WASTE MANAGEMENT – 23ETC 15F

MODULE – I

INTRODUCTION TO WASTE MANAGEMENT

Waste management is defined as the total supervision of waste production, handling, processing, storage, and transport from its point of generation to its final acceptable disposal.

Common terminologies in Solid waste management

Refuse: Waste which can be used as raw material for some other purpose.

Garbage: The waste which is rich in moisture content.

Rubbish: Combustible and non-combustible solid waste, excluding food waste or other putrescible materials. Typically combustible waste consist of materials such as paper, cardboard, plastics, textiles, rubber leather, wood and garden trimmings. Non-combustible includes items such as glass, crockery, tin cans, and aluminium, ferrous and nonferrous metals.

Scrap: Metal waste is generally called as scrap.

Construction and demolition waste: Wastes from residential building and other structures are classified as demolition waste. Waste from remodeling and repairing of residential and commercial and industrial building and similar structures are classified as construction waste. These waste includes dirt, stones, concrete, bricks, plasters and plumbering, heating and electrical parts.

Special wastes: Wastes such as street sweepings, road side litters, catch basin debris, dead animals and abundant vehicles are classified as special waste.

Treatment plant waste: The solid and semi-solid waste water, waste water from industrial areas is included in this classification.

CLASSIFICATION OF WASTE

Classification of waste based on their physical state

- Solid waste
- Liquid waste
- Gaseous waste

Solid waste: These are the unwanted substances that are discarded by human society that includes urban waste, industrial, agricultural, biomedical and radioactive waste.

Liquid waste: Waste generated from washing, flushing and from manufacturing process.

Gaseous waste: These are the waste generated in the form of gases from automobiles, buring of petroleum and when it gets mixed with atmosphere it leads to acid rain.

Classification of Waste based on Bio Degradability

Bio degradable waste: Biodegradable wastes are such waste materials which are and can be degraded by natural factors like microbes (e.g. bacteria, fungi and a few more), and abiotic elements like temperature, UV, oxygen, etc. Some examples of such wastes are food materials, kitchen wastes, and other natural wastes.

Non bio degradable waste: Non-biodegradable wastes are those that cannot be decomposed or dissolved by natural agents. They remain on earth for thousands of years without any degradation. Hence, the threat caused by them is also more critical. A notable example is plastics which are a commonly used material in almost every field.

Classification of waste based on effect on human health

Hazardous waste: Hazardous waste is waste that has been identified as potentially causing harm to the environment and human health and therefore needs special, separate treatment and handling.

Non-hazardous waste: Non-hazardous waste, as the name implies, is not dangerous but harms the environment. It must be disposed of appropriately to comply with the rules. It includes household waste, such as food and bathroom waste, and corporate waste, such as waste from factories and farms. Waste might be obnoxious, but it isn't harmful.

Classification of waste based on the source of generation

Household waste/ Residential waste: The different household wastes which are collected during household activities like cooking, cleaning, etc. are known as domestic wastes. Example: leaves, vegetable peels, excreta, etc.

Residential waste is classified into two types: Dry waste: Refers to all items that are not considered wet/soiled items. These includes both recyclable and non-recyclable materials such as bottles, cans, clothing, plastic, wood, metals, glass and paper.

Wet waste: Refers to all items that are organic like food items soiled food rappers, hygiene products, yard waste, tissues and paper towels.

Industrial Waste: These are the wastes created in factories and industries. Most industries dump their wastes in rivers and seas which cause a lot of pollution. **Industrial Waste:** These are the wastes created in factories and industries. Most industries dump their wastes in rivers and seas which cause a lot of pollution. Example: plastic, glass, etc.

Commercial Waste: Commercial wastes are produced in schools, colleges, shops, and offices. Example: plastic, paper, etc.

Agricultural Waste: Various wastes produced in the agricultural field are known as agricultural wastes. Example: cattle waste, weed, husk, etc.

E-waste: E-waste means electrical and electronic equipment, whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment and repair processes.

Medical waste: Medical waste is a subset of wastes generated at health care facilities, such as hospitals, physicians' offices, dental practices, blood banks, and veterinary hospitals/clinics, as well as medical research facilities and laboratories.

Construction and demolition waste: Construction and demolition (C&D) waste is generated from construction, renovation, repair, and demolition of houses, large building structures, roads, bridges, piers, and dams.

Radioactive/ nuclear waste: Radioactive (or nuclear) waste is a by-product from nuclear reactors, fuel processing plants, hospitals and research facilities.

NEED FOR WASTE MANAGEMENT

- Due to improper disposal of solid waste particularly by waste management organizations, the collected wastes gets heap up and become a problem for both the environment and also for the public.
- By dumping of huge garbage, drives biodegradable materials to decay and decompose under abnormal, uncontrolled and unhygienic conditions. After a few days of decomposition, it becomes a breeding ground for different types of disease-causing

insects as well as infectious organisms. A foul smell is produced and it also spoils the aesthetic value of the area.

- The solid wastes collected from different industries include toxic metals, chemicals, and other hazardous wastes. When these wastes are released into the environment, they can produce biological and physicochemical problems to the environment, the chemicals may drain into the soil and pollute the groundwater and also alter the productivity of the soils in that particular area.
- In rare cases, the hazardous wastes may get mixed up with the ordinary garbage and other combustible wastes causing the disposal process even harder and risky.
- By burning the paper and other scraps along with the hazardous wastes, dioxins and poisonous gasses are produced and released into the air which results in causing various diseases including chronic disease, skin infections, cancer, etc.

ELEMENTS OF WASTE MANAGEMENT

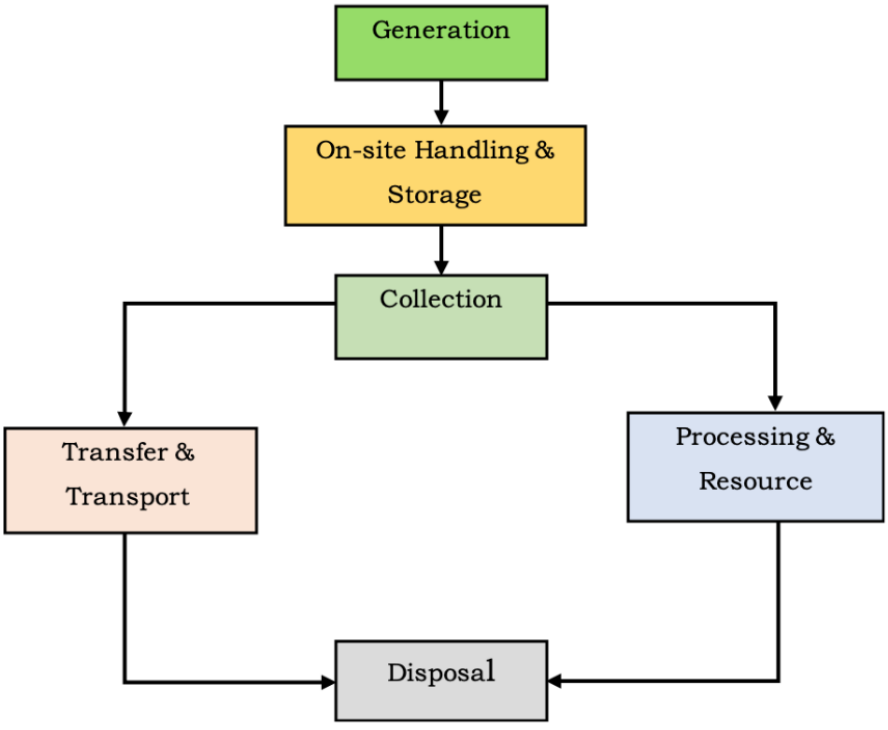

Figure: Elements of waste management.

Waste generation: waste generation encompasses activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal. Wastes are generated at the start of any process, and thereafter, at every stage as raw materials

are converted into goods for consumption. For example, wastes are generated from households, commercial areas, industries, institutions, street cleaning and other municipal services. The most important aspect of this part of the SWM system is the identification of waste.

(ii) **Waste handling, storage, sorting, storage and processing at the source:** Waste handling and sorting involves the activities associated with the management of waste until they are placed in storage for collection. • Handling also encompasses the movement of loaded container to the point of collection. • Sorting of waste components is an important step in handling and storage of solid waste at the source. For example, the best place to separate waste materials for reuse and recycling is at the source of generation. Households are becoming more aware of the importance of separating newspaper and cardboard, bottle/glass, kitchen wastes and ferrous and nonferrous materials. • Onsite storage is of primary importance because of public concerns and aesthetic consideration. Unsightly makeshift containers and even open ground storage, both of which are undesirable, are often seen are any residential and commercial sites. • Processing at the source involves activities such as backyard waste composting.

(iii) **Waste collection:** the functional element of collection includes not only the gathering of solid waste and recycling materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be materials processing facility, a transfer station or a landfill disposal site.

iv) **Sorting, Processing and transportation of solid waste:** The sorting, processing and transformation of solid waste materials is the fourth of the functional elements. The recovery of sorted materials, processing of solid waste and transformation of solid waste that occurs primarily in the locations away from the source of waste generation are encompassed by this functional element. • Sorting of mixed waste usually occurs at a material recovery facility, transfer station combustion facilities and disposal sites. Sorting often includes the separation of bulky items, separation of waste components by size using screen, manual separation of waste components and separation of ferrous and non ferrous metals. • Waste processing is undertaken to recover conversion products and energy. • The solid waste can be transformed by a variety of biological and thermal process. The most commonly used biological transformation process is aerobic composting. The most commonly used thermal transformation is incineration. Waste transformation is undertaken to reduce the volume, weight, size of waste without resources recovery.

(iv) **Transfer and transport: This functional element involves:** • The transfer of wastes from smaller collection vehicles to the larger transport equipment. • The subsequent transport of waste usually over long distances o a processing or disposal site. The transfer usually takes place at a transfer station.

(vii) **Waste disposal:** Today the Disposal of waste by landfilling or uncontrolled dumping is the ultimate fate of all solid wastes, whether they are residential wastes collected and transported directly to a landfill site, residual materials from material recovery facilities, residue from the combustion of solid wastes. Thus, land use planning becomes a primary determinant in the selection, design and operation of landfill operations. A modern sanitary landfill is a method of disposing solid waste without creating a nuisance and hazard to public health.

MUNICIPAL SOLID WASTE

CLASSIFICATION OF MUNICIPAL SOLID WASTE

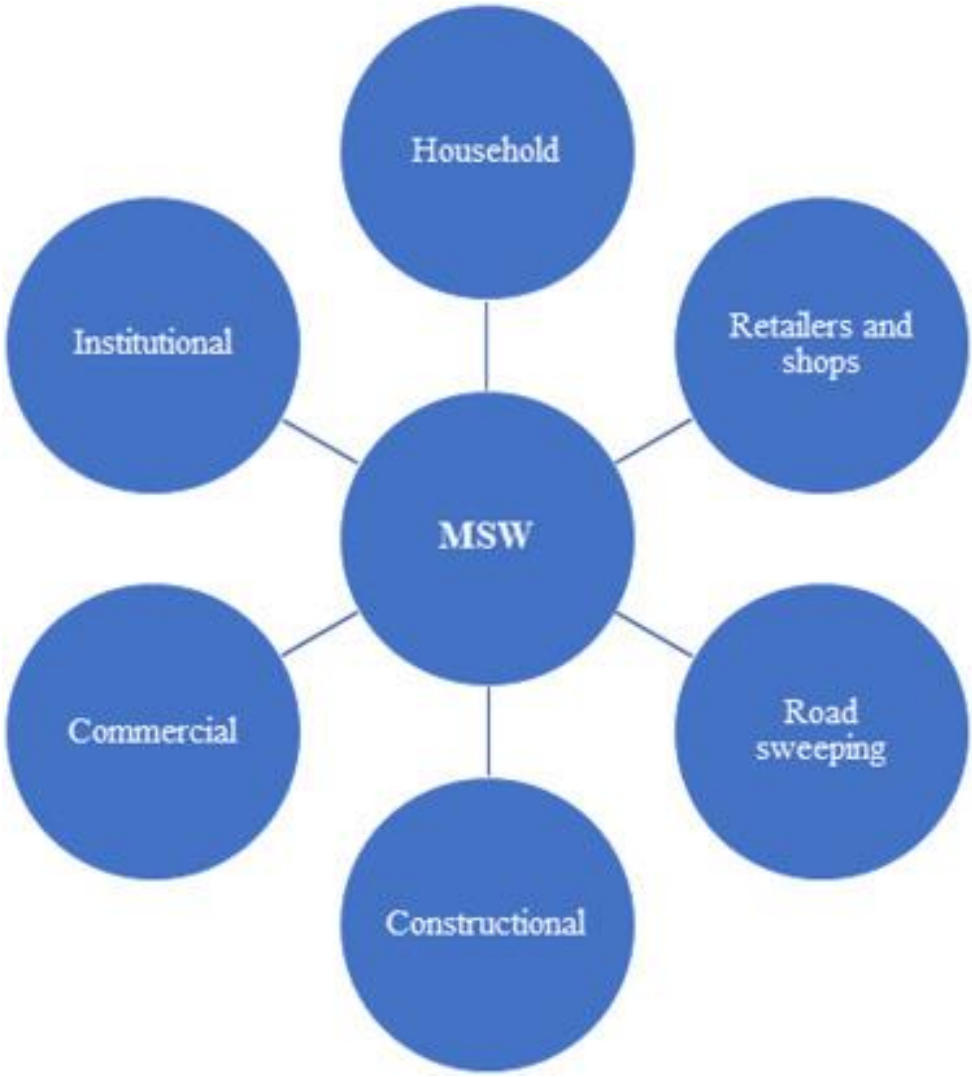

Figure: Classification of Municipal solid waste.

COMPOSITION AND QUANTITY OF MUNICIPAL SOLID WASTE (MSW)

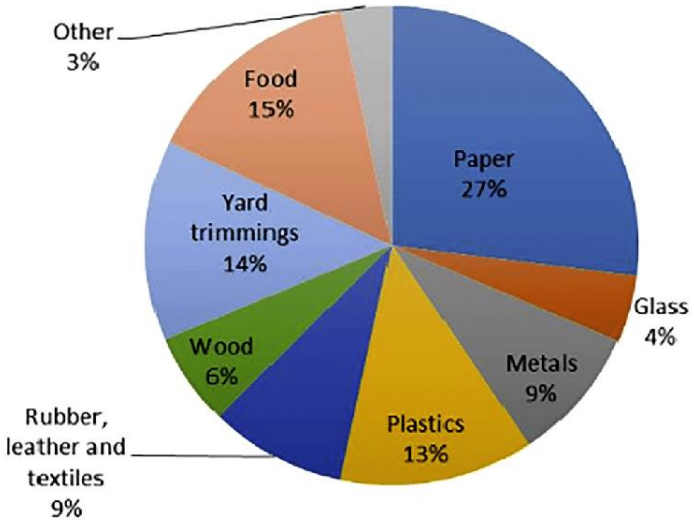

Figure: Composition and quantity of Municipal solid waste.

MUNICIPAL COLLECTION SERVICE / RESIDENTIAL COLLECTION SERVICE

Collection service varies depending upon the type of dwelling unit, collection for low rise detached dwellings and collection for medium and high rise apartments are considered separately.

The most common types of residential services in various parts of the country include

1. Curb

2. Alley

3. Set out – Set back

4. Set out

5. Backyard carrying

1. Curb – is used for low rise detached dwelling. This is a manual type of collection system where in the waste are collected in a curb on a collection day and the containers are returned back to their storage location until the next collection.

2. Alley - are part of the basic layout of a city or a given residential area. Alleys are storage of container used for solid waste collection.

3. Set out – Set back – Containers are set out from the owner's property and set back after being emptied by additional crew.

4. Set out – this service is essentially the same as set-out & set-back, except that the home owner is responsible for returning the container back their storage location.

5. Backyard Carrying – The collection crew is responsible for entering the owner's property and removing the waste from their storage location.

Types of Collection Systems Based on the mode of operation, collection systems are classified in to two categories:

1. Hauled container systems

2. Stationery container systems

Hauled container systems

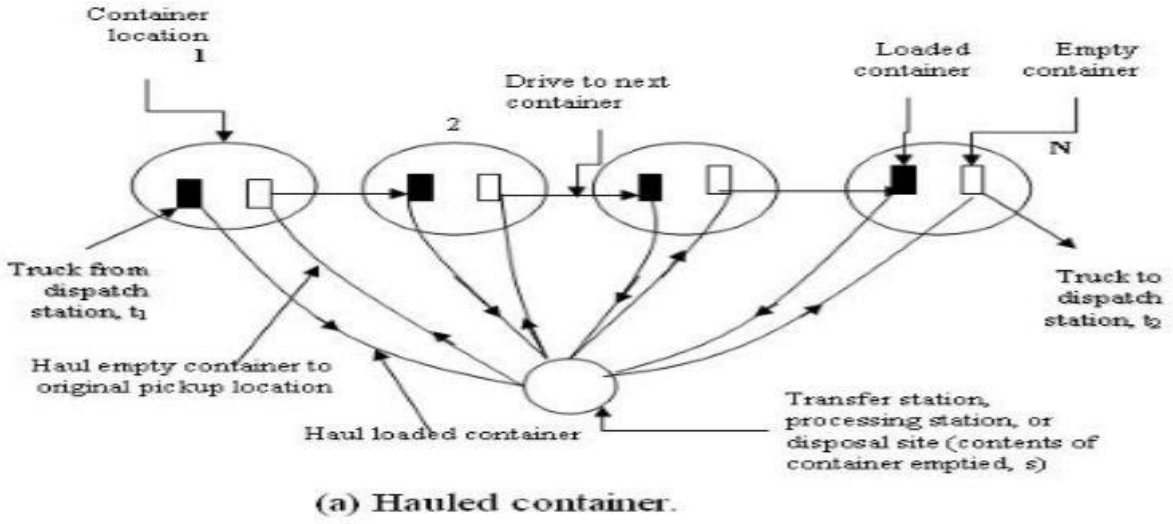

Figure: Hauled container.

Collection system in which the containers used for the storage of waste are hauled to the processing, transfer or disposal site, emptied and returned to either their original location or some other location are defined as hauled container system. The collector is responsible for driving the vehicle, loading the containers and emptying the contents of containers at disposal site.

Advantages: Hauled container systems are flexible containers of many different shapes and sizes are available for collection of all types of wastes.

Disadvantages

1. Because the container used in this system must be filled, usually the use of very large containers often lead to low volume utilization.

2. Through this system requires only one truck and driver to accomplish the collection cycle, each container picked up requires a round trip to disposal site.

Stationary Container Systems

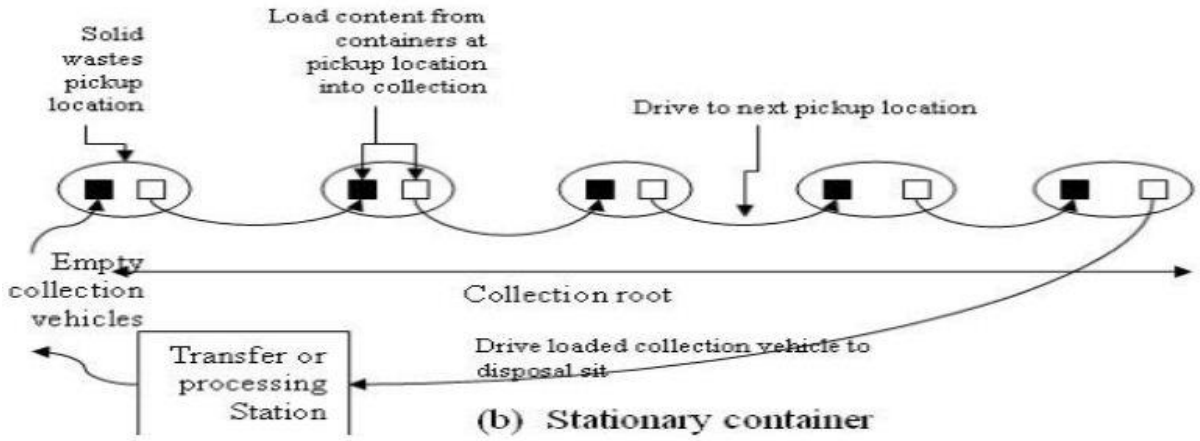

Figure: Stationary Container

Collection system in which the container used for the storage of waste remains at the point of waste generation, except when moved for collection are defined as stationery container system. There are two main types of stationery container systems

1. Those in which self-loading compactors used

2. Those in which manually loaded vehicles are used.

Trips to the disposal site, transfer station, or processing station are made after the contents of a no of containers have been collected and compacted and collection vehicle is full. Because a variety of container sizes and types are available, these systems may be used for collection of all types of wastes.

TRANSFER MEANS AND METHODS (TRANSPORT METHODS)

Transfer Means and Methods (Transport Methods) Motor vehicles, rail road's and ocean going vessels are the principle means used to transport waste. Pneumatic and hydraulic systems have also been used.

1. Motor Vehicle Transport - Motor vehicles used to transport solid wastes on highway should satisfy the following requirement.

- The vehicles must transport wastes at minimum costs
- Wastes must be covered during haul operation
- Vehicles must be designed for highway traffic
- Vehicle capacity must be such that allowable weight limits are not exceeded
- Methods used for unloading must be simple and dependable.

In the recent years because of their simplicity and dependability, open top trailers and semitrailers have found wide acceptance for the transport of waste. Some trailers are equipped with sumps to collect any liquid that accumulate from the solid waste.

2.Rail Road Transport - Although Rail road's were commonly used for the transport of solid waste in the past, they are now used by a few communities. However renewed interest is again developing in the use of rail road for hauling solid waste especially to remote areas where highway travel is difficult and rail lines now exist.

3. Water Transport – Barges, scows and special boats have been used in the past to transport solid wastes to processing location and to seasides and ocean disposal sites, but ocean disposal is no longer practiced by developing countries.

4. Pneumatic Transport – Both low pressure air and vacuum conduit transport systems are used to transport solid waste.

- The most common application is the transport of waste from high density apartment or commercial activities to central location for processing or for loading into transport vehicles.

DISPOSAL OF MSW

Different Methods of MSW disposal

Sanitary Landfilling

Shredding and Pulverization

Composting

Incineration

Barging into sea

1. Sanitary Landfilling

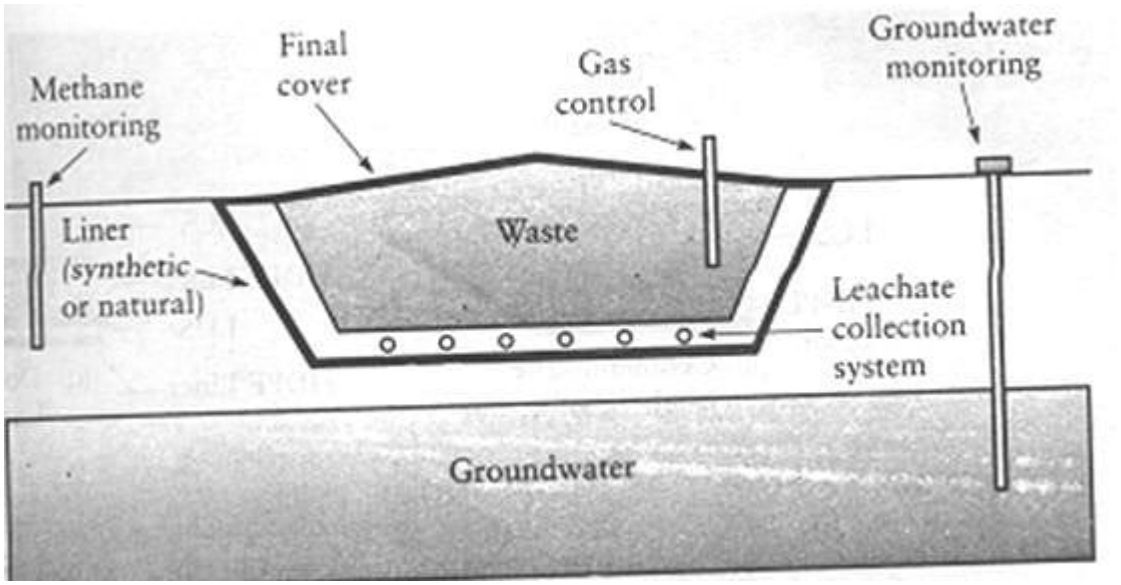

Figure: Sanitary Landfill

Sanitary Landfilling is a waste management method that involves the disposal of solid waste into specially designed areas known as the sanitary landfills. It is a process where waste materials, such as household garbage, construction debris, and industrial waste, are carefully deposited and compacted in designated locations. Landfills are engineered sites with measures in place to minimize the impact on the environment and public health.

The process of landfilling begins with selecting suitable land for the landfill site, considering factors such as distance from residential areas, water sources, and geological stability. The waste is then transported to the landfill and systematically placed in layers or cells. As the waste accumulates, it is compacted to reduce its volume and create more space for additional waste.

To minimise the environmental impact, various measures are implemented in modern sanitary landfills. These include liners at the bottom of the landfill to prevent the leakage of contaminants into the soil and groundwater. The waste is also covered daily with a layer of soil or other materials to control odours, reduce the spread of litter, and deter pests. Additionally,

landfills are equipped with monitoring systems to detect and manage any potential issues, such as gas emissions or leachate (liquid runoff from waste).

While landfilling is an established method of waste disposal, there is an increasing emphasis on waste reduction, recycling, and resource recovery to minimise the amount of waste sent to landfills. Nonetheless, landfills remain an important component of waste management systems, ensuring the proper containment and disposal of solid waste in a controlled manner.

A sanitary landfill is an engineered waste disposal site designed to minimize environmental pollution and protect public health. The process begins with careful site selection, followed by the construction of a bottom liner to prevent contamination of groundwater. Waste is then compacted and covered with a layer of soil each day to minimize odor and prevent the spread of disease. Leachate, a liquid by product, is collected and treated, while methane gas is often captured and used for energy generation. Monitoring systems ensure long-term environmental compliance.

2. Shredding and Pulverization: The decomposable materials in refuse are isolated from glass, metal, and other inorganic items through sorting and separating operations. These are carried out mechanically, using differences in such physical characteristics of the refuse as size, density, and magnetic properties. Shredding or pulverizing reduces the size of the waste articles, resulting in a uniform mass of material. It is accomplished with hammer mills and rotary shredders.

3. Composting: Another method of treating municipal solid waste is composting, a biological process in which the organic portion of refuse is allowed to decompose under carefully controlled conditions. Microbes metabolize the organic waste material and reduce its volume by as much as 50 percent. The stabilized product is called compost or humus. It resembles potting soil in texture and odour and may be used as a soil conditioner or mulch.

Composting offers a method of processing and recycling both garbage and sewage sludge in one operation. As more stringent environmental rules and siting constraints limit the use of solid-waste incineration and landfill options, the application of composting is likely to increase. The steps involved in the process include sorting and separating, size reduction, and digestion of the refuse.

There are two types of composting

1) Banglore method of composting

2) Indoor method of composting

Bangalore method of composting is developed by scientist Dr. L.N. Acharya in 1939 (at IISC Bangalore) to make use of town residues and night soil. It is an anaerobic method that is conventionally carried out by digging trenches or pits. This method is mainly suitable for scanty rainfall areas.

Pit preparation:

Pits/trenches should be dug 1 m deep while length and breadth can be varied according to the land availability and volume of wastes to be composted.

Filling the pit: The pit should be filled with alternate layers of organic residues and night soil and could be covered/plastered with a layer of soil/earth to protect the compost from external elements like rain and flies. It is necessary to have sloping walls and sloping bottom to prevent the waterlogging conditions in the pits/trenches

- At first, 15 cm of organic refuse is added at the bottom of the trench/pit.
- A 5 cm layer of night soil is spread over the refuse layer
- This alternate layering is carried out until the pit is full.
- Now, these layers of wastes/pit are covered with 15 - 20 cm of refuse above the ground level.
- Now the pit is left undisturbed (without turning) for 3 months. Meanwhile, a reduction in the volume of the wastes takes place.
- Alternate layers of refuse and night soil are added again on top of reduced the contents.
- Now the pit/trench is ultimately covered with a layer of soil/earth in a dome shape. This layer prevents unwanted organisms to enter the compost and also helps in moisture losses from the compost.
- For initial 8 -10 days, aerobic composting takes place while, anaerobic composting takes place at a slower rate thereafter.
- Compost will be ready in six to eight months.

Nutrient composition of the Bangalore compost:

- Nitrogen = 1.5%
- Phosphorus = 1%
- Potassium = 1.5%

Advantages:

- Compost is protected from altering weather conditions.
- Problems such as breeding of flies, moisture loss

- No need of turning
- Protected from rains

Disadvantages:

- Requires a long time for the stabilization of the materials
- Need more load space
- Expensive to follow.
- Indore method of composting:
- Indore method of composting was developed by A. Howard and Y.D. Wad (at Institute of Plant Industry, Indore). It is an aerobic composting that is associated with turnings when needed.
- Measurements of the pit:
- Length: 3 - 3.5 m (depends on the quantity of waste)
- Breadth: 1.5-2 m
- Depth: 1 m

Filling the pits:

- At first, organic materials (dry wastes) that are brought from the cattle sheds are spread at the bottom for 15-20 cm
- Now a slurry made from 4.5 kgs dung, 3.5 kgs urine-soaked mud, and 4.5 kgs of inoculum from a 15-day old compost pit is added evenly over the dry waste layer.
- Water is sprinkled to make the materials wet enough (50% moisture should be maintained)
- In this way, the pit should be filled (within 1 week) until it reaches 1 foot above the ground level.
- Now the pit should be covered with a thin layer of bedding material with wood ashes and urine-soaked mud.

Turning:

- Turning of the materials should be done to aerate the pits for proper decomposition of the wastes.
- **1st turning:** Between the 10th-15th day after filling the pits
- **2nd turning:** After 15 days of the first turning
- **3rd turning:** After 2 months of the second turning

Nutrient composition:

- Nitrogen: 0.8%
- Phosphorus: 0.3%
- Potassium: 1.5%

Advantages:

- Requires short period for stabilization of the materials

- Need less land space
- This method is not associated with odour problems
- It is a complete environment friendly process.

Disadvantages:

- No protective layer
- Requires regular turning to ensure proper aeration in the pits
- Composting pit needs to be at an elevated site, near to cattle shed and water source
- Need manpower for turning
- Associated with problems like moisture loss and breeding of flies.

Incineration: Waste incineration is the use of high temperature furnaces to combust waste and reduce its volume by 95% and mass by 80-85%. Remember though, that the mass isn't actually lost, it's just moved into the atmosphere as water vapor and other flue gasses including dioxins. The remaining salts, metals and other non-combustible elements in the waste are left in the ash that is then disposed of in a landfill. Incineration involves burning the organic waste at a very high temperature (about or more than 1000°C). Burning the waste at such a high temperature reduces the volume of waste. A small amount of ash produced by incineration can be disposed into a landfill site. Incineration is suitable for countries with small land sizes.

Barging into Sea: The dumping of waste is at the top of the list of activities that contaminates the ocean. Therefore, dumping is the practice of depositing all waste items from factories and industries, tankers and ships, and sewerage waste materials, into oceans and seas.