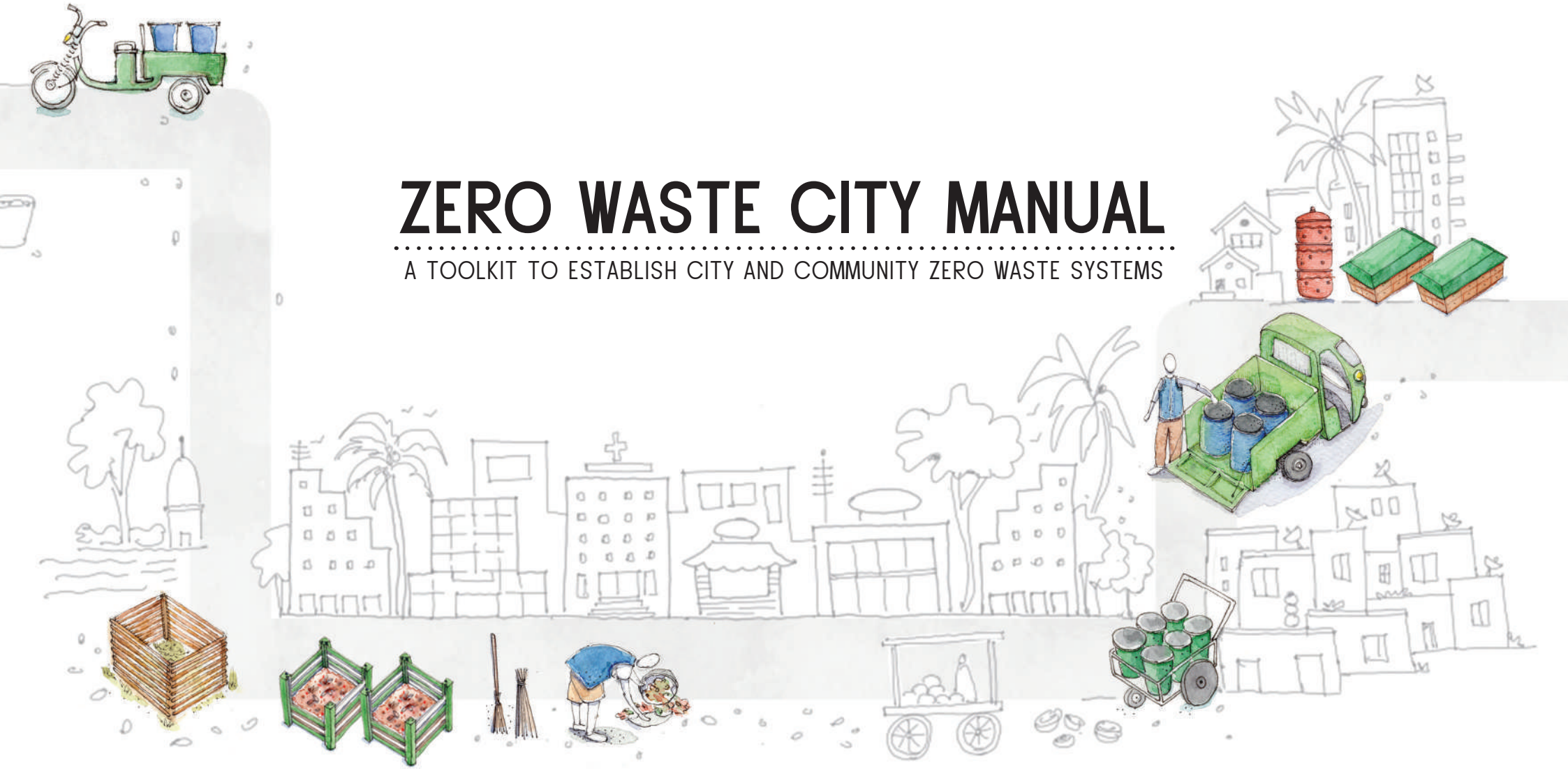
ZERO WASTE CITY MANUAL

A TOOLKIT TO ESTABLISH CITY AND COMMUNITY ZERO WASTE SYSTEMS



CAG
Citizen consumer and civic Action Group

#break free from plastic

gaia

The vision for the Zero Waste City Initiative is to minimise the movement of solid waste to disposal sites or facilities. This document presents a practicable plan for municipalities to process waste in-situ and within wards, aggregate recyclables and domestic hazardous waste at the zone level, and leverage the private formal and informal waste networks that already thrive in all Indian cities. It has been prepared based on our ground experience of working with the Greater Chennai Corporation to transition from a centralised waste to a zero waste system. Chennai is a mega-city with a population of approximately 8 million and an area of 426 sq km. It is based on Chennai's existing municipal boundaries and waste dynamics, and can be adapted to other cities based on their local context.

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The lead author is Satyarupa Shekhar, Director - Urban Governance (CAG) with contributions from Vamsi S Kapilavai (CAG).
It was reviewed by Shibu K Nair (Independent consultant), Dharmesh Shah (Independent consultant), Miko Alino (GAIA), and Felicia Dayrit (GAIA).
It has been designed by Noorain Ahmed (noorainahmed.com).

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Citizen consumer and civic Action Group (CAG) is a non-profit, non-political and professional organisation that works towards protecting citizens' rights in consumer and environmental issues and promoting good governance processes including transparency, accountability and participatory decision-making.

Global Alliance for Incinerator Alternatives (GAIA) is a worldwide alliance of more than 800 grassroots groups, non-governmental organisations, and individuals in over 90 countries whose ultimate vision is a just, toxic-free world without incineration.

#breakfreefromplastic is a global movement envisioning a future free from plastic pollution made up of 1,400 organisations from across the world demanding massive reductions in single-use plastic and pushing for lasting solutions to the plastic pollution crisis.

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GLOSSARY

AGG – Aggregator
BOV - Battery Operated Vehicle
BWG – Bulk Waste Generator
BWG (R) – BWG residential
BWG (C) – BWG commercial
BWG (I) – BWG institutional
CDD – Construction & Demolition Debris
D2D – Door to Door Collection
GCC – Greater Chennai Corporation
HH – Household
IWP – Informal Waste Picker
KW – Kabadiwalla
MCC – Micro Composting Centre
MRF – Material Recovery Facility
P/MRF – Private Material Recovery Facility
PRO – Producer Responsibility Organisation
RCY – Recycler
RRC – Resource Recovery Centre
SD – Scrap Dealer
SHG – Self Help Group
SP – Service Provider
WW – Waste Worker

CONTENTS

1. INTRODUCTION

The main aim of the Zero Waste Cities Manual is to provide a practical guide for the implementation of a zero waste system that emphasises decentralisation, source segregation, resource recovery, and informal sector inclusion. The vision for a zero waste system is to minimise movement of solid waste generated to disposal sites or facilities. As far as practicable, waste should be processed and converted in-situ, at decentralised composting or organic waste processing units or sent to specialised scientific disposal centres.

Decision making for waste and other environmental problems are embedded in complex and poorly understood systems. The terrain is usually complicated with the presence of several contesting interests, and requires balancing social and economic interests. Precautionary principles bridge the gap between weakly understood causes of potentially either grave or irreversible environmental damages and potentially costly policy interventions. These principles provide a moral justification for acting even though causation is unclear.

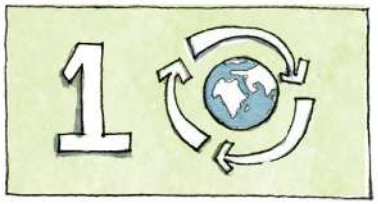
Ethics, social equity and future risks are the basis for the precautionary principle, which is a useful guideline in environmental decision making. It has four central components:

(1) Take preventive action in the face of uncertainty
(2) Shift the burden of proof to the proponents of an activity
(3) Explore a wide range of alternatives to possibly harmful actions
(4) Increase public participation in decision making

This manual is designed for use by those working to establish a city-wide waste management system. It can also be used by communities and organisations to advocate for decentralised waste management systems at the neighbourhood or community levels.

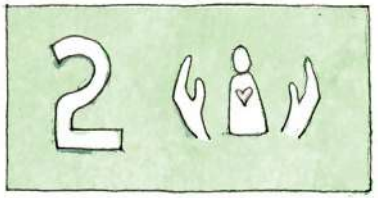
GUIDING PRINCIPLES

In designing a response to environmental problems posed by waste, it is important to remember that decision makers primarily hold a social responsibility to protect human and environmental health. They can use the following guiding principles:



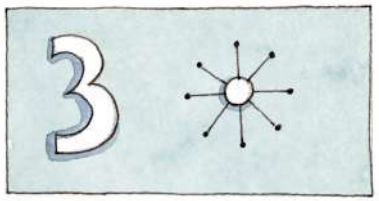
Environmental sustainability

Ensure that SWM is conducted in an environmentally sustainable manner.



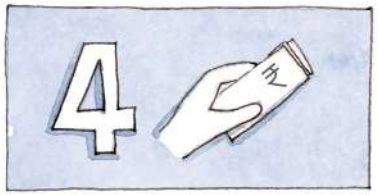
The Right to live in a healthy and pollution-free environment

As enshrined in the Right to Life under Article 21 of the Constitution of India.



Decentralised waste management

Implement, encourage and incentivize decentralised waste management in accordance with the Proximity Principle, which holds that waste should be disposed of or managed close to the point where it is generated.

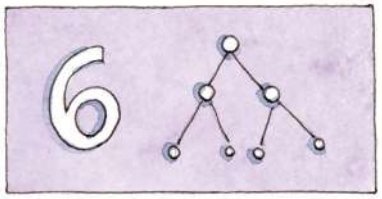


"Polluter Pays"

To be implemented where possible to ensure that the generator of waste is primarily liable for waste management and the costs associated with it.

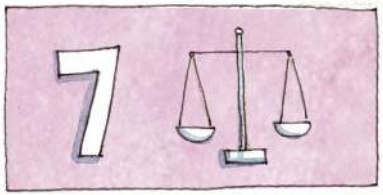
Extended Producer Responsibility

producers/ manufacturers and brand owners should be made liable for the residual waste of their products, packaging and delivery models. They should redesign their products and processes to eliminate environmental, social and economic costs.



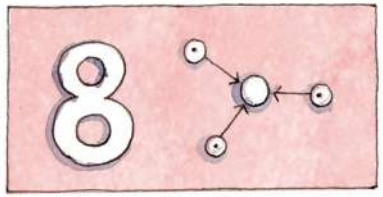
Waste hierarchy

The waste hierarchy ranks waste management options according to sustainability and what is best for the environment. Top priority is accorded to preventing and reducing waste production. If waste is not produced, then there is no question of disposal. When waste is produced, the hierarchy gives precedence to preparing it for reuse, followed by recycling, then recovery, and last of all, disposal.



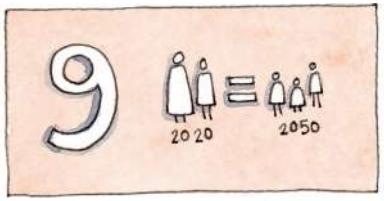
Fair labour practices

Ensure that all individuals employed or otherwise engaged in the execution of SWM are treated in accordance with national and international labour norms, including the concept of 'decent work' used by the International Labour Organisation.



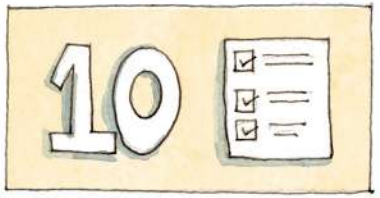
Informal sector inclusion

Include, integrate, or accommodate wherever possible, economically vulnerable segments of society, such as waste pickers, who are, traditionally or otherwise, dependent on waste for their livelihoods. This will ensure their Right to Livelihood through either employment or access to waste.



Inter-generational equity

Pursue the implementation of a system of SWM that does not compromise the ability of future generations to live healthy and sustainable lives.



Target-oriented management

Ensure timely compliance with all rules and regulations.

FALSE SOLUTIONS

There are a few myths that can undermine - and even derail - a zero waste vision and strategy. Decision makers, especially those working on public policy, should remain alert to solutions that promise quick fixes or path dependence.

ZERO WASTE IS NOT POSSIBLE

So long as we make and use materials, there will be discards. These will never be zero, but that is no reason to take zero action. Small steps to reduce, repair, reuse and recycle material discards can help us reduce waste and minimise the burden on the environment.

CONSUMERS ARE RESPONSIBLE

Businesses have perpetuated the popular opinion that consumers are responsible for waste and municipalities are responsible for its mismanagement. Businesses make the primary choice of materials and delivery methods. They should also include post-consumer design and be liable for residual materials. Citizens can be more responsible by choosing to repair and reuse, and also selecting products that minimise post-use material discards.

TECHNOLOGY IS A PANACEA

Each of the materials we use and discard have different impacts on human and environmental health. These impacts cannot be predicted with certainty in all conditions and contexts. This is why a single technology cannot be the answer. In fact, several technologies marketed as quick 'solutions' cause dangerous - often irreversible - hazards, and preclude other sustainable and economical solutions. These include incinerators, organic waste converters, and 24-hour composters. These are expensive to establish and maintain, and lead to dependence for a long period.

WASTE TO ENERGY

Converting waste to energy is often touted as the solution to managing waste with the added benefit of generating energy. On the contrary, these plants are associated with air, soil and water pollution through metals (mercury, lead and cadmium), organics (dioxins and furans), acid gases (sulphur dioxide and hydrogen chloride), particulates (dust and grit), nitrogen oxides and carbon monoxide. The technology used goes by many names - incineration, gasification, plasma arc and pyrolysis.

PLASTICS CAN BE RECYCLED

Plastics have become ubiquitous in their shape and use. Unfortunately, this has resulted in pervasive pollution with unimaginable toxins in our environment. They degrade into micro and nano particles and fibres, and are known to enter the food chain with ease. They cannot be recycled - only downcycled - with significant economic, social and environmental costs.

PLASTIC IS ENVIRONMENTALLY FRIENDLY

Many claims that plastic has a smaller environmental footprint than wood, metal, and glass are used to push their continued use. These claims are erroneous and do not consider the impacts of extraction of raw materials, processing using hazardous chemicals, and disposal in landfills and marine pollution. Refill and reuse solutions are most environmentally friendly, and conducive to zero waste.

PLASTICS ARE PRO POOR

Big businesses promote sachets and other small packaging as pro poor in that all people can afford the smaller quantities. Unfortunately, sachets are made of several layers of plastic and aluminium using chemical adhesives. These cheap plastics are designed for use-and-throw, and are impossible to collect and recycle. These pollute the soil, water and air, with the health hazards borne by the poorest sections of our society.

BIOPLASTICS CAN REPLACE PLASTICS

Bioplastics are made from a combination of fossil fuel and plants. Switching from fossil fuel to plants will require farmlands and forests to be diverted to grow specific plants, depriving humans and animals of food, and causing enormous environmental degradation. These are neither biodegradable or compostable in natural conditions,and cannot be distinguished from conventional plastic.

2. ROAD MAP

A zero waste system aims at 100% in-situ organic waste processing within city boundaries, thereby ensuring 100% segregation at source, eliminating contamination of recyclables by organic waste, maximising recycling, reducing landfilling and other polluting technologies, and avoiding resultant greenhouse gas emissions, air pollution, groundwater contamination and public health hazards. These outcomes can be achieved by the following outputs and activities.

LEGISLATIVE FRAMEWORK

A conducive policy environment is critical to the success of any good waste management system. A national or regional policy needs corresponding rules that make it actionable by village and municipal authorities.

A big part of the waste problem is the enormous amount of plastic waste. This is why countries and states across the world are enacting legislations that call for greater producer responsibility towards the use of plastic in products, packaging and delivery, their collection and treatment, and also disposal. These could include the ban the use of several plastic products, particularly single use plastic, such as bags, cutlery and straws, and higher taxes or subsidies to encourage replacing plastics with materials with a lower environmental footprint.

STAKEHOLDERS

A city or community waste management system should involve the people and entities that have a stake in the waste management in the city. These would include waste generators, waste enterprises, informal waste pickers, resident associations, non-governmental organisations, and influencers.

Waste Generators - Identify by their type (residential/ commercial/ institutional), size (bulk/ non-bulk), and location (hubs, markets, parks, beaches), any other identifiers (dense/congested neighbourhoods)

Service Providers - Identify by their specialisation (materials - paper, plastic, textile, glass, metal, medical, etc), capacity (bulk/ non-bulk), services (collection, processing, suppliers to producers/ recyclers), formal and informal sector actors

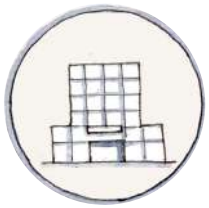
Others can include researchers, communicators, scientists, and communities, especially vulnerable and marginalised groups

HH
Independent, Slums

BWG
Residential apartments

BWG
Institutional: Public and private offices, schools, colleges

BWG
Commercial: Hotels, restaurants, guest houses



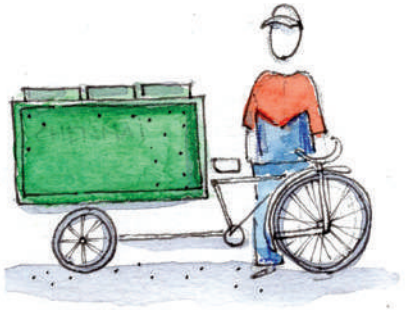
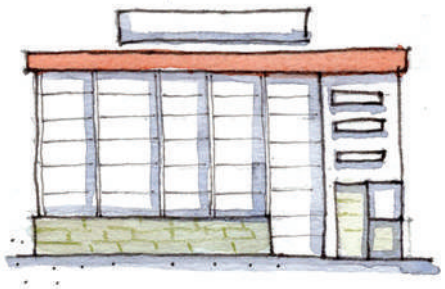
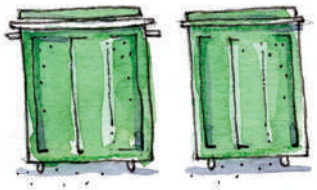
BWG
Commercial: Service

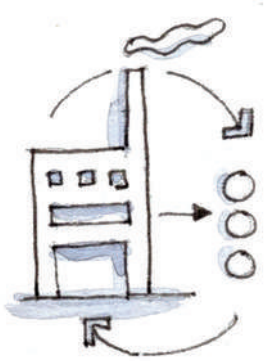
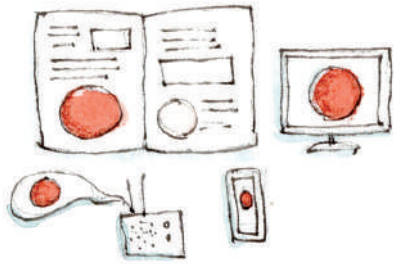
BWG
Commercial: Poultry, Fish, Meat

BWG
Commercial: Markets

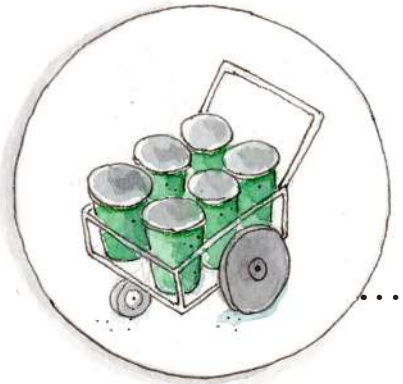
Public Spaces
Religious, parks, beaches, street sweeping

Public Spaces
Street food/ fruits & vegetables/ vendors

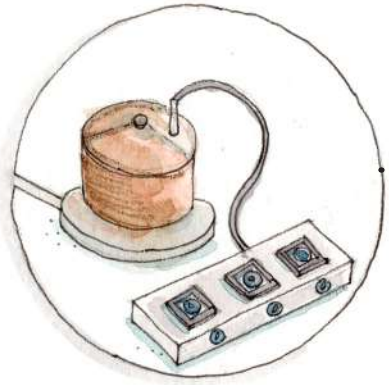
OUTPUTS	ACTIVITIES
 100% DOOR TO DOOR COLLECTION	1. Evaluate current coverage, route, frequency, number of houses covered per collection vehicle, attendance 2. Reschedule routes to ensure complete coverage and link collection vehicles to specific MCCs and MRFs 3. Establish daily collection of regular biodegradable, non biodegradable and domestic hazardous waste 4. Daily monitoring and reporting to ensure complete coverage of primary collection 5. Establish calendar for collection of special categories of waste
 ADEQUATE AND FUNCTIONAL INFRASTRUCTURE	1. Evaluate current usage, capacity, functionality, and human resources 2. Add, repair or modify facilities for composting, and segregated storage of non-biodegradable discards 3. Install all necessary equipment to sort, weigh, shred, sieve, dry materials 4. Train staff on composting and MRF operation, documentation and reporting 5. Empanel or register local scrap shops for movement of materials for recycling 6. Establish retail of compost, seeds, EM solution and home composting units 7. Create section for donation of non-biodegradable items
 COMPLETE COVERAGE FOR STREET SWEEPING	1. Evaluate existing practice, schedules, routes, waste handling 2. Modify schedules, assigning area and timings 3. Install dry leaves collection points (bins with lock and key at fixed intervals) (as relevant) 4. Allot dust bins with wheels/ wheel barrows for collection of sweep waste (as relevant) 5. Identify and assign people for community monitoring of street sweeping
 NO DUMPSTERS IN PUBLIC PLACES	1. Map existing location of dumpsters 2. Undertake campaign to communicate the removal of dumpsters 3. Develop a time table and locations for mobile dumpsters in consultation with the households 4. Identify the users of dumpsters and work with them to get engaged to a route for collection 5. Deploy 1 tricycle/ BOV per 4 dumpsters removed 6. Reschedule all tricycles/BOV as routine street side collection with specific time and locations

OUTPUTS	ACTIVITIES
 BULK WASTE GENERATORS MANAGE THEIR OWN WASTE	1. Enumerate all BWGs along with category (residential, commercial, institutional), size, location, and existing waste infrastructure and processes 2. Empanel the service providers for the area 3. Facilitate link between service providers and BWGs 4. Issue notice (with clauses and conditions of fines / spot fines for non compliance) with a timeline to set up own facility or arrangement to manage waste either at source or engage service providers with their own facilities 5. Make an inspection report to find status of BWGs after the deadline given 6. Mandate daily reporting for service providers to report to zone administration
 COMMUNICATION	1. Establish ward and community committees to participate in planning, implementation, and monitoring 2. Establish social media channels for regular, authentic information 3. Use newspapers, social media, TV and radio to publish authentic, regular and timely information regarding collection schedules, processes, etc 4. Create a channel for residents to interact with local staff and also to report non-collection or any other complaints
 CIRCULARITY	1. Engage farmers, urban gardeners, and horticulturists to take compost 2. Encourage neighbourhood repair services, swaps and exchanges 3. Invite influencers to use MCCs, MRFs and RRCs to conduct workshops on waste reduction, repair and reuse, home composting, urban agriculture

MODEL WARD LAYOUT



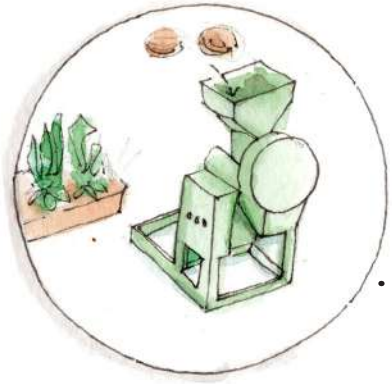
Low income neighbourhood (densely populated) serviced by push carts designed for narrow streets

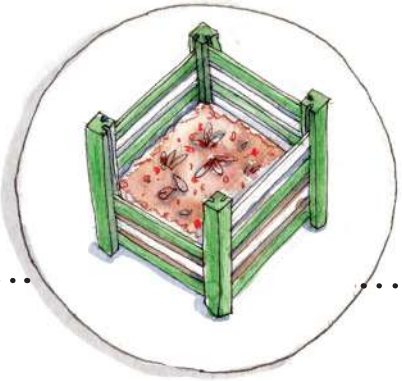


Canteen with biogas plant

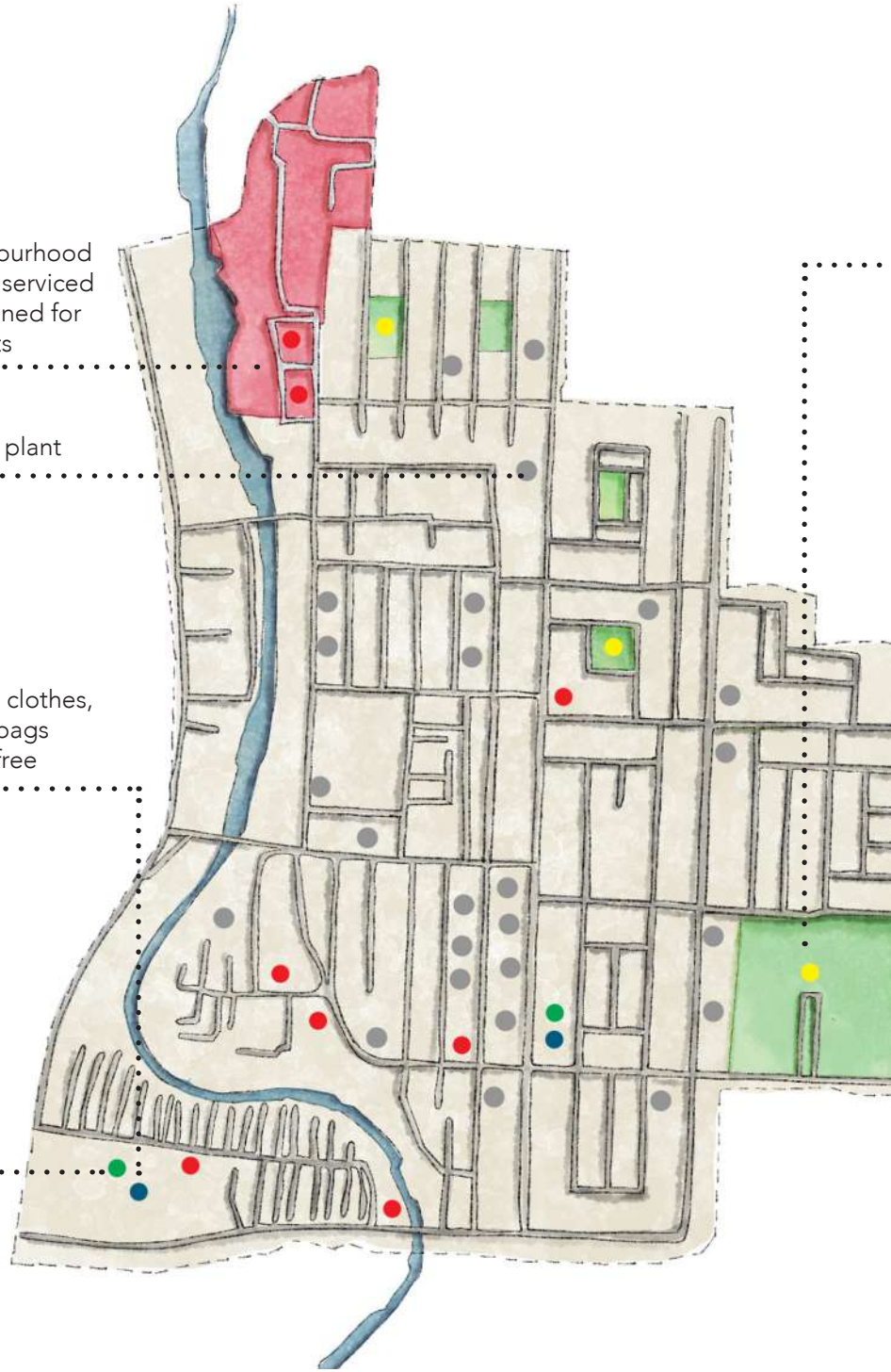
MRF with repaired clothes, footwear and bags available for free

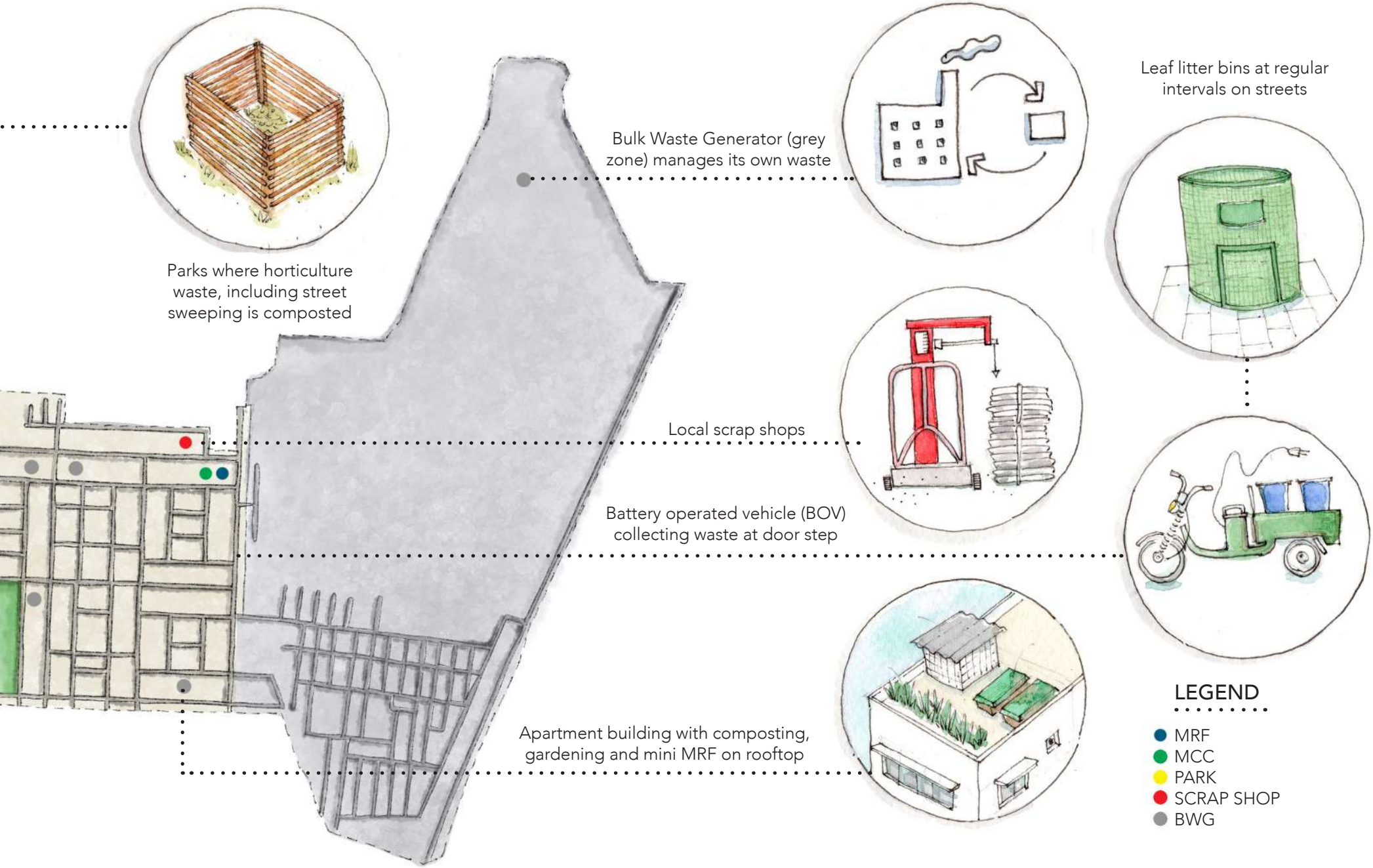
MCC with composting, coconut pulveriser and kitchen garden





Community composting in aerobic bins



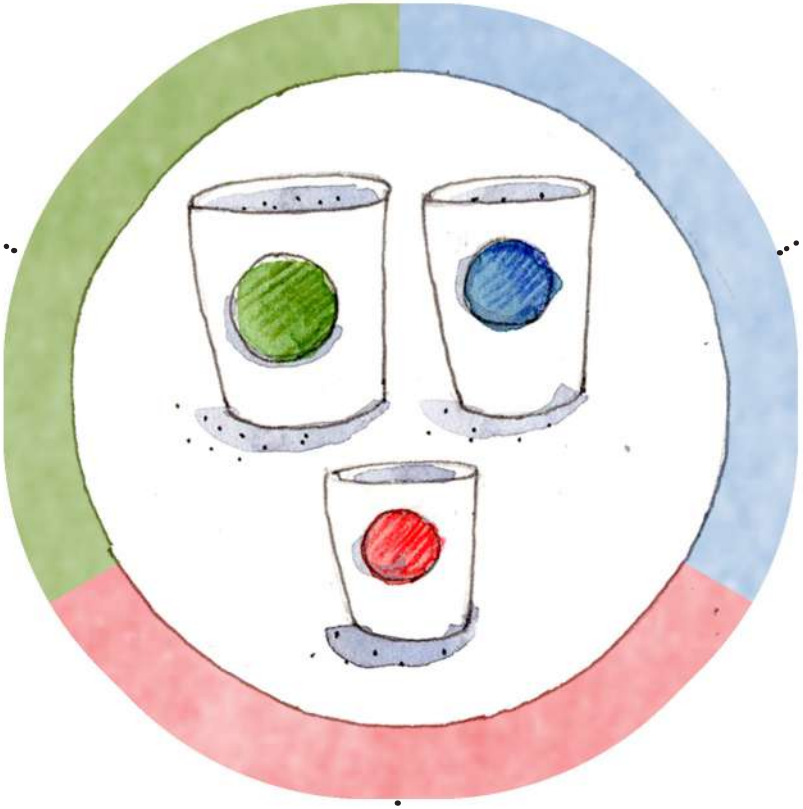

Parks where horticulture waste, including street sweeping is composted
Bulk Waste Generator (grey zone) manages its own waste
Leaf litter bins at regular intervals on streets
Local scrap shops
Battery operated vehicle (BOV) collecting waste at door step
Apartment building with composting, gardening and mini MRF on rooftop
LEGEND
MRF
MCC
PARK
SCRAP SHOP
BWG

3. KNOW YOUR WASTE

Cities and communities should undertake a waste audit to clearly identify waste generation to establish baseline or benchmark data. A waste audit is a physical analysis of waste composition to provide a detailed understanding of problems, identify potential opportunities, and give a detailed analysis of waste composition. A brand audit is a physical categorisation and counting of branded plastic packaging. to identify the companies most responsible for plastic pollution and potential actions that cities and communities can take to hold them accountable.

There are three broad categories of waste that we generate at home. These are biodegradable, non-biodegradable and hazardous.

BIODEGRADABLE WASTE
Organic waste that typically originates from plant or animal sources, which may be degraded by other living organisms hence this waste generally gets absorbed in the soil.



NON-BIODEGRADABLE WASTE
Non-biodegradable waste cannot be decomposed naturally. Much of it can be recycled if properly cleaned and stored. These can be transformed through a process into raw materials for producing new products, which may or may not be similar to the original products. This kind of waste hence is generally re-processed and does not increase the waste in the city.

HAZARDOUS WASTE
There are several other materials used and discarded that need specialised handling to recycle and dispose. These should not be discarded with other household wastes.

BIODEGRADABLE WASTE

Organic waste that typically originates from plant or animal sources, which may be degraded by other living organisms hence this waste generally gets absorbed in the soil.

Pet faeces and litter are bio-degradable but contain pathogens that need to be treated differently. DO NOT compost it with waste that is meant for growing food. Compost for pet faeces can be used for ornamental plants or grass

1. Fruit and vegetable peels 2. Egg shells 3. Tea leaves and coffee grind 4. Soile tissues 5. Meat and bones 6. Garden and leaf litter (small twigs, leaves)
7. House sweeping dust 8. Prayer flowers, garlands, banana leaves 9. Cooked food leftovers 10. Ashes

Slow Biodegradable Waste

11. Coconut shells, sugarcane fibre, banana trees/plants, tree branches (All these take time to degrade and should be kept in separate receptacles)

NON-BIODEGRADABLE WASTE

Non-biodegradable waste cannot be decomposed naturally. Much of it can be recycled if properly cleaned and stored.

If mixed with biodegradable or hazardous waste it gets contaminated and cannot be recycled

1. Paper (newspaper, paper, books, magazines) 2. Glass (bottles, mirrors, jars) 3. Metal (containers, wires) 4. Plastic (bottles, containers, boxes, cutlery, bags, straws, cigarette butts) 5. Textile (clothes, rags, mop heads) 6. Rubber and Leather (footwear, wallets, belts, bags, suitcases, upholstery) 7. Wood (furniture, show pieces)

HAZARDOUS WASTE

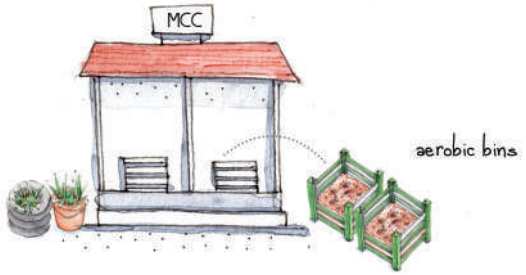
There are several other materials used and discarded that need specialised handling to recycle and dispose. These should not be discarded with other household wastes.

1. Electrical: Batteries, flashlights, button cells, light bulbs, tubelights, CFL's, photographic audio/video tapes and their containers, digital thermometers, etc.
2. Electronics: personal computers, mobile phones, telephones, MP3 players, audio equipment, televisions, calculators, GPS automotive electronics, digital cameras and players, video recorder (eg. DVD), camcorders, etc. 3. Aerosols, bleaches, kitchen and drain cleaning agents and their containers 4. Expired/discarded medicines (strips and containers) 5. Cosmetic items, paints, oils, lubricants, glues, thinners, and their containers 6. Mercury-containing products (eg. thermometer) 7. Car betteries, oil filers and car care products 8. Insecticides, pesticides, and herbicides and their empty containers 9. Others: packaging materials, thermocol sheets, stationary
SANITARY WASTE : 10. Diapers, menstrual napkins, wet wipes, tampons 11. Condoms 12. Hair, nail clippings 13.Syringes, blades, injection vials

4. INFRASTRUCTURE

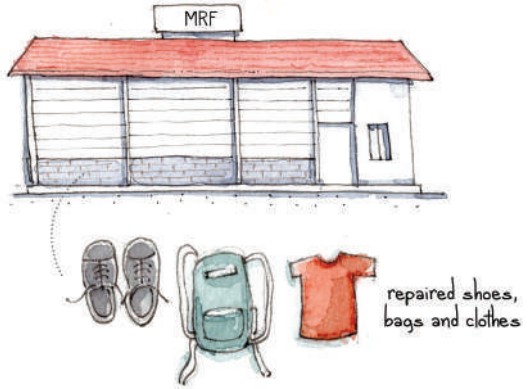
A. MICRO COMPOSTING CENTRE (MCC)

- facility to collect and compost biodegradable discards.
- MCCs will be the first point of contact for residences and the location where waste workers will take the D2D waste.
- MCCs will have machinery and equipment to manage organic waste (shredder, pulveriser, weigh scales, sieves, etc)
- Each ward should have a minimum of three standard MCCs



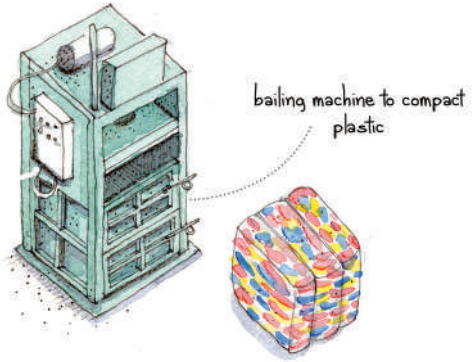
B. MATERIAL RECOVERY FACILITIES (MRF)

- Space where non-biodegradable materials is sorted into basic categories (paper, plastic, rubber, textile, glass, metal)
- MRFs should be equipped with an office (with computer) to maintain data in digital formats and rest facilities for staff
- MRFs also have an awareness centre, where the public can obtain technical knowledge on waste management
- MRFs can have retail sales of compost, seeds, EM solution and cocopeat
- Repaired clothes, footwear, bags, etc can be available for free
- Informal waste pickers and scrap shops can buy these materials, and unsold materials are transferred to RRCs
- To incentivise the MRF staff, the revenue can be shared
- Each ward should have three standard wards



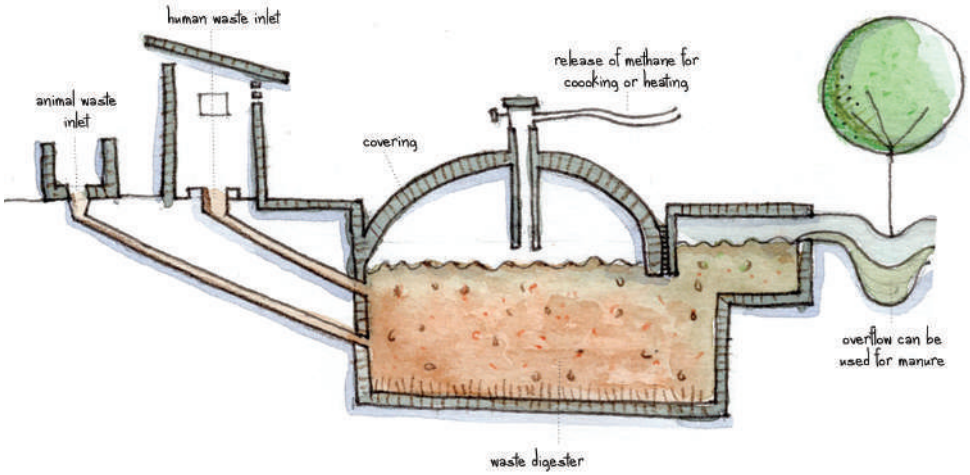
C. RESOURCE RECOVERY CENTRES (RRC)

- Space to receive, sort, clean and dry material discards, shred, disassemble, pack, bale, manage rejects, and sale or supply to recyclers
- RRCs will have necessary infrastructure, machinery, tools and human resources for secondary processing of specific materials (eg. electrical, electronic, glass, plastics)
- There should be one RRC per zone. Existing waste transfer stations can be revamped in design and operation
- Service providers servicing BWGs and scrap shops can bring the waste they cannot sell.
- Recyclable waste will be channelised to specialised vendors, recyclers or producers



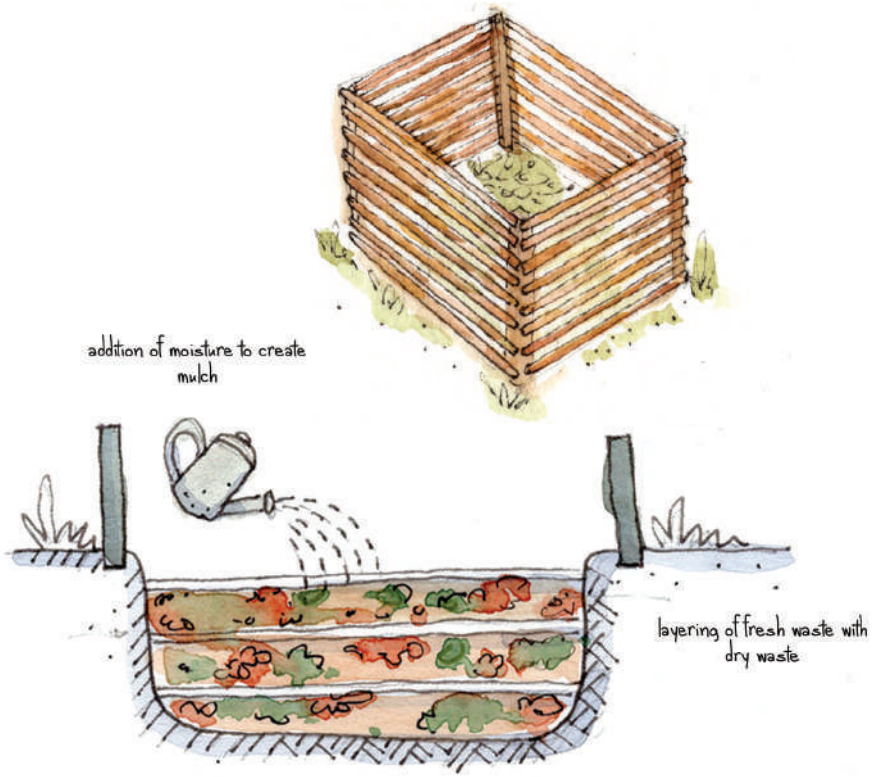
D. BIOGAS PLANT

- biodegradable waste can be processed to generate methane that can be used as fuel.
- Such units should be set up in community kitchens and anganwadis (day care centres)
- Restaurant organic waste can be sent to biogas units to ensure continuous and stable feed
- BWGs are encouraged to set up their own biogas units and allow nearby small restaurants to contribute their biodegradable waste

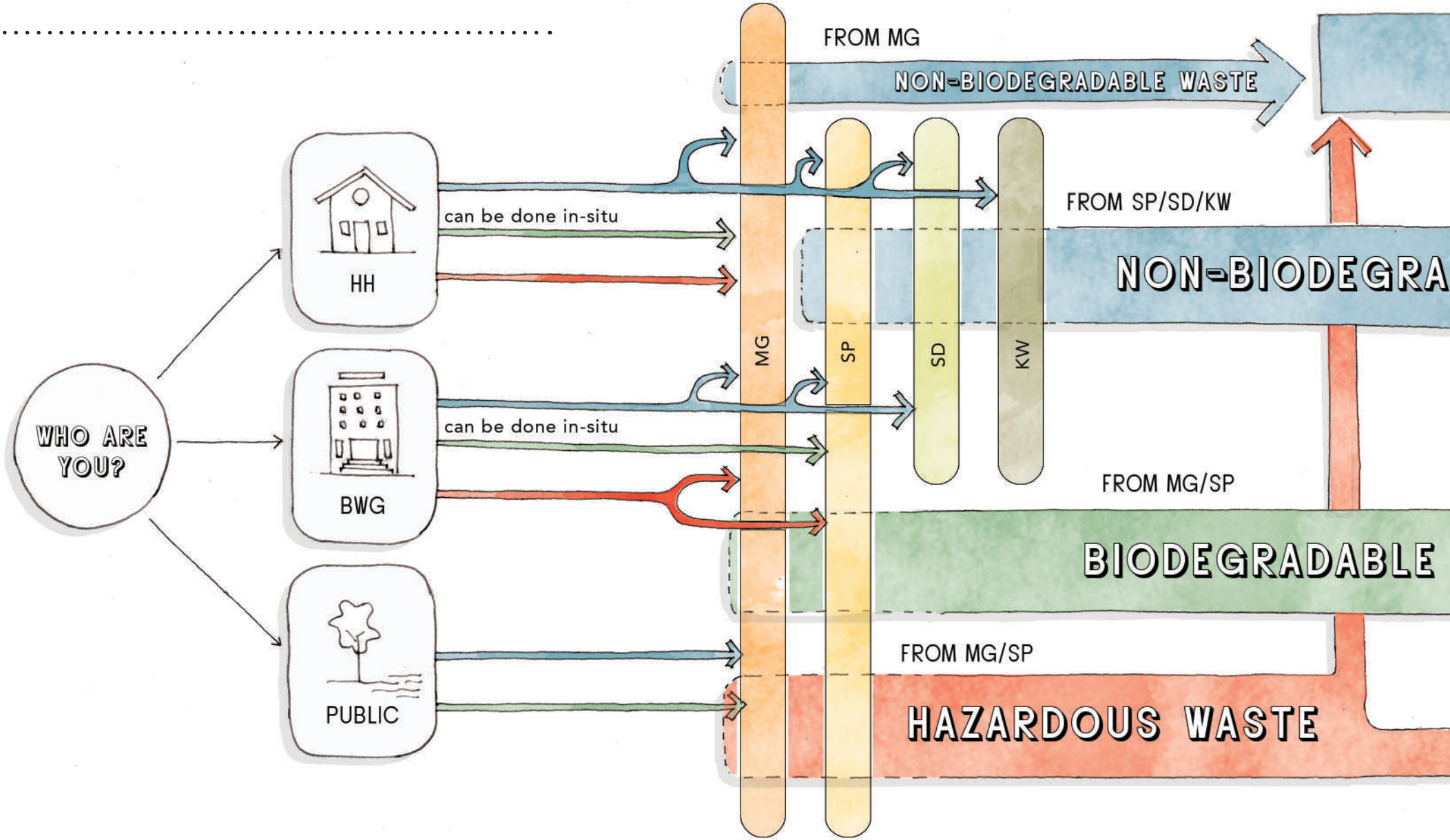


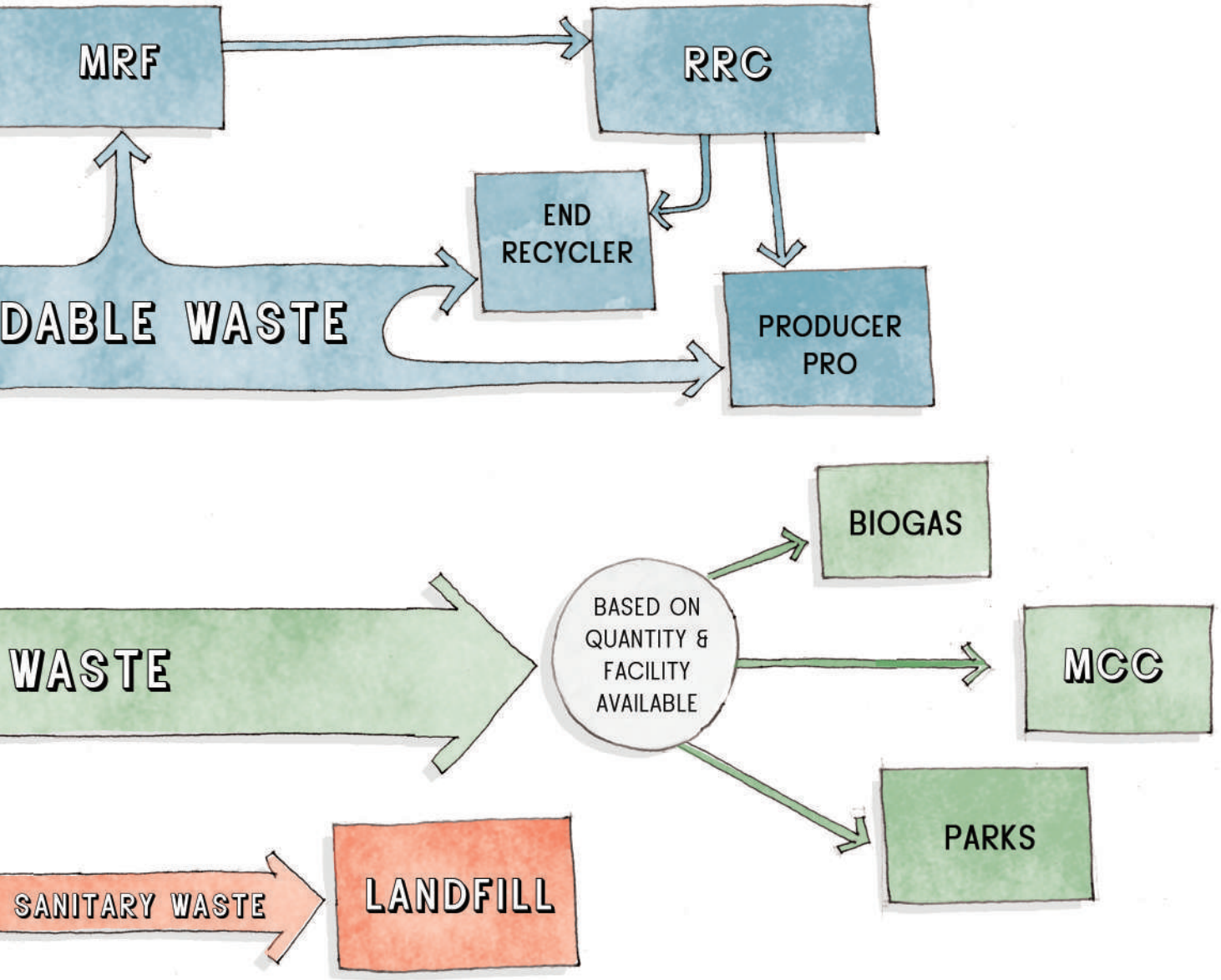
E. MULCH PITS

- Each public park will compost horticulture waste in large pits
- Parks Department can provide on-call service for tree pruning either directly or through empanelled contractors. This should be coordinated with the collection schedule.
- Waste generators can also bring their garden waste at their own cost to parks



5. FLOW OF MATERIALS





Non-biodegradable waste

Biodegradable waste

Hazardous Waste

MG (MUNICIPAL GOVERNMENT)

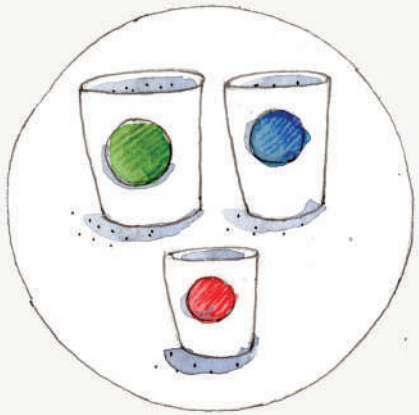
SP (SERVICE PROVIDER)

SD (SCRAP DEALER)

KW (KABADIWALA)

MCC: Micro Composting Centre
RRC: Resource Recovery Facility
MRF: Material Recovery Facility
PRO: Producer Responsibility Organisation
HH: Household
BWG: Bulk Waste Generator

6. SOURCE SEGREGATION



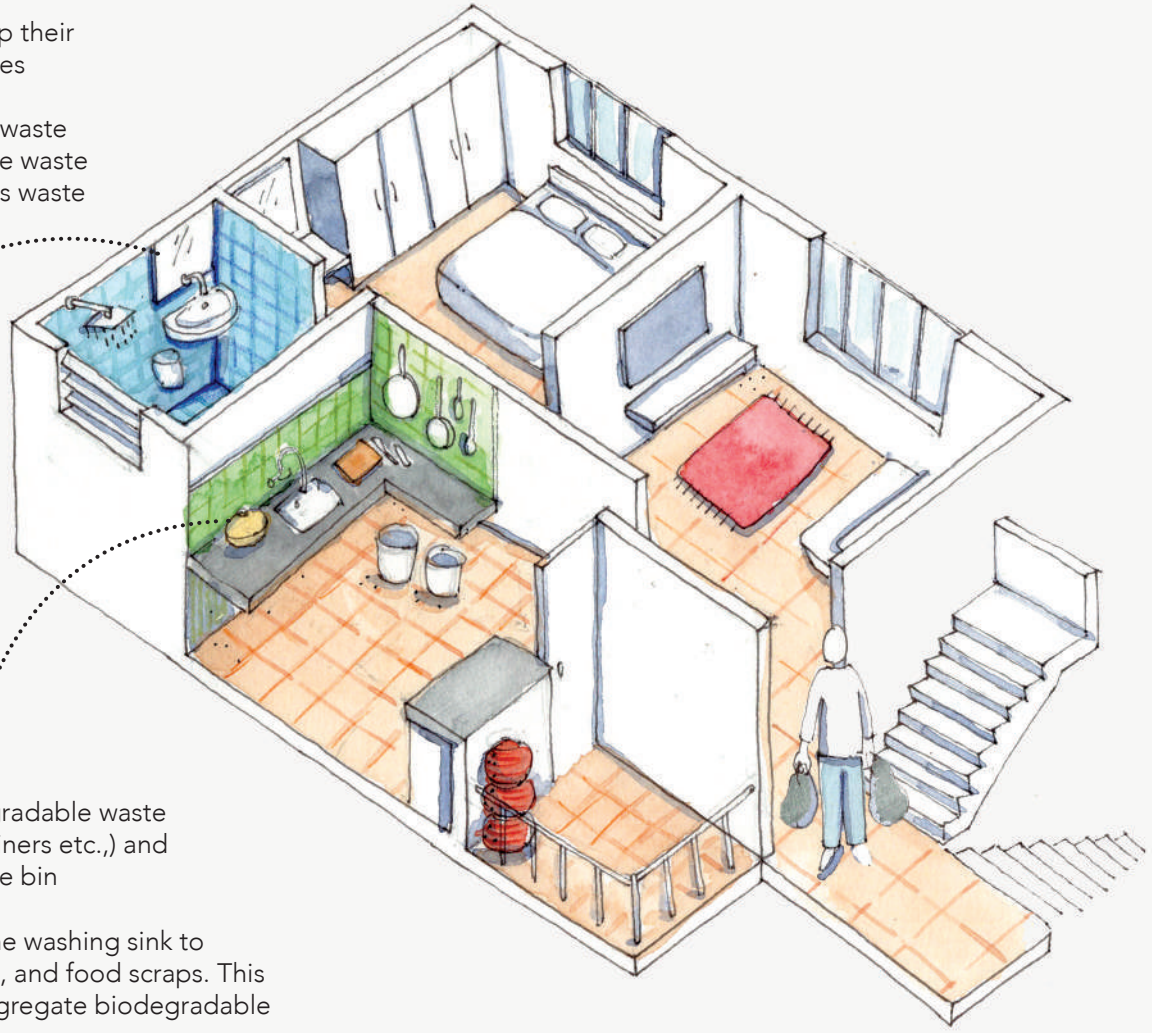
All waste generators should keep their waste in three separate categories

1. Green bins = Biodegradable waste
2. Blue bin = Non-biodegradable waste
3. Red bin = Domestic hazardous waste

Tightly wrap sanitary waste in paper, mark with a large red dot and place in domestic hazardous waste bin

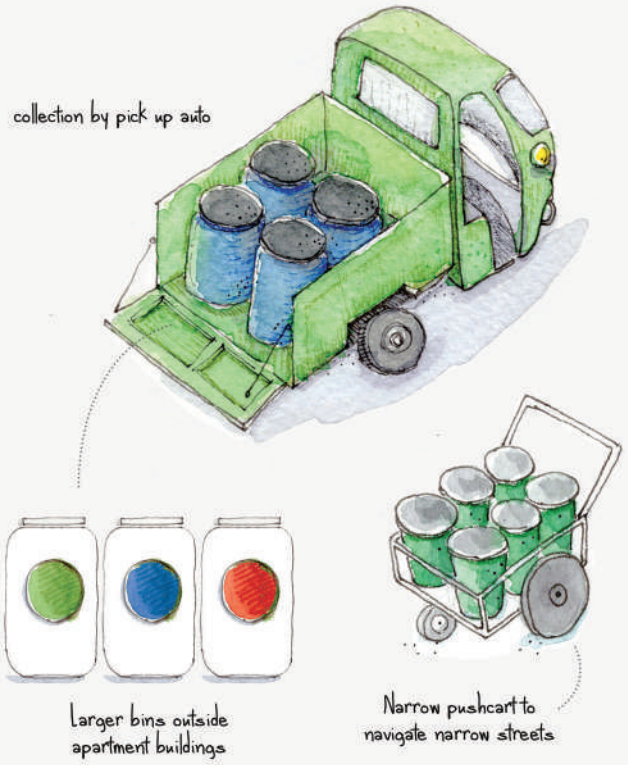
Rinse contaminated non-biodegradable waste (milk packets, food parcel containers etc.,) and store them in non-biodegradable bin

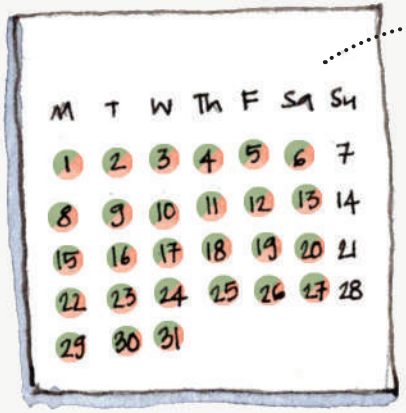
Place a small bin or bowl near the washing sink to collect fruit and vegetable peels, and food scraps. This simple habit makes it easy to segregate biodegradable materials at source



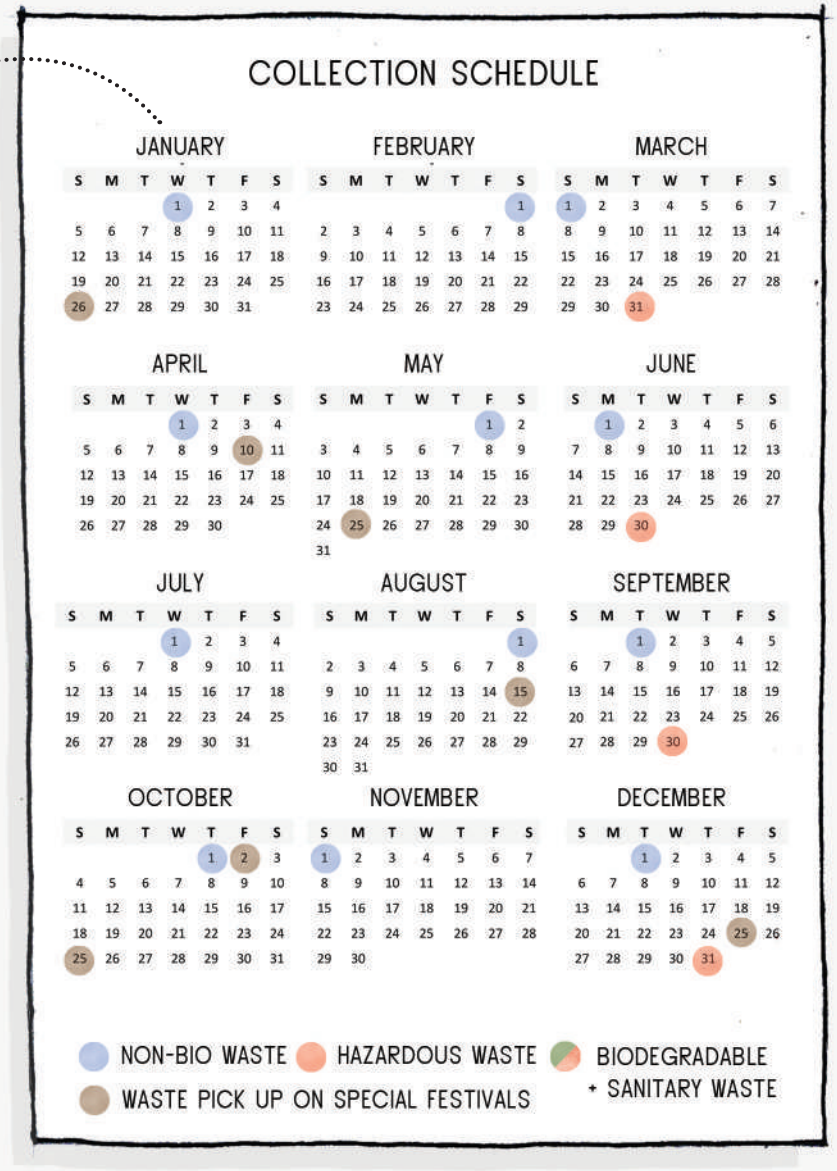
7. COLLECTION

Keep the separate bins close to the gate/ door/ exit to ease disposal by residents and housekeeping staff. It also makes it convenient for waste collectors to access the waste. Apartment buildings can place mini MRF to collect non-biodegradables in a segregated manner.

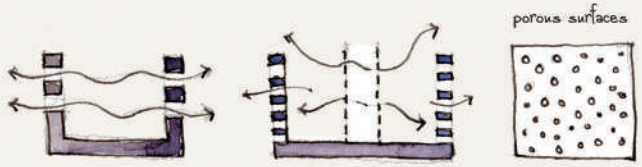




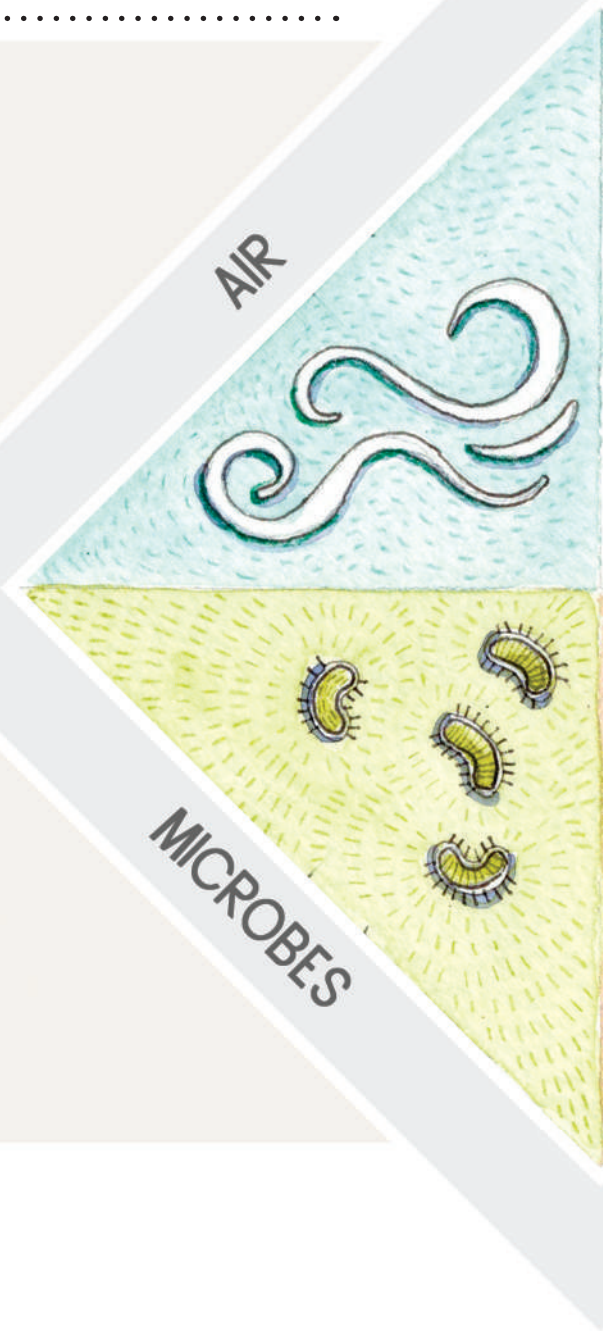
Municipal governments can prepare and publish a calendar of the collection schedule for different categories of waste. Regular waste, such as biodegradable and sanitary waste, should be collected everyday. Slow biodegradable and non-biodegradable waste can be collected on a monthly basis. Glass, footwear, domestic hazardous wastes can be removed on a quarterly basis. The city government can also have special collection drives according to local festivals or public holidays when residents typically discard certain materials.



8. COMPOSTING



In the absence of oxygen the decomposing process may change to anaerobic digestion where ammonia and hydrogen sulfide are produced, along with methane and carbon dioxide. This leads to stinking. To avoid this proper aeration should be provided for the composting device. Perforated tanks/ containers, earthen wares with micro porous surfaces, large containers / tanks with aeration pipes at regular intervals are appropriate for composting. In some cases air compressors can be used to aerate compost piles.



Composting requires microbes, such as mesophilic and thermophilic bacteria, actinobacteria, fungi-molds, yeasts, protozoa and rotifers. All these microbes are freely available in nature. For efficient composting we can increase their presence by sprinkling:

Artificially cultured mix of these microorganisms is available in the market in powder as well as liquid form. They are called EM (Effective Microorganisms) solutions and or inoculums. Even matured compost can be used as inoculum for composting fresh organic waste.

Composting is a process of getting organic matter decomposed into compost with the help of microorganisms. Compost is a soil conditioner which amends the soil with nutrients and helps retain water in soil, thereby improving the productivity of soil.

Compost increases organic matter in soil and thereby helps to sequestrate carbon to soil.There are four elements necessary for good composting.

The presence of water helps the decomposition process.However, too much water means no air percolation and it will stink. If there is too little water means the surface will be dry where microbes will not survive, and composting will stop. So in wet conditions mix the organic waste with water absorbing materials like dry leaves, rice husk, saw dust, pieces of paper etc. If it is too dry, sprinkle water, cow dung slurry, or buttermilk.

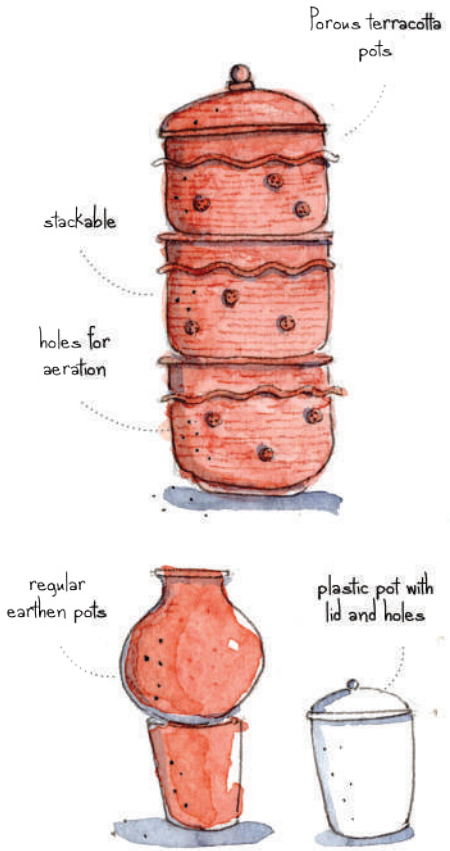
The microorganisms get energy for decomposition of biodegradable content from carbon. All the organic waste matters have carbon and nitrogen but in varying ratios. Dried leaves or brown matter contains more carbon, and meat waste contains less carbon but more nitrogen. Balancing the carbon – nitrogen ratio is very important in the composting process. Less carbon means excess nitrogen and they will get converted into ammonia, resulting in foul odours during the composting process. It is assumed that for every part of nitrogen 25-30% of carbon is required. In practical terms it is recommended to use equal volume of dry materials and wet materials.

Phase 1: mesophilic bacteria decompose simple elements in the biodegradable discards. Temperature (20~30) °C
Phase 2: Thermophilic bacteria decompose complex elements, such as proteins, fats, carbohydrates, cellulose, hemi cellulose, and kill germs. Temperature (50~60) °C
Phase 3: Mesophilic bacteria decompose the rest of the materials. The temperature reduces and the compost cools down.

AEROBIC COMPOSTING

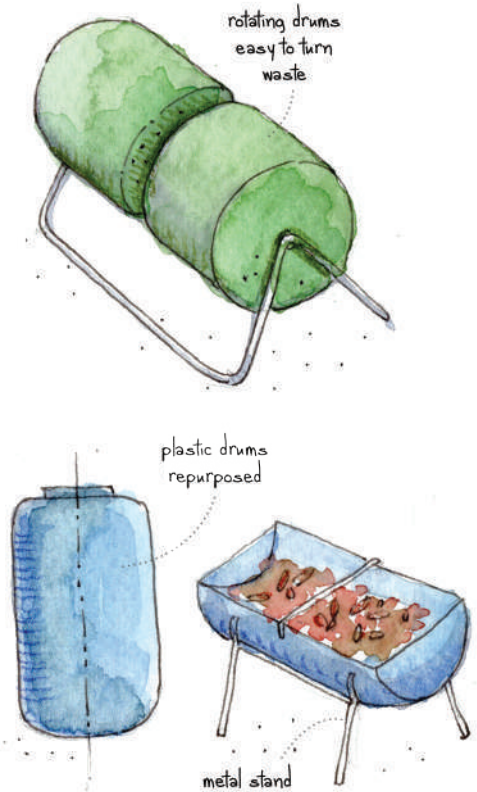
Terracotta pots

Earthen wares are porous in nature, so have good air circulation. They can be stacked or placed separately. Plastic vessels can be used but they need to have holes on the sides.



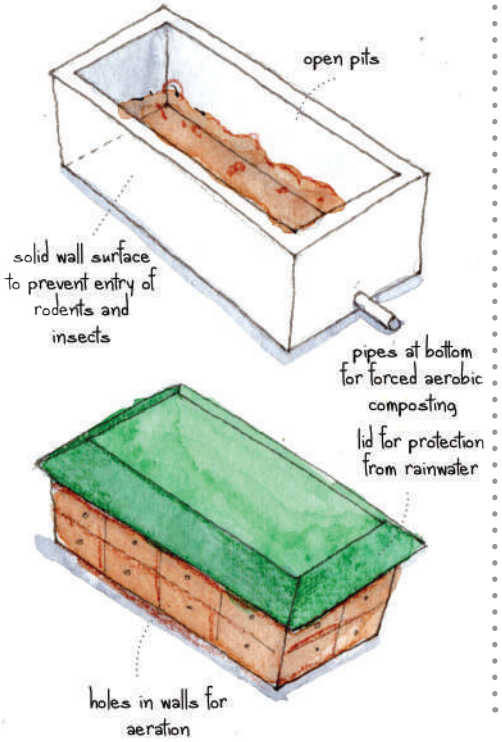
Barrels

Old metal or plastic drums or barrels can be used for composting. Rotating drums are also easy to use and effective as they make it easy to turn the waste. These have a hatch to insert waste and remove compost when ready. Twin drums are useful to allow waste in one drum to compost while the other can continue to receive biodegradable waste.



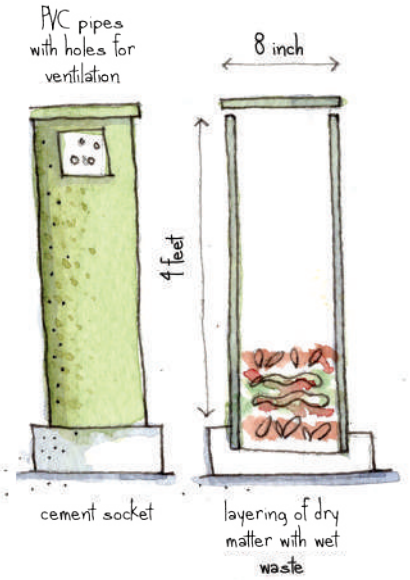
Tanks

Large bins or tanks can be used on rooftops of apartments for composting. They should have lids to protect rain water and rodents from entering. They may have air holes for aeration. To prevent rats and or insects getting in the holes can be covered with mesh. If the tanks do not have holes, they should have vertical perforated pipes or pipes laid in the bottom of the tank connected to a compressor pump that forces air into the composting pile.



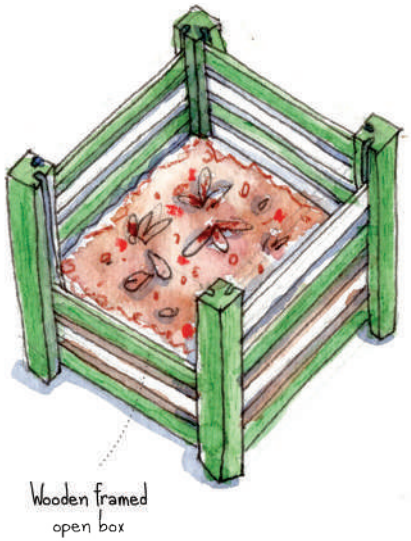
PVC Pipes

Ordinary PVC pipes with 8 inch diameter and 1.2 meter length with a cement block base can be used for composting. Each pipe should have holes on the top for ventilation and covered with a net to prevent insects from entering. At the bottom of the pipe a layer of dry leaves should be placed and sprinkled with EM solution / cow dung solution / curd solution. Biodegradable waste can be deposited and covered with a handful of dry leaves. This process is repeated till the pipe is full. The dry leaves act as a sponge and trap air inside for composting.



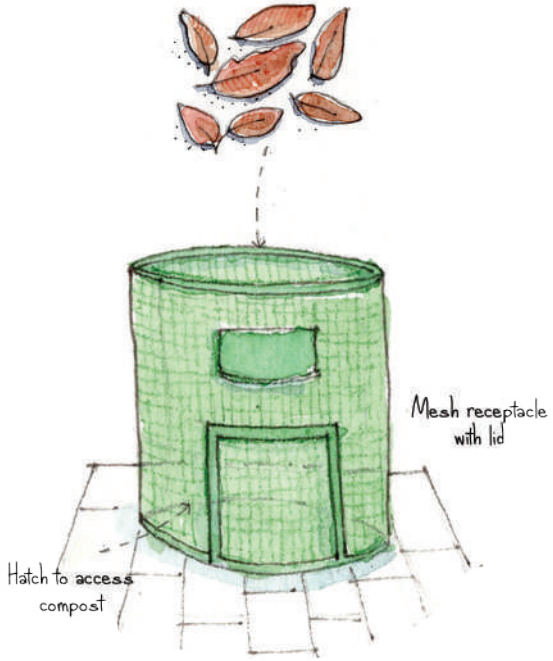
Aerobic Bin (Thumburmoozhi model)

Aerobic bin is an excellent solution for composting biodegradable waste. Effective use and maintenance of these bins would not cause the emission of foul odour and moreover, the heat produced during the process kills pathogens. Aerobic bins are constructed in such a way that it enables proper air circulation, proper draining of leachate and an easy way of collecting biodegradable waste in layers. No turning or mixing of the equipment is required. See Appendix for details on construction and maintenance.



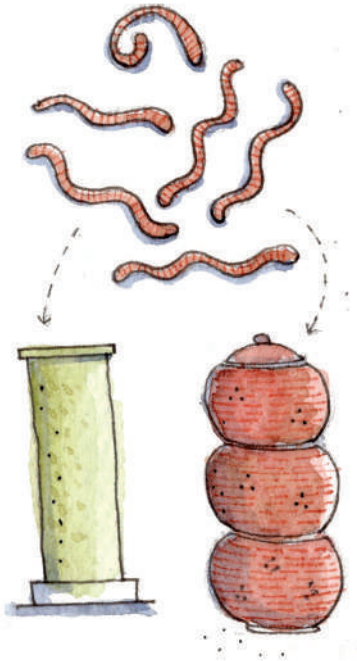
Leaf Composter

Mesh receptacle with a lid and base to prevent rodents from entering. It also has a hatch to remove compost when ready. The lids should have a lock so that only authorised staff can dispose only leaves and prevent the disposal of other material discards. These can be placed at regular intervals on streets to collect street sweepings, which can also reduce transport to parks and MCCs.



Vermicomposting

This is a type of composting which Vermicomposting is a type of composting in which certain species of earthworms are used to enhance the process of organic waste conversion and produce a better end-product. Earthworms feed on the organic waste materials and pass excrement, called castings, or vermicompost. The chemical secretions in the earthworm's digestive tract help break down soil and organic matter, so the castings contain more nutrients that are immediately available to plants. This can improve the biological, chemical, and physical properties of the soil.



ANAERBOIC COMPOSTING

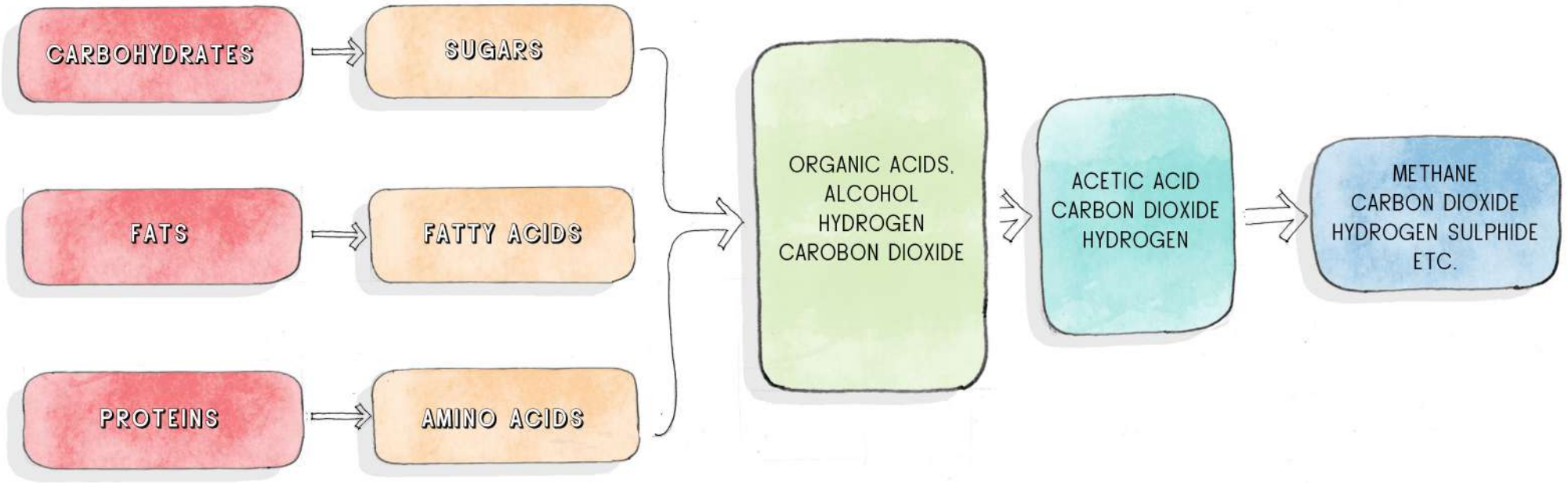
Anaerobic digestion is a process in which microorganisms break down biodegradable material in the absence of oxygen. Anaerobic digestion is a renewable energy source because the process produces methane and carbon dioxide rich biogas suitable for energy production. Also, the nutrient-rich solids left after digestion can be used as fertiliser. The calorific value would be 5735 K cal/ m3 . Anaerobic digestion is a complex biochemical process of biologically mediated reactions by a consortium of microorganisms to convert organic compounds into methane and carbon dioxide. It is a stabilisation process, reducing odour, pathogens, and mass reduction.

HYDROLYSIS
A chemical reaction where particulates are solubilised and large polymers converted into simpler monomers;

ACIDOGENESIS
A biological reaction where simple monomers are converted into volatile fatty acids;

ACETOGENESIS
A biological reaction where volatile fatty acids are converted into acetic acid, carbon dioxide, and hydrogen

METHANOGENESIS
A biological reaction where acetates are converted into methane and carbon dioxide, while hydrogen is consumed.



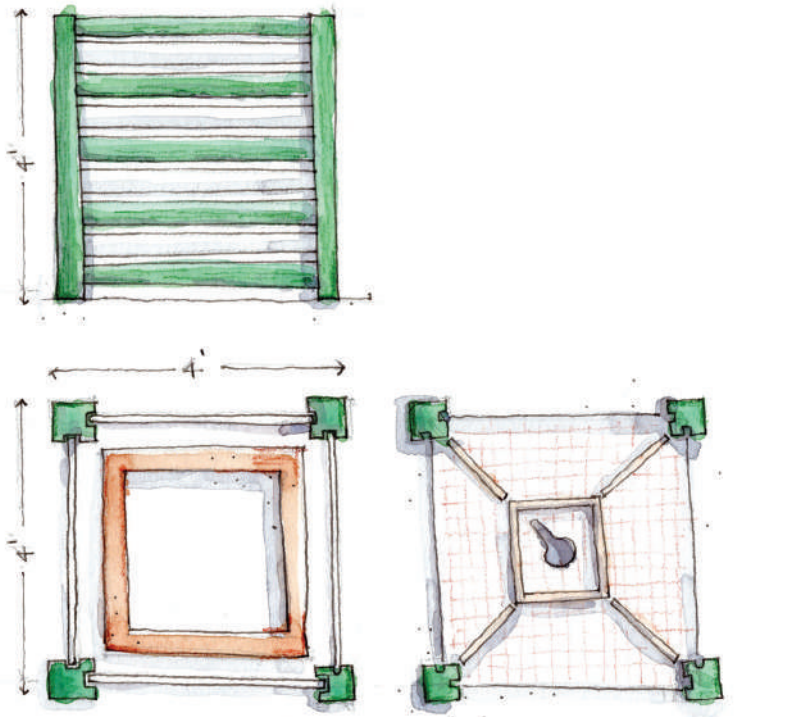
9. APPENDICES

1. AERBOIC BIN

Unit
Each bin is a 4ft x 4ft x 4ft ferro-cement structure with sides made of removable bars of 48 inches length and 3 inches width and with 3 inches width between them. One unit consists of two aerobic bins, so that when one bin is full and is in the composting phase, the other bin can be used for layering biodegradable waste and dry leaves.

Frame
The frame consists of four ferro-cement corner pillars that are plastered to the floor. The pillars have slots to allow for bars to be inserted. Gap fillers/ spacers of ferro-cement blocks of a height of 3 inches are placed at the edges to keep the bars separated and ensure there is sufficient opening for air circulation. Wire mesh is placed along the walls to prevent biodegradable waste from coming out of the bin and from rodents entering the bin.

Wooden Measuring Frame
Rectangular wooden measuring frames of base size 3 x 3 ft and height 6 inches to measure the biodegradable waste added in each layer. This frame gives a gap of 6 inches between the biodegradable waste and the sides of the bin, which prevents the biodegradable waste and leachate from leaking through the sides.



Materials Required for Daily Operation

Drainage
The floor of the bin has an inward slope with a drainage hole in the centre and a perforated drainage hole cover. The drainage hole is connected to a leachate collecting tank through a 6 inch pipe and up to 6 bins can be connected to the pipe. For ease of maintenance, the main drainage pipe to the leachate collecting tank should be straight without any bends. If this is not possible it is advisable to keep a separate straight drainage pipe from each aerobic bin to the leachate collecting tank/pit. There are chances of leachate solidifying inside the pipes and blocking the drainage system, so provision for cleaning the drainage pipe should be kept ready while installing the bin.

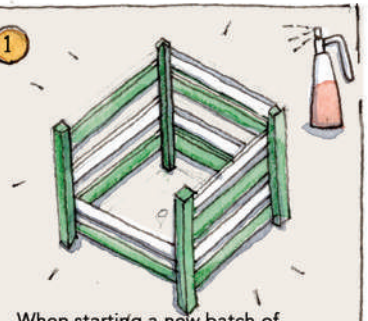
Floor
A mesh frame of wood (4ft x 4ft) is placed at a height of 3 inches from the ground with the support of wooden blocks. This gap prevents the compost from touching the draining hole and prevents the blocking of drainage of leachate.

Leachate collection tank
Leachate drained from the bin during the compost will be collected through pipes below the aerobic bin in a collection pit/tank created on the side of shelter. For a unit handling waste of xx kg per day (30 families), a pit with a volume of 150 litres is necessary.

Leachate overflow tank
Adjacent to the leachate collection tank, a leachate overflow pit is made. Once the leachate collection tank is full, excess leachate will flow into the leachate overflow tank and can be collected in a container.

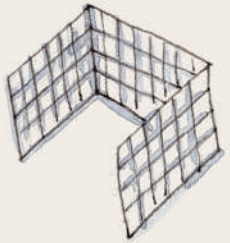
INSTRUCTIONS FOR OPERATION OF AEROBIC BIN

1



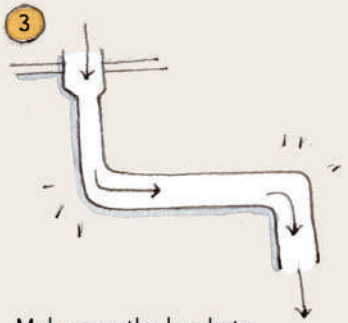
When starting a new batch of compost, clean the bin. Put the bars and gap fillers on 3 sides of the bin till the top. Add 4 bars of the side of access.

2



Cover three sides of the bin with a wire mesh for protection

3

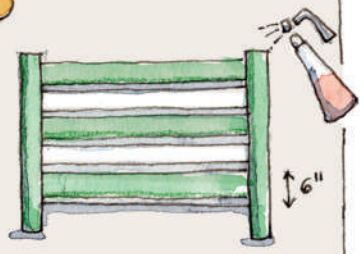


Make sure the leachate drain pipe is clear of any blockages

4

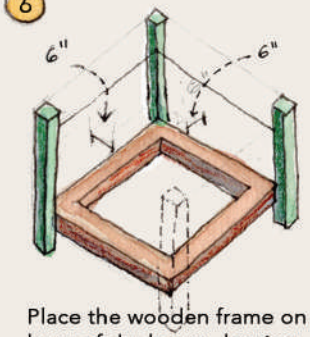
Mark the start date on the bin when you start a new batch for composting

5



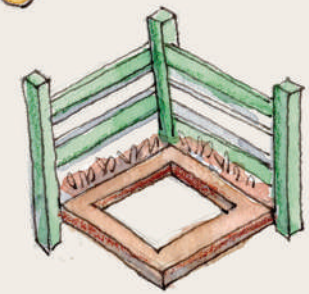
Add a 6" layer of dry leaves as the first layer and spray 150ml diluted inoculum

6



Place the wooden frame on the layer of dry leaves, leaving uniform 6" space all around.

7



fill the 6" gap between the frame and bin with dry leaves

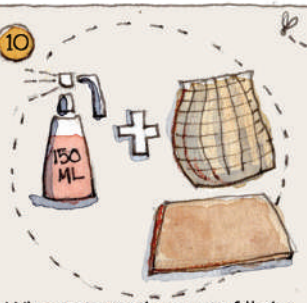
8

Place biodegradable waste inside the wooden frame Spray 150ml of incoculum and place 6" of dry leaves over the same.

9

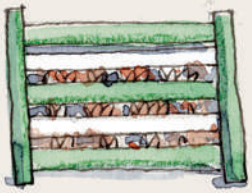
Repeat the steps 6 to 8 till the bin is filled

10



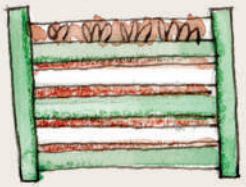
When waste does not fill the frame, spray 150ml of inoculum and cover with jute sacks and cardboard. This will avoid flies and eliminate foul smell.

11



Gradually add bars and wire mesh as the height of waste and dry layers increase. Always make sure the last bar is above the waste layer inside.

12



Last layer in the aerobic bin will be 6" of dry leaves.

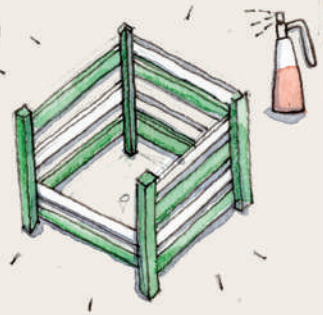
13

Mark the end date once the bin is filled

14

Give 90 days time for decomposing. Extra 15-30 days during monsoons.

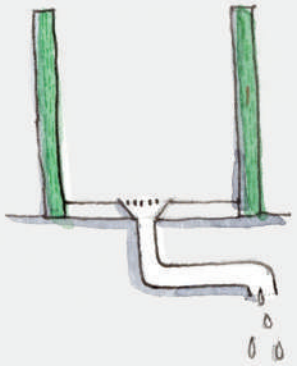
15



Start filling the next aerobic bin, following the same procedure.

PRECAUTIONS WHILE OPERATING AEROBIC BIN

1



Drain liquid content from biodegradable waste, as too much waste in the bin reduces air circulation.

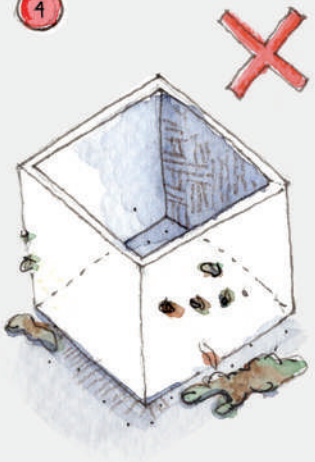
2

Remove any non-biodegradable materials like plastic, glass, clothes, toxic waste or electronic waste.

3

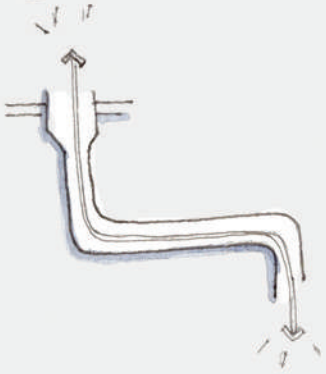
Do a visual inspection for potential problems. Foul smell indicates excess moisture and reduced microbes, hence add dry leaves and inoculum. Maggots indicate moisture in leaves, or excess spraying of incolumum or cow dung.

4



Check for leakage of leachate through walls.

5



Keep drainage pipe free of blockage by removing solidified leachate.

6

When leachate collection tank is full, remove the leachate. Dilute with water in 1:20 ratio and use as a fertilizer.

7

Reduce the proportion of biodegradable waste like lemons, orange and egg shells.

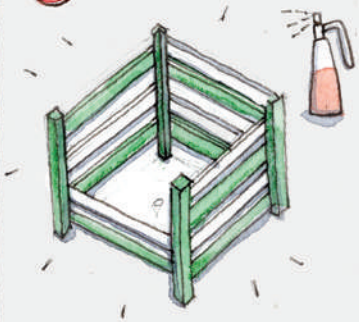
8

Make sure that there is no moisture content in dry leaves used.

9

Diluted inoculum should not be kept for more than 5 days!

10



After removing mature compost, clean the bin and drainage pipe before starting the next batch. At a later stage of composting, viscosity of leachate will increase and there are changes that it will solidify and block the pipe.

2. MICRO COMPOSTING CENTRE (MCC)

MCC is a facility to collect and compost biodegradable discards.
An MCC can be designed with following specifications.

SPECIFICATIONS

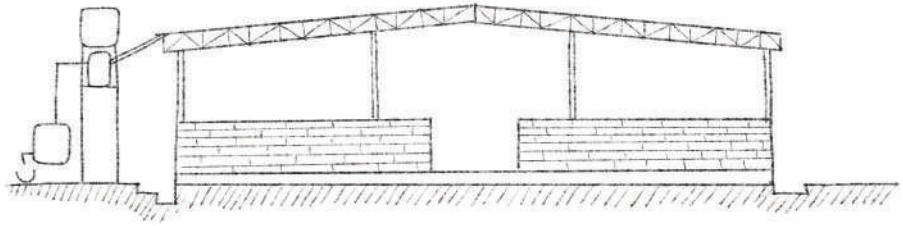
(1) A shed of 5000 to 5700 sq.ft
(2) Shredding machine
(3) Compost tanks
(4) Leachate water treatment tank
(5) Rainwater harvesting tank
(6) Sieving machine
(7) Wall mounted racks to store compost
(8) Water tank
(9) Wash basin for cleaning
(10) Cupboard for Workers
(11) Cupboard for tools
(12) Desk space for office / documentation
(13) Weighing scales
(14) Hooks for hanging sacks / bags
(15) Education exhibition panel
(16) Sign board

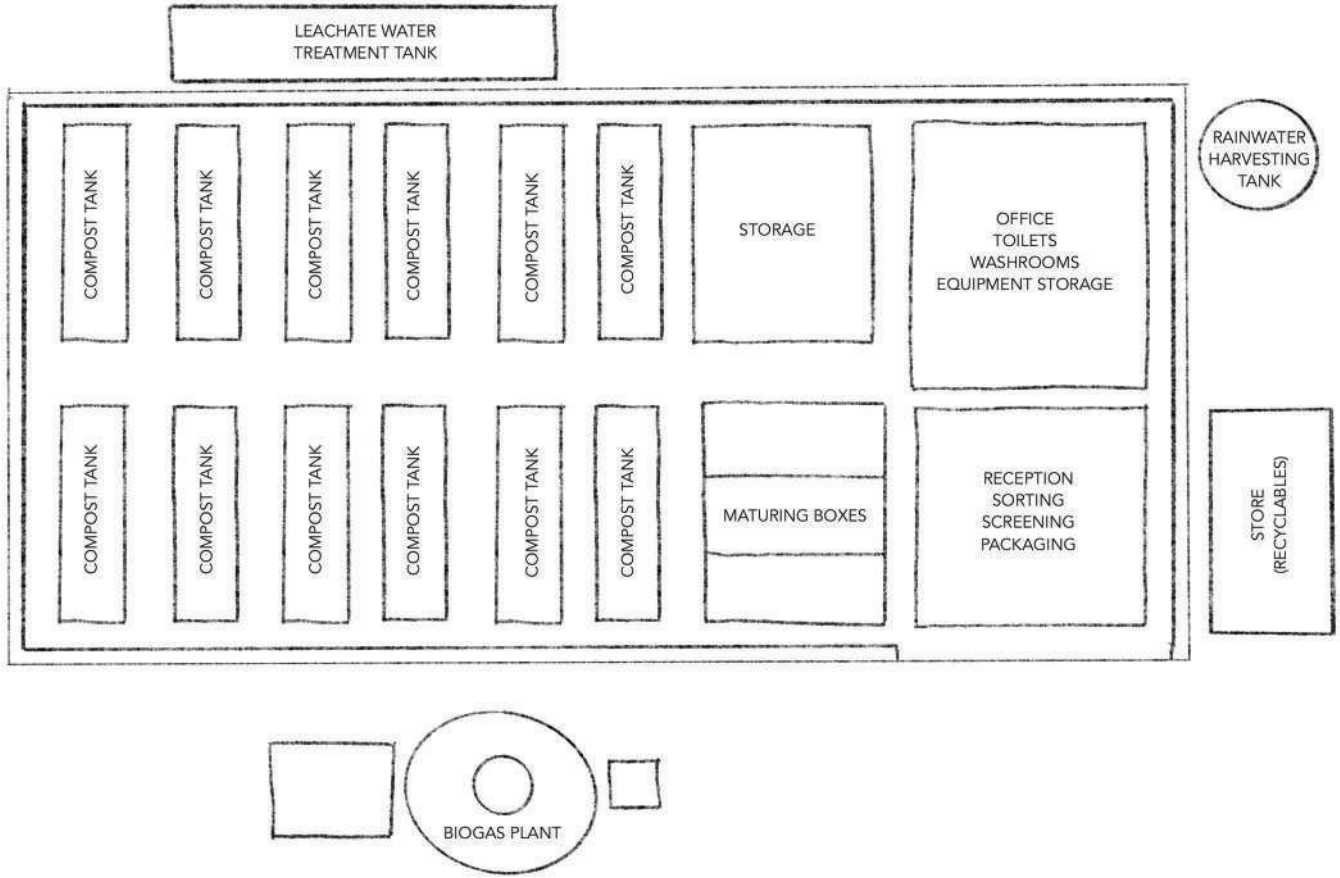
FUNCTIONS

(1) Segregated biodegradable waste is received
(2) Weighing
(3) Sorting/Secondary segregation
(4) Shredding
(5) Mixing/Layering
(6) Composting
(7) Sieving
(8) Bagging and storage
(9) Sale

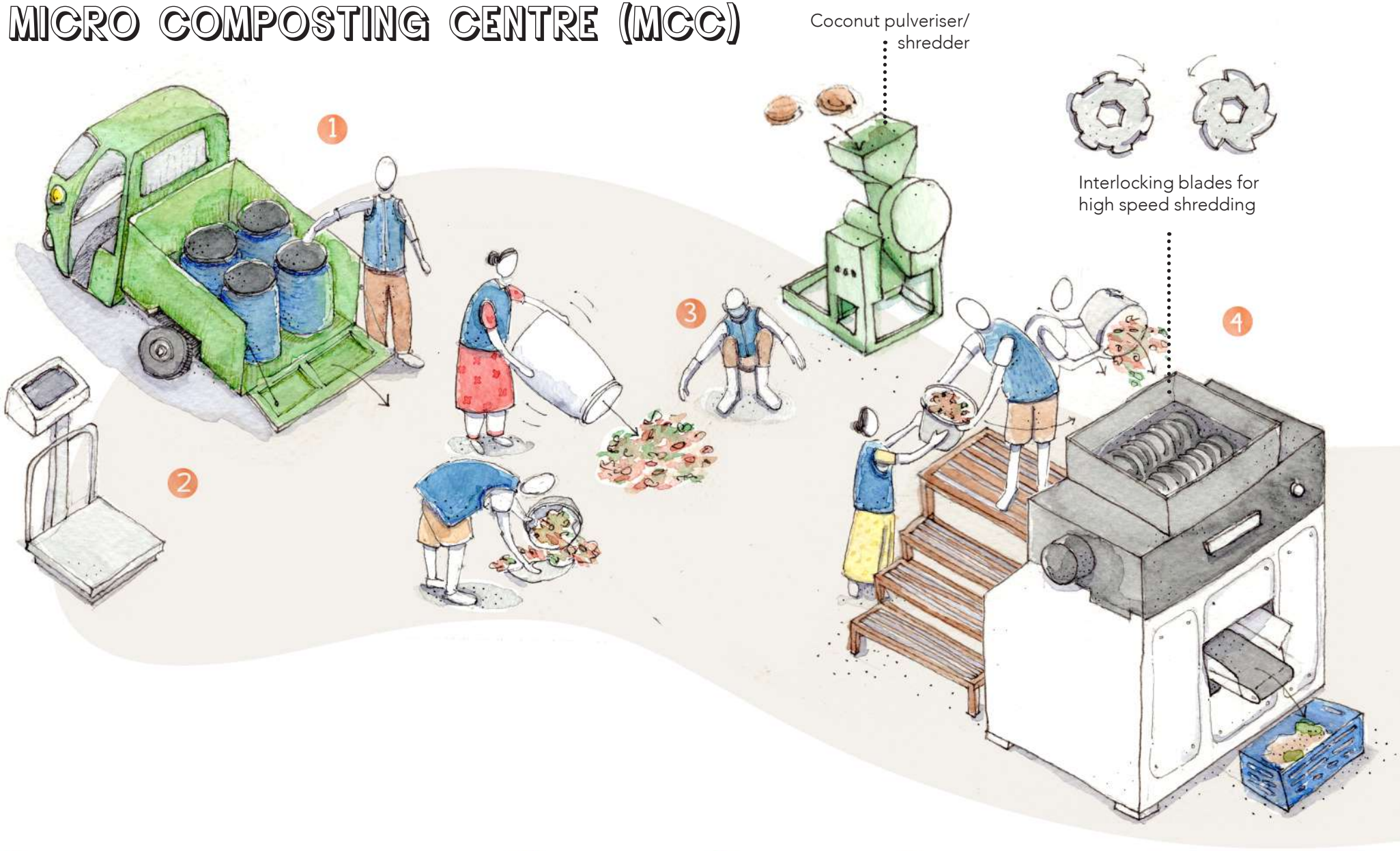
SPACE REQUIREMENT RATIO

Compost tanks	66%
Sorting, shredding, sieving and packaging	12%
Office, toilets, wash room, equipment storage	12%
Storage of compost	10%

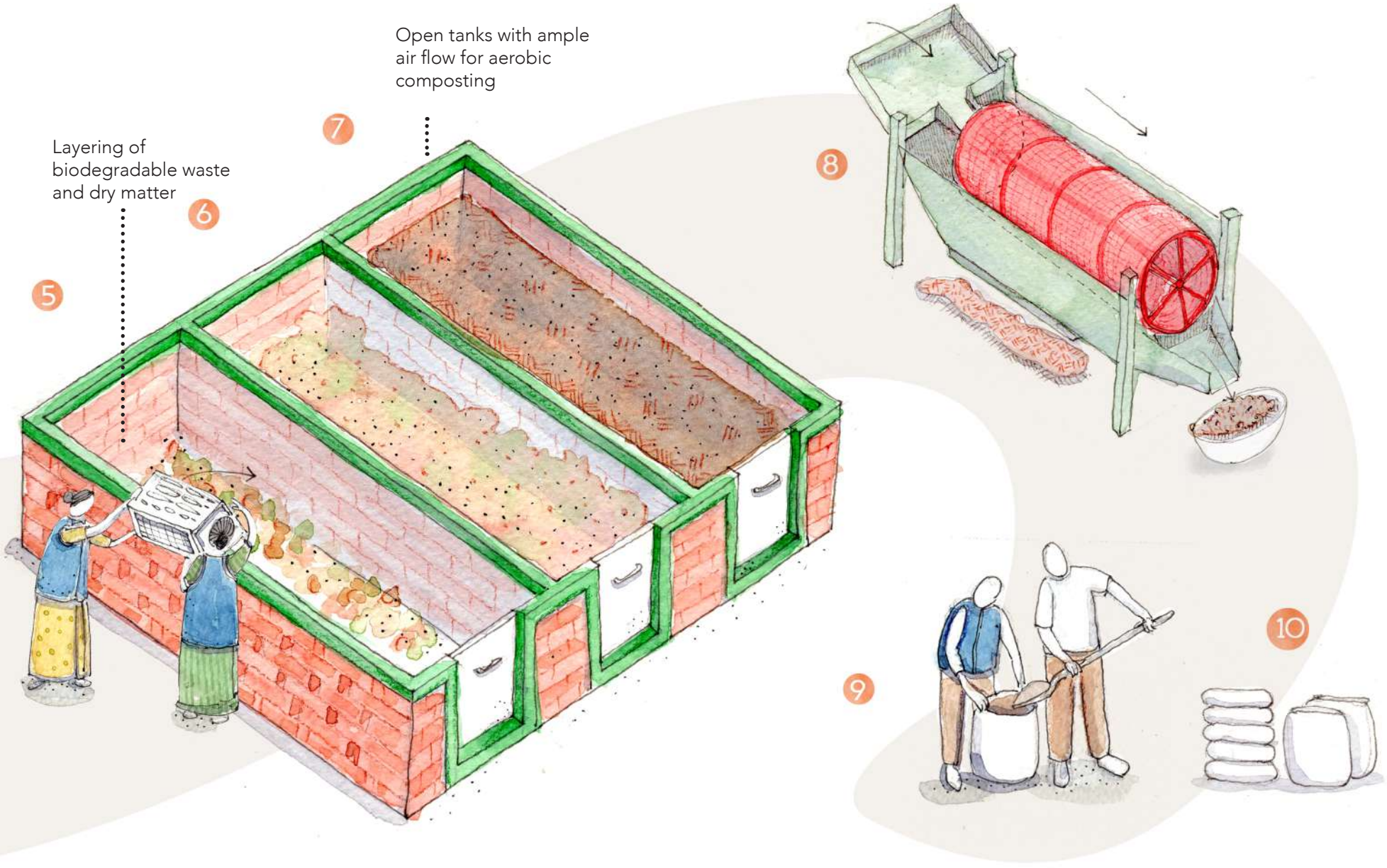




MICRO COMPOSTING CENTRE (MCC)



1 RECEIVING BIODEGRADABLE WASTE 2 WEIGHING 3 SORTING 4 SHREDDING



5 MIXING & LAYERING 6 COMPOSTING 7 MATURING 8 SIEVING 9 STORAGE/BAGGING 10 SALE

3. MATERIAL RECOVERY FACILITY (MRF)

MRF is a centre where non-biodegradable solid waste can be temporarily stored to facilitate collection, segregation, sorting and recovery. Each MRF can be designed with the following specifications.

SPECIFICATIONS

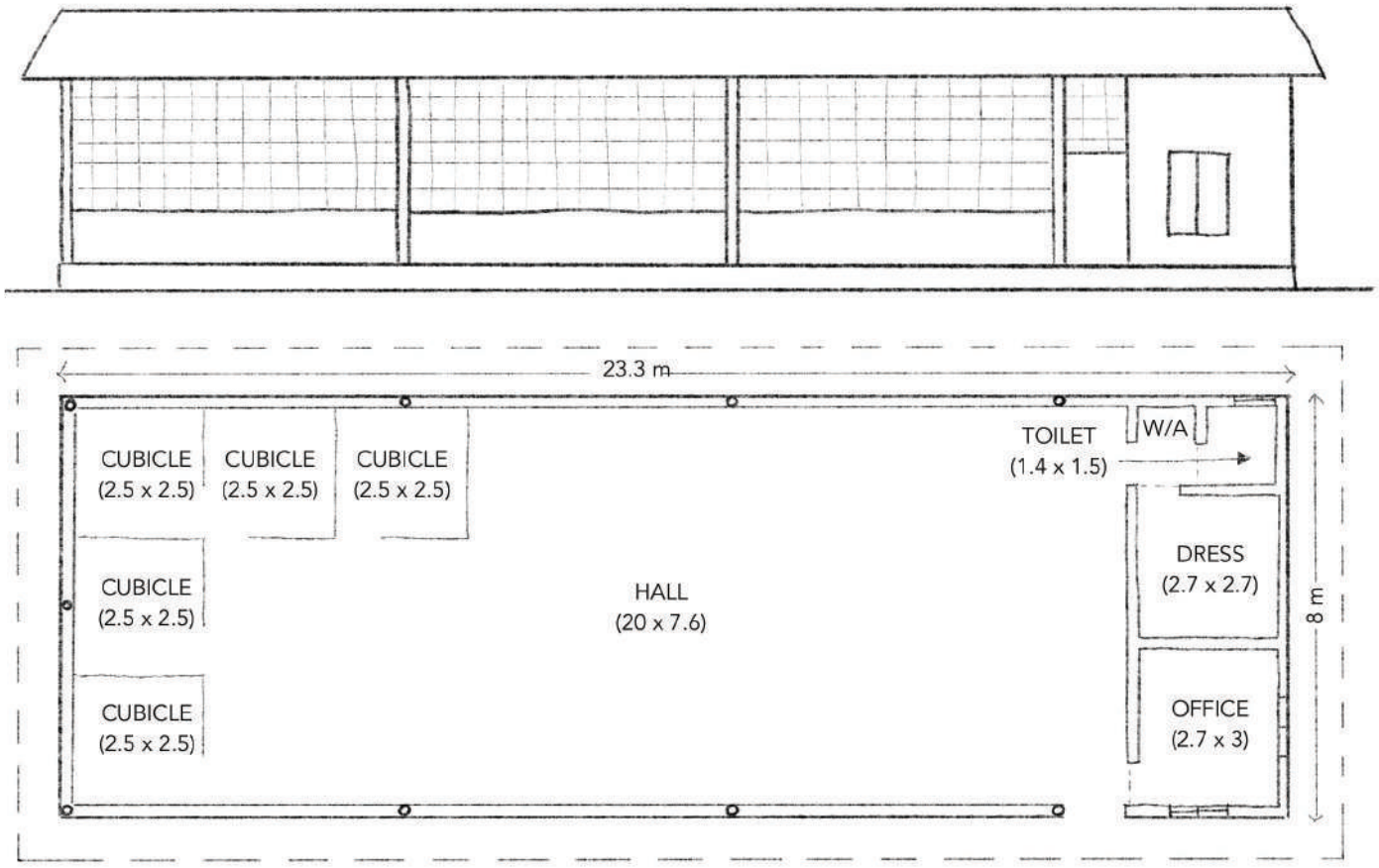
(1) A shed of 100 to 300 sq.ft
(2) Modular and flexible cubicles to store sorted materials
(3) Wall mounted racks to store packed materials
(4) Wash basin for cleaning
(5) Cupboard for Workers
(6) Cupboard for tools
(7) Desk space for office / documentation
(8) Weighing scales
(9) Hooks for hanging sacks / bags
(10) Education exhibition panel
(11) Sign board

FUNCTIONS

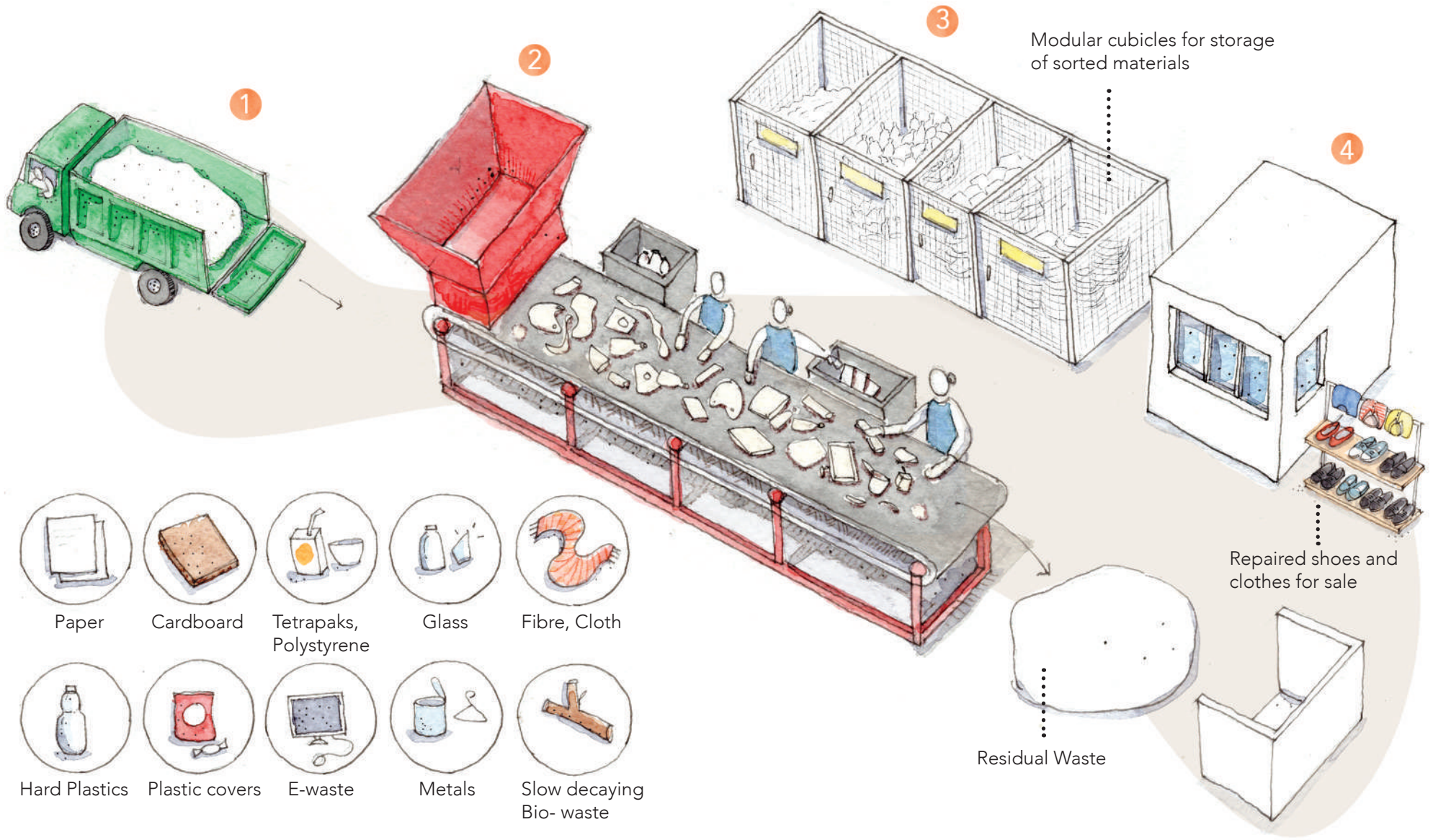
(1) Segregated Materials are received
(2) Sorting
(3) Cleaning
(4) Packing
(5) Documentation
(6) Sale
(7) Supply to RRC

SPACE REQUIREMENT

Paper, mix paper	1
Cardboard	3
Hard Plastics, bottles…	3
Plastic covers, wrappers	4
Tetrapaks, Polystyrene	2
Glass bottles and pieces	1
E-waste, Hazardous-Waste	1
Metals,	1
Fibre, Cloths	2
Others (Slow decaying Biodegradables)	2



MATERIAL RECOVERY FACILITY (MRF)

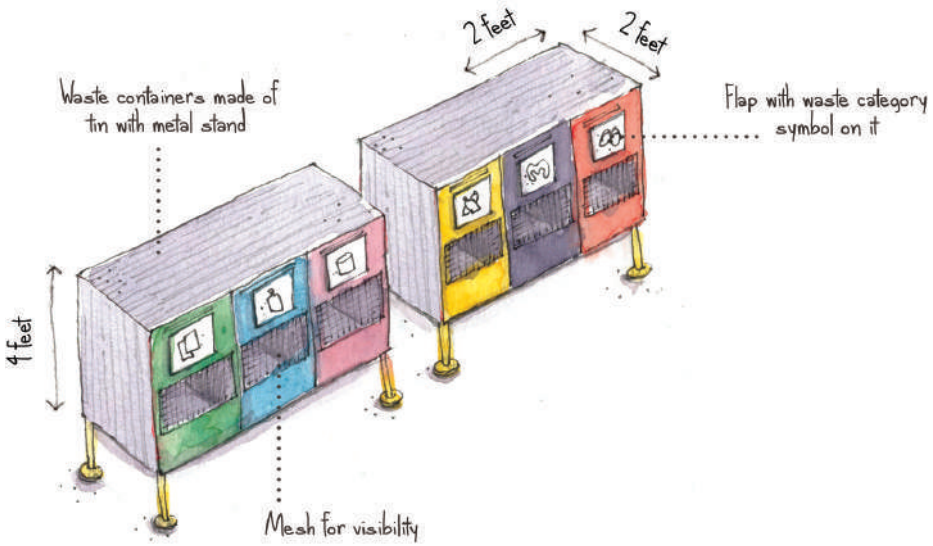


1 RECEIVING MATERIAL 2 SORTING & CLEANING 3 PACKING & DOCUMENTAION 4 SALE /SUPPLY TO RRC

4. MINI MRF

Micro-MRFs can be used to collect and store non-biodegradable in a segregated manner. These eases segregated collection as well.

1. The micro MRF should have a minimum of six compartments with designated colour codes
2. The MRF is made with tin sheets or wire mesh.
3. Each compartment has 2 feet width x 2 feet depth x 4 feet height
4. The opening for each compartment is 1 foot x 1 foot and is at 3 feet height so that it is accessible by adults and children alike
5. The opening to the compartments is a flap with an image of the materials through which the materials are pushed through
6. Inside each compartment should be a collection bag of jute/ cloth. This way the bags can be changed/collected when they are full.
7. Each compartment has a door at the back to remove the bags/materials and clean the compartments regularly



5. RESOURCE RECOVERY CENTRE (RRC)

RRC is a space provided with necessary infrastructure, machinery, tools and human power to sort, clean and store non-biodegradable discards from primarily sorted municipal waste. Each RRC can be designed with the following specifications.

SPECIFICATIONS

(1) A shed with 2000 sq.ft and above
(2) Modular and flexible cubicles to store sorted materials
(3) Wall mounted racks to store packed materials
(4) Wash tubs for cleaning
(5) Driers / blowers
(6) Cupboard for Workers
(7) Cupboard for tools
(8) Desk space for office / documentation
(9) Weighing scales
(10) Hooks for hanging sacks / bags
(11) Water tank
(12) Electricity Connection
(13) Shredding (Plastics, slow decaying bio degradables) and Baling machines
(14) Conveyor belts
(15) Restrooms for workers
(16) Class room / meeting room / exhibition space
(17) Sign board

FUNCTIONS

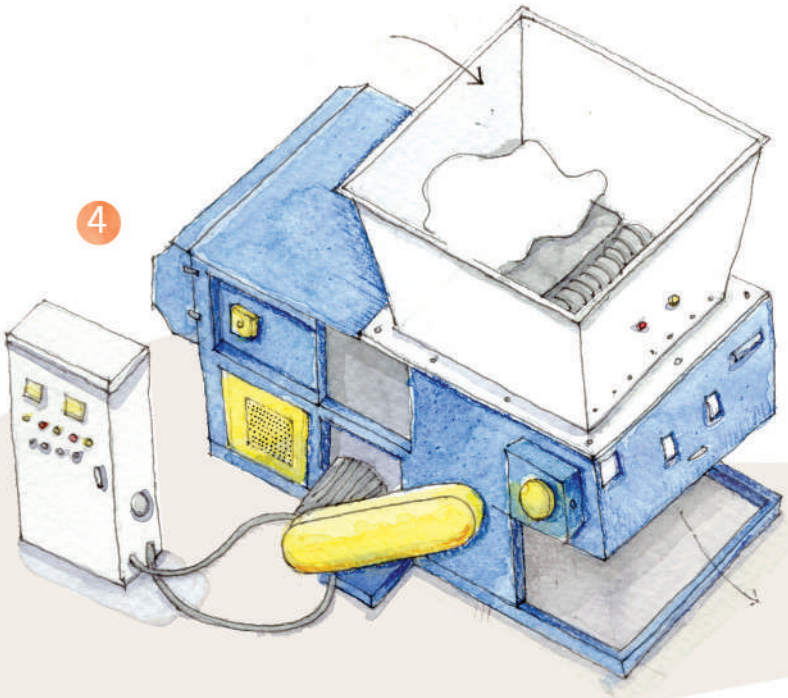
(1) Receiving discards
(2) Sorting
(3) Cleaning/ drying
(4) Pre-processing / shredding / disassembly
(5) Packing/ baling
(6) Rejects management
(7) Documentation
(8) Sale / Supply to recyclers

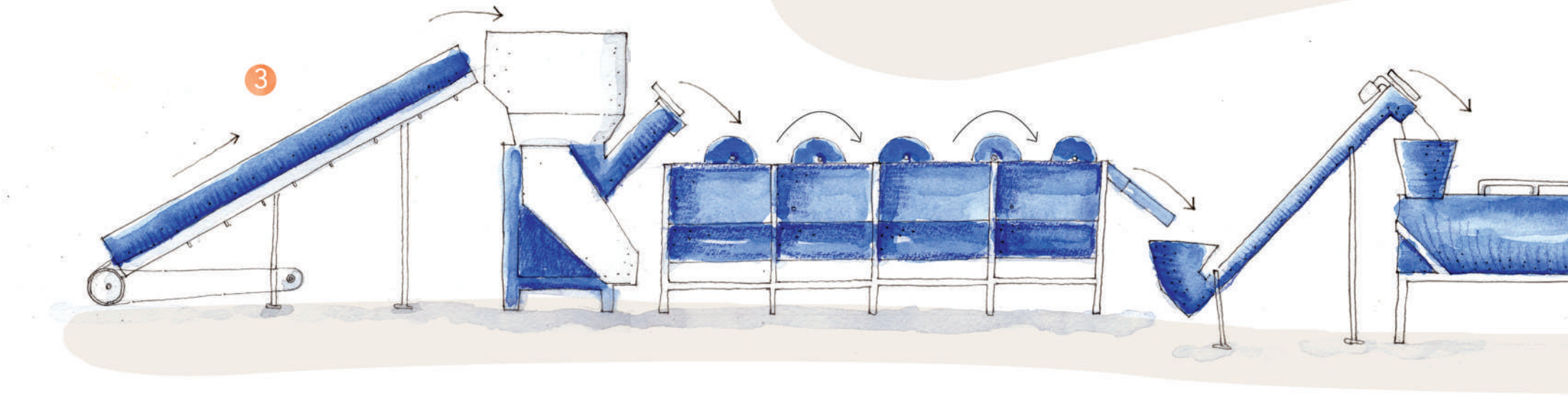
CLASSIFICATION

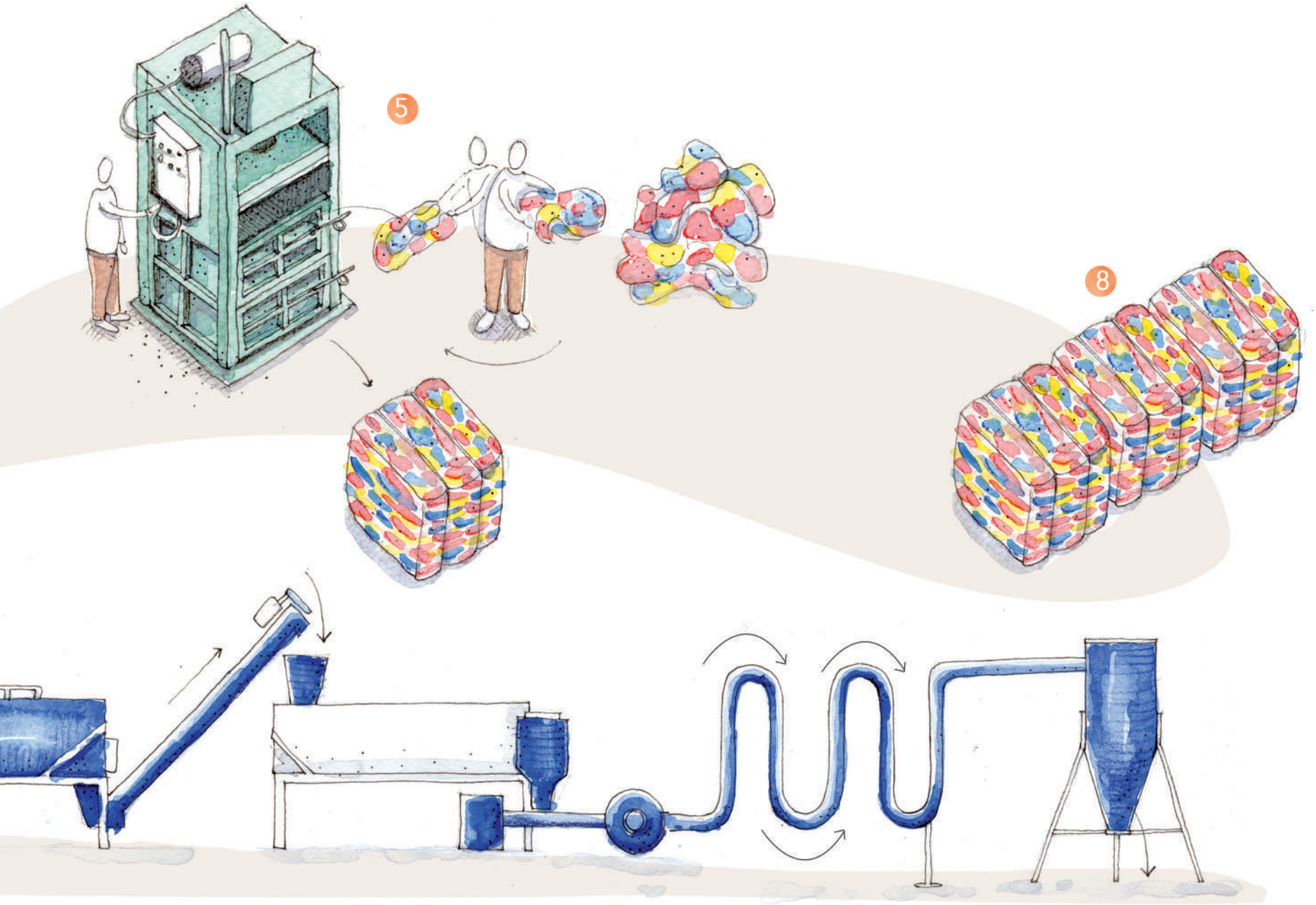
Paper (3-5 sub categories)
Cardboard (2-3 sub categories)
Plastics (5-15 sub categories
Tetrapak
Glass (3 – 15 sub categories)
E-waste (5 – 20 sub categories)
Hazardous-Waste (5 – 10 sub categories)
Metals (5 – 10 sub categories)
Fibre, Cloths (5 – 7 sub categories)
Construction and Demolition Waste (5-10 sub categories)
Slow decaying biodegradable (4-5 categories)
Rejects
Others

RESOURCE RECOVERY CENTRE (RRC)

1. RECEIVING DISCARDS
2. SORTING (REFER TO MRF)
3. CLEANING & DRYING
4. PRE-PROCESSING/SHREDDING/DISASSEMBLY
5. PACKING/BALING
6. REJECTS MANAGEMENT
7. DOCUMENTATION
8. SALE/SUPPLY TO RECYCLERS



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Centre for International Environmental Law (CIEL) www.ciel.org

CAG
Citizen consumer and civic Action Group

246/277B, JJ Road, Alwarpet, Chennai 600 018 INDIA
T: +91(44) 2499 4458/ 2466 0387
W: www.cag.org.in
F: www.facebook.com/CAGChennai/