommended and the same needs to obtain consent from KSPCB. All types of sanitary pads (those with high cellulose content, high moisture content, and those with super absorbent polymers), baby and adult diapers can be incinerated in a community level double chambered incinerator facility. The collected sanitary waste needs to be transported to the centralized facility where it will be tipped into a storage area located near the sanitary waste disposal plant. Skilled workers and the sanitary incinerator operator will then take charge of the waste to ensure its proper destruction. Proper quantification of sanitary waste should be done before fixing the capacity of the plant.

Temperature: All these facilities shall be designed to achieve a minimum temperature of 1050 °C + or - 50^0C in the secondary chamber with a gas residence time of not less than 2 seconds. The temperature of the primary chamber shall be a minimum of 800 ^{0}C (as per the CPCB Guidelines for Bio-medical Waste Incinerator, 2017). There shall be facilities for display of temperatures in both chambers. Once the required temperature is attained, there should be a facility for automatic cut off in both the chambers. Once the temperature drops below required level, there should be a facility for automatic restart.

Ash: Ash generated during the incineration process needs to be transferred to secured landfill facilities like that operated by KEIL at Ambalamedu-Ernakulam and there should be appropriate temporary storage space for ash earmarked at the sanitary waste processing facility before transporting it to a secured landfill.

Waste Water: Wastewater generated at the processing facility should be properly managed using an Effluent Treatment unit and the treated water meeting the standards can be reused for operational purposes.

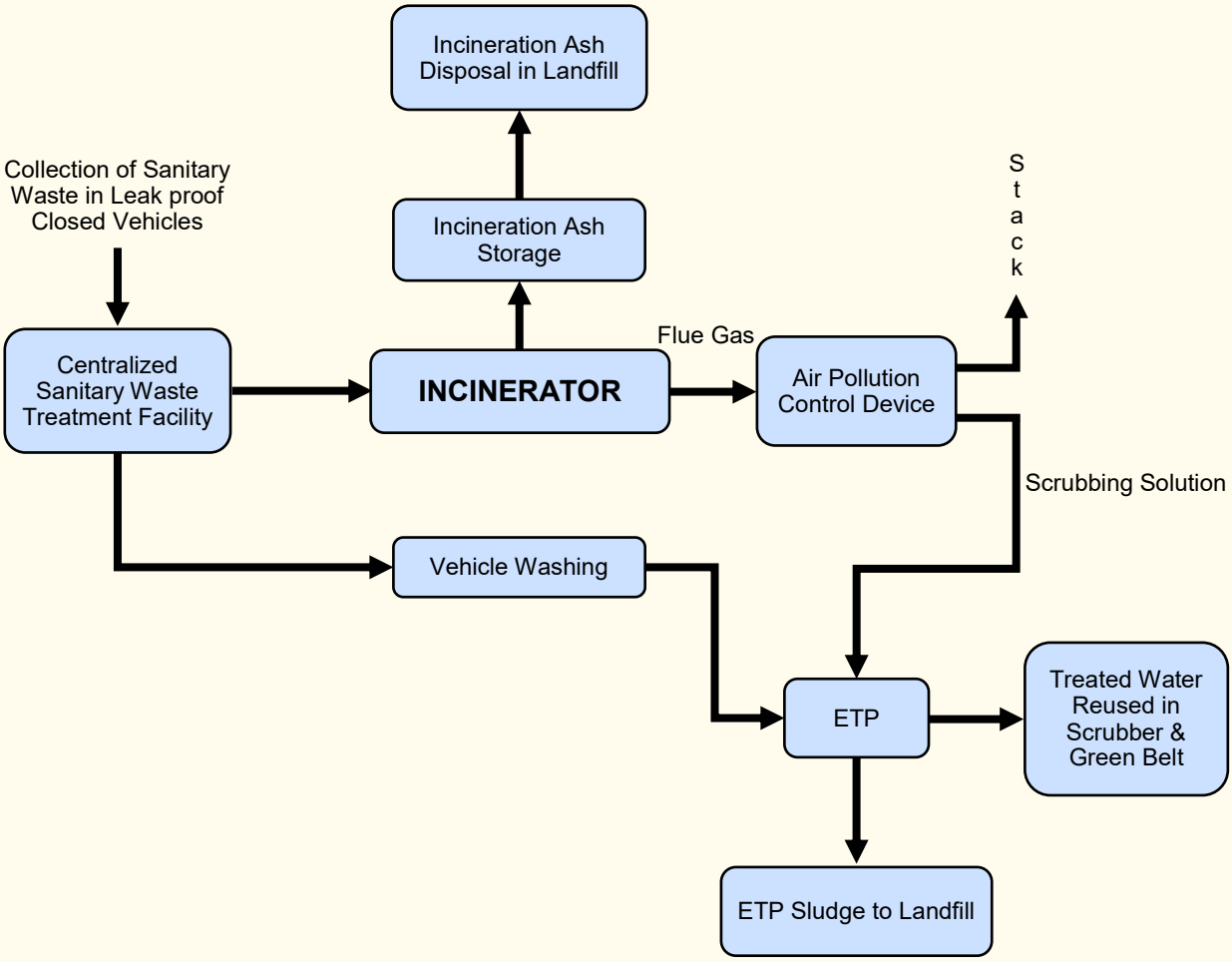


Figure 7.6: Community-level sanitary waste incineration process flow

Specifications of High-Temperature incinerators for processing sanitary waste as per CPCB guidelines are as follows:

Table 7.3: Specifications and Guidelines for Community-Level High-Temperature Incinerators

High-temperature Incinerators (Community Level)	
Type of waste that can be processed: Adult and baby diapers, sanitary napkins, and all types of incinerable domestic bio-medical waste **Where to Use:** Community-level sanitary waste disposal facility	• The incinerator shall be designed for capacity more than 50 kg/hr. • The double chamber incinerator shall preferably be designed on "controlled - air" incineration principle, as particulate matter emission is low in such an incinerator. Minimum 100 % excess air shall be used for overall design. • No incinerator shall be allowed to operate unless equipped with Air Pollution Control Device (APCD). • The incineration ash shall be stored in a closed sturdy container in a masonry room to avoid any pilferage. • Finally, the ash shall be disposed of in a secured landfill. • Emission control measures must be followed as per Schedule II of the Bio-medical Waste Management Rules, 2016, notified under the Environment (Protection) Act 1986. • A skilled person shall be designated to operate and maintain the incinerator.

The location, structural design etc. of the incinerator shall be as per the guidelines of Bio-medical Waste Rules, 2016, published by CPCB under Guidelines for Bio-medical Waste Incinerator, 201, which are as listed below:

1) The size of the opening through which the waste is charged shall be larger than the size of the waste bag to be fed.
2) The waste shall be fed into the incinerator in small batches (about 15-20 % of total capacity of the incinerator) or as recommended by the manufacturer, depending on the capacity of the incinerator.
3) The volume of the primary chamber shall be at least five times the volume of one batch.
4) The size of the secondary chamber shall be properly designed so as to facilitate a minimum of two seconds residence time to ensure combustion of the gas flow, unburnt

material such as volatiles, smoke and soot. For the estimation of residence time in the secondary chamber its volume shall be calculated starting from the secondary burner tip to the thermocouple.

5) The heat input capacity of each burner shall be sufficient to raise desired temperature in the primary and secondary chambers i.e., minimum of 800 °C and 1050±50°C respectively as prescribed under the BMWM Rules, 2016, within maximum of 60 minutes prior to waste charging. However, considering the life of refractory and also to avoid cracks in the refractory, pre-heating and cooling should be done gradually before and after incineration process.

6) There shall not be any manual handling during charging of waste in to the primary chamber of the incinerator. The waste shall be charged in bags through automatic feeding device at the manufacturer's recommended intervals ensuring no direct exposure of furnace atmosphere to the incinerator operator. The device shall prevent leakage of the hot flue gas & any backfire.

7) There shall be a separate burner each for the Primary & Secondary chamber. One or more separate burners each for primary and secondary chambers may be required depending on diameters of the incinerator chambers to maintain desired temperatures in the incinerator chambers.

8) Incinerator walls shall be protected with insulated fire bricks/refractory system. The refractory lining of the chamber shall be strong enough to sustain thermal shocks i.e., minimum temperature of 1000° C in the primary chamber and 1050 +/- 50 ° C in the secondary chamber. The refractory & insulation bricks shall have suitable thickness each & shall conform to IS: 8-1994 & IS: 2042-2006 respectively.

9) The Incinerator shell shall be made of mild steel plate of adequate thickness (minimum 5 mm thick) & painted externally with heat resistant aluminum paint suitable to withstand temperature of 250°C with proper surface preparation and also the outside surface temperature of the incinerator casing being touched during normal operations should not exceed 45 to 50 °C above ambient temperature and should be provided with a safety measure in the form of a spikes or mesh around hot surface which will prevent direct touch.

10) The materials used in the individual parts of the incinerator shall be heat resistance and shall with stand against the mechanical properties, oxidation, corrosion, etc. Refractory lining of all the hot ducts shall be done with refractory castable & insulating castable. Good quality Ceramic wool shall be used at all hot duct flanges & expansion joints.

11) Structural design of the chimney / stack shall be as per IS: 6533-1989. The chimney/stack shall be lined from inside with natural hard rubber suitable for the duty conditions and shall also conform to IS:4682 Part I-1994 or suitable thickness of Fibre Reinforced Plastic (FRP) lining also be used to avoid corrosion due to oxygen and acids in the flue gas.

also be used to avoid corrosion due to oxygen and acids in the flue gas.

12) The incinerator combustion chamber(s) should be designed for easy maintenance of all internal parts including the refractory and insulation.

13) The sides and the top portion of the primary and secondary chambers shall preferably have **rounded corner** from inside to avoid possibility of formation of black or cold pockets/dead zones.

14) Incinerator chambers shall also be fitted with a suitable provision of **pressure gauges** for measuring the air supply or flow rate. Combustion air measurement through flow transmitter should be provided and the display shall be in Programmable Logic Control (PLC)**.** Air supply in the primary and secondary chamber may be regulated between 30%-80% and 170%-120% of stoichiometric requirement respectively. Primary air shall be admitted near / at the hearth for better contact. Flow meter / suitable flow measurement device shall be provided on the primary & secondary air ducting. The combustion air shall be supplied through a separate forced draft fan after accounting for the air supplied through burners.

15) The pressure in the incineration chambers under all circumstances should be lower than the ambient pressure in the room where the incinerator is installed. A minimum negative draft of 1.27 to 2.54 mm (or rounded to 2 to 3 mm) of WC (Water Column) shall be maintained in the primary chamber to avoid leakage of gaseous emissions from the chamber and for safety reasons.Provision shall be made in the primary chamber to measure the Water Column pressure by means of U-Tube manometer or digital display provision and connected with PLC.

16) The burners shall have

    (a) Automatic switching "off/on" control to avoid the fluctuations of temperatures beyond the required temperature range.

    (b) Each burner shall be equipped with spark igniter and main burner.

    (c) Proper flame safeguard provision of the burner shall be installed

    (d) Burner retracting mechanism in both the chambers to safeguard the burners.

    (e) Provide projected type of observation or view ports (high-temperature glass with a metal closure provision) to observe visual condition of the burning process and waste/ash accumulation in the combustion chamber.

    (f) Neither heat, flame, nor particles should be able to pass through the observation or view port.

    (g) Flame of the primary burner
        - shall be pointing towards the centre of the hearth

- shall be having a length such that it touches the waste but does not impinge directly on the refractory floor or wall
- The secondary burner shall be positioned in such a way that the flue gas passes through the flame.

17) The thermocouple sensor location shall be after tip of the burner and before exit of the incinerator chambers.

18) The incineration system must have an automatic emergency vent designed with a provision of valves and a compressor. The emergency vent shall remain closed and such provision it shall not emit flue gases or leakages during normal operation of the incinerator.

19) Also, the Incinerators (combustion chambers) shall be able to incinerate the waste so as to achieve the Total Organic Carbon (TOC) content in the slag and bottom ashes less than 3% or their Loss on Ignition (LoI) shall be less than 5% of the dry weight.

20) The incinerator should have instruction plate(s) attached in a prominent location on the unit that clearly addresses

- Cleaning ashes and slag from the combustion chamber(s) and cleaning of combustion air openings before starting the incinerator (where applicable) and
- **Operating procedures and instructions**. These should include proper start-up procedures, normal shut-down procedures, emergency shut-down procedures, and procedures for loading waste (where applicable).

21) A tamper-proof PLC (Programmable Logic Control) based control system or SCADA in case of all the upcoming new incinerator with higher capacity (i.e., more than 250 Kg/ hour) shall be installed.

7.4.2.1. Air Pollution Control Devices

Suggested air pollution control devices or treatment scheme for the community level incineration system may comprise of the equipment, in combination, with adequate efficiencies to ensure compliance to the stipulated emission standards as given in schedule-II of the Bio-medical Waste Management Rules, 2016

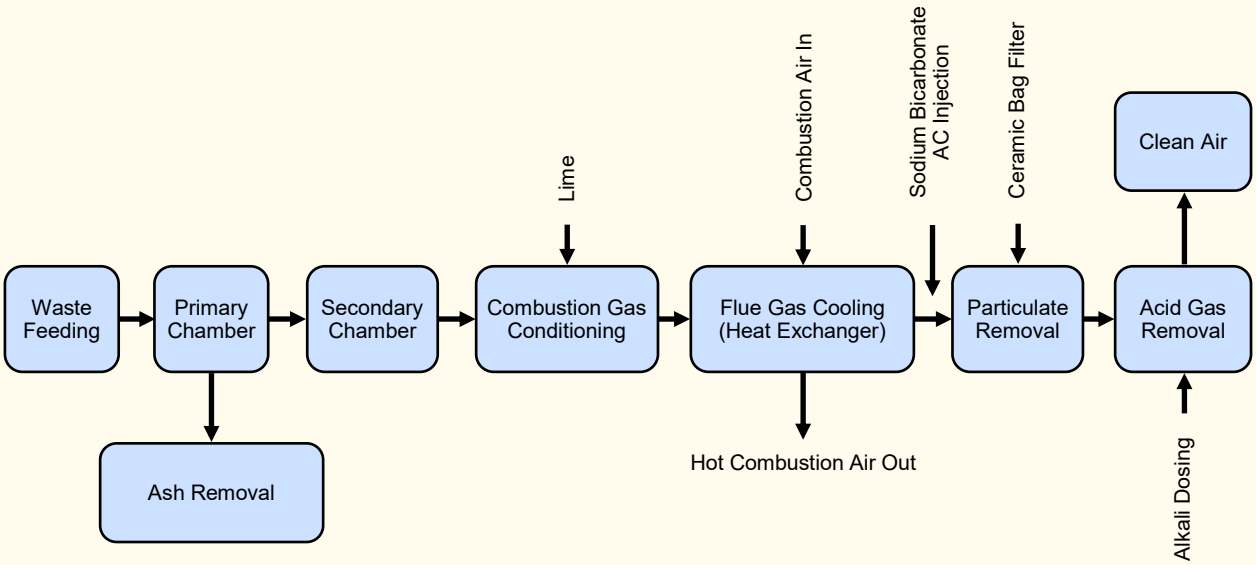


Figure 7.7: Community-level incinerator with dry air pollution control system
(Source: CPCB)

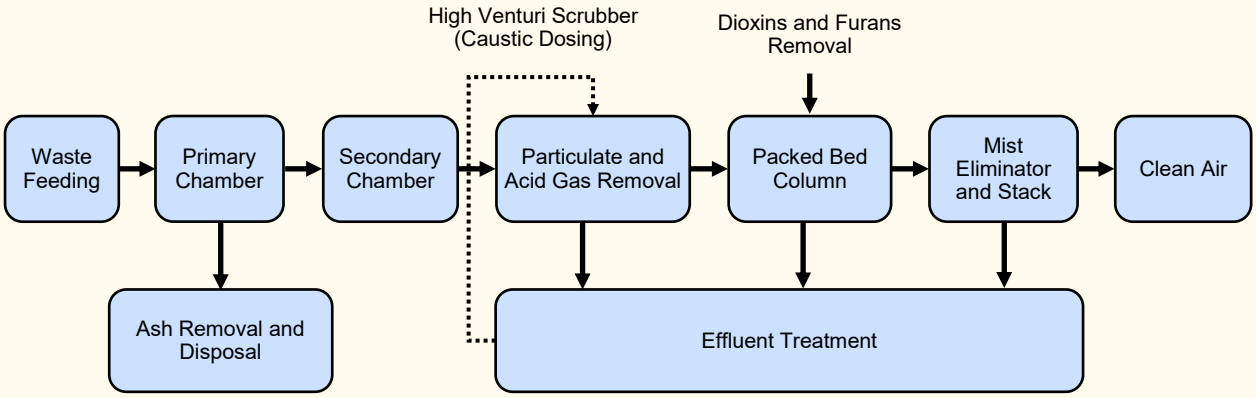


Figure 7.8: Community-level incinerator with wet air pollution control system
(Source: CPCB)

1) There are many combinations of treatment equipment (both wet systems and dry systems or in combination) for enhancement of flue gas cleaning and removal of air pollutants, to comply with the standards. However, in both cases, the exit gas from the secondary chamber should be reduced to less than 220°C in minimum possible time.

2) In the case of wet systems, the material used for the air pollution control systems should be preferably stainless steel to have life and durability of the APCD.

3) In the case of wet air pollution control systems, appropriate treatment to the wastewaters generated from (i) Cleaning of waste storage areas and the facility; (ii) cleaning of exhaust gases shall be provided. Operation of the ETP should be inter-connected with the incineration operation so as to ensure only treated water is recirculated (having pH

around 8) in the APCD for effective cleaning of incinerator flue gas.

7.4.2.2. Effluent treatment plant (ETP)

An ETP is an essential component of the incinerator system, designed to treat and filter water used as a scrubbing medium in the venturi and water scrubber processes. The primary purpose of the ETP is to ensure the proper treatment of scrubbing water, removing contaminants and ensuring its safe and efficient reuse in the scrubber systems.

a. **Treatment Capacity**: The ETP shall have the capacity to effectively treat the volume of water generated from the venturi and water scrubber processes. The system should be designed to handle the flow rate associated with these processes to maintain operational efficiency.
b. **Water Filtration**: The ETP shall incorporate suitable filtration mechanisms to remove particulates, contaminants, and pollutants from the water. Filtration should meet or exceed environmental standards and requirements.
c. **Recirculation System**: The treated and filtered water from the ETP should be efficiently recirculated to the venturi and water scrubber systems for reuse in the fumes filtration process. The design should include pumps and piping systems to ensure the proper distribution of treated water.
d. **Monitoring and Control**: The ETP system should be equipped with monitoring and control instruments to assess the quality of treated water, maintain appropriate treatment parameters, and ensure compliance with regulatory standards.
e. **Safety and Compliance**: Safety features such as spill containment measures should be in place to prevent the release of untreated water.
f. **Materials and Construction:** The ETP system should be constructed using materials that are resistant to corrosion and wear, suitable for prolonged contact with water and potentially corrosive elements. The design and construction should adhere to industry standards for water treatment.
g. **Maintenance and Access:** Provisions for easy access and regular maintenance of the ETP should be included in the design to ensure its continuous and reliable operation. Safety measures should be in place to prevent unauthorized access or tampering with the ETP.

7.4.2.3. Stack emission monitoring provision

The sampling location and other monitoring specification of the porthole, platform ladder (preferably steel scaffolding or spiral stair-case), etc. to collect stack samples from the chimney for monitoring the air pollutants, as and when required shall be as per the CPCBs Guidelines for Stack Emission Monitoring. These facilities shall be maintained safely by the operator. A stack should also be fitted with the aviation lamp at the top.

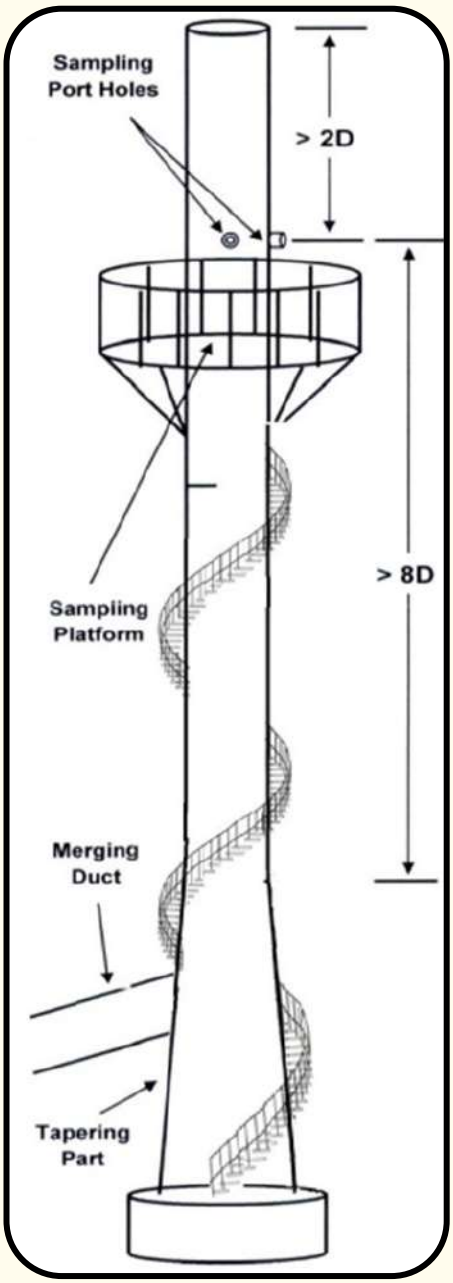


Figure 7.9: Sampling Port for Stack Emission Monitoring

7.4.2.4. Incinerator Room and Waste Storage Room

I. The incinerator structure shall be built in a room with proper roofing and cross ventilation. There shall be a minimum of 1.5 m clear distance in all the directions from the incinerator structure to the wall of the incinerator room.

II. Adjacent to the incinerator room, there shall be a waste storage area. It shall be properly ventilated and washing can be done very easily. The waste storage room shall be washed and chemically disinfected on a daily basis.

III. The floor and inner wall of the incinerator and storage rooms shall have outer covering of impervious and glazed material so as to avoid retention of moisture and for easy cleaning.

IV. The incineration ash shall be stored in a closed sturdy container in a masonry room to

avoid any pilferage. Finally, the ash shall be disposed of in accordance with the BMWM Rules.

7.5 ELECTRICAL SAFETY REQUIREMENTS

a) All the Electrical appliances attached with the incinerator and other machinery should be provided with suitable and necessary safety devices.

b) All cables and wiring should be of copper with insulation and all cable wiring should be in the cable tray.

c) All the workers should be trained properly on electrical safety aspects by the manufacturers and only such trained workers should be engaged for operation of the incinerator.

d) Electrical safety aspects should be maintained as per the Factories Act, 1948

7.6 OFFICE ROOM AND OTHER AMENITIES

Office Room and other amenities for the workers shall also be provided in the plant.

Supplementary Facility/Equipment like **Weighing Machine** (A weighing machine with appropriate capacity is required to be provided based on the incoming waste quantity. The weighing machine shall be installed in front of the storage pit)

Water Pressure Pump (A water pressure pump is to be procured for cleaning purposes. The pump will be used for cleaning vehicles, the storage pit, and other components of the sanitary waste disposal)

Generator (A generator is required for the sanitary waste disposal plant to ensure operational efficiency and to provide backup power in case of an electricity outage)

7.7 REQUIREMENTS OF OPERATOR OF THE INCINERATOR

i. A well trained /competent personnel shall be designated to operate and maintain the incinerator. The operator shall be skilled in manpower, adequate qualification in relevant subjects (having at least qualification of SSC/ITI), and shall be certified by the incinerator supplier in operation & maintenance of the incinerator.

ii. There shall be at least one assistant designated at the incinerator plant to keep track of the wastes, records of incinerator operation, cleanliness of the surrounding area and incinerator & waste storage room. They shall also take care of -

   a. waste charging depending on the designed capacity of the incinerator as per recommendations of the manufacturers,

   b. operation of the incinerator in compliance to the operating standards prescribed under the BMWM Rules;

c. no burning of waste containing chlorinated compounds

d. operation and monitoring of the incinerator by periodic maintenance (i.e., cleaning of combustion chamber, declogging of air inflows and fuel burners)

e. regular and /or continuous measurement of the relevant flue gas parameters such as CO_2, O_2, CO and CE and

f. incineration ash disposal in accordance with the BMWM Rules.

iii. All the staff at the incinerator plant shall put on protective gears such as gumboots, gloves, eye glasses, etc. for safety reasons.

iv. Any accident occurred shall immediately be reported to the facility operator. The facility operator shall have well defined strategies to deal with such accidents/emergencies.

v. The incinerator manufacturer should have OSHAS 18001 certification.

7.8 REQUIREMENTS OF THE INCINERATOR MANUFACTURER

The manufacture should permanently mark on the incinerator indicating

(i) manufacturer's name or trademark

(ii) style, type, model or, date of manufacture of the incinerator

(iii) capacity and also in terms of net designed heat release in heat units per timed period (i.e., British Thermal Units per hour, megajoules per hour, kilocalories per hour).

The incinerator should be procured by the occupier or operator from manufacturer having

(i) Department of Industry Registration;

(ii) Registration with Central Excise and Service Tax.

Also, the Manufacturer shall have to issue the performance guarantee and also certify that the incinerator system has been designed and commissioned such that the system can comply with the stipulated standards along with the latest monitoring results of the system as soon as commissioned.

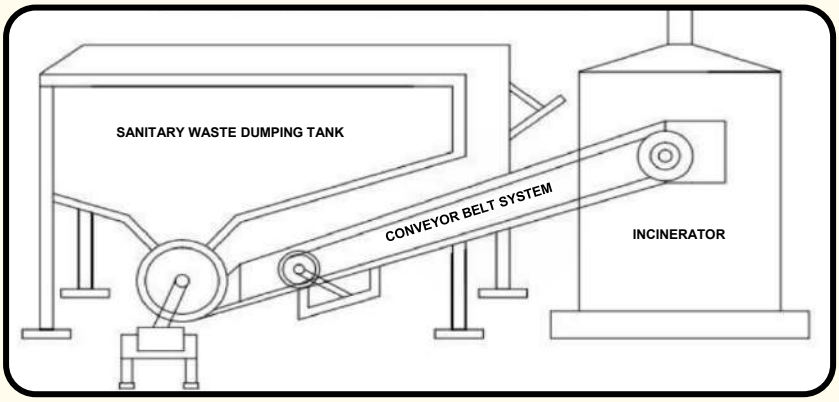


Figure 7.10: Incinerator with conveyor belt system for automated waste feeding

7.9 MODE OF PROJECT IMPLEMENTATION

Community-level sanitary waste incinerators may be set up in any of the following modes:

i. Private Owned

- Both land and the facility owned by the private party
- The operational cost shall also be met by the private party.
- Tipping fee based on weight of the waste to be processed shall be paid by the local body/ Generator to the private agency

ii. PPP Model

- In this model, the construction and operation cost shall be shared by the local body and private investors.
- Tipping fee based on weight of the waste to be processed shall be paid by the local body/ Generator to the private agency
- Operation and maintenance of the plant for a minimum term of 10 years shall be the responsibility of the agency installing the plant.

iii. By Local Body

- The Local Body shall establish the processing and disposal facilities under a DBOT (Design, Build, Operate, Transfer) model, ensuring the O&M for a minimum period of five years. Following this term, the facility shall be operated by a service provider selected through a competitive bidding process.
- Tipping fee fixed based on the expenditure incurred for running the facility

7.10 ROLES AND RESPONSIBILITIES OF STAKEHOLDERS

Table 7.4: Roles and Responsibilities of Stakeholders

Stakeholder	Roles and Responsibilities
Generator	1. Understanding Types and Risks: It is crucial to comprehend the various types of sanitary waste and the hazards and risks associated with improper management practices. 2. Provision for Separate Collection and Storage: Waste generators should ensure the provision of separate collection and storage mechanisms for sanitary waste to prevent contamination and facilitate proper handling. 3. Avoiding Indiscriminate Disposal: Waste generators must refrain from indiscriminately dumping, discarding, or burning sanitary waste, as such practices can lead to environmental pollution and health hazards. 4. Strict Compliance with Regulations: Compliance with the rules, guidelines, bylaws, and instructions issued by relevant authorities is essential to ensure proper management of sanitary waste and to avoid legal repercussions.

	5. Active Participation in Management Systems: Waste generators should actively engage as stakeholders in the management systems designed by local bodies for the collection, transportation, treatment, and disposal of sanitary waste. 6. Timely Payment of User Fees: Waste generators are responsible for promptly paying the user fees fixed by the local body for the collection, transportation, and disposal of sanitary waste to sustain and support waste management initiatives effectively.
LSGIs	1. Bylaw Creation: Local bodies are responsible for formulating bylaws on sanitary waste management, outlining the operational procedures for waste collection, transportation, treatment, and disposal. These bylaws should specify user fees, collection methods, and penalties for violations such as indiscriminate dumping or burning of sanitary waste. 2. Strategy Development and Implementation: Local bodies must develop and execute strategies for the efficient collection, transportation, and disposal of sanitary waste. This may involve direct involvement or engaging service providers for specific tasks within the sector. 3. Establishment of Processing and Disposal Facilities: Local bodies should arrange for processing and disposal facilities for sanitary waste. This can be achieved by setting up and operating their own facilities, contracting service providers through competitive processes, or collaborating with nearby facilities managed by other local bodies or private agencies. 4. Transportation Compliance: Local bodies must ensure that sanitary waste is transported in properly covered, registered vehicles equipped with GPS tracking devices to prevent spillage and monitor transportation routes. 5. Worker Safety: It is the responsibility of local bodies to provide proper personal protective equipment (PPE) to workers engaged in sanitary waste collection, transportation, treatment, and disposal. Regular health check-ups should also be arranged in consultation with medical officers to safeguard worker health. 6. Enforcement against Violators: Local bodies are tasked with taking appropriate measures to prevent the dumping, throwing, or burning of sanitary waste in open areas. Actions should be taken against individuals or entities found violating waste management regulations. 7. Record Maintenance: Proper records should be maintained by local bodies regarding the collection, transportation, and disposal of sanitary waste to ensure accountability and transparency in waste management practices. 8. The local bodies in association or assistance with Producers shall make necessary arrangements for collection and disposal of sanitary waste and promote Extended Producers Responsibilities (EPR) for providing pouch /wrappers for safe handling of sanitary wastes and decentralized deposit centres.

Service Providers	1. Participation in Selection Process: Service providers must be prepared to participate in the selection process initiated by the Local bodies for the appointment of service providers in the sanitary waste management sector. 2. Agreement Execution: Service providers are required to enter into agreements with the Local body to undertake the collection, transportation, and disposal of sanitary waste as per the terms and conditions outlined in the agreement. 3. Compliance with Regulations: Service providers must adhere to all relevant rules, regulations, and guidelines established by the government at the national and state levels, as well as those specified in the bylaws or directives issued by the Local body regarding sanitary waste management. 4. Provision of Proper Equipment and Attire: Service providers are responsible for ensuring that all labourers engaged in sanitary waste management activities wear appropriate uniforms and personal protective equipment (PPE) as mandated for their safety and well-being. 5. Maintenance of Working Environment: Service providers should provide labourers with a conducive and safe working environment, including proper facilities, amenities, and benefits. Additionally, they must ensure that workers receive necessary healthcare and medical assistance as needed.
Labourers	1. Adherence to Directions: Labourers must strictly adhere to the instructions and directions issued to them, regardless of their role in the collection, transportation, or disposal activities of the sanitary waste management system. This includes following safety protocols, handling waste appropriately, and maintaining cleanliness. 2. Participation in Trainings: Labourers are expected to actively participate in all training sessions provided by the relevant authorities or organizations involved in sanitary waste management. These trainings aim to enhance their knowledge and skills related to waste handling, safety procedures, and best practices in waste management.



Figure 7.11: Community-Level Sanitary Waste Incinerator (1 TPD Plant) at Palakkad Municipality

SPECIAL WASTE

8 DOMESTIC HAZARDOUS WASTE

As per Solid Waste Management Rules 2016, **"Domestic hazardous waste**" means discarded paint drums, pesticide cans, CFL bulbs, tube lights, expired medicines, broken mercury thermometers, used batteries, used needles and syringes and contaminated gauge, etc., generated at the household level. Domestic hazardous waste is typically generated in lesser quantities than other waste fractions, however, the potential risks to the environment and human health are disproportionate to its quantum. It becomes especially lethal when given a chance to react with other materials in common landfills. Addressing this waste stream separately through an efficient system of segregation and collection as well as scientific disposal in an environmentally sound manner is very necessary to mitigate the associated risks.

8.1 APPLICABLE RULES

a) **Solid Waste Management Rules, 2016**, as amended from time to time.

Domestic hazardous waste is covered under the Solid Waste Management Rules and it may be noted that the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 **shall not apply** to wastes covered under the Solid Waste Management Rules. The hazardous waste apart from the domestic hazardous waste shall be managed in accordance with the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, as amended from time to time.

b) **Used batteries** are a common item coming under domestic hazardous waste. Exposing the environment to lead and strong corrosive acids found in batteries can cause hazards.

Battery Waste Management Rules, 2022, and its amendment rule in 2023 shall apply to,

(i) Producer, dealer, consumer, entities involved in collection, segregation, transportation, refurbishment and recycling of Waste Battery;

(ii) all types of batteries regardless of chemistry, shape, volume, weight, material composition and use.



Figure 8.1: Used batteries (a common item under domestic hazardous waste)

As per Battery Waste Management Rules,2022 it will be the **responsibility of the consumer,**

(i) to discard Waste Battery separately from other waste streams, especially from mixed waste, domestic waste streams;

(ii) to ensure that Waste Battery are disposed of in an environment-friendly manner by giving them to an entity engaged in collection or refurbishment or recycling;

As per Rule 6 of the Battery Waste Management Rules, local body shall hand over the collected used battery to the producers or agencies acting on their behalf or the entity engaged in refurbishment or recycling with a view to refurbishment or recycling of those Waste Battery or carry out their recycling or refurbishment themselves.

c) Bio-medical waste generated in households during healthcare activities shall be segregated as per **Bio-Medical Waste Management Rules, 2016** (as amended from time to time) and handed over in separate bags or containers to municipal waste collectors. Duties of authorities concerning the management of bio-medical waste shall be as per rule no. 6 of Bio-Medical Waste Management Rules, 2016. As per rules, Local Bodies shall have tie up with the common bio-medical waste treatment and disposal facility to collect this waste from the MCF or directly from the households, for final disposal.

   As per Bio-Medical Waste Management Rules, an on-site treatment and disposal facility shall not be established, if a service of a common biomedical waste treatment facility is available at a distance of seventy-five kilometres. In the absence of the service of a common biomedical waste treatment facility within the prescribed distance, combustible household biomedical waste can be disposed of using a community-level sanitary waste incinerator facility. Combustible household biomedical waste needs to be collected in yellow coloured non chlorinated closed bags, through authorized agencies, and transported to community level sanitary waste incinerator or to common biomedical waste treatment facility.

d) **E-Waste Management Rules** shall apply to every manufacturer, producer refurbisher,

dismantler and recycler involved in manufacture, sale, transfer, purchase, refurbishing, dismantling, recycling and processing of e-waste or electrical and electronic equipment listed in Schedule I, including their components, consumables, parts and spares which make the product operational. Fluorescent and other mercury-containing lamps belonging to the category of domestic hazardous waste are covered under this rule. These are to be collected and transported to a common hazardous waste treatment disposal facility.

8.2 DOMESTIC HAZARDOUS WASTE COLLECTION

- It is necessary to collect domestic hazardous waste independently from dry and wet waste and send it to an approved Hazardous Waste Treatment Storage and Disposal Facility (HWTSDF).
- Based on the published collection calendar, authorized collection agencies like Haritha Karma Sena can carry out the door-to-door collection of DHW.
- It is recommended to undertake the collection of smaller items like batteries coming under the DHW through a door-to-door collection mechanism and larger and heavy items getting deposited by the generator at the deposition centers (drop points).
- As per SWM rules 2016, local bodies shall establish waste deposition centers, at identified prominent locations, for domestic hazardous waste and give direction for waste generators to deposit domestic hazardous wastes at this centre for its safe disposal.
- Such a facility shall be established in a city or town in a manner that one centre is set up for the area of twenty square kilometers or part thereof and notify the timings of receiving domestic hazardous waste at such centers.
- At the dropping centers, the collection of domestic hazardous waste needs to be done in consultation with the HWTSDF, for managing various categories of waste by sending them for recycling or incineration or to a hazardous landfill.
- The collection of waste at the deposition centers must be undertaken in specific coloured bags/containers as stipulated in the rules.
- Also, as per the Hazardous and Other Wastes (Management and Transboundary Movement) Second Amendment Rules, 2023, Municipalities and Local Bodies shall facilitate producers and bulk generators or collection agents to set up large number of collection points for collection of used oils in their jurisdictional areas and the used oils so collected can be auctioned or sold to the authorised recyclers.
- The deposition centers shall obtain authorization from the State Pollution Control Board.
- The deposition centers shall provide the domestic hazardous waste to the actual user or

operator of the disposal facility and maintain records of the same in Form 3 and shall file annual return in Form 4 to the State Pollution Control Board.

8.3 DOMESTIC HAZARDOUS WASTE PROCESSING

Domestic hazardous waste requires a higher degree of containment and it can be managed/disposed of scientifically in the common hazardous waste treatment storage and disposal facilities. These are dedicated facilities equipped with state-of-art technologies for environmentally sound management/disposal of hazardous waste. These facilities consist of secured/ engineered landfills or incinerators, equipped with air pollution control devices, or a combination of both (integrated HW-TSDF).

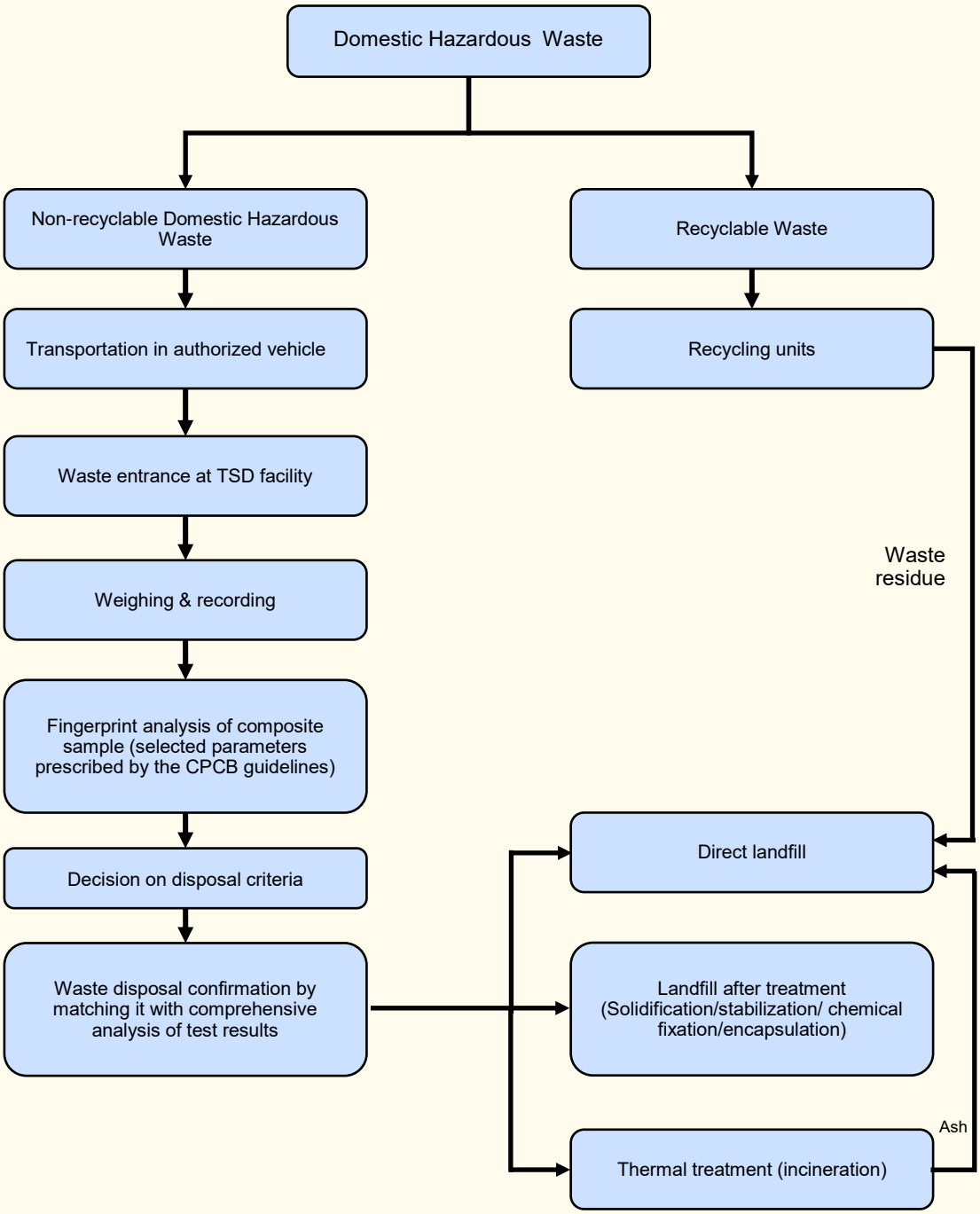


Figure 8.2: Storage and movement of domestic hazardous waste consignment within TSDF based on waste disposal criteria

Domestic hazardous waste transported to a hazardous waste treatment and disposal facility will be categorized and processed as below based on its characteristics:

i) Waste that can be recycled
ii) Waste that can be incinerated
iii) Non-recyclable, non-incinerable waste that needs to go to a hazardous landfill.

8.3.1 Recyclable waste

Some domestic hazardous waste can be recycled for a different purpose or may contain material, which can be extracted for use in manufacturing other products. Domestic hazardous waste that can be recycled includes **used batteries, recyclable contaminated waste, broken or discarded glassware, fluorescent bulbs and tubes** etc. Fluorescent bulbs and tubes can be utilized following the norms of E-waste Management Rules. Reportedly, all the components of fluorescent tubes aside from the fluorescent powder have been reported to be reused (Ref: CSE,2022). CFL tubes shall go to HW TSDF where a registered recycling facility is not available.

Recyclable domestic hazardous waste will be processed as described below:

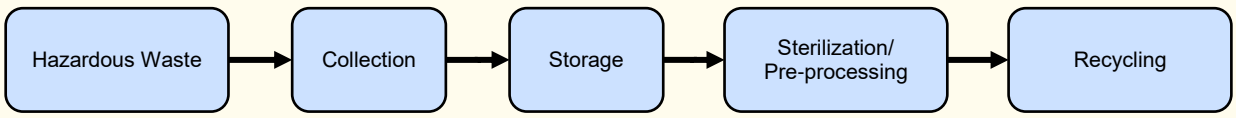


Figure 8.3: Flow Diagram of Recyclable Domestic Hazardous Waste

As per Battery Waste Management Rules, **Waste Battery** collected by the Producer shall be sent for recycling or refurbishing and shall not be sent for landfilling or incineration. The recycling of Waste Battery means recycling of Battery materials such as lead, nickel, lithium, nickel, cobalt, plastics, rubber, glass, etc.

Contaminated recyclable waste generated at households like wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vacutainers with their needles cut, gloves and need to be collected using **red coloured** non-chlorinated plastic bags or containers. This collected waste needs to be sent to Biomedical Treatment Storage and Disposal Facility (BM-TSDF). Treatment options for the contaminated recyclable waste is by autoclaving or microwaving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent to registered or authorized recyclers or for energy recovery or plastics to diesel or fuel oil or for road making, whichever is possible. Plastic waste should not be sent to landfill sites. Local bodies need to have a tie-up with authorized agencies/common biomedical waste treatment facility having the required infrastructures.

Glassware needs to be collected through cardboard boxes with **blue colored** markings. Broken or discarded non-contaminated glasswares can be sent for recycling. However, broken or discarded and contaminated glass except those contaminated with cytotoxic wastes need to be disinfected by soaking the washed glass waste after cleaning with detergent and Sodium Hypochlorite treatment or through autoclaving or microwaving or hydroclaving and then sent for recycling.

Waste sharps including metals like **needles, syringes with fixed needles, blades, or any other contaminated sharp objec**t that may cause puncture and cuts. This includes both used, discarded and contaminated metal sharps. This waste must be collected through White translucent puncture proof, leak proof, tamper proof containers. Treatment option for this type of waste include autoclaving or Dry Heat Sterilization followed by shredding or mutilation or encapsulation in metal container or cement concrete; combination of shredding cum autoclaving; and sent for final disposal to iron foundries (having consent to operate from the State Pollution Control Board) or hazardous landfill or designated concrete waste sharp pit.

8.3.2. Combustible Waste

Thermal oxidation through incineration at hazardous waste treatment disposal facility is one of the proven technologies for the destruction of hazardous waste in all its forms—solid, semi-solid, liquid and gaseous based on the feeding system—so as to render it innocuous in the form of non-toxic and non-hazardous residue. This method is suitable for waste such as **expired medicines, soiled waste, insecticides, pesticides,paints** etc. Discarded paint drums, pesticide cans shall be deposited in the waste deposition centre for its safe disposal at Hazardous Waste Treatment Storage and Disposal Facility (HWTSDF).

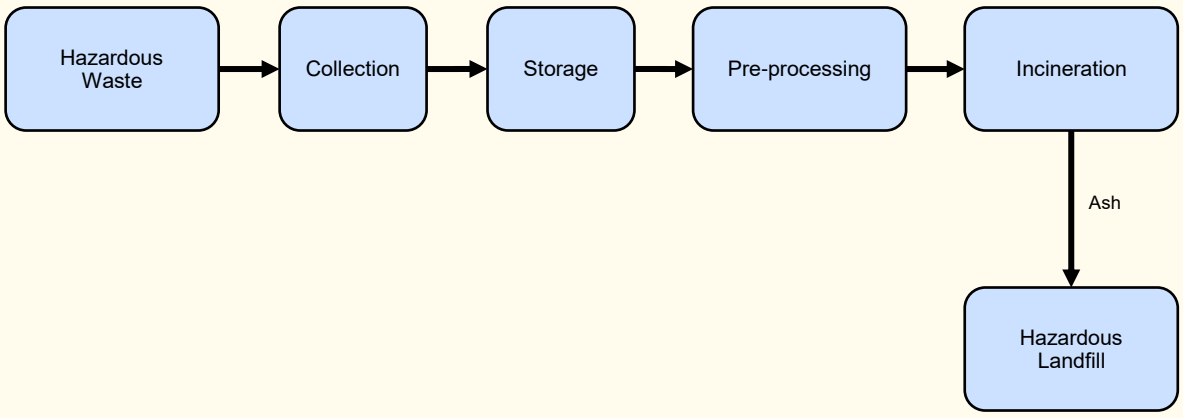


Figure 8.4: Flow Diagram of Combustible Domestic Hazardous Waste

Household biomedical waste like items contaminated with blood, body fluids need to be collected in **yellow coloured** non-chlorinated plastic bags or containers and disposed through Incineration or Plasma Pyrolysis. (In absence of above facilities, autoclaving or micro-waving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery.)

Expired or Discarded Medicines need to be collected in **yellow coloured** non-chlorinated plastic bags or containers and shall be either sent back to the manufacturer or disposed of by incineration. (Expired `cytotoxic drugs and items contaminated with cytotoxic drugs to be returned back to the manufacturer or supplier for incineration at temperature >1200 ^{0}C or to common bio-medical waste treatment facility or hazardous waste treatment, storage and disposal facility for incineration at >1200 ^{0}C Or Encapsulation or Plasma Pyrolysis at >1200 ^{0}C.)

Discarded linen, mattresses, beddings contaminated with blood or body fluid must be collected through non-chlorinated **yellow** plastic bags or suitable packing material. Treatment options for these types of waste include non- chlorinated chemical disinfection followed by incineration or Plasma Pyrolysis or for energy recovery. In the absence of above facilities, shredding or mutilation or combination of sterilization and shredding shall be done and the treated waste shall be sent for energy recovery.

8.3.3. Waste Disposal in Hazardous Landfill

Certain domestic hazardous waste that cannot be recycled or incinerated, needs to be sent to a hazardous/sanitary landfill for disposal eg. ash generated from community-level sanitary waste incinerators.

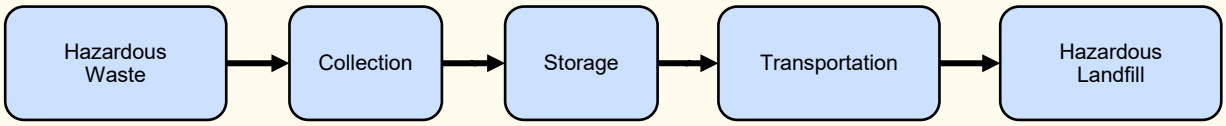


Figure 8.5: Flow Diagram of non-recyclable, non-incinerable Domestic Hazardous Waste

8.3.3.1. Stabilisation of hazardous waste before landfill

Most commonly used pre-treatment techniques include decanting of empty bottles containing hazardous liquids, solidification, stabilisation, chemical fixation and encapsulation. Pre-processing techniques such as solidification and stabilisation can be used for immobilisation of contaminants like heavy metals, but they can also be used for different waste streams including glass pieces and asbestos waste. Various methods for treating waste before final disposal in secured landfills are as follows:

- **Solidification**: Solidification is a process that involves mixing of additive material in waste in order to convert the waste mix into a solid monolith like structure. It includes physical dewatering of waste and the improvement of physical properties such as strength, compressibility and permeability. It is generally applied to waste in which there is high moisture content but low heavy metal concentration.

- **Stabilisation:** Stabilisation includes dewatering/solidification as well as chemical bonding of the additive material/particles with the contaminants. The contaminants are thus made chemically more stable. It is usually done for waste containing toxic metals such as lead, chromium, mercury and nickel.

- **Encapsulation:** Encapsulation is defined as the enclosure or entrapment of waste by some material—such as packing it into a plastic bag

8.3.3.2. Secured landfills for DHW disposal

Secure landfill is suitable for industrial and hazardous solid waste which are pretreated to the stabilisation and solidification stage before entering the landfill.

The stabilisation and solidification of solid waste mean that the waste is pre-treated with a specific process to the minimum or non-hazardous stage. The process will generally remove the acidity or alkalinity stage to the neutralised stage, then process the waste to solid stage and secure the waste using appropriate options. The secured waste is safe for transportation and landfilling.

Each type of waste will require a different stabilisation processing method. Therefore before the stabilising process, each waste will be tested in the laboratory to find its specific property before treatment. For example, the Hg waste will be neutralised by sodium-sulphide. Then it will be mixed with cement to become solid form before disposing to the secure landfill.

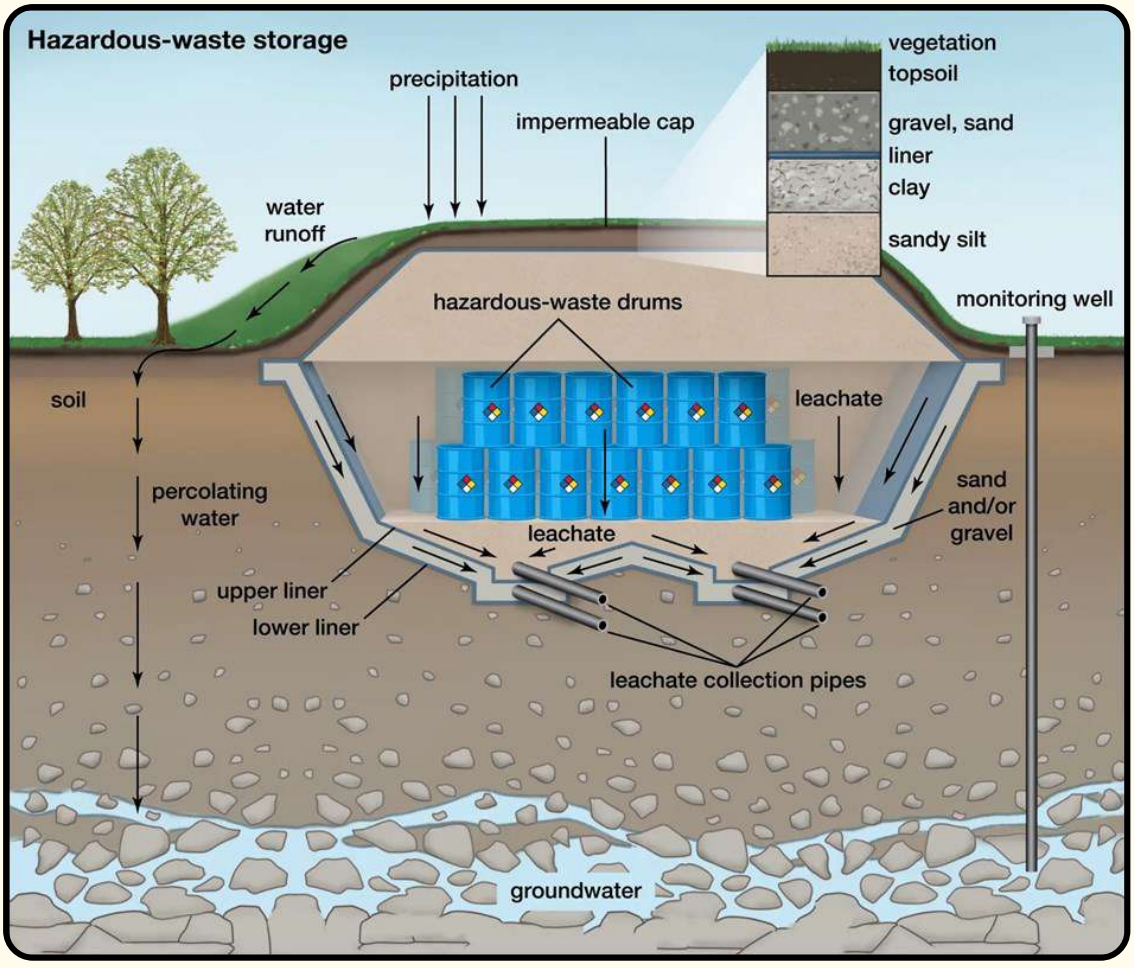


Figure 8.6: Schematic diagram of a secure hazardous-waste landfill with a double leachate collection system

Hazardous waste landfills are defined as waste disposal units, which are designed and constructed in such a way that they cause minimum possible impact to the environment. These landfills have to be designed and constructed as per the guidelines of Pollution Control Board.

Components of secured engineered landfill are liner system, leachate collection and removal system, leak detection system, daily/intermittent cover, gas removal system, capping and closure system, storm water drainage system and redundant liner at bottom.

It is important to understand that the design of secured landfills is similar to that of sanitary landfills used for municipal solid waste rejects. However, there are double protective layers in case of secured landfills such as primary and secondary leachate collection systems and double liner systems. Waste with no leachable toxic metals is directly disposed into the secured landfills at the HW-TSDFs.

Waste with leachable contaminants is first treated by certain methods to render it harmless prior to disposal in secured landfills. Un-stabilized waste may potentially contribute to the generation of hazardous leachate, which can contaminate the groundwater system. The hazardous contaminants in waste must be physically and chemically bound by some material so that there would be no risk of consolidated stress and leaching.

Diagrammatic representation of double liner composite secured landfill is shown in Figure below.

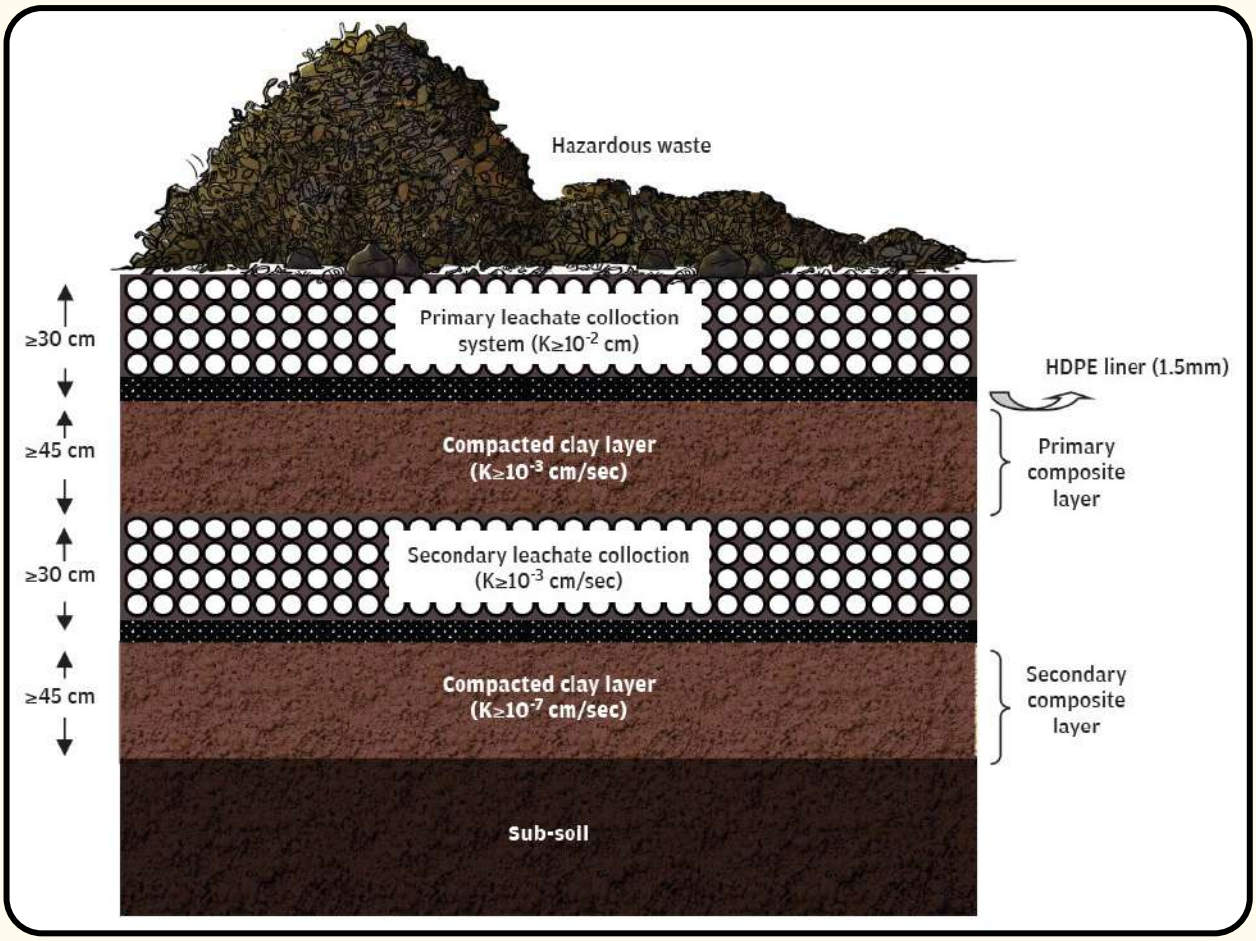


Figure 8.7: Cross-section of double-liner composite system in a secured landfill (CSE,2022)

The specifications of a double-liner composite system in a secured landfill are as follows:

a) Primary leachate collection layer of thickness 30 cm or more and co-efficient of permeability

in excess of 10^{-2} cm/sec.

b) A primary composite liner comprising of

i) A HDPE geomembrane of thickness 1.5 mm or more.

ii) A compacted clay (or compacted amended soil) layer of thickness 45 cm or more having a coefficient of permeability of 10^{-7} cm/sec or less.

c) A secondary leachate collection layer (also called leak detection layer) of thickness 30 cm or more and co-efficient of permeability in excess of 10^{-3} cm/sec.

d) A secondary composite liner comprising of

i) A HDPE geomembrane of thickness 1.5 mm or more

ii) A compacted clay layer of thickness 45 cm or more having a co-efficient of permeability of 10^{-7} cm/sec or less.

8.4 DOMESTIC HAZARDOUS WASTE MANAGEMENT ASPECTS

a) The household shall be responsible for properly handing over the domestic hazardous waste to authorized agencies for safe and environmentally sound management of the same.

b) Every waste generator shall segregate and store the domestic hazardous waste generated by them in separate streams in suitable bins/covers and handover segregated wastes to authorised waste collectors/deposit the waste at deposition centers /drop points, as per the direction or notification by the local authorities from time to time.

c) Local bodies shall ensure safe storage and transportation of the domestic hazardous waste to the hazardous waste disposal facility or as may be directed by the State Pollution Control Board.

d) Authorized agencies shall send the collected waste to approved hazardous waste processing facilities like Kerala Enviro Infrastructure Limited (KEIL) or any other approved facilities.

e) Local bodies shall create public awareness through information, education and communication campaigns and educate the waste generators to practise segregation of waste at the source.

f) Proper data should be kept and maintained by the local bodies on the quantity of domestic hazardous waste being collected and managed and shall be made available to regulating authorities for verification.

9 LEGACY WASTE DUMPSITE REMEDIATION

Solid waste that has been collected and kept for years on some barren land or landfill for long periods of time is called Legacy waste. The Solid Waste Management Rules of 2016 directed Local Bodies to clear legacy waste dumps as well as existing operational dumpsites down to pre-existing ground level through a process called bioremediation or biomining, which refers to an environment-friendly technique to separate soil and recyclables from legacy waste. The process involves stimulating the growth of microorganisms and degrading the target pollutants and separating out soil, recyclables and inerts from the stabilized legacy waste. In absence of potential of bio-mining and bioremediation of dumpsites, they shall be scientifically capped as per landfill capping norms to prevent further damage to the environment. Although capping is mentioned as a method to dispose of legacy waste in CPCB guidelines, it must be noted that SWM Rules 2016 and NGT have mandated that for remediation of legacy waste dumpsites Bioremediation is preferred over Capping.

9.1 PLANNING & SITE PREPARATION

The first step in a dumpsite remediation project is planning and site preparation. This shall start with a detailed site assessment of the dumpsite and estimation of the materials to be processed. Site environment parameters such as baseline study of heavy metals in surface and subsurface soils and water, rainfall, soil type, surface hydrology, topography, wind direction etc. shall be studied before and after bio-mining. The site assessment shall also involve study of different parameters such as geological features, stability of the surrounding area, and proximity of groundwater, and fractions of usable soil, recyclable material, combustible waste, and hazardous waste at the site etc.

9.2 QUANTIFICATION OF LEGACY WASTE TO BE REMEDIATED

- The volume of legacy waste (in m^3) to be remediated shall be generally assessed through Total Station Survey. If it is not feasible, a drone survey may be adopted for large dumpsites having a volume of more than 1 (One) Lakh m^3.
- If required, external survey agencies may be engaged following laid down procedures and the cost for the same shall be met by the local body from available funds.

- Contour mapping of the site shall be done and approved by the Engineer of the local body.

9.3 DUMPSITE REMEDIATION PROCESS (BIO-REMEDIATION & BIO-MINING)

It refers to the excavation of old dumped waste and make windrow of legacy waste thereafter stabilization of the waste through bioremediation i.e. exposure of all the waste to air along with use of composting bio-cultures, i.e. screening of the stabilized waste to recover all valuable resources (like organic fines, bricks, stones, plastics, metals, clothes, rags etc.) followed by its sustainable management through recycling, co-processing, road making etc.

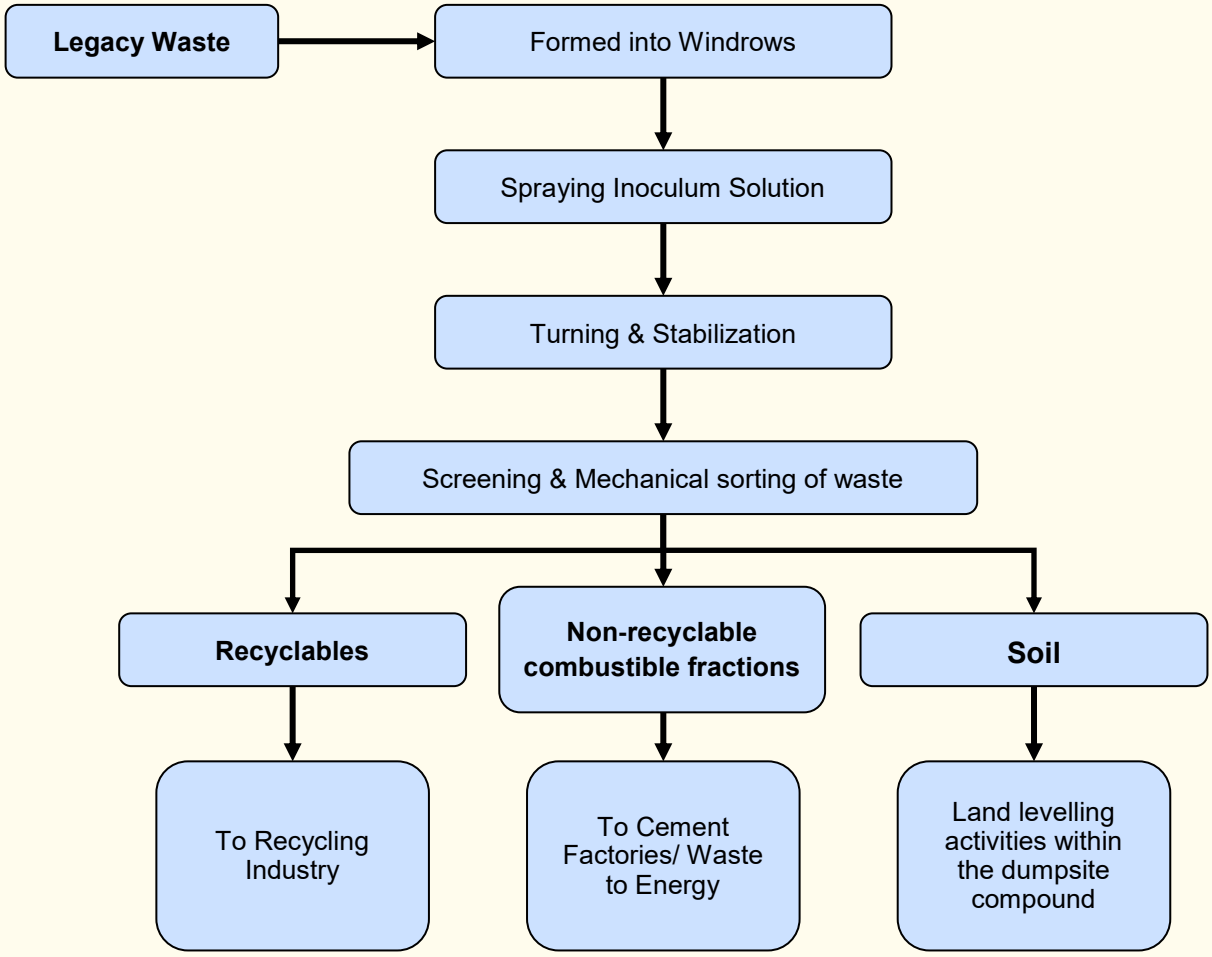


Figure 9.1: Dumpsite Remediation Process Flow

The first step is to excavate legacy waste, loosen it and make windrows so as the leachate can be dried off through solar exposure and all the entrapped methane is removed from the heap. All biodegradable waste, like discarded food, fruit, flower and garden waste, needs air to decompose it in an odourless way without producing leachate. Addition of composting bio-cultures speeds up decomposition and rapidly creates biological heat within the waste that helps to dry it out and reduce its volume by 35-40%. This happens through loss of moisture and by decomposition of some of the aerated waste to carbon dioxide and water vapour. This is called bio-remediation and makes the waste dry enough for screening. Waste is called stabilized when there is no more generation of heat or landfill gas or leachate, and seeds are able to germinate in it.

Then the screening of this stabilized waste into different size fractions shall be done using screen sizes 150 mm. 80 to 100 mm, 24 to 50mm, 12- 16 mm and 4-6 and then that can be usefully used off-site or disposed of without affecting the environment. The finest fraction is called bio-earth or good earth. The coarsest fraction contains bricks, stones, coconut shells, footwear, cloth and larger plastics. Density separation helps recover combustibles which can be used (usually up to 5-10%) as fuel replacement after supplying it to customer requirements.

The lighter mid-fractions are mostly plastics and can be shredded as per industry requirement for use in bitumen hot mix plants to make so called Plastic Roads or as refuse derived fuel for co-processing in cement kilns. Fractions up to 50mm do not require shredding for use as RDF. The heavier mid-fractions are mostly stony inert which can be used in the lowest layers of road -making or plinth-filling or in low-lying areas, but should not contain more than 3-5% plastics by weight. Less than 10% of the original waste remains as totally unusable residual rejects and may remain onsite, either in a small heap or spread to raise the ground level by a couple of meters.

9.4 STAGES OF BIOMINING

1. Pre-Stabilisation



a) Windrowing



b) Inoculum Spraying

Figure 9.2: Pre-Stabilisation Process

2. Loading for Processing



Figure 9.3: Legacy Waste Loading for Biomining

3. Weighing Process



Figure 9.4: Weighing Process



Figure 9.5: Stages of Sorting in Legacy Waste Biomining

5. Materials after sorting



Wood



Metals



HD Plastic



Coconut Waste



Chappals



Tyres



C&D Waste



Glass Bottles

Figure 9.6: Materials Post-Sorting in Biomining Process

9.5 LAND RECOVERY

The benefit of bio-mining lies in abatement of ongoing and future pollution and ill health and in the recovery and re-use of valuable space. This is ideally for continued long-term waste management facilities since public consent for new waste sites is increasingly difficult because of earlier visible mis-management of a virgin site. Cleared dumps are not permitted for habitation for at least 15 years (SWM Rules Schedule I, H (2)). The permissible options are reuse for waste management facilities, open stadia, sports grounds, parks and gardens, parking lots, container yards, warehouses of non-flammables and similar facilities where people are not living or working all day and night. Priority shall be given to set up infrastructures related to waste management in the reclaimed land.



Figure 9.7: Kureepuzha dumpsite during biomining stage and after biomining

9.6 BIOREMEDIATION - POINTS TO BE NOTED

a) Local Body shall make a time bound plan to execute the bio-mining process to clear the old waste.

b) Entry of fresh waste should prevented to the dumpsite before starting the remediation.

c) During the remediation process, the weight of waste before and after segregation shall be noted.

d) Weighbridge, temporary storage facilities for sorted materials, storm water management system, etc need to be established at the site.

e) Opening up of legacy waste leads to the trickling out of leachate, which must be properly collected and treated.

f) Ensure total stabilization of the waste dump by forming windrows and adding bio cultures so that it releases no offensive odors and generates no leachates, so as to have the stabilized material which can be subjected to further sorting procedure.

g) Fire Control, safety and environmental compliance need to be given the utmost priority at biomining sites.

h) Contaminated wastes that may be uncovered during reclamation operations require special handling and disposal requirements as per CPCB guidelines. Precautions must be taken while excavating as it releases gases like methane, Sulphur dioxide and other gases which may cause explosion and fire.

i) Hazardous waste such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive waste, if found, during excavation, sorting or segregation shall be handled as per the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.

j) Handover any domestic hazardous waste/ biomedical waste if found during excavation, sorting/ segregation to the nearest biomedical/ hazardous waste facility. This waste shall be handled as per Biomedical Waste Management Rules, 2016.

k) The stone, bricks, ceramics which are removed while screening and raking to be sent for land filling or for filling up of low-lying area, while the recyclables like plastic, glass, metal, rugs cloth recovered from the waste can be forwarded for recycling.

l) The soil recovered to be used for refilling the ground on the same site for greenery.

m) Legacy C&D waste if found during excavation, shall be segregated and the Contractor shall be responsible to ensure alternate uses for C&D waste as per the C&D Waste Rules, 2016.

n) The recovered construction and demolition waste to be recovered and sent to C&D processing facility for producing building materials and the left-over of the waste to be sent to a secured landfill.

o) The project machines to be deployed depends upon the type and condition of waste in the dumpsite and generally machineries like trommels, horizontal screens, excavators, backhoe loaders, magnetic separators, cyclone separators, etc are deployed for effective sorting of waste.

p) The Contractor shall ensure processing of the Legacy Waste in accordance with CPCB guidelines for handling Legacy Waste (Old Municipal Solid Waste dated Feb 2019) along with SWM Rules 2016 (as amended from time to time).

q) Segregate the excavated garbage in the land portion earmarked into as many categories as possible in compliance with CPCB guidelines. Maximize the separation of recyclables viz. glass, metal etc. from the dumpsite. Maximize the separation of components for generation of Refuse Derived Fuel (“RDF”) from the dumpsite.

r) Daily monitoring of the progress of work to be done by a team headed by an expert.

s) The Contractor shall take necessary steps and processes to minimize environmental pollution while carrying out remediation/ reclamation of legacy waste at the dumpsite. The Contractor shall take all reasonable steps to ensure that there is control of odour, dust and treatment generated leachate, flies, rodents and bird menace and fire hazards in and

around the dumpsite during the period of remediation work.

t) Odour and Dust Management: Odour and dust from a dump site causes problems for workers as well as nearby residents, and so must be controlled by stabilizing the waste and regular spraying of bio culture solution on the waste heaps

u) Carry out soil, air, ground water and noise baseline studies so that the same will be available to evaluate post Remediation/ Reclamation of the Dumpsite from authorized laboratories/agencies and submit the reports.

v) Periodic environmental monitoring needs to be undertaken to ensure that there is no pollution caused during the remediation phase.

9.7 EQUIPMENT'S REQUIRED FOR THE PROCESSING OF LEGACY WASTE

The major equipment that is deployed is in the processes like excavation, shredding, screening, air classification and ferrous separation. As per suitability and requirement, appropriate choices of equipment should be made.

i) Screening equipment

Trommels (different size sieves- separate the soil material, combustibles and inerts): Trommels are rotating cylindrical screens that are inclined at a downward angle with the horizontal. Material is fed into the trommel at the elevated end and the separation occurs while the material moves down the drum. The tumbling action of the trommel effectively separates materials that may be attached to each other. Length, angle and diameter of the drum, depth of the material and the speed of rotation are important specifications in configuring the trommel to accomplish the desired goals. Screen sizes commonly used are one or more of the following: 150 mm, 80 to 100 mm, 24 to 50mm, 12-16 mm and 4-6mm. Trommel screens are more effective than vibrating screens for dumpsite reclamation. Vibrating screens, however, are smaller, easier to set up, and more mobile.



Figure 9.8: Trommel

Air Density Separators/Classifiers (to separate the stones, papers, plastics and such light fractions): Air classification is utilized to separate light materials from heavier materials through the use of an air stream of sufficient velocity to carry away the lighter materials. A cyclone separator may be used in conjunction with the air classifier to remove the lighter separated fraction from the air stream after it exits the classifier throat. The cyclone separator uses a centrifugal action that results from the airflow through the cyclone to move the materials to the walls of the separator.

Ballistic Separators: Deployed to separate stones and soil & humus



Figure 9.9: Ballistic Separator

Magnetic Separator: To separate out metals

ii) Handling Equipment

• **Loaders (Front Load) & Excavators**: The old waste dump contains leachate at different layers and various gases and odour-causing substances. Before starting the excavation process, it is necessary to vent out these gases and drain out the leachate. An excavator or front end loader may be used to dig up and transport the dumped material to elevator conveyor belts, then to the sorting machinery.

• **Elevator and conveyor Belts**: Belt conveyors system is utilized for effectively transporting materials up steep inclines and is extremely versatile**.**

• **Baling Machines**

• **Shredders (optional)**

iii) Other Equipment

• **Odour control sprayers:** are wheeled tractors with a cab and movable spray arm mounted on a rotating platform. A large reservoir tank mounted behind the cab holds neutralizing agents, usually in liquid form, to reduce smell of exposed wastes.

9.8 SWM RULE 2016 - LEGACY DUMPSITE REMEDIATION PROVISIONS

The Government of India has notified the Solid Waste Management Rules (SWM) Rules, 2016 for proper and effective management of municipal solid waste (MSW). Under the SWM Rules, 2016, following provisions have been made to manage old dumps of MSW. **3.1 Rule 15 - Duties and responsibilities of local authorities and village Panchayats of census towns and urban agglomerations-** The local authorities and Panchayats shall investigate and analyse all old open dumpsites and existing operational dumpsites for their potential of biomining and bioremediation and wheresoever feasible, take necessary actions to bio-mine or bio-remediate the sites.

9.9 MODE OF EXECUTION

Local Self Governments can engage agencies expertised in this sector through open tender to carry out dumpsite remediation in compliance with the guidelines of the Central Pollution Control Board.

9.9.1. Project Cost Estimation and Formulation by LSG

- Detailed report regarding the site conditions, nature of dump, history of dumping and other basic details shall be prepared in the format given in **G.O.(Rt)No.2629/2022/LSGD** dated 29-10- 2022
- The estimate for biomining shall be prepared as per the specification and data given in **G.O.(Rt)No.2629/2022/LSGD** dated 29-10- 2022

9.9.2. Technical Sanction

- Technical sanction for the project shall be issued by the concerned Engineer in LSGD (LID & EW) as per the existing financial powers and necessary reporting to the Chief Technical Examiner (Finance Wing) may be ensured for compliance as per norms.

9.9.3. Implementation steps for remediation of legacy waste dumpsites by LSGIs

As per **G.O.(Rt)No.2629/2022/LSGD** dated 29-10- 2022, the implementing officer for legacy waste remediation shall be the Engineer of the LSGI.

9.9.4. Tendering

- Request for Proposals (RFPs-Two cover bid) clearly mentioning the scope of work, terms and conditions for reclamation of legacy waste dump sites shall be prepared and published as per laid down procedures.
- Conditions/eligibility criteria in the RFP shall be fixed based on the guidelines given in “SBM-U Advisory on Landfill Reclamation” published by MoHUA and CPHEEO
- It shall be ensured to mention in the scope of work that remediation of legacy waste dumpsites shall be undertaken as per the “Guidelines for Disposal of Legacy Waste (Old Municipal Solid Waste)” issued by Central Pollution Control Board

- The technical proposals received should be evaluated and technically qualified bidders shortlisted for further stage of bid approval. A Technical committee shall be formed at LSGI level for evaluation of the technical bids with the following members;
    - Secretary
    - LSGD (LID & EW) Engineer
    - Health Official (in the case of Urban local bodies)
    - Technical expert from District Suchitwa Mission
    - Representative from District Pollution Control Board
    - Other experts from academic institutions if any
- Financial bids of the technically shortlisted firms should be opened at LSGI level and approved as per procedures and norms
- Letter of Award (LoA) is to be issued to the selected contractor/agency and agreement executed.

INFRASTRUCTURE DEVELOPMENT

10 MODERN SLAUGHTERHOUSE

A slaughterhouse is a facility where livestock animals are slaughtered to provide consumables and designed to expedite the slaughter of live farmed animals. Slaughterhouses act as the starting point of the meat industry, where stock comes from farms/markets to enter the food chain. Traditional, unregulated practices in meat processing can pose significant risks to public health, leading to contamination, disease transmission, and poor meat quality. Modern slaughterhouses, equipped with advanced technologies and strict hygiene standards, are essential to meet the growing demand for safe food products. They implement sanitary handling, proper waste disposal, and efficient processing systems, minimizing the risk of contamination and ensuring compliance with food safety regulations. Furthermore, these facilities allow for humane animal treatment, controlled environments, and traceability of meat products, which are crucial for consumer confidence and public health. By reducing the spread of foodborne illnesses and improving overall meat quality, modern slaughterhouses play a critical role in promoting food safety, public health, and sustainability in the meat industry.

Modern slaughterhouses can play a significant role in advancing the circular economy by efficiently utilizing byproducts from waste, transforming what would traditionally be discarded into valuable resources. In a circular economy, waste materials are repurposed to create new products, reducing environmental impact and promoting resource sustainability. Byproducts such as bones, blood, fat, and offal from slaughterhouses are processed into useful materials like fertilizers, animal feed, biofuels, and pharmaceuticals. These practices minimize waste generation and reduce the need for virgin raw materials. Additionally, waste-to-energy technologies capture biogas from organic waste, further contributing to energy production. This approach not only enhances economic efficiency but also decreases environmental pollution and carbon emissions, supporting sustainability in the meat industry.

10.1 PROCESS FLOW

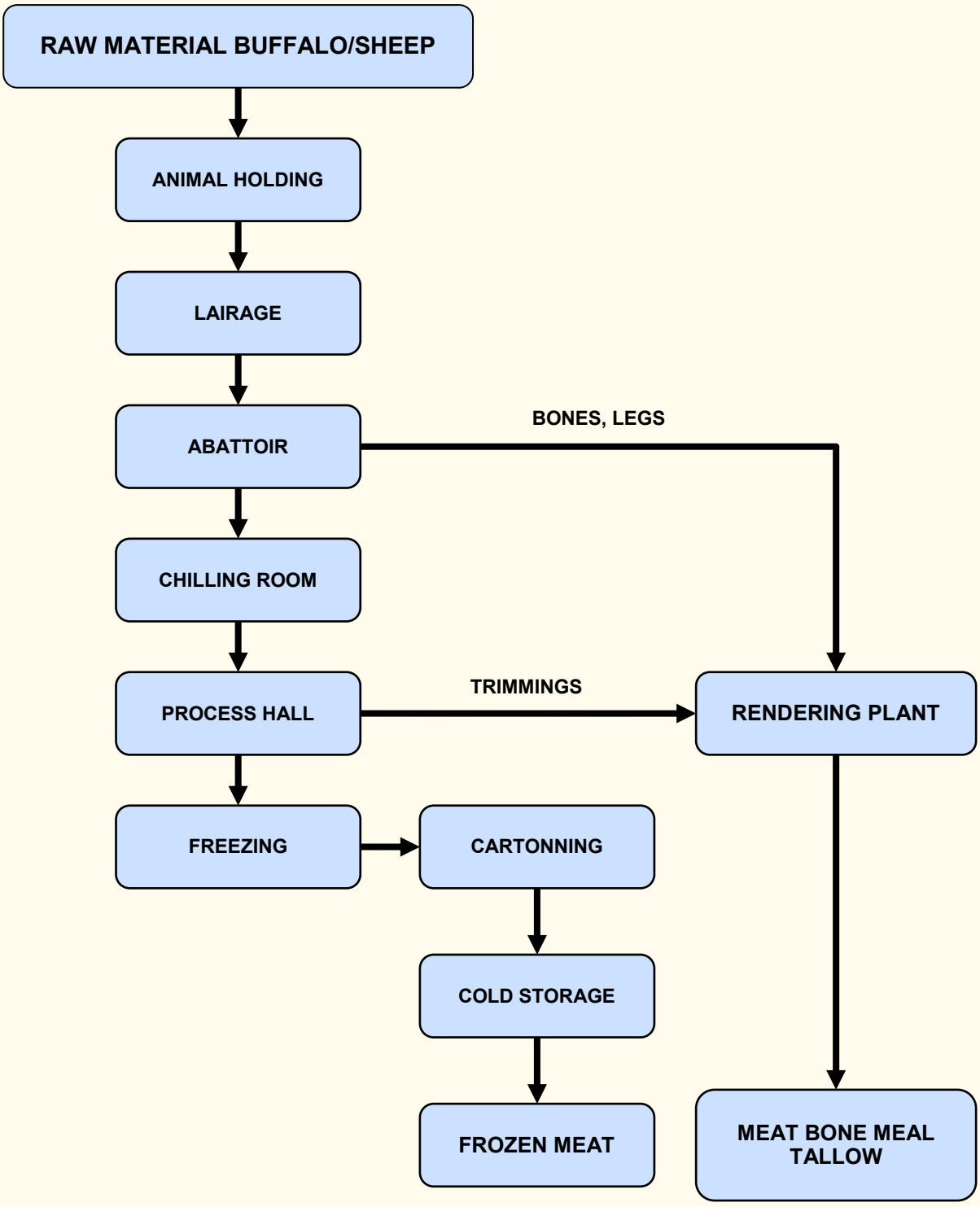


Figure 10.1: Modern Slaughter House - Process Outline

10.2 BASIC FACILITIES REQUIRED AT A SLAUGHTERHOUSE

The infrastructure required for a modern slaughterhouse depends upon the maximum daily slaughtering, by products utilization strategy and proposed treatment & disposal options of the waste generated. It shall be located closer to production centre (livestock farms) rather than consumption centres, as transport of meat either in refrigerated or non-refrigerated trucks is much easier than transporting live animals, which is a critical determinant of meat quality. There shall be copious supply of potable water, three-phase electricity connection and proximity to public transport. The site shall be from flooding, objectionable odours, smoke, dust or other contamination.



Figure 10.2: Modern Slaughterhouse

The slaughterhouse shall have the following essential facilities:

1. Facilities for proper unloading of animals.
2. Holding pens for animals before slaughter (Lairage).
3. Ante mortem inspection facility (see IS 1982).
4. Foot dip with disinfectants.
5. Stunning pen/area.
6. Facilities to carry out humane slaughter/Religious -Jhatka/Halal methods.
7. Overhead rail system.
8. Slaughter hall to ensure maintenance of strict hygiene during slaughter.
9. Facilities for flaying and dressing and washing of carcasses.
10. Post mortem examination facilities .
11. Hot water washing facilities (82°C).
12. Knife sterilizers.
13. Emergency slaughter hall.
14. Detained and condemned meat room.
15. Movable or permanent working platforms.

16. Wide doors (1.37m/4.5 feet) for free passage of meat carcasses.
17. Knee/elbow/foot operated wash basins.
18. Separate rooms for cleaning gut, stomach and intestines.
19. Stainless steel bins for blood, edible and inedible offals.
20. Storage of fats/hide/pig bristles/horns/hooves, if necessary.
21. Separate demarcation between clean and unclean area.
22. Meat inspector/veterinarian room.
23. Veterinary laboratory.
24. Lockers/rest room/laundry/toilets for meat handlers.
25. Store room.
26. Electrical and machine room.
27. Chilling and freezing rooms.
28. Boiler and steam generators.
29. Isolation pen for sick and suspected animals.
30. Waterproof flooring and side walls.
31. Proper drainage with catch basins.
32. Traps and vents for drainage.
33. Good ventilation with adequate lighting.
34. Potable water supply and storage tanks.
35. Effluent treatment plant.
36. Separate place for storing manure.
37. Protection against pest and vermin.
38. Office room, first aid and security room.
39. Facility for vehicle washing.
40. Non-corrodible food grade equipment and instruments.
41. Disposal of condemned carcass/material - Incineration.
42. Rendering plant.
43. Refrigerated or non-refrigerated covered vehicles/trucks for transport of carcass.
44. Dispatch area for finished product.



Figure 10.3: Drainage

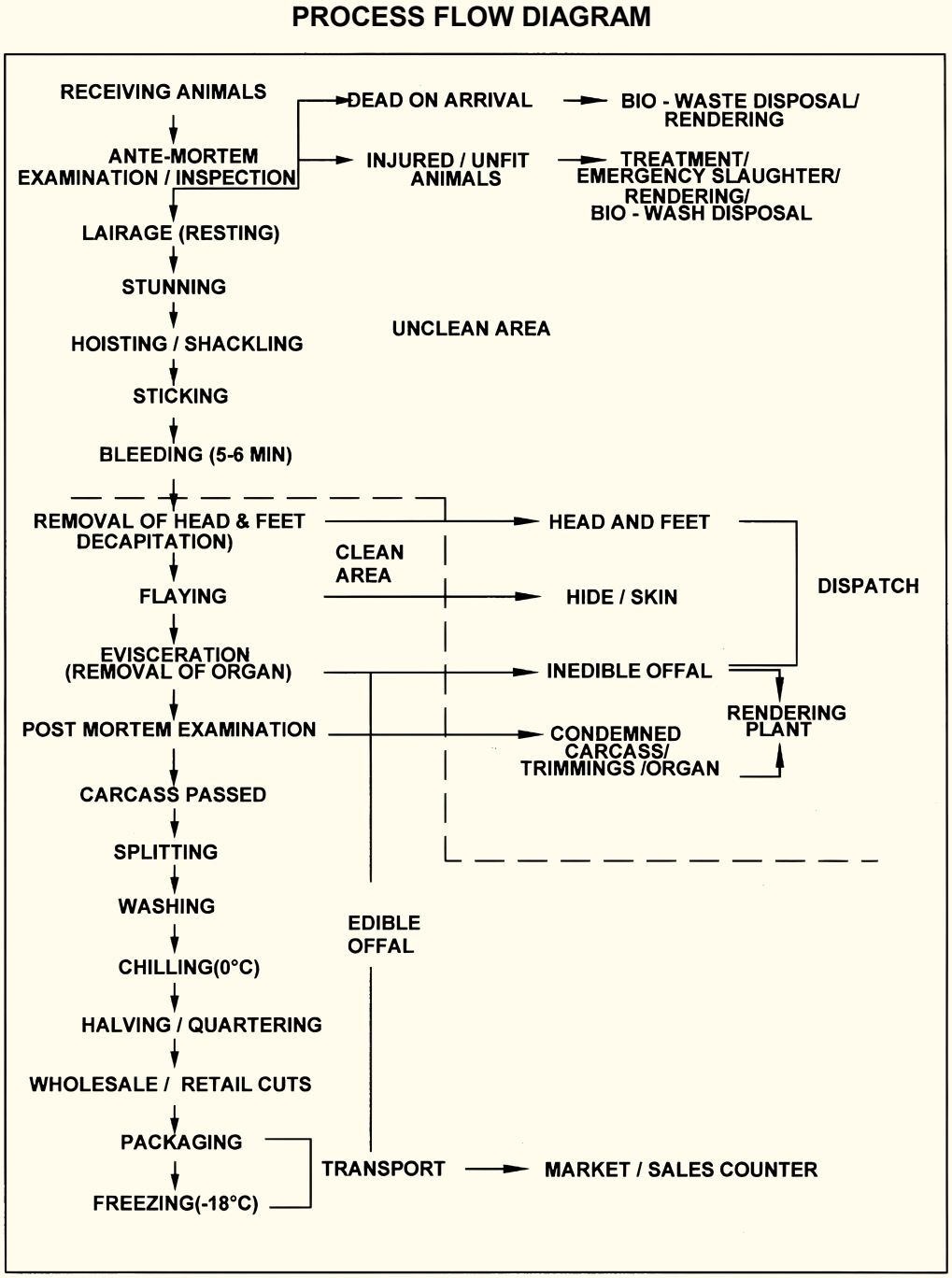


Figure 10.4: Modern Slaughterhouse- General Process Flow Diagram (Ref: IS Code-IS 4393)

10.2.1. Reception Area or Resting Grounds

The abattoir (slaughterhouse) shall have a reception area of adequate size or resting grounds where the livestock are subjected to veterinary inspection before they are passed on to lairage for resting for 24 h.

This shall have the following facilities.

10.2.2. Facilities for unloading ramp

a. Unless all animals are arriving on hoof, proper ramps for direct unloading of animals from trucks should be provided.

b. Ramps should be positioned to be even with the vehicle; width should be suitable enough for animals.

c. Ramps should have side protection and non-slip floors and be aligned so that there are no gaps where an animal might become trapped and injured.

d. Ideally, animals should not have to walk up or down ramps with slopes not greater than 30° to the horizontal (1 in 2.75 or 4 in 11).

e. It is better to use hydraulic loading platforms or hydraulically operated lifting decks on vehicles.

f. The ramps should directly lead to an ante-mortem area with office room for the veterinary inspector.

g. The reception area or resting grounds shall have a facility for watering and examining animals before sending to holding pens.

h. Separate isolation pens shall be provided with watering and feeding arrangements for: (a) sick animals or animals suspected to be suffering from contagious and infectious diseases, and (b) injured or fractious animals, in order to segregate them from the remaining animals.

i. Adequate holding area shall be provided according to the class of animals to be slaughtered.

j. The holding area shall have water and feeding facilities.

k. The resting grounds should have overhead protective shelters.

10.2.3. Lairage

a. Animals should be kept in the lairage without overcrowding or injury or being exposed to climatic stress. The lairage shall be adequate in size for the number of animals to be kept. Space sufficient to house three days supply of cattle and/or two days supply of sheep or pigs is considered necessary.

b. Space provided to animals should be such that the animal can freely move and express its normal behaviour patterns as far as possible.

c. The space provided in the pens shall be not less than **2.3 m^2 - 2.8 m^2** per animal for **cattle** which are kept without tying and not less than **3.3 m^2** per animal for the tied one.

d. The space provided in the pens shall be not less than **0.6 m^2** per animal for medium sized **pigs** and not less than **0.7 m^2** per animal for **heavy pigs, calves, sheep and goats**.

e. The animals shall be kept separately depending upon their type and class. There shall be no mixing of animals of different species. There shall be separate pens for male and female, horned and polled, animals in heat (oestrous) and pregnant animals.

f. The lairage shall be roofed and so constructed as to protect the animals from extreme climatic conditions like heat, cold and rain to avoid stress. Handling facilities should be designed to ensure ease of handling and to prevent injury to animals.

g. Floors shall have mild slopes to prevent accumulation of water and prevent water logging. Slurry and manure should be frequently removed from the shelter facilities.

h. Lairage should be maintained dry, clean and free from rodents and insects. The lairage shall have adequate facilities for cleaning and/or drying of animals; adequate supply of clean water for drinking and washing and facilities for feeding whenever necessary; and ante-mortem inspection.

i. Where separate lairage or sections are to be provided for livestock meant for Jhatka and Halal, complete visual separation shall be effected and entrances shall be as far apart as possible.

10.2.4. Slaughter Halls

a. The slaughter halls and ancillary accommodation thus provided shall be separated, keeping in view the economic and local requirements, by solid walls depending upon the site. Exits to such sections shall be kept as far apart as possible.

b. Separate space shall be provided for stunning (wherever applicable), bleeding and dressing of the carcasses.

10.2.5. Races

a. Single-file race should not be too wide, crowded and should not appear as a dead end. Single-file races must be narrow enough to prevent animals from turning around or becoming wedged beside each other.

b. Cattle race should be wide (76 cm) and races for pigs, goats and sheep should have only 3 cm of clearance on each side of the largest animal.

c. Curved race is more efficient because animals entering the race cannot see people or other activity up ahead, provided laid out correctly.

10.2.6 Stunning Area (wherever applicable)

a. The area in front of the stunning pen should be at least 3m in width to the opposing wall or bleeding trough and be fitted with upright bars 5cm in diameter and 1.2 m high, spaced in 40 cm intervals for safety purposes. Animals should enter the device easily. Animal's vision should be blocked so that they do not see people or suddenly moving objects. Metal shields should be installed around the animal's head on box type restrainers. Animals tend to panic when they lose their footing. Non-slip flooring should be provided in box-type restrainers and a non- slip cleated entrance ramp should be provided on conveyor restrainers. Animals should never be left in a stunning box or restraint device but should be stunned and slaughtered immediately after entry with rituals or otherwise, as the case may be.

b. Knocking section may be so planned as to suit the animal and particularly the ritual slaughter, if any. It should have facilities to slaughter crippled animals brought from ante-mortem inspection area to the slaughter department and also the floor and hand washing facilities. An animal shall not be slaughtered in sight of other animals.

10.2.7 Bleeding Area

A curbed-in bleeding area of adequate size should be provided. The bleeding trough should be at least 1.5 m wide for cattle, possessing a good gradient, side walls of the same height, and two drains, one for blood and one for water for the purpose of cleaning. The length of the bleeding line will depend on the throughput and the system of conveying carcasses, but should be generous, since the majority of blood flow requires 6-8 min. It shall be so located that the blood shall not be splashed on other animals being slaughtered or on the carcass being skinned. Blood drain and collection should be immediate and proper. A floor wash point should be provided for intermittent cleaning. Also a hand-wash basin and knife sterilizer should be provided for the sticker to sterilize the knife and wash his hands periodically.

10.2.8 Carcass Washing Facility

A curbed and separately drained area or an area of sufficient size sloped 33 mm/m to a floor drain, where approved carcasses may be washed with a jet of water, should be provided. Carcass should be washed with hot water at > 74 °C for at least 10 s. The treatment of carcass with one or more of the following is also permitted for cleaning purpose:

1. Chlorine;
2. Organic acids for example acetic acid, lactic acid, citric acid, fumaric acid;
3. Hydrogen peroxide;
4. Antimicrobials; and
5. Phosphates.

10.2.9. Ancillary Accommodation

- A separate room and hanging space shall be provided for emptying and cleaning of stomachs and intestines. This room shall have a separate exit.
- Condemned carcasses should be disposed off at the rendering plant. If rendering facilities are not provided, the condemned material should be denatured and held in watertight metal containers in suitable inedible product room pending daily removal by contractors for disposal through suitable prescribed waste disposal methods.
- Suitable and sufficient accommodation shall be provided for the retention of all meat condemned as unfit for human consumption and shall be locked up separately.
- If a separate block for hide curing or skin drying is not provided in the abattoir, the hides or skins may be stored in a separate room and removed daily.
- Suitable and sufficient facilities shall be provided for the isolation of meat requiring further examination by the veterinary inspector in a suitable laboratory within the premises of the abattoir.

10.2.10. Veterinary Laboratory

A room equipped for carrying out a trichinoscopic test is compulsory in abattoirs handling pigs. In larger premises, a well-equipped laboratory is essential, not only for the preliminary diagnosis of animal disease but also to maintain the overall hygienic standards.

10.2.11. Veterinary Office

An adequately equipped lockable room for the exclusive use of the veterinarian/meat inspectors. The rooms should be provided with hand-washing and shower facilities, and lockers for clothing (clean and dirty) and meat inspection equipment. A convenient means of cleaning footwear before entry into changing rooms is an advantage.

10.2.12. Labour Welfare Facilities

- Well located toilet rooms (1 per 15 employees) should be provided in the abattoir building sufficiently away from slaughter walls.
- A separate hall with lockers and shower facilities (1 per 15 employees) should be provided.
- Adequate drinking water and washing facilities (cleaning agents, soap and chemicals) should be provided at convenient locations.
- Adequate facilities for cloak room, canteen with dining hall and first-aid should also be provided.
- A store room for overalls, equipment and clean manual implements, normally required for the work, must be provided.

- Hand basins or wash trough with taps controlled preferably with the knee or elbow must be provided at the exit of these facilities.

10.2.13 Isolation Block

It is also called an emergency slaughterhouse or miniature abattoir. In large abattoirs isolation block is necessary for detention of suspected animals for its observation and treatment and if necessary to do emergency slaughter in case of fractured, injured animals. The isolation block will have a small lairage to keep 4 cattle with a slaughter hall, cooling hall, bacteriological laboratory, incinerator and sterilization rooms. This block must be located at a distance from the main buildings and workers should not move from here to the main buildings. It should be situated near to the suspect meat detention room and should be in direct communication with the by-products department.

10.2.14. Chiller and Freezer Rooms

The Chiller room shall have temperature of 0 °C to 4 °C and the freezer room shall have a temperature of –18 ± 2 °C. Hanging halls, if air-conditioned, should have temperatures not higher than 10 °C. Two retaining compartments constructed of rust-resistant wire gauge or expanded metal portion extending from about 75 mm above ground to ceiling should be provided, one for holding retained carcasses and the other for holding the carcasses affected with Cysticercus bovis.



Figure 10.5: Chiller Room

10.2.15. Rails for Carcasses

Any of the following systems for line dressing can be taken into operation, the type depending mainly on the level of throughput, equipment design and species.

A) Gravity Rail System

Recommended for 10-40 animals per hour, carcass is suspended from a spreader and single

wheel trolley or runner are gravitated to each station and stopped by a manually operated stop on the overhead rail.

B) Intermittent Powered System

Recommended for 10-75 animals per hour, it involves the mechanical moving of the carcasses suspended on a spreader and trolley along a level rail at intervals by means of a variable timing device which can be pre set to suit the slaughter rate.

C) Continuous Powered System

Recommended for 40-120 animals per hour, here dressing line is in continuous motion with more sophisticated equipment light mechanical hide puller, moving top inspection table and the carcass can be revolved a full 360° while on the rail allowing the operator to work all sides from one position.



Figure 10.6: Rails for Carcasses

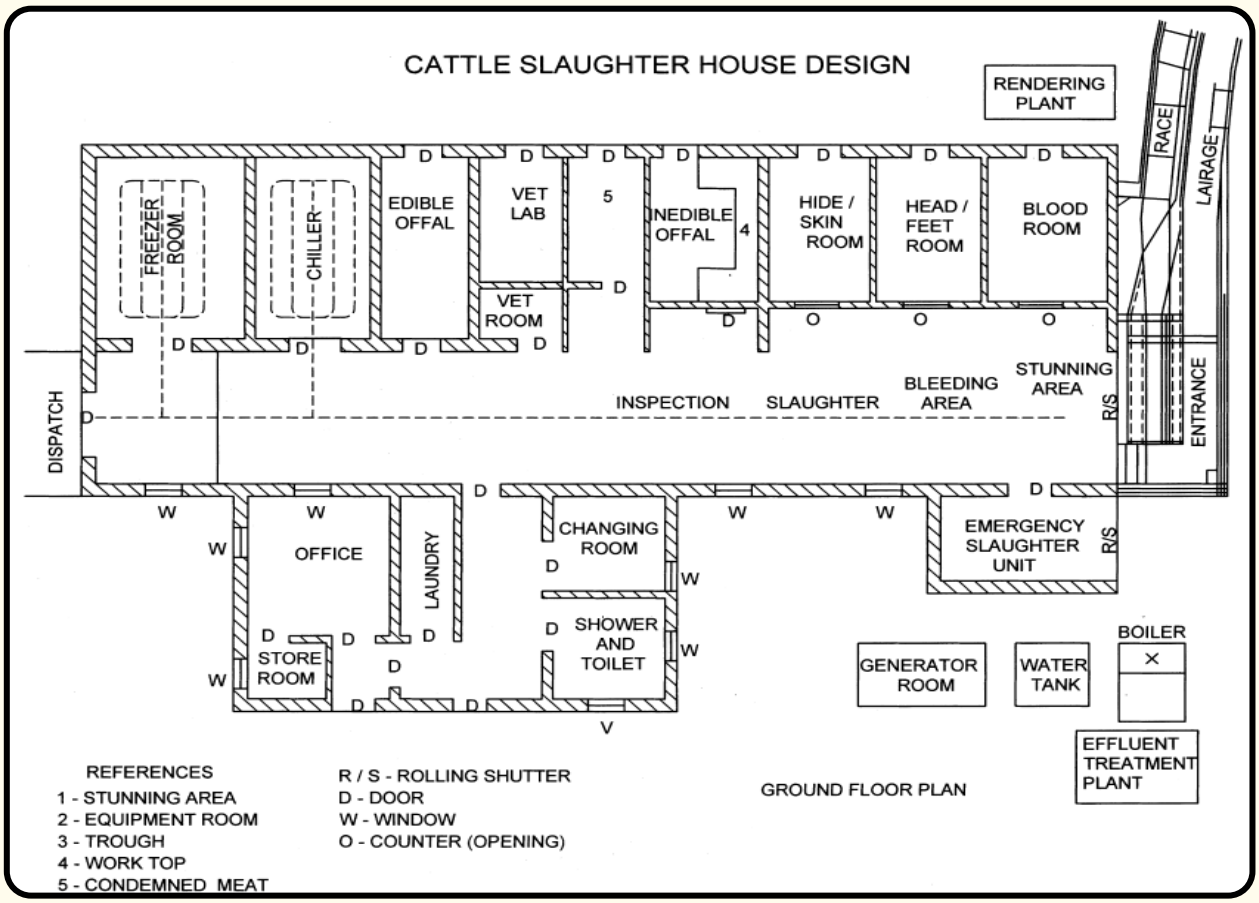


Figure 10.7: Typical layout plan for cattle slaughterhouse (Ref: IS Code-IS 4393)

10.3 CIVIL CONSTRUCTION

A. Abattoir Premises

Should have concrete brick wall with barbed wire fencing upto 10 feet, with security in order to control the unauthorized entry of vehicles, persons and animals. Larger houses should be planted with trees in order to make the premises environment friendly.

B. Plant Building

Materials used shall be impervious, easily cleansable, and resistant to wear and corrosion. Materials such as wood, plasterboard, and porous acoustic-type boards, which are absorbent and difficult to keep clean, should not be used in edible departments.

C. Floors

The floors should be non-absorbent and non-slippery with rough finish, and shall have suitable gradient for drainage.

D. Interior Walls

Interior walls should be smooth and flat and constructed of impervious materials such as glazed brick, glazed tile, smooth surfaced Portland cement plaster, or other non-toxic, non-absorbent material applied to a suitable base. It is recommended that the interior walls should have washable surface up to the height of 2 m from the floor so that the splashes may be washed and disinfected.

E. Ceilings

Ceilings should be of good height (5 m or more is desirable in work rooms). So far as structural conditions permit, ceilings shall be smooth and flat. Ceilings shall be constructed of Portland cement plaster, large size cement asbestos boards with joints sealed with a flexible ceiling compound, or other acceptable impervious material and finished so as to minimize condensation, mould development, flaking and accumulation of dirt. The walls (above glazed type portion) and ceiling may be painted with water- resistant paint to maintain them clean.

F. Doorways and Doors

Doorways through which product is transferred on rails or in hand trucks **shall be at least 1500 mm wide**. Doors shall either be of rust-resistant metal construction throughout, or if made with rust-resistant metal having tight soft wood, they shall be clad on both sides with soldered or welded seams.

G. Screens and Insect Control

All windows, doorways, and other openings that may admit flies should be equipped with effective insect and rodent screens. 'Fly chaser' fans and ducts or air curtains shall be provided over doorways in the outside wall of food handling areas that are used for dispatch or receiving.

H. Vehicular Areas for Trucks

Concrete paved areas, properly drained and extending at least 6 m from building, loading docks or livestock platforms shall be provided at places where vehicles are loaded or unloaded. Pressure washing jets and disinfection facilities for trucks carrying animals should be provided. Vehicles which offload live animals, loads intestines, heads and feet as well as vehicles removing paunch contents, condemned material and refuse are restricted to the dirty area and may not enter areas where meat vehicles and staff who handle meat are to be found. Separate routes for stock and meat vehicles should be provided. Approach roads should be at least 6 m wide. Drainage and cleaning facilities should be available in vehicle parking areas where animals are offloaded or meat is loaded.

10.4 SUPPLY OF WATER

- A sufficient and constant supply of potable water (see IS 10500) shall be available at adequate pressure throughout the premises.
- The pressure for the general purpose of floor washing, etc, may preferably be 30 psi to 50 psi for thorough floor cleaning.
- For thorough and efficient washing of carcasses, a higher pressure of 150 psi to 250 psi is

recommended.

- A constant supply of clean hot water shall be available in the slaughter hall and workrooms during working hours.
- Hot water is required at not less than 82 °C for frequent sterilisation of equipment.
- Where non-potable water is used for fire control, steam production and cooling refrigeration equipment, etc, it shall be carried in completely separate lines preferably identified by colour and with no cross-connection or back siphonage with lines carrying potable water.
- Water requirement for an abattoir for pigs is approximately 454 litre/animal/day.
- Water requirement for an abattoir for cattle is approximately 272 litre/animal/day.
- Water requirement for an abattoir for sheep and goat is approximately 45 litre/animal/day plus 25 percent at a reasonable pressure of 15 psi.
- Water should be tested once in a month for bacteriological requirements and once in six months for chemical requirements (see IS 10500).

10.5 CLEANING TECHNIQUES

Depending upon the requirement any of the following types of cleaning can be used:

1. Manual cleaning,
2. Mechanical cleaning,
3. High pressure cleaning,
4. Moist steam cleaning, and
5. Foam cleaning.

10.6 WASTE MANAGEMENT IN SLAUGHTERHOUSE - KERALA PCB CRITERIA

Kerala State Pollution Control Board circular no. KSPCB/70/2022-SEE-3 dated 21/11/2022 had issued directions to install a rendering plant at the slaughterhouse. The slaughter waste generated in the units shall be processed completely in their own rendering plant.

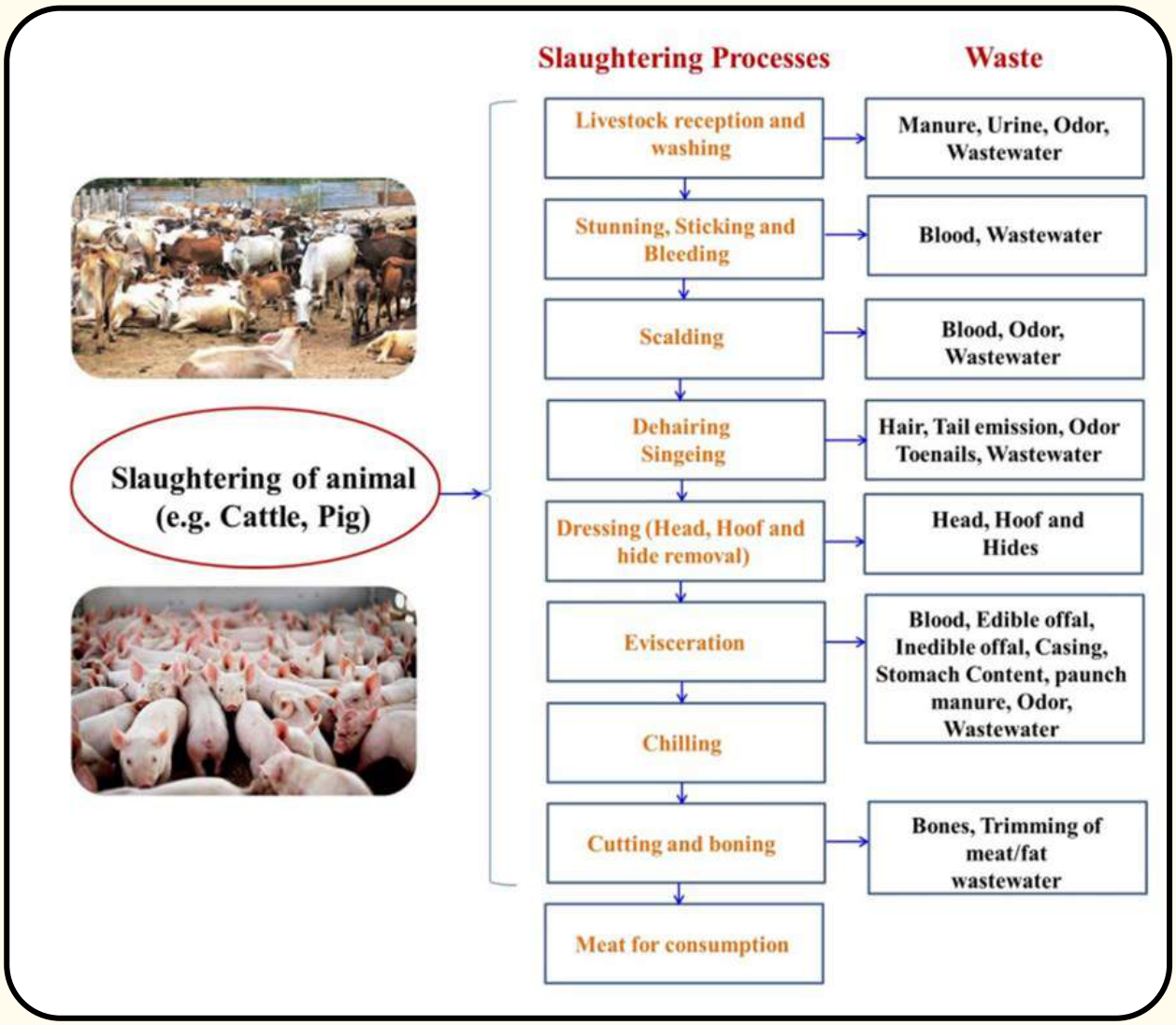


Figure 10.8: Waste generation during various stages from slaughterhouse

10.7 EFFLUENT TREATMENT PLANT

Slaughterhouse effluent consists of blood, gut, urine, fat, wash water (utensils, meat, and floor), food particles in the intestines of the animals and offal waste. The main contaminants in the effluent are organic in nature and are characterized by high COD, BOD, nitrates and phosphates. The pollution potential of effluent from bovines (cow, ox, and buffalo) is 2.5 times higher than in sheep, goat, and veal abattoirs.

Typical inlet characteristics of raw slaughterhouse effluent and standards for treated effluent are given in the Table below (CPCB, 2017). The treatment units must be designed to comply with the standards specified by the Central Pollution Control Board (as in the Table).

Table 1: Typical raw slaughterhouse effluent characteristics and standard for treated effluent

Sl.No	Parameter	Concentrations (Raw effluent)	Concentrations (Treated effluent)
1	pH	7.6 to 8.2	6.5 to 8.5
2	Total Suspended Solids (mg/L)	1500 to 4500	50
3	BOD (mg/L)	1200 to 4000	30 (BOD_3 at 27□)
4	COD (mg/L)	3000 to 7000	250
5	Oil & Grease		10

The following treatment scheme can be used to treat the effluent from the slaughterhouses. The effluent from the slaughterhouse is allowed to enter the fine screen, where the small solid particles are removed. The effluent passing the fine screen will be allowed to enter the Dissolved Air Floatation, where the solid particles, oil and fats will be removed from the effluent by the mechanical skimming device. The effluent will be then allowed to enter the high rate anaerobic digester, where the organic materials will be digested. The microbial inoculum for the high rate anaerobic digester shall be procured from a working slaughterhouse effluent anaerobic digester for the initiation of effective digestion.

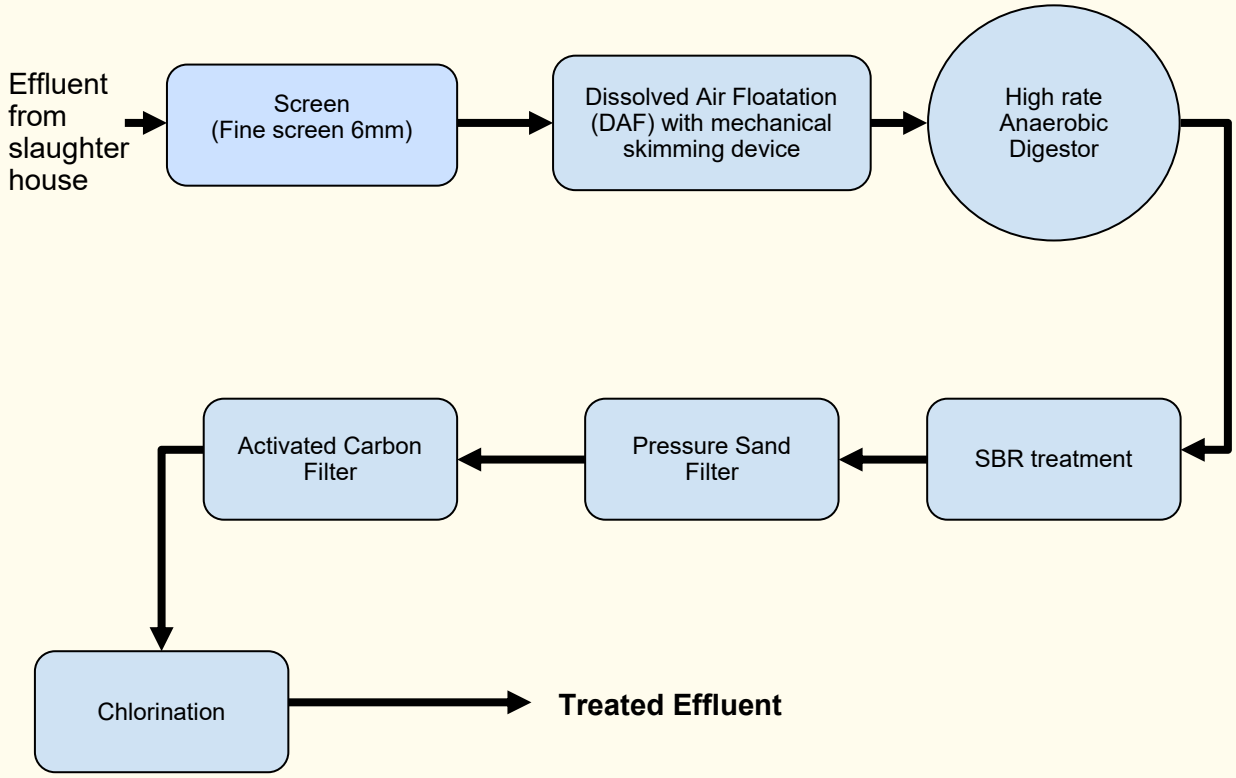


Figure 10.9: Schematic treatment process of ETP

Post-anaerobic digestion, the effluent is allowed to pass through sequencing batch reactor which further reduces the pollutants in the effluent. Consequently, the effluent is passed to activated carbon filter, pressure sand filter and chlorination to remove the colour and the harmful pollutants in the effluent.

10.8 ODOUR CONTROL SYSTEM THROUGH BIOFILTERS

Biofilters use adsorption methods to control the generated odour. A biofilter is any type of filter with biomass attached to the filter media. Odour producing substances will be adsorbed by filter material and decompose safely by bacteria, so clean air comes out with very minimum odour.

10.9 SAFETY REQUIREMENT

There shall be adequate fire fighting arrangements and portable first aid. Fire appliances shall be fixed in accordance with IS 2190.

11 CREMATORIUM

Cremation is a process of disposal of human body on dead; and crematoriums are facilities where this is done in a scientific way. In relatively olden times and in some places even now, cremation is done using pyre. This, uncontrolled burning for ceremonial disposal of body is now becoming difficult owing to the scarcity of privately owned land, density of population and difficulty to get wood and similar materials to make pyre. In this context, the possibility of using other sources of energy to burn off the dead body gained importance and that has led to the acceptance of electric cremators and now the gas fired cremators. In gas fired cremators, the fuel used for burning is LPG, which has a very high calorific value and this makes the system much more efficient than the electric cremator and hence preferable. In a gas crematorium, the burning takes place in a controlled manner with proper treatment for the emanating gases, before venting it.



Figure 11.1: Modern Gas Crematorium (indicative layout)

A crematorium is a facility that houses a cremator, having a cremation chamber or retort which is able to generate about 850-1000 °C. In this chamber, the body of a deceased is incinerated and reduced to bone fragments. Modern cremators have adjustable-control systems that monitor cremation to see its completion and subsequently shut it down. The time required for cremation varies from body to body, but mostly it is possible to complete the process within 1-1.5 hrs of operation.

As it is required to have proper guidelines in place while setting up and operating crematoriums, the state of Kerala has already incorporated such provisions in The Kerala Municipality Act 1994 and The Kerala Panchayat Raj Act 1994. The Kerala Panchayat Raj (Burial and Burning Grounds) Rules, 1998 clearly stipulates the requirements for setting up a crematorium in Panchayaths.

As the Local Self Government Institutions (LSGIs) are the ones that provide infrastructural facilities for such common purposes, actions are taken to set up modern crematorium facilities which would be helpful particularly for the landless.



Figure 11.2: Gas- powered Cremator



Figure 11.3: Gas- powered Cremator



Figure 11.4: Gas- powered Cremator

11.1 CREMATOR COMPONENTS

The design of the cremator shall be in accordance with the Suchitwa Mission specifications, and shall include:

The Furnace System shall comprise of:

1) Primary Combustion Chamber
2) Body Loading Trolley
3) Hot Duct
4) Secondary Combustion Chamber
5) Cyclone Separator
6) Venturi Wet Scrubber
7) Mist Eliminator
8) Dilution System
9) Stack/Chimney
10) Control Panel
11) Ash Chamber/Ash Removal facility

11.2 TECHNICAL SPECIFICATIONS

Table 11.1: Technical Specifications of Crematorium

1	Primary Chamber	Appropriate shape with a minimum specified interior volume of 2.2 m^3. Made with MS of minimum plate thickness of 5 mm.
2	Secondary Chamber	Separate secondary chamber shall be provided above the primary chamber, designed properly so as to facilitate a minimum of two seconds residence time to ensure combustion of the flue gas flow. For the estimation of residence time in the secondary chamber its volume shall be calculated starting from the secondary burner tip to the thermocouple. The minimum flow of the flue gas in the secondary chamber shall be 0.6 m3/ sec at 1050°C
3	Door of primary chamber	Front opening, vertical sliding, counter weight balanced with view port.
4	Furnace bed & Structure	Made up of cast iron/ stainless steel with high quality IS 8 refractory bricks as insulation.
5	Proper thermal insulation shall be provided for primary and secondary chambers and connecting pipes.	
	Internal	IS 8 refractory brick lining and insulation brick lining combined with a min. thickness of 230 mm to withstand 1500°C with high quality castable fire clay and mortars with specific type of curing to the furnace.

	External	Outer skin temperature of the furnace wall to be maintained below 50°C. Insulation brick/Rock wool as per TS 6701 and ASTM C-680 (optional if insulation bricks are used)
6	Fuel	Liquefied Petroleum Gas/Natural gas
7	LP Gas cylinders	Minimum 8 numbers
8	Gas pipe line from gas cylinder storage room	Copper piping with pressure gauge
9	Burner System	Fuel: LPG/Natural gas 4 Nos. for the primary chamber and 2 Nos. for secondary chamber each having 100 kW with minimum LPG draw 4 kg/hr in such a way that High pressure, full length burner on either side of primary and secondary chamber. Features: • Fully automatic burners with fan, motor, pump, ignition transformer & electrode, flame sensor, sequence controller, gas solenoid valve, air/gas pressure switches. • Stepless fully modulating operation • Allows air gas fine tuning • Ability to obtain optimum combustion values by regulating combustion air and gas • Integrated with PLC control for burner trip alarm/hooter and other specified safety features.
10	Dilution system with ID fan	ID fan with at least 3 HP and 1270 CFM blowers to bring down the concentration of pollutants.
11	Combustion Air Supply	With at least 1HP blower for the supply of air for incineration of the body in the primary chamber and for supply of excess air to the secondary chamber.
12	Motors	All motors should conform to IE-2 specifications.
13	Venturi scrubber, cyclone separator and mist eliminator	Integrated or separate units shall be provided to remove particulate matter and harmful emissions before letting it out to the atmosphere.
14	Chimney	30m height chimney as per CPCB norms and State PCB norms. Made of MS bottom dia. 1000 mm, top diameter 325 mm with specified thickness as per the drawing. From bottom up to 18m ht. MS sheet with thickness varying from 8 mm to 6 mm with inner lining lagged with high alumina refractory in the conical area. From 18m-24m ht, MS cylinder 400 mm dia and 5 mm thick. From 24 m -30 m, MS cylinder 325 mm dia.
15	Chimney Support and other accessories	• Support for chimney if there is any structural requirement • Ladder shall be provided for the entire height of the chimney.

16	Chimney connection	200 mm minimum dia. MS refractory lagged pipe from 3 HP ID blower to chimney/manifold.
17	Foundation for chimney	As per site condition
18	Sampling port	At 11m from the chimney bottom.
19	Lightning arrestor	At the top of the chimney and to be connected to the ground
20	Earth pit	Up to 3m as per requirement.
21	Temperature Sensor	Adequate nos.of k-type thermocouples/RTD in primary and secondary chambers. In the Secondary chamber the location of the thermocouple shall be at the end of the Secondary chamber or before admission of dilution medium.
22	Temperature Control and Indication	Solid State digital type temperature indicator controller 0-1200°C in each chamber. The sensor must be inserted at the top of the cremation furnace chambers.
23	Safety Controller	PLC based control. Safety features: • Able to prevent the charging door from being opened unless the temperature in the primary chamber is below the set point or when the burners are in ignited mode. • Automatically shut down the fuel flow to the burner at the end of the cremation cycle.
24	Ash removal facility	At front/rear side of primary chamber, scraping by manual operation, with hinged type door manually operated.
25	Painting	Steel items other than SS to be painted with high temperature resistant paints.
26	Trolley	Stretcher type trolley fully SS with SS bed and provision for easy sliding of the body into the primary chamber with min. size of 11ft x 3 ft x 2ft
27	Primary chamber Temperature	850 ± 50°C
	Secondary chamber Temperature	1100 ± 50°C
	Chimney/Stack Temperature	Min. 200°C
28	Cremation time/body	60-90 minutes
29	LPG consumption	12 ± 2 kg (max.)
30	Emissions	As per KSPCB standards
31	Operation and Maintenance	The agency authorized should provide 12 months free O&M for the entire system. During this period one personnel of the local body shall be trained by the agency. After the free service of 12 months, the service provider should be ready to undertake the O&M for a period of 10-15 years, if required by the LSGIs.

11.2.1. Primary Combustion Chamber

Primary Combustion Chamber is for the incineration of the human dead body. The incineration is achieved by maintaining the temperature of the chamber and also supplying air for combustion. The moment the body is introduced, it catches fire and the incineration process starts.



Figure 11.5: Primary Combustion Chamber

11.2.2. Body Loading Trolley

For loading and transferring the body to the furnace, a trolley that moves on rails is to be provided.



Figure 11.6: Body Loading Trolley

11.2.3. Hot Duct

Hot air ducts are integral parts of heat-related applications because they are designed to withstand elevated temperatures.



Figure 11.7: Hot Air Duct

11.2.4. Secondary Combustion Chamber

In the secondary combustion chamber, the gas emitted from the primary chamber is again incinerated. The size of the secondary chamber shall be properly designed so as to facilitate a minimum of two seconds residence time to ensure combustion of the gas flow, unburnt material such as volatiles, smoke and soot. For the estimation of residence time in the secondary chamber its volume shall be calculated starting from the secondary burner tip to the thermocouple.



Figure 11.8: Secondary Combustion Chamber

11.2.5. Cyclone Separator

A Cyclone separator is installed to remove particulate matter from the flue gases. After the secondary combustion chamber, the gases pass through a cyclonic separator to remove larger particulate matter (solid particles) from the gas stream by using centrifugal force



Figure 11.9: Cyclone Separator

11.2.6. Venturi Wet Scrubber

After removing larger particulates, the gases go to the venturi scrubber. It uses a liquid (usually water) to capture smaller particles and gaseous pollutants.



Figure 11.10: Scrubbing System

11.2.7. Mist Eliminator

Following the venturi scrubber, a mist eliminator is used to remove any remaining water droplets or mist that might have been carried over from the scrubbing process, preventing moisture from reaching the next stages.

11.2.8. Dilution System

The dilution system would typically be used to dilute the exhaust gases with fresh air before final release. This step can reduce the concentration of pollutants and cool the gases before they exit through the chimney.

11.2.9. Chimney

The Chimney/stack needs to have a height of 30 m from the ground and this is required from the point of view of pollution control through dilution and dispersion. It shall be ensured that the pipe is structurally stable. There shall be a ladder system associated with the chimney which could be used for maintenance when there is some kind of repair work in the chimney or for painting the chimney. Both the chimney as well as the ladder shall be in mild steel and shall be painted to control the corrosion of the material. Both the parts shall be properly grounded so as to have strong footing that would enable the structure to withstand heavy winds.



Figure 11.11: Scrubbing System

11.3 PROCEDURE AND PROCESS OF CREMATION

Cremation is the process of reducing dead bodies to basic chemical compounds in the form of gases and bone fragments. This is accomplished through burning at high temperatures, vaporization and oxidation.

The cremation of bodies shall be undertaken based on procedures devised by the LSGIs. The dependents/relatives of the deceased have to visit the LSGI and obtain the cremation forms. The forms, after duly filling and signing, has to be submitted to the LSGI with necessary support documents. The applicant, then has to go to the crematorium with the receipt of payment and get the time of cremation. Usually the cremation time shall be between 8 am and 6 pm on all cremation days.

After the religious rituals, the body will be handed over to the crematorium operator for cremation. In the cremator, LPG gas is injected and burned to raise the inside temperature of the chamber. When the cremation furnace temperature reaches 8000C, the human body is placed on the body charging trolley and the trolley moves forward as the furnace door opens. The body charging trolley lays the body on the cremation bed and comes backward and when it is out, the cremation furnace door will completely close, for the cremation to begin.

During cremation, flue gas from primary chamber is let out into the secondary chamber where the hazardous gases and toxics and other volatile substances are completely burned and moved out as hot flue gas into the venturi scrubber with water, and finally the scrubbed and cleaned gas is passed out through the 30 m chimney.

After burning, the ash remaining represents very roughly 3.5% of the body's original mass (2.5% in children). Ashes of adults can be said to weigh from 1.8 kg (women) to 2.7 kg (men). The cremator needs to have an ash pit to collect the cremation remains which is collected in an urn and given to the relatives of the deceased.

To cremate a human body, about 14-18 Kg of LPG and about 1-1.5 hours is required.

12 REFUSE DERIVED FUEL

Refused derived fuel (RDF) means fuel derived from combustible waste fraction of solid waste like plastic, wood, pulp or organic waste, other than chlorinated materials, in the form of pellets or fluff produced by drying, shredding, dehydrating and compacting of solid waste. The processing of several fractions of solid waste that are combustible in nature but are not recyclable – such as soiled paper, soiled cloth, contaminated plastics, multi-layer packaging materials, other packaging materials, pieces of leather, rubber, tyre, polystyrene (thermocol), wood, etc. has remained a challenge that unnecessarily end up at the landfill site. These fractions can be processed and converted to refuse derived fuel (RDF) which can be utilised as alternative fuel in various industries in line with the principle of waste to wealth.

The production of RDFs from solid waste offers a solution to address the growing waste issues. At the same time, these RDFs enable industries to substitute fossil fuels. The principle of RDF production is recovering quality fuel fractions from the waste, particularly through the removal of recyclable particles such as metal and glass, and converting the raw waste into a more usable form of fuel with uniform particle size and higher calorific value than raw solid waste.

The quantity of RDF that can be produced per tonne of solid waste varies depending on the type of collection, pre-processing and composition of the waste source. The usual yield of RDF from mixed solid waste is in the range of 20-30 %, although if the waste is properly segregated, a yield of 80-90 % can be achieved. Depending on the need of the end user, RDF fluff can be further processed in the densification unit to produce RDF pellets. RDF pellets offer the advantage of volume reduction and corresponding transportation cost savings while transferring the combustible waste fraction to a cement factory for co-processing.

Table 12.1: SWM Rules 2016 for RDF

Reference	Rules/Activities
Criteria for waste to energy process.	(i) Non-recyclable waste having calorific value of 1500 Kcal/kg or more shall not be disposed of on landfills and shall only be utilised for generating energy either or through refuse derived fuel or by giving away as feedstock for preparing refuse derived fuel. (ii) High calorific wastes shall be used for co- processing in cement or thermal power plants.

Duties of the industrial units located within one hundred km from the RDF and Waste to Energy plants based on solid waste	All industrial units using fuel and located within 100 km from a solid waste-based RDF plant shall make arrangements within six months from the date of notification of SWM rules to replace at least 5% of their fuel requirement by RDF so produced.

Table 12.2: Benefits of using RDF in Cement Kilns

Indicators	Benefit
Feeding of RDF	The installation of an alternate fuel feeding mechanism enables RDF to be fed into the cement kiln without any difficulty. Usually, cement factories build a separate entry point for Alternative Fuels & Raw Materials which can include pharma waste, packaging waste, lubricants, etc. The same feeding mechanism can be used for RDF.
Impact on Product	Very high temperatures of approximately 1400ºC and a residence time of 4-5 seconds in an oxygen rich atmosphere ensure complete combustion of RDF without affecting the productivity. The fuel has a calorific value of around 3000 Kcal which can generate enough thermal energy required in the processes in these plants, reducing the use of non-renewable fossil fuels like coal.
Environmental Impact	RDF usage replaces fossil fuels with materials which would have been landfilled leading to emissions. Furthermore, improper landfilling would have allowed leachate to run into ground water and become a major source of pollution. Furthermore, very high-temperature incineration followed by a stack emission monitoring mechanism ensures that emissions into the atmosphere are within safe allowable limits.
Residual Disposal	Acidic gases generated in the combustion process are neutralised by the alkaline raw material in the cement kiln and are incorporated into the cement clinker. The interaction of the raw material and the flue gases in the clinker ensures that the non-combustible part of the residue is held back in the process and is incorporated in the clinker in an almost irreversible manner. No additional waste is generated in the process

12.1 VARIOUS STAGES IN RDF PROCESSING

12.1.1. Collection and Segregation of Waste

Dry waste collected from door to door and transported to decentralized waste management facilities after separating recyclables and the leftover segregated combustible fraction can be processed for making RDF. At the RDF processing plant, manual and mechanical separation need to be carried out again to separate recyclable materials, if any, and shall be sent to recycling units. Proper source segregation, collection and transportation of segregated solid waste for resource recovery shall be ensured by the Local body so that only non-recyclable combustible fraction can be sent for co-processing.

12.1.2. Storage

Necessary arrangements shall be made for the safe storage of segregated combustible fractions of waste before conversion to RDF. Depending on the frequency of transportation of material, to the nearest RDF Plant or waste to energy facility, storage facilities for waste fractions shall be provided in MCFs/RRFs. As per the guidelines of CPHEEO Manual, adequate arrangements for firefighting approved by the competent authority shall also be installed.

12.1.3. RDF Preparation

After removing the recyclable materials, the left-over material, which is a segregated combustible fraction, is then processed through a dedicated facility having screening, shredding, air density separation, blending, etc. to produce the desired quality RDF. The RDF producers shall ensure that the quality of RDF produced is as per standards defined and agreed by the end user.



Figure 12.1: RDF Fluff

12.1.4. Making of RDF Briquettes

Converting RDF fluff to briquette is essential to ensure volume reduction while transporting the RDF to cement factories for coprocessing. Making of RDF briquettes is done through the following steps:

a) Preparation of materials,

b) Shredding,

c) Drying 1,

d) Carbonization process,

e) Sieving process,

f) Mixing raw materials,

g) Molding and compaction,

h) Drying 2,

i) Testing of RDF briquette quality.



Figure 12.2: RDF Briquette Making Machine



Figure 12.3: RDF Briquettes

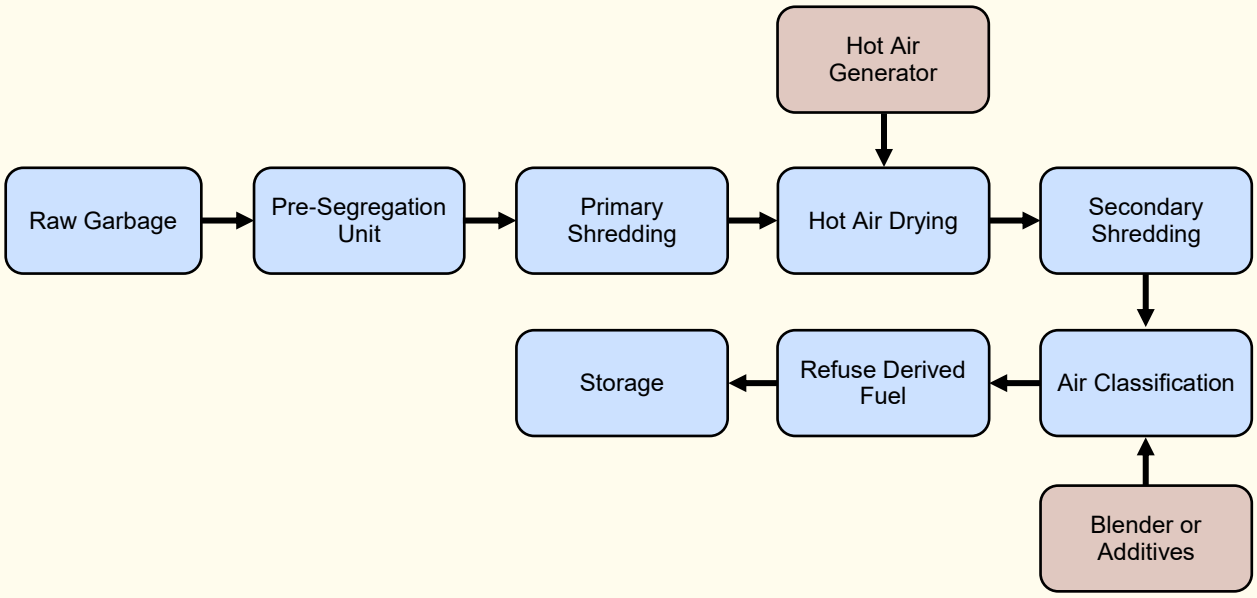


Figure 12.4: Refuse Derived Fuel Production Line (Pelletization)

12.1.5. Transportation

The safe and regular transportation of RDF or segregated combustible waste fractions to nearest waste to energy or cement plants shall be done by LBs or Private operators, as the case may be. Proper accounting system shall be maintained regarding the quantity of waste processed and that handed over to the waste to energy or cement plants.

12.2 STANDARD COMPONENTS OF RDF PLANT

- **Solid waste receiving, sampling, hand sorting and bag-opening area**: The solid waste arriving in trucks or compactors is unloaded for collection of samples, hand sorting of large components, and transported to the bag-opening machines.

12.3 ESSENTIAL COMPONENTS OF RDF PLANT

The specifications of an RDF plant can vary depending on its size, input capacity, and intended end product, but generally include the following key components and specifications:

- **Input Capacity**- Capacity can vary from plants processing 5 tons per day- 100 tons per day, depending on waste generation in the region.
- **A twin-shaft primary shredder** designed to shred solid waste to less than 100 m.
- **A rotary trommel** is then used for separating the fine sand and silt from the solid waste before it can be sent for further processing. The material tumbles in the rotary screen as it moves ahead across the length of the screen and the fine silt and sand get removed through the holes provided in the screen. The rest of the material is discharged onto the belt conveyor which carries the material for further processing. After the trommel, a belt for hand sorting (separation of recyclables) should be placed.
- **An air density separator and dryer** consist of a rectangular column designed to separate light fractions from heavy inert. The material is introduced at the top section and air blast is given at its bottom. Both incoming and outgoing materials pass through their respective airlock valves. It is a three-stage process. High pressure air blast de-agglomerates the incoming materials and the very light fraction is sucked up. Furthermore, the air blast from the bottom of the column moves the medium-sized fraction of the material up in the air. The bottom fraction consists of heavy material that falls through the airlock and gets discharged. Hot air can also be injected into the system to lower the moisture content of the material.
- **A twin shaft secondary shredder** is designed to shred the material to **less than 50 mm**. Further components include a main drive motor, a reduction gear box, other integral components and a starter panel.
- **The fine shredder** is designed to reduce the size of the RDF fluff after it has passed through the secondary shredder.
- **Pellet making machine** is designed to produce fuel pellets, with a 16 – 25 mm diameter, by extrusion. Ground and conditioned material is fed to the pellet press by gravity feed. A roller presses the material through die holes and extrudes the material. The size of pellets can be adjusted by a knife provided below the die press. The pellets are cooled on a cooling conveyor and sent for storage.
- **Transportation:** After a quality check of RDF, transportation to cement plants/ waste to energy plants can be done.
- **Emission Standards:** Emission of the machine should confirm to the standards of PCB.

O&M and Forward Linkage: The operation and maintenance of the RDF plant should be done through a service provider. The forward linkage for the RDF produced (Dry Powder (Fluff)/ Briquette/ Pellets) shall be the responsibility of the O&M service provider and LSGI should ensure this linkage before issuing purchase order.

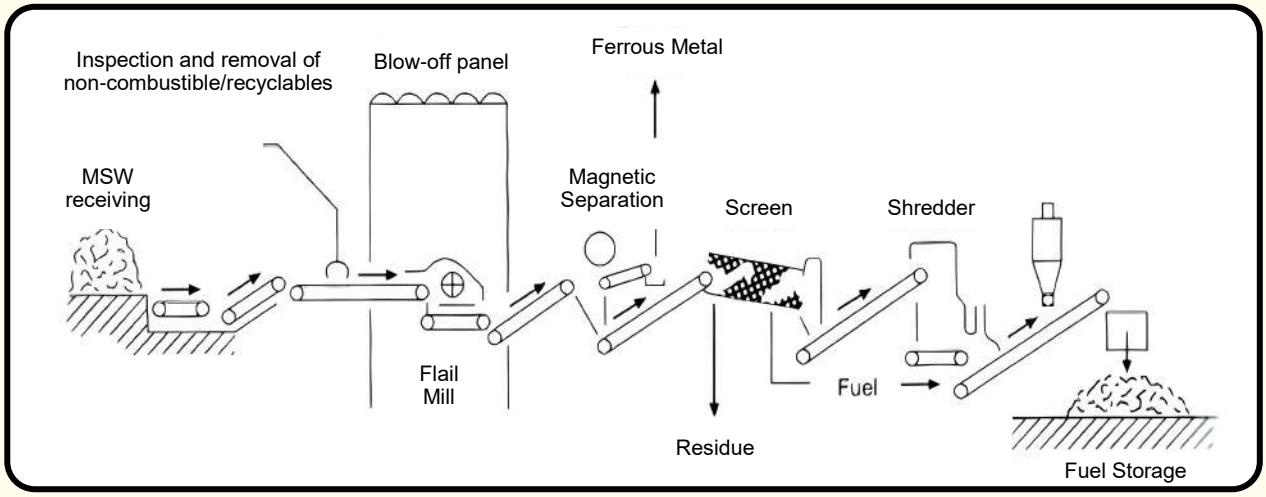


Figure 12.5: Schematic Overview of RDF Manufacturing Process

12.4 QUALITY OF RDF

The required quality of RDF is determined by the end use of the fuel. Ministry of Housing and Urban Affairs, specifies the broad specification of RDF suitable for the Indian cement plants as follows:

- Moisture – preferably < 20 per cent
- Size – depending on the process limitations of the specific cement plant
- Chlorine – preferably <0.7 per cent, depending on the particular raw mix and fuel mix
- Calorific value – preferably >3000 kcal/ kg
- Sulphur – <2 per cent, however this depends on the particular raw mix and fuel mix
- Free of restricted items such as PVC, explosives, batteries, aerosol containers and bio-medical waste.

The following categories of wastes are **not recommended** for pre-processing or co-processing:

- Biomedical waste
- Asbestos-containing waste
- Electronic scrap
- Entire batteries
- Explosives
- Corrosives
- Mineral acid wastes
- Radioactive Wastes
- Unsorted municipal garbage

12.5 MODE OF PROJECT EXECUTION

The setting up of an RDF plant in a local body may be done through the following modes. Priority shall be given to tipping fee-based models as the financial investment to LB will be the least in this case.

i) Private Owned

- Both land and the facility owned by the private party
- The operational cost shall also be met by the private party.
- Tipping fee based on weight of the waste to be processed shall be paid by the local body or Generator to the private agency

ii) PPP Model

- In this model, the construction and operation cost shall be shared by the local body and private investors.
- Tipping fee based on weight of the waste to be processed shall be paid by the local body or Generator to the private agency
- Operation and maintenance of the plant for a minimum term of 10 years (in case of machines having smaller capacity, minimum 5 Years) shall be the responsibility of the agency installing the plant.

iii) By Local Body

- The Local Body shall establish the processing and disposal facilities under a DBOT (Design, Build, Operate, Transfer) model, ensuring the O&M for a minimum period of five years. Following this term, the facility shall be operated by a service provider selected through a competitive bidding process.
- Tipping fee fixed based on the expenditure incurred for running the facility.

Figure 12.3: Tentative Project Requirements

Sl. No	ITEM	PROJECT DETAILS			
1	Plant Capacity	5 TPD	10 TPD	50 TPD	100 TPD
2	Plot area (Approx)	25 Cents	50 Cents	80 Cents	100 Cents
3	Project Cost (Approx)	Rs. 3.5 Cr	Rs. 6.5 Cr	Rs. 9.0 Cr	Rs. 12.5 Cr

12.6 TENTATIVE REQUIREMENTS OF SETTING UP AN RDF PLANT

Sl. No	ITEM	PROJECT DETAILS
1	Plant Capacity	To be specified based on the estimated waste generation
2	Volume Reduction	75- 90%
3	Output	Dry Powder (Fluff)/ Briquette/ Pellets
4	Output Quality	Minimum net calorific value should be 3000 Kcal/kg
5	Emission Standards	Emission of the plant should conform to the standards of Pollution Control Board
6	Intended Use	For direct co processing in cement kiln/ similar use, which should be ensured by the contractor/ agency
7	Ash – maximum permissible	<15 %
8	Moisture – maximum permissible	< 20%
9	Chlorine –maximum permissible	< 1.0 %
10	Sulphur – maximum permissible	<1.5 %
11	Any offensive odour to be controlled	
12	The process flow for RDF production shall be as per CPHEEO “Guidelines on Usage of Refuse Derived fuel in various industries”.	
13	The agency shall ensure that the plant meet all the regulatory and legal requirements	

Table 12.4 : Machineries required for setting up an RDF plant

MACHINERIES REQUIRED	
1	Twin shaft primary shredder (to less than 100 m)
2	Rotary trommel
3	Air density separator
4	Dryer
5	Twin shaft secondary shredder (to less than 50 mm)
6	Fine shredder
7	Pellet making machine
8	Conveyor belt
9	Weighing mechanism

Note: *More details can be obtained from Table 8 of CHPEEO "Guidelines on Usage of Refuse Derived Fuel In various industries – 2018."*

ANNEXURE

LIST OF AGENCIES EMPANELLED FOR BIO & NON- BIODEGRADABLE WASTE MANAGEMENT AS OF JULY, 2024

For the most up-to-date list of empanelled agencies, please check our website.

AGENCIES EMPANELLED FOR BIO WASTE MANAGEMENT

HOUSEHOLD LEVEL COMPOSTING DEVICES

VERMI COMPOSTING UNIT

Sl.No	NAME OF AGENCY	CONTACT DETAILS	VALID TILL
1	OLEENA MAHILASAMAJAM ഒലീന മഹിളാസമാജം	West Hill P.O, Calicut-673 005. Ph:0495- 4040447, 9846721713 Email: oleenams@yahoo.co.in	31.03.2025
2	KERALA AGRO INDUSTRIES CORPORATION LTD. കേരള അഗ്രോ ഇൻഡസ്ട്രീസ് കോർപറേഷൻ	Kissan Jyothi,Fort 695 023 ,Trivandrum Email: mdofficekaic@gmail.com kaicgeneralsection@gmail.com Ph: 0471 - 2471343, 2471344, 2471345 7558880453	31.03.2025
3	WELFARE SERVICES ERNAKULAM വെൽഫെയർ സർവീസസ് എറണാകുളം	SAHRUDAYA TECH 45/2416, Sahrudaya, Anchumuri, Ponnurunni, Vyttila PO, Ernakulam- 682 019 Ph. 0484 2344243, 2347829, 8943710720, 9446688822, 8943710720 Email: sahrudayatech@gmail.com	31.03.2025
4	SAAYUJYA സായൂജ്യ	Reg.No.Q.198/08 Cherukattu Building, Vadaserikara.P.O, Pathanamthitta-689662 Ph:9497135247,9447596263 bruben.abraham@gmail.com	31.03.2025
5	THE REGIONAL AGRO INDUSTRIAL DEVELOPMENT CO-OPERATIVE OF KERALA LTD. (RAIDCO)	SPCA Road,Post Box No. 407 Kannur -670 002. Ph:0497 -2700875, 2700276,2700192, 9446005920, 9446005845 info@raidco.in managingdirector@raidco.in	31.03.2025
6	EARTH CARE SOLUTIONS	12/453-7, Desha Sneham Building, North Kammath Lane, MG Road, Pootholde P.O, Thrissur 680 004 Ph:8592053562, earthcaresolutions@gmail.com	31.03.2025

PIPE COMPOSTING

1	THE REGIONAL AGRO INDUSTRIAL DEVELOPMENT CO-OPERATIVE OF KERALA LTD. (RAIDCO)	SPCA Road,Post Box No. 407 Kannur -670 002. Ph:0497 -2700875, 2700276,2700192, 9446005920, 9446005845 info@raidco.in managingdirector@raidco.in	31.03.2025
2	ALLEPPY BIOTECH ആലപ്പി ബയോടെക്	37/2055, PV Building, Kollamkudimugal Road, Thrikkakara, Ernakulam - 682021 Ph: 9447489423	31.03.2025

POT COMPOSTING

1	OLEENA MAHILASAMAJAM ഒലീന മഹിളാസമാജം	West Hill P.O, Calicut-673 005. Ph:0495- 4040447, 9846721713 Email: oleenams@yahoo.co.in	31.03.2025
2	ALLEPPY BIOTECH ആലപ്പി ബയോടെക്	37/2055, PV Building, Kollamkudimugal Road, Thrikkakara, Ernakulam - 682021 Ph: 9447489423	31.03.2025
3	KERALA STATE POTTERY MANUFACTURING CORPORATION (KSPMMWDC)	Ayyankali Bhavan (2nd Floor), Kanakanagar, Kowdiar PO Trivandrum Ph: 04712727010 Email: kspwdctpm@gmail.com	31.03.2025

RING COMPOSTING UNIT

1	OLEENA MAHILASAMAJAM ഒലീന മഹിളാസമാജം	West Hill P.O, Calicut-673 005. Ph:0495- 4040447, 9846721713 Email: oleenams@yahoo.co.in	31.03.2025
2	SURYA DISTRIBUTORS സൂര്യ ഡിസ്ട്രിബ്യൂട്ടേഴ്സ്	Reg.No.TIN:32120994971 47/1198, Dream Tourist Home Building Pier Road, Thalassery, Kannur. PIN- 670 101 Ph: 8606555693, 9605421220 E-mail: suryatly@gmail.com neilboban@gmail.com	31.03.2025
3	HARITHABHAM BIOGAS ഹരിതാഭം ബയോഗ്യാസ്	2nd floor, Zees tower, Opposite HDFC bank, Kozhikode 673 011 harithabhambiogas@gmail.com Ph: 9447345806	31.03.2025
4	KERALA AGRO INDUSTRIES CORPORATION LTD. കേരള അഗ്രോ ഇൻഡസ്ട്രീസ് കോർപറേഷൻ	Kissan Jyothi,Fort 695 023 ,Trivandrum Email: mdofficekaic@gmail.com kaicgeneralsection@gmail.com Ph: 0471 - 2471343, 2471344, 2471345 7558880453	31.03.2025
5	BIOENERGY TECH ബയോ എനർജി ടെക്	Punthala,Purakkad P.O Alappuzha - 688 561 9995295012, 8089295012 bioenergytech08@gmail.com	31.03.2025
6	SAROVARAM EDUCATION & CHARITABLE TRUST (SET) സരോവരം എഡ്യൂക്കേഷൻ & ചാരിറ്റബിള് ട്രസ്റ്റ്	Sreenilayam,Kannamangalam north Chettikulangara P O, Mavelikara, Alappuzha 690106 Ph: 0479-2348499, 9447887876 setctk@yahoo.in	31.03.2025
7	BION RENEWABLE ENERGY SOLAR SERVICE ബയോൺ റിന്യൂവബിൾ എനർജി സോളാർ സർവീസ്	Vazhathope, Thadayampadu PO, Idukki -685 602 04862235033, 9496444207 sajinellikunnelidk@gmail.com	31.03.2025
8	SAAYUJYA സായൂജ്യ	Reg.No.Q.198/08 Cherukattu Building, Vadaserikara.P.O, Pathanamthitta-689662 Ph:9497135247,9447596263 bruben.abraham@gmail.com	31.03.2025
9	BLUE FLAME BIO ബ്ലൂ ഫ്ലേം ബയോ	Thodupuzha, Idukki - 685605 Ph:9946214075, 9496992545 blueflamebio@gmail.com	31.03.2025

10	THE REGIONAL AGRO INDUSTRIAL DEVELOPMENT CO-OPERATIVE OF KERALA LTD. (RAIDCO)	SPCA Road,Post Box No. 407 Kannur -670 002. Ph:0497 -2700875, 2700276,2700192, 9446005920, 9446005845 info@raidco.in managingdirector@raidco.in	31.03.2025
11	GRIHALAKSHMI ഗൃഹലക്ഷ്മി	E.K. Sunil Kumar, EruvattuKizhakkeveeduPattena, Neeleswaram, Kasargod Email: ekspattena@gmail.com Ph: 9447392894	31.03.2025
12	DINAMITHRA ദിനമിത്ര	Vadakkakom (H), Cheng alam SPO, Kottayam – 686022 04812523382, 9446714642, 9037650080 dinamithrabioplant@gmail.com	31.03.2025
13	AGRO FLAME അഗ്രോ ഫ്ലേം	AGGRO FLAME INDUSTRIES PVT. LTD. Kumbazha,Pavumba P.O, Karunagappally, Kollam – 690 574. Ph: 9846218166, 7034587222 E-mail : agroflame14@gmail.com Website: www.agroflame.in	31.03.2025
14	GUNA SREE VERMI COMPOST & SOLID WASTE MANAGEMENT	Kakkodi, Makkada P.O, Kozhikode – 673 611 Ph: 9846027160 rajanmvipanchika@gmail.com	31.03.2025
15	SHUDHI WASTE CONVERTION UNIT ശുദ്ധി വേസ്റ്റ് കോൺവെർഷൻ യൂണിറ്റ്	9/226 B, Vadakara,Kozhikode E-mail: gstrajithcement@gmail.com Ph: 9947954017, 0496 2515135	31.03.2025
16	HARITHA RING COMPOST INDUSTRIES ഹരിത റിങ് കമ്പോസ്റ്റ് ഇൻഡസ്ട്രീസ്	Alakode P.O, Kannur- 670 571 Ph: 9447165135, 9544996677 E-mal: harithabioindustries747@gmail.com	31.03.2025
17	MAHYOOBAH WASTE MANAGEMENT മഹ്യൂബ വേസ്റ്റ് മാനേജ്മന്റ്	Kaithakkadpost,Cheruvathoor, Kasaragod- 671313 Ph: 9447541414, 9847581786 mahyoobah@gmail.com abdullauk@gmail.com	31.03.2025
18	AMRUTHA AGRO INDUSTRIES അമൃത അഗ്രോ ഇൻഡസ്ട്രീസ്	Poyiloor PO, Kannur - 670 698 amruthaagrokannur@gmail.com Ph: 9495687772, 9495906688	31.03.2025
19	PAKKAYIL CEMENT CRAFT WORKERS (Work Shop) പാക്കയിൽ സിമന്റ് ക്രാഫ്റ്റ് വർക്കേഴ്സ്	Industrial Co-operative Society Ltd., R No. IND(D) 343 Vadakara Beach PO, Kozhikode Ph: 9895628851, 9447347944 E-mail: pakkayil.society@gmail.com	31.03.2025
20	FLORET TECHNOLOGIES ഫ്ളോറെറ്റ് ടെക്നോളോജിസ്	2nd Floor, HeeraChambers, MG Road, Trivandrum - 695 023 9020087007, 9446664103, 9809439600 Email : florettechnologies@gmail.com anu.aalilaa@gmail.com	31.03.2025
21	MARIA HYGIENE SOLUTION മരിയ ഹൈജീൻ സൊല്യൂഷൻ	Punna Residency, Near Calicut International Airport, Kozhikode – 673 647, Email: unaiskondotty@gmail.com Ph: +01 9946443004, +91 9947073004	31.03.2025
22	YANISCO യാനിസ്ക്കോ	Fousiya TK, PudukudiChirayi, Kondotty Malappuram – 673 638 E-mail:- yaniskondotty@gmail.com Ph:9846894505	31.03.2025
23	GOLDEN BUILDERS ഗോൾഡൻ ബിൽഡേഴ്സ്	KP8/115, Punnassery, Kakoor, Kozhikode – 673 613 Ph: 9526900740 muhasiboo7@gmail.com jumanahasim087@gmail.com	31.03.2025

24	FUTURE SURE ഫ്യൂച്ചർ ഷുവർ	9/631, Mundallur, Peralassery, Peralassery Temple Road, Kannur - 670 622 futuresure11@gmail.com Ph: 8606555693, 9605421220	26.02.2027
25	EMERALD ENTERPRISES	Door No. 16/ 1224, Seminari Road, Edakochi, Ernakulam Cochin - 682010 Ph : 9633334086, 9497460086 emeraldfrp2013@gmail.com	31.03.2025
26	HARIYALI	HARIYALI, Green Technology Centre, J T Road, Vatakara, Muncipality. Mob: 9645151956, Email: hariyalihss@gmail.com	20.06.2027
27	KAPIGRO TECHNOLOGIES PVT. LTD	3/194A, Melur Post, Koilandy, Kozhikode – 673 306 Mob:9746497630 nithin.ramdas@gmail.com www.kapigro.com	25.07.2027
28	VISMAYA DEEPAM	1st Floor, Room No. 243k/2, Kottakkal, Kozhikode 673 521 Mob : 9946992217, 7994225950 Email : vismayabio@gmail.com	25.07.2027

BUCKET COMPOSTING UNIT

1	BIO FLAME ബയോ ഫ്ളയിം	Opp. Popular Hyundai, Vettu road, Kazhakuttom P.O, Thiruvananthapuram 10, Ph: 0471 -2415333, 8907174516, 9349909900 Email: bioflameindia@gmail.com mailtomaju@gmail.com	31.03.2025
2	BHARAT SEVAK SAMAJ ഭാരത് സേവക് സമാജ്	Satbhavana Bhavan,Kowdiar.P.O, Thiruvananthapuram-695003 Ph:0471-2439322, 9048001332 Email: gopakumarbsstvpm@gmail.com	31.03.2025
3	KERALA AGRO INDUSTRIES CORPORATION LTD. കേരള അഗ്രോ ഇൻഡസ്ട്രീസ് കോർപറേഷൻ	Kissan Jyothi,Fort 695 023 ,Trivandrum Email: mdofficekaic@gmail.com kaicgeneralsection@gmail.com Ph: 0471 - 2471343, 2471344, 2471345 7558880453	31.03.2025
4	SANTA POLYMERS സാന്റാ പോളിമേഴ്സ്	T.V PuramP O, Vaikam, Kottayam - 686 606 PH: 04829 219014, 9526392392 9847089314 santapolymers@gmail.com	31.03.2025
5	THE REGIONAL AGRO INDUSTRIAL DEVELOPMENT CO-OPERATIVE OF KERALA LTD. (RAIDCO)	SPCA Road,Post Box No. 407 Kannur -670 002. Ph:0497 -2700875, 2700276,2700192, 9446005920, 9446005845 info@raidco.in managingdirector@raidco.in	31.03.2025
6	DINAMITHRA ദിനമിത്ര	Vadakkakom (H), Cheng alam SPO, Kottayam – 686022 04812523382, 9446714642, 9037650080 dinamithrabioplant@gmail.com	31.03.2025
7	PELICAN BIOTECH & CHEMICAL LABS പെലിക്കൻ ബയോ ടെക് & കെമിക്കൽ ലാബ്സ്	PELICAN KENTERRA PVT. LTD 117/3, Vayalar PO, Cherthala, Alappuzha – 688 536 Ph:0478 2560206 9961787333, 9961787333 E-mail : contact@pelicanbiotech.com manoj@pelicanbiotech.com	31.03.2025
8	ALLEPPY BIOTECH ആലപ്പി ബയോടെക്	37/2055, PV Building, Kollamkudimugal Road, Thrikkakara, Ernakulam - 682021 Ph: 9447489423	31.03.2025
9	MARIA HYGIENE SOLUTION മരിയ ഹൈജീൻ സൊല്യൂഷൻ	Punna Residency, Near Calicut International Airport, Kozhikode – 673 647, Email: unaiskondotty@gmail.com Ph: +01 9946443004, +91 9947073004	31.03.2025

GARDEN COMPOSTER

1	BIOTECH RENEWABLE ENERGY PVT. LTD	M.P Appan Road, Vazhuthacaud, Thycaud P.O, Trivandrum- 595 011. Mob : 0471 2321909, 2332179, 2331909 Email : mailtobiotech@gmail.com	25.07.2025

KITCHEN BIN

1	RAM BIOLOGICALS റാം ബയോളജിക്കൽസ്	8/528-1, Kuttiadi Irrigation Project Office, Moottoli, Kakkodi P.O, Calicut Phone:0495-4025433, 3296858, Mobile: 9446048233. 7025269558 E-mail : rambiol@rediffmail.com rambiologicals@gmail.com	31.03.2025
2	RAIDCO	SPCA Road,Post Box No. 407 Kannur -670 002. Ph:0497 -2700875, 2700276,2700192, 9446005920, 9446005845 info@raidco.in managingdirector@raidco.in	31.03.2025
3	ALLEPPY BIOTECH ആലപ്പി ബയോടെക്	37/2055, PV Building, Kollamkudimugal Road, Thrikkakara, Ernakulam - 682021 Ph: 9447489423	31.03.2025
4	GREEN VILLAGE ഗ്രീൻ വില്ലേജ്	P-67, Pullaikonam Lane II, Sasthamangalam, Trivandrum - 695010 greenvillage.green@gmail.com Ph: 9895532192	31.03.2025
5	SCRAPPY INNOVATIONS PVT. LTD സ്ക്രാപ്പി ഇന്നോവേഷൻസ്	HO WP 18/108-HJK, 1st Floor, Saj building, Manjeri Road, Wandoor, Malappuram – 679 328 Ph:83 42 888 333, 9946427485 Email: info@scrappyinnovation.com	31.03.2025
6	KAPIGRO TECHNOLOGIES PVT. LTD കാപിഗ്രോ ടെക്നോളോജിസ്	3/194A, Melur Post, Koilandy, Kozhikode – 673 306 Mob:9746497630 nithin.ramdas@gmail.com www.kapigro.com	31.03.2025

PORTABLE BIO- BIN UNIT

1	Portable Household Bio-bin Unit	BHARAT SEVAK SAMAJ ഭാരത് സേവക് സമാജ്	Satbhavana Bhavan,Kowdiar.P.O, Thiruvananthapuram-695003 Ph:0471-2439322, 9048001332 Email: gopakumarbsstvpm@gmail.com	31.03.2025
2		GREEN TECHNOLOGY FOR BETTER LIFE (GTBL) ഗ്രീൻ ടെക്നോളജി ഫോർ ബെറ്റർ ലൈഫ്	Pattikkad (Near Railway Gate),Perinthalmanna,Malappuram 9605167710, 7902448783, 9447007172 gtbl2013@gmail.com	31.03.2025
3		UNIVERSAL BIOGAS യൂണിവേഴ്സൽ ബയോഗ്യാസ്	20/1145A14, IInd Floor, Calicut Business Center, Kallai, Calicut - 673 003 E-mail: universalbiogasplant@gmail.com pallithazamshafi@gmail.com Ph: 7736066020, 9072836373, 9946448899	31.03.2025

4	Portable Household Bio-bin Unit	KERALA AGRO INDUSTRIES CORPORATION LTD. കേരള അഗ്രോ ഇൻഡസ്ട്രീസ് കോർപറേഷൻ	Kissan Jyothi,Fort 695 023 ,Trivandrum Email: mdofficekaic@gmail.com kaicgeneralsection@gmail.com Ph: 0471 - 2471343, 2471344, 2471345 7558880453	31.03.2025
5		WELFARE SERVICES ERNAKULAM വെൽഫെയർ സർവീസസ് എറണാകുളം	SAHRUDAYA TECH 45/2416, Sahrudaya, Anchumuri, Ponnurunni, Vyttila PO, Ernakulam- 682 019 Ph. 0484 2344243, 2347829, 8943710720, 9446688822, 8943710720 Email: sahrudayatech@gmail.com	31.03.2025
6		SANTA POLYMERS സാന്റാ പോളിമേഴ്സ്	T.V PuramP O, Vaikam, Kottayam - 686 606 PH: 04829 219014, 9526392392 9847089314 santapolymers@gmail.com	31.03.2025
7		NORTHAMPS ENV SOLUTIONS നോർത്താംപ്സ്	Irumpanam P.O, Thrippunithura Ernakulam -682 309 Ph: 9895463766 e-mail: info@northamps.com northampsenvsolution@gmail.com	31.03.2025
8		THE REGIONAL AGRO INDUSTRIAL DEVELOPMENT CO-OPERATIVE OF KERALA LTD. (RAIDCO)	SPCA Road,Post Box No. 407 Kannur -670 002. Ph:0497 -2700875, 2700276,2700192, 9446005920, 9446005845 info@raidco.in managingdirector@raidco.in	31.03.2025
9		PELICAN BIOTECH & CHEMICAL LABS PVT LTD പെലിക്കൻ ബയോ ടെക് & കെമിക്കൽ ലാബ്സ്	PELICAN KENTERRA PVT. LTD 117/3, Vayalar PO, Cherthala, Alappuzha - 688 536 Ph:0478 2560206 9961787333, 9961787333 E-mail : contact@pelicanbiotech.com manoj@pelicanbiotech.com www.Kenterra.in	31.03.2025
10		ALLEPPY BIOTECH ആലപ്പി ബയോടെക്	37/2055, PV Building, Kollamkudimugal Road, Thrikkakara, Ernakulam - 682021 Ph: 9447489423	31.03.2025
11		OLLOS BIO-TECH PVT. LTD ഒലോസ് ബയോടെക്	11/38/C, Shivadam, Gothamb Road,MalayattoorP.O.,Ernakulam-683587 Ph: -9846270108 ollosecotech@gmail.com	31.03.2025
12		MARIA HYGIENE SOLUTION മരിയ ഹൈജീൻ സൊല്യൂഷൻ	Punna Residency, Near Calicut International Airport, Kozhikode - 673 647, Email: unaiskondotty@gmail.com Ph: +01 9946443004, +91 9947073004	31.03.2025
13		YANISCO യാനിസ്ക്കോ	Fousiya TK, PudukudiChirayi, Kondotty Malappuram - 673 638 E-mail:- yaniskondotty@gmail.com Ph:9846894505	31.03.2025
14		EMERALD ENTERPRISES,	Door No. 16/ 1224, Seminari Road, Edakochi, Ernakulam Cochin - 682010 Ph : 9633334086, 9497460086 emeraldfrp2013@gmail.com	31.03.2025

BIO COMPOSTER BIN

1	BIO FLAME ബയോ ഫ്ളയിം	Opp. Popular Hyundai, Vettu road, Kazhakuttom P.O, Thiruvananthapuram 10, Ph: 0471 -2415333, 8907174516, 9349909900 Email: bioflameindia@gmail.com mailtomaju@gmail.com	31.03.2025
2	GREEN TECH ഗ്രീൻ ടെക്	Padmatower, TC 30/C2125, Kanjirampara, Maruthumkuzhy, Sasthamangalam, Tvm-30 Ph: 04712367755, 9446462999 Email: greentechrec@gmail.com	31.03.2025
3	RAM BIOLOGICALS റാം ബയോളജിക്കൽസ്	8/528-1, Kuttiadi Irrigation Project Office, Moottoli, Kakkodi P.O, Calicut - 673 611 Phone:0495-4025433, 3296858, Mobile: 9446048233. 7025269558 E-mail : rambiol@rediffmail.com rambiologicals@gmail.com	31.03.2025
4	SANTA POLYMERS സാന്റാ പോളിമേഴ്സ്	T.V PuramP O, Vaikam, Kottayam - 686 606 PH: 04829 219014, 9526392392 9847089314 santapolymers@gmail.com	31.03.2025
5	THE REGIONAL AGRO INDUSTRIAL DEVELOPMENT CO-OPERATIVE OF KERALA LTD. (RAIDCO)	SPCA Road,Post Box No. 407 Kannur -670 002. Ph:0497 -2700875, 2700276,2700192, 9446005920, 9446005845 info@raidco.in managingdirector@raidco.in	31.03.2025
6	AGRO FLAME അഗ്രോ ഫ്ലേം	AGGRO FLAME INDUSTRIES PVT. LTD. Kumbazha,Pavumba P.O, Karunagappally, Kollam - 690 574. Ph: 9846218166, 7034587222 E-mail : agroflame14@gmail.com Website: www.agroflame.in	31.03.2025
7	ALLEPPY BIOTECH ആലപ്പി ബയോടെക്	37/2055, PV Building, Kollamkudimugal Road, Thrikkakara, Ernakulam - 682021 Ph: 9447489423	31.03.2025
8	GUNA SREE VERMI COMPOST & SOLID WASTE MANAGEMENT ഗുണ ശ്രീ വെർമി കമ്പോസ്റ്റ് & സോളിഡ് വേസ്റ്റ് മാനേജ്മന്റ്	Kakkodi, Makkada P.O, Kozhikode - 673 611 Ph: 9846027160 rajanmvipanchika@gmail.com	31.03.2025
9	SHUDHI WASTE CONVERTION UNIT ശുദ്ധി വേസ്റ്റ് കോൺവെർഷൻ യൂണിറ്റ്	9/226 B, Vadakara,Kozhikode E-mail: gstrajithcement@gmail.com Ph: 9947954017 - 0496 2515135	31.03.2025
10	MARIA HYGIENE SOLUTION മരിയ ഹൈജീൻ സൊല്യൂഷൻ	Punna Residency, Near Calicut International Airport, Kozhikode - 673 647, Email: unaiskondotty@gmail.com Ph: +01 9946443004, +91 9947073004	31.03.2025
11	YANISCO യാനിസ്ക്കോ	Fousiya TK, PudukudiChirayi, Kondotty Malappuram - 673 638 E-mail:- yaniskondotty@gmail.com Ph:9846894505	31.03.2025
12	GREEN VILLAGE ഗ്രീൻ വില്ലേജ്	P-67, Pullaikonam Lane II, Sasthamangalam, Thiruvananthapuram - 695010 greenvillage.green@gmail.com Ph: 9895532192	31.03.2025

GEE BIN (2 bin & 3 bin System)

1	E-NADU YUVAJANASAHAKARANA SANGHAM ഇ- നാട് യുവജന സഹകരണ സംഘം	Chazhicaud Building , Opposit Panchayath office Veliyannur P.O, Kottayam - 686634 E-mail:- sajeshmarvel@gmail.com Ph: 9447709388	31.03.2025
2	FOAB SOLUTIONS PRIVATE LTD ഫോബ് സൊല്യൂഷൻസ്	Startups Valley TBI, Amaljyothi College of Engineering Koovappally, Kanjirappally, Kottayam- 686518 + 91 9497333999, 9497009880 foabsolutions@gmail.com	31.03.2025

BOKASHI BUCKET

1	GLOBAL PHARMACEUTICALS ഗ്ലോബൽ ഫാർമസ്യൂട്ടിക്കൽ	Thavakkara Complex,Thavakkara, Kannur - 670002 Phone: 0497-2766255, 9446094255 7012804255 globalwatersys@gmail.com	31.03.2025
2	MARIA HYGIENE SOLUTION മരിയ ഹൈജീൻ സൊല്യൂഷൻ	Punna Residency, Near Calicut International Airport, Kozhikode - 673 647, Email: unaiskondotty@gmail.com Ph: +01 9946443004, +91 9947073004	31.03.2025

V-COMPOSTER

1	V CARE SHOPPING V കെയർ ഷോപ്പിംഗ്	V Care Business Park, Kripa Valiyavilappuram, Ottashekharamangalam PO, Trivandrum - 695 125 Ph: 9916354389 E-mail:- subeesh@gmail.com	31.03.2025

BIO DIGESTOR POT

1	HI-TECH BIO FERTILIZERS INDIA Hi -Tech ബയോ ഫെർട്ടിലൈസേർസ് ഇന്ത്യ	34/1841-A1, Edappally, Ernakulam – 682 024 Phone: 0484 - 2533361, Mob: 9446523365, 9447033360, 9446395333 hitech@cleancity.in	31.03.2025
2	WELFARE SERVICES ERNAKULAM വെൽഫെയർ സർവീസസ് എറണാകുളം	SAHRUDAYA TECH 45/2416, Sahrudaya, Anchumuri, Ponnurunni, Vyttila PO, Ernakulam- 682 019 Ph. 0484 2344243, 2347829, 8943710720, 9446688822, 8943710720 Email: sahrudayatech@gmail.com	31.03.2025
3	SANTA POLYMERS സാന്റാ പോളിമേഴ്സ്	T.V PuramP O, Vaikam, Kottayam - 686 606 PH: 04829 219014, 9526392392 9847089314 santapolymers@gmail.com	31.03.2025
4	BLUE FLAME BIO ബ്ലൂ ഫ്ലേം ബയോ	Thodupuzha, Idukki - 685605 Ph:9946214075, 9496992545 blueflamebio@gmail.com	31.03.2025
5	NORTHAMPS ENV SOLUTIONS നോർത്താംപ്സ്	Irumpanam P.O, Thrippunithura Ernakulam – 682 309 Ph: 9895463766 e-mail: info@northamps.com northampsenvsolution@gmail.com	31.03.2025
6	AGRO FLAME അഗ്രോ ഫ്ലേം	AGGRO FLAME INDUSTRIES PVT. LTD. Kumbazha,Pavumba P.O, Karunagappally, Kollam – 690 574. Ph: 9846218166, 7034587222 E-mail : agroflame14@gmail.com Website: www.agroflame.in	31.03.2025
7	ALLEPPY BIOTECH ആലപ്പി ബയോടെക്	37/2055, PV Building, Kollamkudimugal Road, Thrikkakara, Ernakulam - 682021 Ph: 9447489423	31.03.2025
8	MARIA HYGIENE SOLUTION മരിയ ഹൈജീൻ സൊല്യൂഷൻ	Punna Residency, Near Calicut International Airport, Kozhikode – 673 647, Email: unaiskondotty@gmail.com Ph: +01 9946443004, +91 9947073004	31.03.2025
9	YANISCO യാനിസ്ക്കോ	Fousiya TK, PudukudiChirayi, Kondotty Malappuram – 673 638 E-mail:- yaniskondotty@gmail.com Ph:9846894505	31.03.2025
10	KERALA STATE POTTERY MANUFACTURING CORPORATION (KSPMMWDC)	Ayyankali Bhavan (2nd Floor), Kanakanagar, Kowdiar PO Trivandrum - 695003 Ph: 04712727010 Email: kspwdctpm@gmail.com	31.03.2025
11	EARTH CARE SOLUTIONS	12/453-7, Desha Sneham Building, North Kammath Lane, MG Road, Pootholde P.O, Thrissur 680 004 Ph:8592053562, earthcaresolutions@gmail.com	31.03.2025
12	EMERALD ENTERPRISES	Door No. 16/ 1224, Seminari Road, Edakochi, Ernakulam Cochin - 682010 Ph : 9633334086, 9497460086 emeraldfrp2013@gmail.com	31.03.2025

INSTITUTIONAL LEVEL BIO BIN UNITS

1	ALLEPPY BIOTECH ആലപ്പി ബയോടെക്	37/2055, PV Building, Kollamkudimugal Road, Thrikkakara, Ernakulam - 682021 Ph: 9447489423	31.03.2025
2	PELICAN BIOTECH & CHEMICAL LABS PVT LTD പെലിക്കൻ ബയോ ടെക് & കെമിക്കൽ ലാബ്സ്	PELICAN KENTERRA PVT. LTD 117/3, Vayalar PO, Cherthala, Alappuzha – 688 536 Ph:0478 2560206 9961787333, 9961787333 E-mail : contact@pelicanbiotech.com manoj@pelicanbiotech.com www.Kenterra.in	31.03.2025
3	NORTHAMPS ENV SOLUTIONS നോർത്താംപ്സ്	Irumpanam P.O, Thrippunithura Ernakulam – 682 309 Ph: 9895463766 e-mail: info@northamps.com northampsenvsolution@gmail.com	31.03.2025
4	HI-TECH BIO FERTILIZERS INDIA Hi -Tech ബയോ ഫെർട്ടിലൈസേർസ് ഇന്ത്യ	34/1841-A1, Edappally, Ernakulam – 682 024 Phone: 0484 - 2533361, Mob: 9446523365, 9447033360, 9446395333 hitech@cleancity.in	31.03.2025
5	CREDAI CLEAN CITY MOVEMENTS ക്രെഡായ് ക്ലീൻ സിറ്റി മൂവ്മെൻറ്സ്	CCC ZERO WASTE PVT. LTD., House of Credai,2nd Floor, JNI Stadium Link Road, Kochi - 682 017, +91484 2951052, 9961055355, 9605009901 info@ccczerowaste.com , com@ccczerowaste.com	31.03.2025

COMMUNITY LEVEL COMPOSTING FACILITIES

AEROBIC BIN COMPOSTING UNIT

Sl.No	NAME OF AGENCY	CONTACT DETAILS	VALID TILL
1	INNOVATIVE FIBER PRODUCTS ഇന്നൊവേറ്റീവ് ഫൈബർ പ്രോഡക്ട്സ്	Innovative Energy Systems, V/672/A,Kodaly, Pady PO, Mattathur Thrissur - 680 699 Ph: 9846009201, 98605268345 innovative010@gmail.com	31.03.2025
2	NEO ENERGY നിയോ എനർജി	VRP 12/524(A), Kattachalkuzhy P O, Balaramapuram, Tvm-003 Ph: 0471-2400099, 9400068111/222/ 999 Email: neoenergyin@gmail.com	31.03.2025
3	UNIVERSAL BIOGAS യൂണിവേഴ്സൽ ബയോഗ്യാസ്	20/1145A14, IInd Floor, Calicut Business Center, Kallai, Calicut - 673 003 E-mail: universalbiogasplant@gmail.com pallithazamshafi@gmail.com Ph: 7736066020, 9072836373, 9946448899	31.03.2025
4	RAM BIOLOGICALS റാം ബയോളജിക്കൽസ്	8/528-1, Kuttiadi Irrigation Project Office, Moottoli, Kakkodi P.O, Calicut – 673 611 Phone:0495-4025433, 3296858, Mobile: 9446048233. 7025269558 E-mail : rambiol@rediffmail.com rambiologicals@gmail.com	31.03.2025
5	BIOENERGY TECH ബയോ എനർജി ടെക്	Punthala,Purakkad P.O Alappuzha – 688 561 9995295012, 8089295012 bioenergytech08@gmail.com	31.03.2025
6	SAROVARAM EDUCATION & CHARITABLE TRUST (SET) സരോവരം എഡ്യൂക്കേഷൻ & ചാരിറ്റബിൾ ട്രസ്റ്റ്	Sreenilayam,Kannamangalam north Chettikulangara P O, Mavelikara, Alappuzha 690106 Ph: 0479-2348499, 9447887876 setctk@yahoo.in	31.03.2025
7	SANTA POLYMERS സാന്റാ പോളിമേഴ്സ്	T.V PuramP O, Vaikam, Kottayam - 686 606 PH: 04829 219014, 9526392392 9847089314 santapolymers@gmail.com	31.03.2025
8	DINAMITHRA ദിനമിത്ര	Vadakkakom (H), Cheng alam SPO, Kottayam – 686022 04812523382, 9446714642, 9037650080 dinamithrabioplant@gmail.com	31.03.2025
9	FLORET TECHNOLOGIES ഫ്ളോറെറ്റ് ടെക്നോളോജിസ്	2nd Floor, HeeraChambers, MG Road, Trivandrum - 695 023 9020087007, 9446664103, 9809439600 Email : florettechnologies@gmail.com anu.aalilaa@gmail.com	31.03.2025
10	MARIA HYGIENE SOLUTION മരിയ ഹൈജീൻ സൊല്യൂഷൻ	Punna Residency, Near Calicut International Airport, Kozhikode – 673 647, Email: unaiskondotty@gmail.com Ph: +01 9946443004, +91 9947073004	31.03.2025

ORGANIC WASTE CONVERTOR (OWC)

1	Organic composting bin	AGRO FLAME അഗ്രോ ഫ്ലേം	AGGRO FLAME INDUSTRIES PVT. LTD. Kumbazha, Pavumba P.O, Karunagappally, Kollam – 690 574. Ph: 9846218166, 7034587222 E-mail : agroflame14@gmail.com	31.03.2025
2	Organic Waste Convertor Machine (above 100-2000 kg).	EARTH RECYCLER PVT. LTD	No. 58/1,MAR Avenue, Woothacuttan street, Chennai, Tamil Nadu - 600 003 Email: dawood@earthrecycler.com Ph: + 91 9962777755,+ 91 9940688306, 8939181555, 99951328000	31.03.2025
3	Organic Waste Converter Machine (OWC) for pilot basis for 2 years	VIKASIT ECOSYSTEMS വികാസിറ്റ് ഇക്കോസിസ്റ്റംസ്	Plot 456, 1st Floor,Door #9, Peenya 2nd, Bangalore - 560058 Ph no. 8281808555, 9606596849 EMail ID : shrini@vikasiteco.com	31.03.2025
4	Organic waste converter machine	M WAY CONSULTANTS AND DEVELOPERS Pvt. Ltd.	Hiba Annexe,Pada North, Karunagappally, Kollam-690518 Ph:0476-2621388, 9387733562 mwayconsultants@gmail.com	31.03.2025
5	OWC Mobile composting unit with extended aerated windrow composting system	TECH FARM INDIA ടെക് ഫാം ഇന്ത്യ	Brahma Organic Farm Poikayil, Kaithukuzhi, Adichanalloor P.O, Kollam, Kerala.-691011 Phone:9605582928, 9605582938 techfarmindia474@gmail.com	31.03.2025
6	Organic waste composter (OWC) and Compressed Biogas through anerobic digestion and VPSA technology purification on PPP projects	SYNOD BIOSCIENCE	SYNOD BIOSCIENCE, Ezhupunna South, Cherthala, Alappuzha - 688 535 Ph: 8073815184 Email: info@synod.in	20.06.2027
7	OWC Plants in PPP mode	METSI ENVIRO TECH PVT. LTD.	Metsi Enviro Tech Pvt. Ltd. No 120/30, C-2 2nd Cross, Hennur, Bangalore-560043 Karnataka. Mob : 9060988475 Email : sales@metsiet.com	20.06.2027

NADEP COMPOST (Ventilated Aerobic Tank)

1	OMEGA ECOTECH PRODUCTS INDIA PVT LTD	No 91/5D, Maha Nagar, Saravanampatti, Coimbatore, Tamil Nadu - 641035. Mob : 9443703384 Email : omegaeco@gmail.com	20.06.2027

BIOGAS PLANTS

PORTABLE AND FIXED DOME TYPE BIO-GAS PLANTS

1	BIOSPHERE ബയോസ്പിയർ	Sri. Sri..VKRA 141 A, Kadiyakkonam Lane Vazhottukonam, Vattiyoorkavu Thiruvananthapuram - 695013 Ph:9495624085, 9496797855 E-Mail: biosphere01@gmail.com pradeepbiosphere@gmail.com	31.03.2025
2	FERT (Future Energy Resource Team) ഫ്യൂച്ചർ എനർജി റീസോർസ് ടീം	#57, BodiNagar,Thattamala, Kollam -691020 04742727355, 8547853835 Email: info@fertworld.com madhu@fertworld.com	31.03.2025
3	POORAM BIOGAS പൂരം ബയോഗ്യാസ്	Pooram Integrated Women's Welfare Society, Near Government Ayurvedic Hospital, Anad P.O, Nedumangad-694541, Phone: 9562793329, 6282303963, Email poorambio@gmail.com	31.03.2025
4	PAVOOR BIOGAS പാവൂർ ബയോഗ്യാസ്	21/184 Panamthodil Jn, Chavara PO, Kollam - 691 583 Email: pavoorbiogas@gmail.com Ph: +91 7559866155, +91 9048024362	31.03.2025
5	GREEN TECH ENGINEERING ഗ്രീൻ ടെക് എൻജിനിയറിങ്	NH47, SL Puram PO, Cherthala, Alappuzha-688523 04782860233, 9447347515 greentechkerala@gmail.com	31.03.2025
6	BIOGEN ബയോജെൻ	KINFRA Film & Video Park, SainikaSchool P.O, TVPM- 695585 Ph: 0471 2417887,2416887, 9746464683 E-mail: biogenkinfra@gmail.com	31.03.2025
7	SREETECH ശ്രീടെക്	Avittom, Bypass Road, Paruthikuzhy, ManacaduPO Thiruvananthapuram 9496253913, 2507858 E-mail: sreetechtvm@gmail.com	31.03.2025
8	SIGMA POLLUTION CONTROL EQUIPMENTS (I) PVT LTD സിഗ്മ പൊല്യൂഷൻ കൺട്രോൾ എക്വിപ്മൻറ്റ്സ്	1st floor, M.H Building, Opp M.S.M College, Kayamkulam, Alapuzha- 690 502 Ph:9947034501, 9744330633, 0479-2443746, 2143222 info@sigmawaterpurifier.com	31.03.2025
9	THE ANDHYODAYA ദി അന്ത്യോദയ	Reg.No:REG:ER 1555/90 M.C.Road, Angamaly683572 Ernakulam. Ph:0484 2453548,3254881 9388607010, 9946667531 Email: andhyodaya@gmail.com	31.03.2025
10	EMERALD ENTERPRISES എമറാൾഡ് എന്റർപ്രൈസസ്	Door No. 16/1224, Seminari Road, Edakochi, Ernakulam, Cochin – 682010 Ph: 9633334086, 9497460086 E-mail: emeraldfrp2013@gmail.com	31.03.2025
11	NEW TECH BIOGAS AGENCY ന്യൂ ടെക് ബയോഗ്യാസ് ഏജൻസി	Punnakulam , Kuzhalmandam P.O, Palakkad, Pin - 678 702 Ph:9287910982 newtechbiogas@gmail.com	31.03.2025

12	DEEPAM BIOGAS AGENCY ദീപം ബയോഗ്യാസ് ഏജൻസി	ArunBhavan , Neerillaparappur, Kadampuzha P.O, Malappuram - 676553, Ph: 0494-2618477, Mob: 9847243763, 9447638847 Vijayadeepam2021@gmail.com	31.03.2025
13	RADIANT MARKET BEAMS റേഡിയൻറ് മാർക്കറ്റ് ബീംസ്	17/247 C, Pavamani Road, Kozhikode – 673001, Ph: 0495 – 2722855, 9562903150, 9847002150 Email: radiant25@gmail.com	31.03.2025
14	BIO ENERGY SOLUTION ബയോ എനർജി സൊല്യൂഷൻ	FF44 Vyapara Bhavan, Bank Road, Calicut-673002 Ph: 8089420720 E-mail: mail@bioenergysolutions.in bioenergysolution4@gmail.com	31.03.2025
15	VISMAYA DEEPAM വിസ്മയ ദീപം	1st Floor,Room No. 243k/2,Kottakkal, Near Sargalaya, Vatakara, Kozhikode 673 521 vismayabio@gmail.com Ph: 9946992217, 7994225950	31.03.2025
16	INNOVATIVE FIBER PRODUCTS ഇന്നൊവേറ്റീവ് ഫൈബർ പ്രോഡക്ട്സ്	Innovative Energy Systems, V/672/A,Kodaly, Pady PO, Mattathur Thrissur - 680 699 Ph: 9846009201, 98605268345 innovative010@gmail.com	31.03.2025
17	BIO FLAME ബയോ ഫ്ളയിം	Opp. Popular Hyundai, Vettu road, Kazhakuttom P.O, Thiruvananthapuram 10, Ph: 0471 –2415333, 8907174516, 9349909900 Email: bioflameindia@gmail.com mailtomaju@gmail.com	31.03.2025
18	NEO ENERGY നിയോ എനർജി	VRP 12/524(A), Kattachalkuzhy P O, Balaramapuram, Tvm-003 Ph: 0471-2400099, 9400068111/222/ 999 Email: neoenergyin@gmail.com	31.03.2025
19	BHARAT SEVAK SAMAJ ഭാരത് സേവക് സമാജ്	Satbhavana Bhavan,Kowdiar.P.O, Thiruvananthapuram-695003 Ph:0471-2439322, 9048001332 Email: gopakumarbsstvpm@gmail.com	31.03.2025
20	KERALA AGRO INDUSTRIES CORPORATION LTD. കേരള അഗ്രോ ഇൻഡസ്ട്രീസ് കോർപറേഷൻ	Kissan Jyothi,Fort 695 023 ,Trivandrum Email: mdofficekaic@gmail.com kaicgeneralsection@gmail.com Ph: 0471 - 2471343, 2471344, 2471345 7558880453	31.03.2025
21	BION RENEWABLE ENERGY SOLAR SERVICE ബയോൺ റിന്യൂവബിൾ എനർജി സോളാർ സർവീസ്	Vazhathope, Thadayampadu PO, Idukki -685 602 04862235033, 9496444207 sajinellikunnelidk@gmail.com	31.03.2025
22	HI-TECH BIO FERTILIZERS INDIA ഹൈ-ടെക് ബയോ ഫെർട്ടിലൈസേർസ്ഇന്ത്യ	34/1841-A1, Edappally, Ernakulam – 682 024 Phone: 0484 - 2533361, Mob: 9446523365, 9447033360, 9446395333 hitech@cleancity.in	31.03.2025
23	NAVAJYOTHI BIOGAS നവജ്യോതി ബയോഗ്യാസ്	13/176, Eloor Ferry Road, Udyogamandal PO, Ernakulam- 683501 Ph: 8891339563 navajyothibiogas@gmail.com	31.03.2025
24	NORTHAMPS ENV SOLUTIONS നോർത്താംപ്സ്	Irumpanam P.O, Thrippunithura Ernakulam – 682 309 Ph: 9895463766 e-mail: info@northamps.com northampsenvsolution@gmail.com	31.03.2025

25	AGRO FLAME അഗ്രോ ഫ്ലേം	AGGRO FLAME INDUSTRIES PVT. LTD. Kumbazha,Pavumba P.O, Karunagappally, Kollam – 690 574. Ph: 9846218166, 7034587222 E-mail : agroflame14@gmail.com Website: www.agroflame.in	31.03.2025
26	AJESH RENEWABLE ENERGY SOLUTIONS അജേഷ് റിന്യൂവബിൾ എനർജി സൊല്യൂഷൻസ്	TC31/1087/1, Parakkudi Lane(PKLRA 50) Pettah P.O.,Thiruvananthapuram-695024 04712461436, 9447231883 Email: jayamohanjm@yahoo.com	31.03.2025
27	GREEN TECH ഗ്രീൻ ടെക്	Padmatower, TC 30/C2125, Kanjirampara, Maruthumkuzhy, Sasthamangalam, Tvm-30 Ph: 04712367755, 9446462999 Email: greentechrec@gmail.com	31.03.2025
28	GREEN TECHNOLOGY FOR BETTER LIFE (GTBL) ഗ്രീൻ ടെക്നോളജി ഫോർ ബെറ്റർ ലൈഫ്	Pattikkad (Near Railway Gate),Perinthalmanna,Malappuram 9605167710, 7902448783, 9447007172 gtbl2013@gmail.com	31.03.2025
29	UNIVERSAL BIOGAS യൂണിവേഴ്സൽ ബയോഗ്യാസ്	20/1145A14, IInd Floor, Calicut Business Center, Kallai, Calicut - 673 003 E-mail: universalbiogasplant@gmail.com pallithazamshafi@gmail.com Ph: 7736066020, 9072836373, 9946448899	31.03.2025
30	SURYA DISTRIBUTORS സൂര്യ ഡിസ്ട്രിബ്യൂട്ടേഴ്സ്	Reg.No.TIN:32120994971 47/1198, Dream Tourist Home Building Pier Road, Thalassery, Kannur. PIN- 670 101 Ph: 8606555693, 9605421220 E-mail: suryatly@gmail.com neilboban@gmail.com	31.03.2025
31	BIOTECH RENEWABLE ENERGY Pvt.Ltd. ബയോ ടെക് റിന്യൂവബിൾ എനർജി	Post Box No. 520, Biotech Towers, M P Appan Road, Vazhuthakad, Thycadu PO, Trivandrum -695014 0471 2321909, 2332179,2331909 mailtobiotech@gmail.com	31.03.2025
32	BIOENERGY TECH ബയോ എനർജി ടെക്	Punthala,Purakkad P.O Alappuzha – 688 561 9995295012, 8089295012 bioenergytech08@gmail.com	31.03.2025
33	SAROVARAM EDUCATION & CHARITABLE TRUST (SET) സരോവരം എഡ്യൂക്കേഷൻ & ചാരിറ്റബിള് ട്രസ്റ്റ്	Sreenilayam,Kannamangalam north Chettikulangara P O, Mavelikara, Alappuzha 690106 Ph: 0479-2348499, 9447887876 setctk@yahoo.in	31.03.2025
34	WELFARE SERVICES ERNAKULAM വെൽഫെയർ സർവീസസ് എറണാകുളം	SAHRUDAYA TECH 45/2416, Sahrudaya, Anchumuri, Ponnurunni, Vyttila PO, Ernakulam– 682 019 Ph. 0484 2344243, 2347829, 8943710720, 9446688822, 8943710720 Email: sahrudayatech@gmail.com	31.03.2025
35	SANTA POLYMERS സാന്റാ പോളിമേഴ്സ്	T.V PuramP O, Vaikam, Kottayam - 686 606 PH: 04829 219014, 9526392392 9847089314 santapolymers@gmail.com	31.03.2025
36	THE REGIONAL AGRO INDUSTRIAL DEVELOPMENT CO-OPERATIVE OF KERALA LTD. (RAIDCO)	SPCA Road,Post Box No. 407 Kannur -670 002. Ph:0497 -2700875, 2700276,2700192, 9446005920, 9446005845 info@raidco.in managingdirector@raidco.in	31.03.2025

37	GRIHALAKSHMI ഗൃഹലക്ഷ്മി	E.K. Sunil Kumar, EruvattuKizhakkeveeduPattena, Neeleswaram, Kasargod Email: ekspattena@gmail.com Ph: 9447392894	31.03.2025
38	DINAMITHRA ദിനമിത്ര	Vadakkakom (H), Cheng alam SPO, Kottayam – 686022 04812523382, 9446714642, 9037650080 dinamithrabioplant@gmail.com	31.03.2025
39	ALLEPPY BIOTECH ആലപ്പി ബയോടെക്	37/2055, PV Building, Kollamkudimugal Road, Thrikkakara, Ernakulam - 682021 Ph: 9447489423	31.03.2025
40	RAM BIOLOGICALS റാം ബയോളജിക്കൽസ്	8/528-1, Kuttiadi Irrigation Project Office, Moottoli, Kakkodi P.O, Calicut – 673 611 Phone:0495-4025433, 3296858, Mobile: 9446048233. 7025269558 E-mail : rambiol@rediffmail.com rambiologicals@gmail.com	31.03.2025

PORTABLE BIOGAS PLANT

1	NURO SYSTEMS നൂറോ സിസ്റ്റംസ്	Gandhi BazarShopping Complex No. 7, Cherthala, Alappuzha - 688 524 Ph: 9846188088 Email: nurowatersystems@gmail.com	31.03.2025
2	SUN RICE SOLAR സൺ റൈസ് സോളാർ	Beenachi PO, SulthanBathery, Wayanad - 673 592 Ph: 9048802810 sunricesolarwayanad@gmail.com	31.03.2025
3	EVERSHINE SHG BIOGAS എവർഷൈൻ SHG ബയോഗ്യാസ്	Chungathara, Malapuram- 679 334 Ph:9447274090 Email: everbio457@gmail.com	31.03.2025
4	NIRAVU ZERO WASTE MANAGEMENT നിറവ് സീറോ വേസ്റ്റ് മാനേജ്മന്റ്	Parambath House, VengeriPO, Kozhikode - 673 010 Ph: 0495-2371301, 9447383669, 9447276177, niravuvengerikzd@gmail.com	31.03.2025
5	OLEENA MAHILASAMAJAM ഒലീന മഹിളാസമാജം	West Hill P.O, Calicut-673 005. Ph:0495- 4040447, 9846721713 Email: oleenams@yahoo.co.in	31.03.2025
6	HARITHABHAM BIOGAS ഹരിതാഭം ബയോഗ്യാസ്	2nd floor, Zees tower, Opposite HDFC bank, Kozhikode 673 011 harithabhambiogas@gmail.com Ph: 9447345806	31.03.2025
7	SAAYUJYA സായൂജ്യ	Reg.No.Q.198/08 Cherukattu Building, Vadaserikara.P.O, Pathanamthitta-689662 Ph:9497135247,9447596263 bruben.abraham@gmail.com	31.03.2025
8	BLUE FLAME BIO ബ്ലൂ ഫ്ലേം ബയോ	Thodupuzha, Idukki - 685605 Ph:9946214075, 9496992545 blueflamebio@gmail.com	31.03.2025
9	B M INDUSTRIES ബി എം ഇൻഡസ്ട്രീസ്	Kadavoor PO South Punnamattem, Kothamangalam, Ernakulam 686 671 Ph:9446665775 mathewsgeorge73@gmail.com	31.03.2025

10	E-NADU YUVAJANASAHAKARANA SANGHAM ഇ-നാട് യുവജന സഹകരണ സംഘം	Chazhicaud Building , Opposit Panchayath office Veliyannur P.O, Kottayam - 686634 E-mail:- sajeshmarvel@gmail.com Ph: 9447709388	31.03.2025
11	PELICAN BIOTECH & CHEMICAL LABS PVT LTD പെലിക്കൻ ബയോ ടെക് & കെമിക്കൽ ലാബ്സ്	PELICAN KENTERRA PVT. LTD 117/3, Vayalar PO, Cherthala, Alappuzha – 688 536 Ph:0478 2560206 9961787333, 9961787333 E-mail : contact@pelicanbiotech.com manoj@pelicanbiotech.com www.Kenterra.in	31.03.2025
12	GREEN JYOTHI BIOGAS ഗ്രീൻ ജ്യോതി ബയോഗ്യാസ്	Elanjickal, Pottancaud PO 20 Acer, Idukki – 685 565 Email:- sibisebastian521@gmail.com Ph: 8848120147, 9447170521	31.03.2025
13	XL-BIOGAS XL ബയോഗ്യാസ്	AM Building, Opposite PWD GuestHouse Nilambur Malappuram – 679329 Mob: 9544693383 E-mail Id: xl.startupco@gmail.com	31.03.2025
14	YANISCO യാനിസ്ക്കോ	Fousiya TK, PudukudiChirayi, Kondotty Malappuram – 673 638 E-mail:- yaniskondotty@gmail.com Ph:9846894505	31.03.2025
15	GPS RENEWABLES PVT. LTD GPS റിന്യൂവബിൾസ്	B5, 1302, South City,ArekereMico layout Bangalore – 560076 Ph: 080- 4977 0101/02 Mob: 9731272138, 09480189447 E-Mail: sreekrishna@gpsrenewables.com info@gpsrenewables.com **Regional Address:** GPS RENEWABLES PVT. LTD., B-Hub, Mar Ivanios Vidya Nagar, Nalanchira Thiruvananthapuram- 695015 Mob: 9986088401	31.03.2025
16	BIOTECH RENEWABLE ENERGY Pvt.Ltd. ബയോ ടെക് റിന്യൂവബിൾ എനർജി	Post Box No. 520, Biotech Towers, M P Appan Road, Vazhuthakad, Thycadu PO, Trivandrum -695014 0471 2321909, 2332179,2331909 mailtobiotech@gmail.com	31.03.2025
17	NAVAJYOTHI BIOGAS നവജ്യോതി ബയോഗ്യാസ്	13/176, Eloor Ferry Road, Udyogamandal PO, Ernakulam- 683501 Ph: 8891339563 navajyothibiogas@gmail.com	31.03.2025
18	HARIYALI	HARIYALI, Green Technology Centre, J T Road, Vatakara, Muncipality. Mob: 9645151956 Email: hariyalihss@gmail.com	20.06.2027
	FED BATCH BIOGAS PLANT		
1	VENAD RESOURCE MANAGEMENT	Pada North, Karunagapally, Kollam 690518 Mob : 9447739861, 9446032934 Email : venadresource@gmail.com	24.07.2025

FIXED/ FLOATING DOME TYPE BIOGAS PLANT (DBOT MODEL)

1	SOCIO ECONOMIC UNIT FOUNDATIONS	JAKRA-43, VJ Lane, Vellayambalam, Sasthamangalam P.O, Thiruvananthapuram-695010. Mob: +91 9744655894 Email: seufhq@gmail.com	12.03.2027

NISARGRUNA BIOGAS PLANT (DBOT MODE)

1	SNL BIOENERGETICS	SNL Bioenergetics, Urapakkam, Chennai Mob : +91 9663330849 Email: snlbioenergy@gmail.com	25.07.2027

CBG PLANT (PPP MODE)

1	EAT EASY FNB	Eat Easy FnB, Thrissur-680012, Kerala, India. Mobile : +919995599500, +916238858862, Email :ceo@eateasyfnb.com	25.07.2027
2	SYNOD BIOSCIENCE (Through anerobic digestion and VPSA technology)	SYNOD BIOSCIENCE, Ezhupunna South, Cherthala, Alappuzha - 688 535 Ph: 8073815184 Email: info@synod.in	20.06.2027

CBG PLANT (BIO URJA MODEL) (DBOT MODE)

1	GPS RENEWABLES PRIVATE LIMITED	3rd Floor, Prestige Pinnacle, 7th Block, Koramangala, Bengaluru Karnataka. Mob: +91 9480189447 Email: rajesh@gpsrenewables.com	12.03.2027

GAS CREMATORIUM

1	HI-TECK CREMATORIUM PVT. LTD	Building No. XIII/592, Chirayam, Panayikkulam PO, Aluva, Ernakulam - 683 511, Ernakulam	31.03.2025
2	RAIDCO KERALA LIMITED	(Raidco Tower, SPCARoad Kannur - 670 002. Ph: 0497 2700875, 9446005920, 9446005845, E-mail:info@raidco.in	31.03.2025
3	NEESHAN & LJ Pvt Ltd	Ground floor, Building No 10/231, Manhalankal, Pulikurumba, New Naduvil, Kannur, Kerala-670582 Mobile : 9544168622 Email:jobincegeorge1914@gmail.com	25.07.2024

BLACK SOLDIER FLY TECHNOLOGY

1	To implement Biodegradable waste management projects in PPP mode using the Black Soldier Fly Larvae (BSF) Technology	FABBCO BIOCYCLE & BIO PROTEIN TECHNOLOGY	Ward No. XVI,Anakkara Panchayat, Anakkara Village, Pattambi Taluk, PalakkadDistrict, Kerala. E-mail ID- usmanap63@gmail.com Phone: 91-7034122222	17.10.2024
2	Bio conversion of municipal organic waste into compost using Black Soldier Fly larvae technology (DBO model)	AMALA ECO CLEAN PVT LTD	Amala Eco clean Pvt Ltd XI/564, Lissy Nagar, Varanad P.O, Cherthala - 688539. Mob : 9633794894/ 9387095287 Email :info@amalaeco.com	23.06.2027

FISH WASTE TO FEED PROCESSING (DBOT MODE)

1	Empanelled as prospective investor for the collection and processing of fish waste (Converted into fish meal for Aquatic/ Poultry feed) in DBOT mode	NPM ASSOCIATES	NPM Associates, 14/72, Firoz Manzil, Kechery P.O Thrissur, Kerala -680501, Ph : 9656021212, Email : npmassociates2019@gmail.com	28.06.2027

MECHANIZED AEROBIC COMPOSTING UNIT (PPP MODE)

1	TECH FARM INDIA	Tech Farm India, Kaithakuzhy, Adichanalloor, Kollam, Kerala - 691573 Mob : 9605582928, 9605582938 Email: techfarmindia474@gmail.com	28.06.2027

AGENCIES EMPANELLED FOR NON-BIO WASTE HANDLING
അജൈവ മാലിന്യം കൈകാര്യം ചെയ്യൽ

PLASTIC WASTE (FORWARD LINKAGE FROM MCF/RRF)

Sl. No	NAME OF AGENCY	CONTACT DETAILS	DISTRICTS FOR WHICH THE AGENCY IS EMPANELLED	VALID TILL
1	GREEN TECH ECO CONSULTANCY ഗ്രീൻ ടെക് ഇക്കോ കൺസൾട്ടൻസി	Pranavam, Pragathi Nagar 47, Kilikolloor, Kollam - 691004 Ph: 7012953988 Email: greentechkollam07@gmail.com	KOLLAM	14.03.2026
2	PANDAS WORLD ECO SOLUTION പാണ്ടാസ് വേൾഡ് ഇക്കോ സൊല്യൂഷൻ	1/733 Kottara Meeyannoor P.O, Kollam, Kerala - 691524 Ph: 8129297746 Email: pandasmail2022@gmail.com	KOLLAM	14.03.2026
3	EVER GREEN ECO SOLUTIONS (GREEN LIFE) എവർ ഗ്രീൻ ഇക്കോ സൊല്യൂഷൻസ്	23/226A Mannanchery, Kalavur, Alappuzha Ph: 9633671990 Email: siru87374@gmail.com	ALAPPUZHA	14.03.2026
4	EKAIVA ECO SOLUTIONS ഏകൈവ ഇക്കോ സൊല്യൂഷൻസ്	Nerikuzhi Building, Karikode, Kottyam, Kerala Ph: 9846745434 Email: ekaivaecosolutions@gmail.com	KOTTAYAM	14.03.2026
5	CEE KAY GREEN CARE AGENCY സി കേ ഗ്രീൻ കെയർ ഏജൻസി	29/1802 A (24/1640 A) Kendriya Bhadhar Bristow Road, Willingdon Island, Kerala, Ernakulam - 682003 Ph: 9946733332 Email: ceekayscochin@gmail.com	ERNAKULAM	14.03.2026
6	BAYMAX WASTE MANAGEMENT SOLUTIONS ബേമാക്സ് വേസ്റ്റ് മാനേജ്മന്റ് സൊല്യൂഷൻസ്	12/750 Alangad, Panayikulam Kara, Masjid Road, Aluva - 683511 Ph: 8921510152 Email: fasfahad13@gmail.com	ERNAKULAM	14.03.2026
7	KONARIS ADVANCED POLYMERS കോനാരിസ് അഡ്വാൻസ്ഡ് പോളിമേഴ്സ്	1/458, Industrial Development Plot, West Hill, Kozhikode - 673005 Ph: 9387685396 Email: info@konarisindia.com	ERNAKULAM, WAYANAD, KOZHIKODE	14.03.2026
8	MALABAR ECO SOLUTIONS PVT LTD മലബാർ ഇക്കോ സൊല്യൂഷൻസ്	Door No 10/10, Thottathodi, Kovilakam Road, Mankada, Malappuram, Kerala - 679324 Ph: 9539966966 Email: malabarecosolutions@gmail.com	PALAKKAD	14.03.2026

9	GREEN WORMS ECO SOLUTIONS LLP ഗ്രീൻ വേർമ്സ് ഇക്കോ സൊല്യൂഷൻസ്	140 B, The Crest Building, Varakkal Road, Westhill Kozhikode, Kozhikode - 673005 Ph: 9961457464 Email: info@greenworms.org	MALAPPURAM, WAYANAD, KASARGOD	14.03.2026
10	UNIVERSAL BIOGAS യൂണിവേഴ്സൽ ബയോഗ്യാസ്	20/1145A14, IInd Floor, Calicut Business Cente, Kallai, Calicut - 673003 Ph: 9946622477, 9544106939 Email: officeuniversalbiogas@gmail.com	MALAPPURAM, KOZHIKOD	14.03.2026
11	SHUDHI SOLUTIONS ശുദ്ധി സൊല്യൂഷൻസ്	25/325 C2, Manalody, Nilambur, Malappuram Ph: 9747024494 Email: shudhisolutions@gmail.com	MALAPPURAM	14.03.2026
12	THALIR ZERO WASTE തളിർ സീറോ വേസ്റ്റ്	Vythiri Chundale, Wayanad-673123 Ph: 8848757326 Email: thalirzerowast@gmail.com	WAYANAD	14.03.2026
13	THIRUVONAM ECO INDUSTRIES PVT LTD തിരുവോണം ഇക്കോ ഇൻഡസ്ട്രീസ്	5/4A Mademmakulam Road, Olayambadi P.O, Kannur-670306 Ph: 8089059500 Email: thiruvonamecoindpvtltd@gmail.com	KANNUR, WAYANAD	14.03.2026
14	ROYAL MRC റോയൽ MRC	Ground Floor, Prince Arcade 8/229/B, Mananthavady Kalpetta Road, Kalpetta, Wayanad - 673122 Ph: 8848974291 Email: royalmrc051@gmail.com	WAYAAND	14.03.2026
15	MAHYOOBAH WASTE MANAGEMENT മഹ്യൂബ വേസ്റ്റ് മാനേജ്മന്റ്	AGPW 13-898, Thekepalli Building, Thekkepuram, Athinhal, Manikoth P.O, Kanghangad - 671316, Kasaragod Ph: 9961855050 mahoobahwastemanagement@gmail.com	KASARGOD	14.03.2026
16	PLAN@EARTH	12/457 A, U C College P.O, Aluva - 683102 Ph: 9746474181 Email: info@planatearth.org	ERNAKULAM	15.03.2026
17	MOVENPRO ENVIRO SOLUTIONS LLP മോവൻപ്രോ എൻവിറോ സൊല്യൂഷൻസ്	11/314, Kakkad, Tirurangadi, Malappuram Ph: 9037237400 Email: movenpromail@gmail.com	MALAPPURAM	15.03.2026
18	REFTO PRIVATE LIMITED COMPANY റെഫ്റ്റോ പ്രൈവറ്റ് ലിമിറ്റഡ് കമ്പനി	Poovarani P.O, Pala, Kottayam Ph: 9605707171 Email: service.refto@gmail.com	KOTTAYAM	15.03.2026

19	CHRIS GLOBAL TRADERS ക്രിസ് ഗ്ലോബൽ ട്രേഡേഴ്സ്	Resource Recovery Facility, Near Indoor Cricket Stadium, Tiruvalla - 689101, Pathanamthitta Ph: 9496002423 Email: chrismamatha@gmail.com	PATHANAMTHITTA	15.03.2026
20	ECO GREEN ഇക്കോ ഗ്രീൻ	15/137A, 15/ 137 B, Parappur road, Kottakkal, Malappuram - 676503 Email: ecogreenkkl@gmail.com Ph: 9400337794	MALAPPURAM	15.03.2026
21	PLASTO	Kozhikkoden Kunnu, Olavana, Kozhikode - 673019 Email : plastomrfclt@gmail.com Ph: 9645303606	KOZHIKODE	15.03.2026
22	NATURE GUARD PLASTIC WASTE MANAGEMENT	23/500 C.D.E.F., Koilandy P.O, Kozhikode - 673305. Email: shafraztvng@gmail.com Ph: 8075642288, 891951040, 9567365541	KOZHIKODE	20.07.2026
23	PLANET EARTH ECO SOLUTIONS PRIVATE LIMITED	6/781A, Kavungal Parambu-Chelakulam Road, Kizhakkambalam, Ernakulam - 683556 Ph: 9895133328 Email: info@planetearthes.com	ERNAKULAM	25.07.2026
24	NORTHAMPS ENV SOLUTION	Naduvileveettil Building, Irumpanam, Thripunithura, Cochin - 682309 Ph: 9048133766 Email: info@northamps.com	ERNAKULAM, IDUKKI	24.07.2026
25	TRASH GOLD ECO SOLUTION	22/628, Vallekulam, Pallatheri, Elappully, Palakkad - 678005 Ph: 9947850674 Email: trashgoldecosolution@gmail.com	PALAKKAD	24.07.2026
26	RECLAPSE INDIA PVT LTD	2nd Floor, 38/984-14, JMA Trade Centre, Poothole, Thrissur, Kerala - 680004	THRISSUR	07.08.2026

PLASTIC WASTE MANGEMENT (DBOT MODE)

1	Empaneled for segregation, baling and forward linkages of plastic waste in DBOT mode.	GREEN WORMS ECOSOLUTIONS LLP	140 B, The Crest Building, Varakkal Road Junction, West Hill, Kozhikode- 673005 Ph : 9656363502 Email : info@greenworms.org	26.06.2027
2	Empaneled for segregation, bailing and forward linkage of plastic waste, shoe waste, fabric waste, MLP and glass waste in DBOT mode.	PLAN AT EARTH	12/457 A, U C College PO, Aluva- 683102 Phn : 9746474181 Email : info@planatearth.org	23.06.2027
3	Empaneled for segregation, baling and forward linkage of plastic waste	MOVENPRO ENVIRO SOLUTIONS LLP	MOVENPRO ENVIRO SOLUTIONS LLP TM 12/38-A16, KAKKAD POST, MALAPPURAM DT, 676306 Phn : 9037237400 Email :movenpromail@gmail.com	26.06.2027
4	Empanelled for establishing plastic waste management (segregation, baling and forward linkage of plastic waste) facilities.	NORTHAMPS ENV SOLUTION	435/A, NADUVILE VEETTIL BUILDING, REFINERY ROAD, IRIMPANAM PO, TRIPUNITHURA, KOCHI. 682309 Ph: 0484-4038766 / 9048133766 Email: info@nothamps.com	26.06.2027
5	Prospective investor for establishing Non Biodegradable waste management facilities (segregation, baling and forward linkage of plastic waste) in DBOT mode	RECITY NETWORK PRIVATE LIMITED	Recity Network Private Limited, Shop No 16, Citi Mall, New Link Road, Andheri West, Mumbai 400053. Phn : 9819694739 Email : akhilesh.mohan@recity.in	28.06.2027
6	Empaneled for establishing plastic waste management facilities. (Forward linkage of plastics waste from MCF/ RRF)	A4 MERCANTILE PVT LTD	A4 Mercantiles Pvt Ltd, Thrikkakara P.O, Kochi, Ernakulam, 682021 Phn : 9526755666 / 1800 890 5089 / 9947893617 Email : theras@aakri.in / help@aakri.in	28.06.2027

PLASTIC RECYCLING PLANT (DBOT MODE)

1	Prospective investor for establishing non biodegradable waste management facilities (Plastic recycling plant) in DBOT mode	ABL ENGINEERING AND SERVICES	ABL Engineering and Services Block No.15 , KINFRA, Kunnamthanam, Mallappally , Pathanamthitta 689581. Phn : +918547688272 Email : albucheeri.ind@gmail.com	28.06.2027
2	Empaneled for establishing plastic waste management/ recycling plants in DBOT mode	HAMARA PLASTICS	IX/ 368 A, Kurichilakkodu,Kodanadu P.O, Ernakulam, 683544 Phn : 9947702486 Email : hamaraplastic@gmail.com	26.06.2027

SANITARY WASTE (COMMUNITY LEVEL)

1	FLORET TECHNOLOGIES ഫ്ളോറെറ്റ് ടെക്നോളോജിസ്	2nd Floor, HeeraChambers, MG Road, Trivandrum - 695 023 9020087007, 9446664103, 9809439600 Email : florettechnologies@gmail.com anu.aalilaa@gmail.com	05.03.2027

SANITARY WASTE (INSTITUTIONAL LEVEL)

1	HLL LIFECARE LIMITED HLL ലൈഫ്കെയർ	HLL Bhavan, Poojappura Thiruvananthapuram - 695 012 Ph: 0471- 2354949 7824847891 Email: dhruvanr@lifecarehll.com	05.03.2027
2	FLORET TECHNOLOGIES ഫ്ളോറെറ്റ് ടെക്നോളോജിസ്	2nd Floor, HeeraChambers, MG Road, Trivandrum - 695 023 9020087007, 9446664103, 9809439600 Email : florettechnologies@gmail.com anu.aalilaa@gmail.com	05.03.2027

SANITARY WASTE (COLLECTION)

1	A4 MERCANTILE PVT LTD	A4 Mercantiles Pvt Ltd, Thrikkakara P.O, Kochi, Ernakulam, 682021 Phn : 9526755666 / 1800 890 5089 / 9947893617 Email : theras@aakri.in / help@aakri.in	28.06.2027

E-WASTE (COLLECTION)

1	Collection and forward linkage of Household hazardous waste, sanitary waste and E-waste.	A4 MERCANTILE PVT LTD	A4 Mercantiles Pvt Ltd, Thrikkakara P.O, Kochi, Ernakulam, 682021 Phn : 9526755666 / 1800 890 5089 / 9947893617 Email : theras@aakri.in / help@aakri.in	28.06.2027

E-WASTE MANAGEMENT (DBOT MODE)

1	Collection, Storage, Dismantling & Recycling of E-Waste in DBOT mode	SAHYA SOLUTIONS സഹ്യ സൊല്യൂഷൻസ്	3/310, Badayil Estate, Meloram P.O, Peruvanthanam Idukki - 685532 Ph: 9447930447 E-mail: sahyakerala@gmail.com faisalksfaisalks@gmail.com	14.03.2027

HAIR WASTE MANAGEMENT (DBOT MODE)

1	Collection & treatment of Hair waste (converted into Organic Fertilizer) in DBOT mode ഹെയർ വേസ്റ്റ്	ASH LOGIX ആഷ് ലോജിക്സ്	16/1129, Nida, Kanjikode, Pudusseri, Palakkad - 678 621 Ph: 9447771981 E-mail: ashlogixkjd@gmail.com	12.03.2027

UPCYCLING OF USED TEXTILE/CLOTHS

1	APSARA TRAINING INSTITUTE FOR SKILL DEVELOPMENT AND MANAGEMENT	Apsara Training Institute for Skill Development and Management. Kanniyampuram,Ottapalam - 679104 Email : apsarainstitute@gmail.com Mobile : 9447935772	25.07.2027