

SOLID WASTE MANAGEMENT

Munish K. Chandel
**Centre for Environmental Science
and Engineering**
IIT Bombay

What is Solid Waste?

- **Solid or semi solid materials, which possess no more value and is the waste for the primary user.**
 - Agricultural Wastes
 - Mining Wastes
 - Industrial Wastes

Municipal Solid Waste (MSW)

- Urban waste (**Municipal Solid Waste**) as opposed to agricultural, mining and industrial wastes.
- **Biomedical Waste and Electronic Waste** are also produced in urban areas but are dealt separately in Indian rules.

Municipal Solid Waste (MSW)



SOLID WASTE MANAGEMENT--

WHY ?

- Solid wastes discarded in the streets and roads could lead to the breeding of rodents and fleas which could lead to spread of several diseases.
 - E.g. **Bubonic Plague** killed half of 14th century Europe.
- Solid wastes could lead to **air and water pollution.**

Deonar Dumping Ground, Mumbai



Source: <http://timesofindia.indiatimes.com/city/mumbai/Massive-fire-at-Deonar-dumping-ground-again/articleshow/50985954.cms>

Deonar Dumping Ground, Mumbai



NASA image



Is Municipal Solid Waste Management Difficult?

- Treatment of MSW becomes difficult once we mix different types of wastes together.
- Each categories of waste generated, take their own time to degenerate
 - Organic waste(food waste) can degrade biologically within 1-2 weeks.
 - Glass bottles will not degrade biologically --never

Problem of Solid Waste

There are different categories of waste generated, each take their own time to degenerate

The type of litter we generate and the approximate time it takes to degenerate	
Type of litter	Approximate time it takes to degenerate the litter
Organic waste such as vegetable and fruit peels, leftover foodstuff, etc.	A week or two.
Paper	10–30 days
Cotton cloth	2–5 months
Wood	10–15 years
Woolen items	1 year
Tin, <u>aluminium</u> , and other metal items such as cans	100–500 years
Plastic bags	One million years?
Glass bottles	undetermined

SOLID WASTE GENERATION

- **How much MSW you generate everyday?**
- **Calculate...**
- **What is the composition?**

SOLID WASTE GENERATION

- Small towns
 - 100 g/p/day
- Medium towns
 - 300-400 g/p/day
- Large towns
 - 500 g/p/day or more

In general varies between 0.3-0.6 kg/person/day

QUANTITY OF WASTE GENERATION

- ~62 million tonnes of MSW generated annually by 377 million people in urban areas
- More than 80% is disposed at dump (uncontrolled)

(Source: Report of the Task Force on Waste to Energy (Volume I) , 2014

http://planningcommission.nic.in/reports/genrep/rep_wte1205.pdf

QUANTITY OF WASTE GENERATION

<u>GARBAGE</u>	<u>% OF TOTAL</u>
Waste Generated in 6 Mega Cities	18.4%
Waste Generated in Metro Cities (1 Million Plus Towns)	17.1%
Waste Generated in Other Class-I Towns (0.1 Million Plus Towns)	37.1%
	72.5%

**TOTAL QUANTITY OF SOLID WASTE
GENERATED IN URBAN AREAS
OF THE COUNTRY**

**1.15 LAKH TONNE
PER DAY (TPD)**

Source: Guidelines for Preparation of Detailed Project Reports and Selection of Technologies for Processing and Final Disposal of Municipal Solid Waste Using 12th Finance Commission Grants.

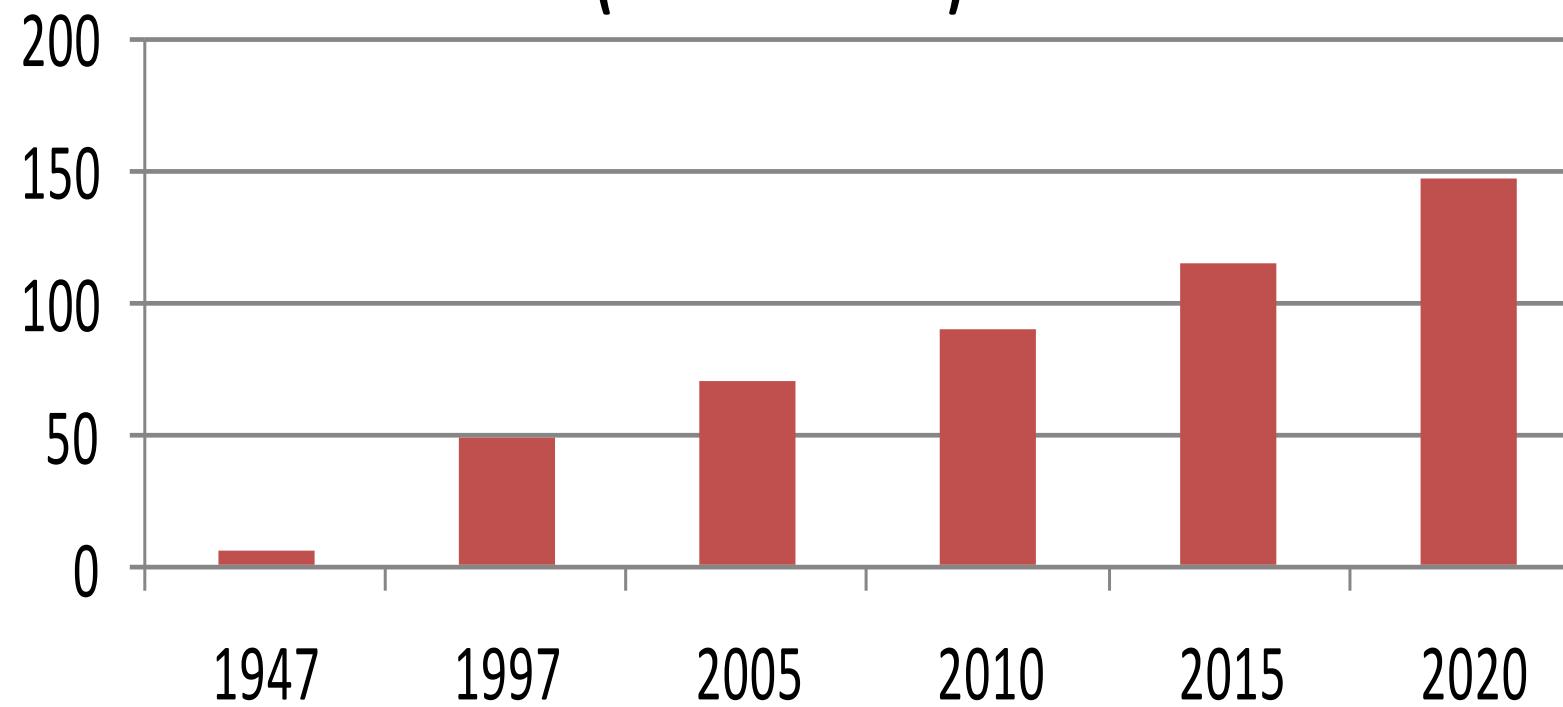
How much it cost to manage MSW?

- **Urban Local Bodies** spend ~Rs. 500-1500/- per tonne on MSW management
 - 60-70% of it is spent on collection alone
 - 20% - 30% is spent on transportation
 - Hardly any fund is spent on treatment and disposal of waste
- **Collection efficiency:**
 - Major metro cities: 70-90%
 - Smaller cities: < 50%

Source: Position Paper on PPP in Solid Waste Management. November 2009, [http://www.pppinindia.com/pdf/
ppp_position_paper_solid_waste_mgmt_112k9.pdf](http://www.pppinindia.com/pdf/ppp_position_paper_solid_waste_mgmt_112k9.pdf)

TOTAL WASTE GENERATED

(million tonne)



How much land is required to manage MSW?

- 3 -3.5% of annual growth of urban population would lead to ~5% annual increase in MSW generation.
- By this trend and if waste not disposed properly, >1400 sq. km of land would be required by 2047 for its disposal.

Source: Position Paper on PPP in Solid Waste Management. November 2009, [http://www.pppinindia.com/pdf/
ppp_position_paper_solid_waste_mgmt_112k9.pdf](http://www.pppinindia.com/pdf/ppp_position_paper_solid_waste_mgmt_112k9.pdf)

CHARACTERISTICS OF MUNICIPAL SOLID WASTE GENERATED BY MERTO CITIES

Characteristics (Percent by wt.)

Sl . N o.	Metro city	Paper	Textile	Leather	Plastic	Metal	Glass	Ash, Fine earth & others	Comp ostabl e matter
1	Mumbai	10.0	3.6	0.2	2.0	-	0.2	44.0	40.0
2	Delhi	6.6	4.0	0.6	1.5	2.5	1.2	51.5	31.78
3	Hyderabad	7.0	1.7	-	1.3	-	-	50.0	40.0
4	Jaipur	6.0	2.0	-	1.0	-	2.0	47.0	42.0
5	Kanpur	5.0	1.0	5.0	1.5	-	-	52.5	40.0
6	Chennai	10.0	5.0	5.0	3.0	-	-	33.0	44.0
7	Visakhapatnam	3.0	2.0	-	5.0	-	5.0	50.0	35.0

SOLID WASTE MANAGEMENT

- Solid waste management may be defined as the management of waste from its generation to the final disposal that uses the best principles of public health, economics, engineering and conservation.

(Source: Environmental Audit of Municipal Solid Waste Management TECHNICAL REPORT: 118 June 2006)

http://wgbis.ces.iisc.ernet.in/biodiversity/pubs/ces_tr/TR118_SPoonaChal/Index.htm.

FUNCTIONAL ELEMENTS OF SOLID WASTE MANAGEMENT SYSTEM

- Waste generation and primary storage
- Collection
- Separation, storage and processing at the source
- Transfer and transport
- Processing & recovery
- Disposal

Bin for Source Segregation and Storage



Bin for Source Segregation and Storage





Litter Bins



Street Sweepings

- **Manual sweeping**
- **Mechanical sweepers**

Street Sweepings



Manual Sweeping



Mechanical Sweeper

Collection

- Door to Door Collection
- Community Bins

Community Bins: Commercial Complexes, Multistoried Apartments



Community Bins: Commercial Complexes, Multistoried Apartments



Packers/Compactors Trucks

- Municipal solid waste at the curbside has a density of ~100-200 kg/m³ in developed countries and 300-400 kg/m³ in India.
- At those low densities, collection vehicles fill too fast, which means multiple, time-wasting trips to the disposal site would be needed.
- Modern trucks, called *packers*, have hydraulic, compactors that can compress that waste to as much as 750 kg/m³ density.
- Compaction Ratio: 2-3

Compactors



Compactors



Transportation System

- Selection of proper number and size of trucks.
- Choosing the most efficient collection routes and schedules.
- Locating transfer stations if they were to be used.

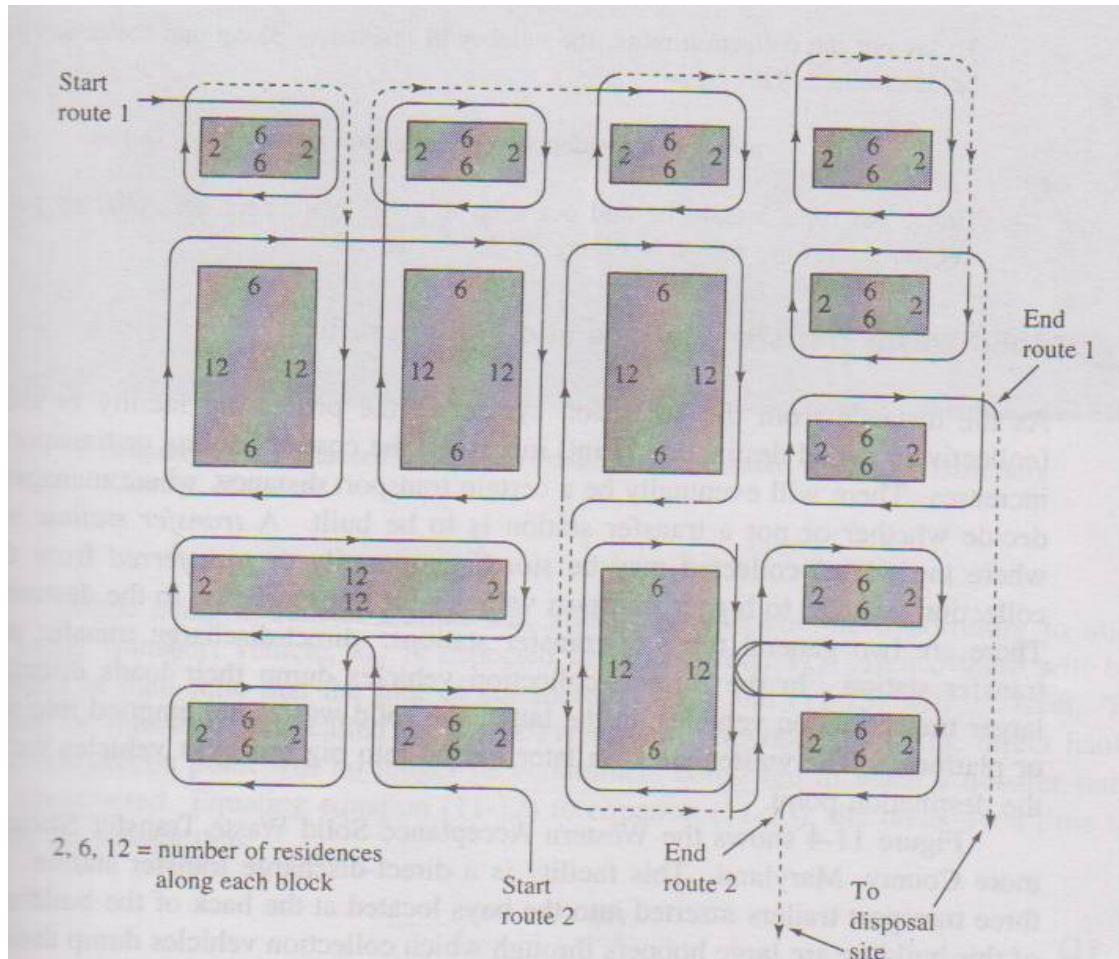
COMPLEX SOLID WASTE TRANSPORTATION SYSTEM

- With the growing importance of recycling and composting, those basic operations have become more complicated.
- Now, a municipality may have separate trucks, routes, schedules, and destinations for recyclables and compostable materials—all of which need to be coordinated with already existing refuse collection system.

Transportation System

- **Large vs Small Trucks**
- Larger trucks cost more, but they do not- have to make as many trips back and forth to the disposal site, which can more than offset the higher capital costs.
- Larger trucks, however, are also less manoeuvrable in crowded urban areas, and their weight may exceed allowable limits for residential streets.

Routing

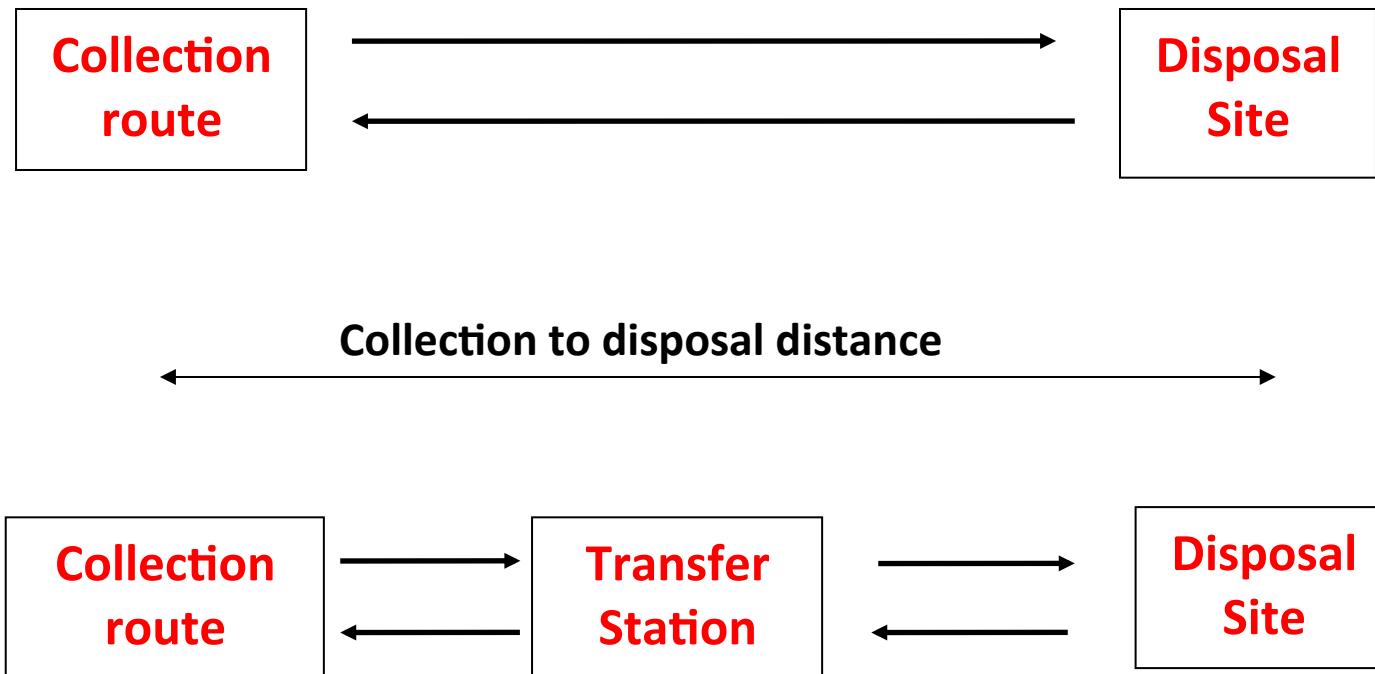


Route
emphasizing
right turns
and a
minimum
amount of
deadheading

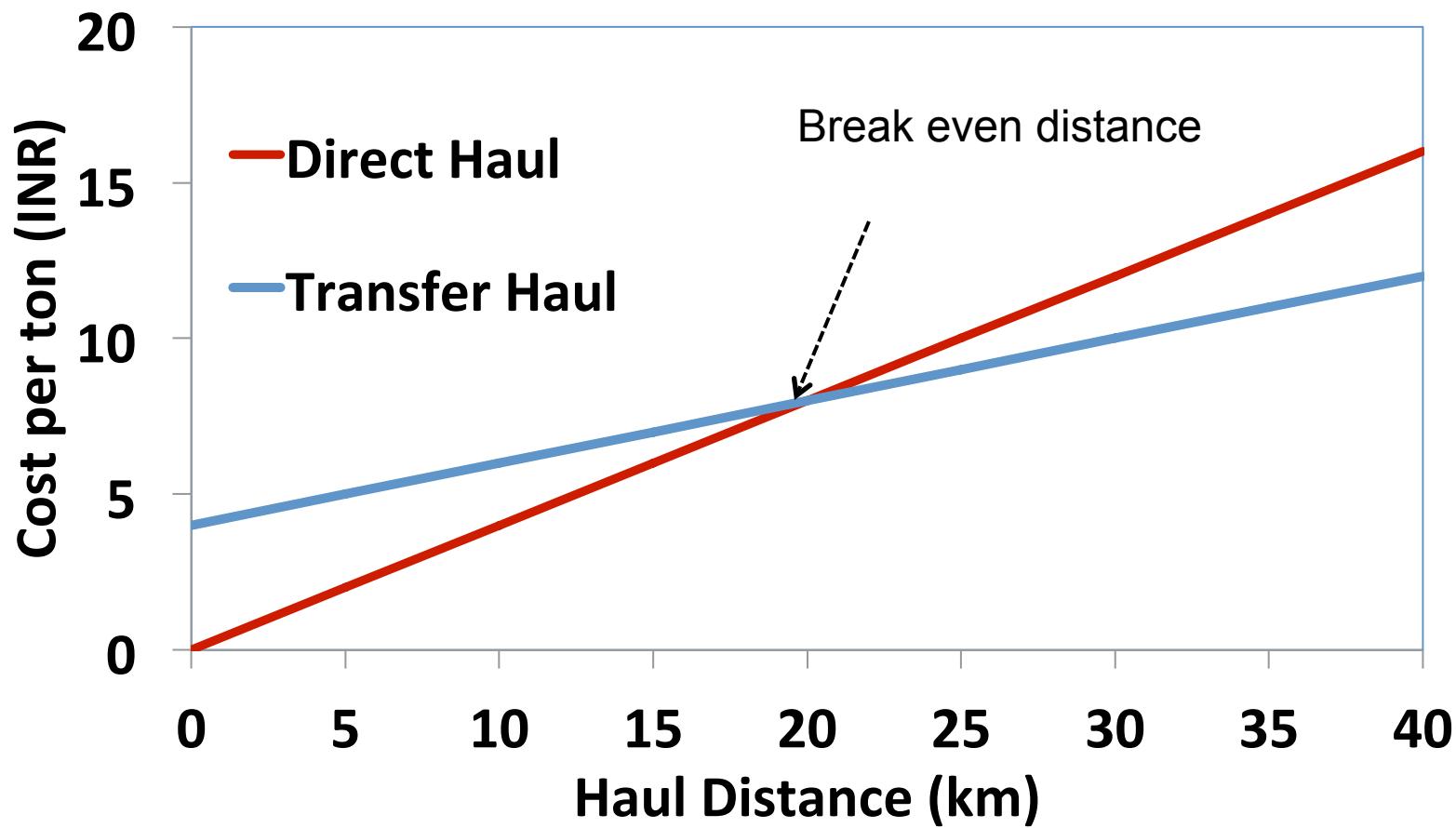
Transfer Station

- A ***transfer station*** is a facility where the wastes collected may be stored temporarily or *transferred* from the smaller collection vehicles to bigger transport vehicles for transportsations to the destination point.
- As the distance from the collection system to the processing facility or disposal site (collectively called destination point) increases, the cost of hauling or transportation also increases.
- There will eventually be a certain transport distance, where management must decide whether or not a transfer station is to be built.

Transfer Station



Transfer Station



TRANSFORMATION OF SOLID WASTE

TRANSFORMATION OF SOLID WASTE

Why transform solid waste?

- Efficient storage, handling and transport
- Reduce disposal cost
- Stabilize waste
- Destroy toxic element (chemical or biological entities)
- Generate useful energy
- Re-use

TRANSFORMATION OF SOLID WASTE

- Physical method
- Chemical method
- Biological method

Physical Transformation

Transformation Process	Transformation Method	Transformation Products
1 . Component Separation	Manual and/or Mechanical separation	Individual components of MSW
2. Volume Reduction	Application of energy in the form of force or pressure	Original waste component altered in form and reduced in size
3. Size Reduction	Application of energy in the form of shredding, grinding, or milling	The original waste components altered in the form of and reduced in size.

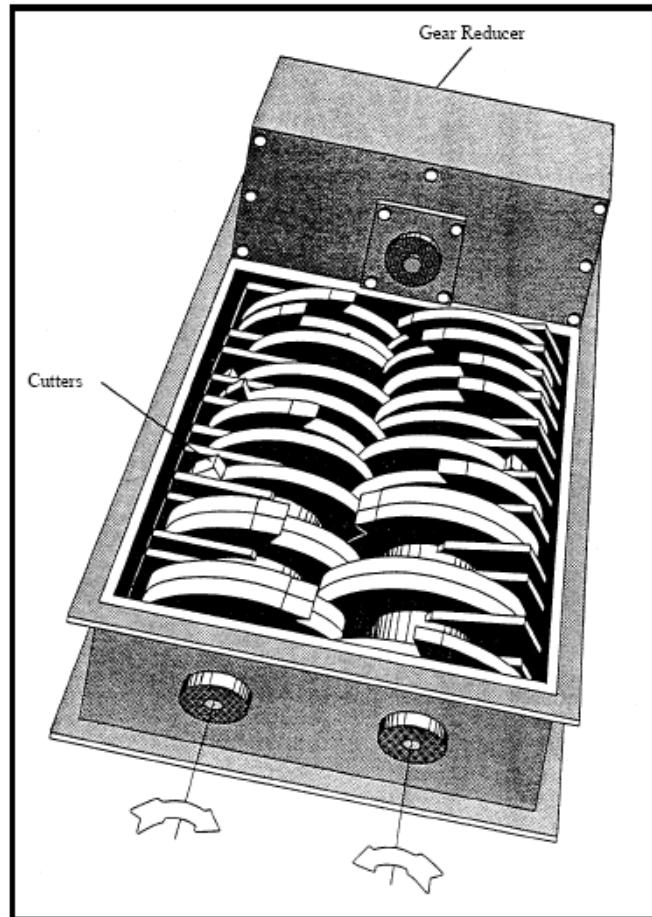
Chemical Transformation

Transformation Process	Transformation Method	Transformation Products
1.Combustion	Thermal Oxidation	Carbon dioxide (CO ₂), Sulfur dioxide(SO ₂), other oxidation products, and Ash
2.Pyrolysis	Destructive distillation	A gas stream containing a variety of gases, tar and/or pyrolytic oil, and char
3.Gassification	Starved air combustion	A low calorific value synthetic gas, charcoal containing carbon and the inerts originally in the fuel, and oil.

Biological Transformation

Transformation Process	Transformation Method	Transformation Products
1. Composting	Aerobic biological conversion	Compost (Humus like material used as a soil conditioner or organic fertilizer)
2. Anaerobic digestion (Low or high-solids)	Anaerobic biological conversion	Methane (CH_4), Carbon dioxide (CO_2), trace gases, digested humus or sludge

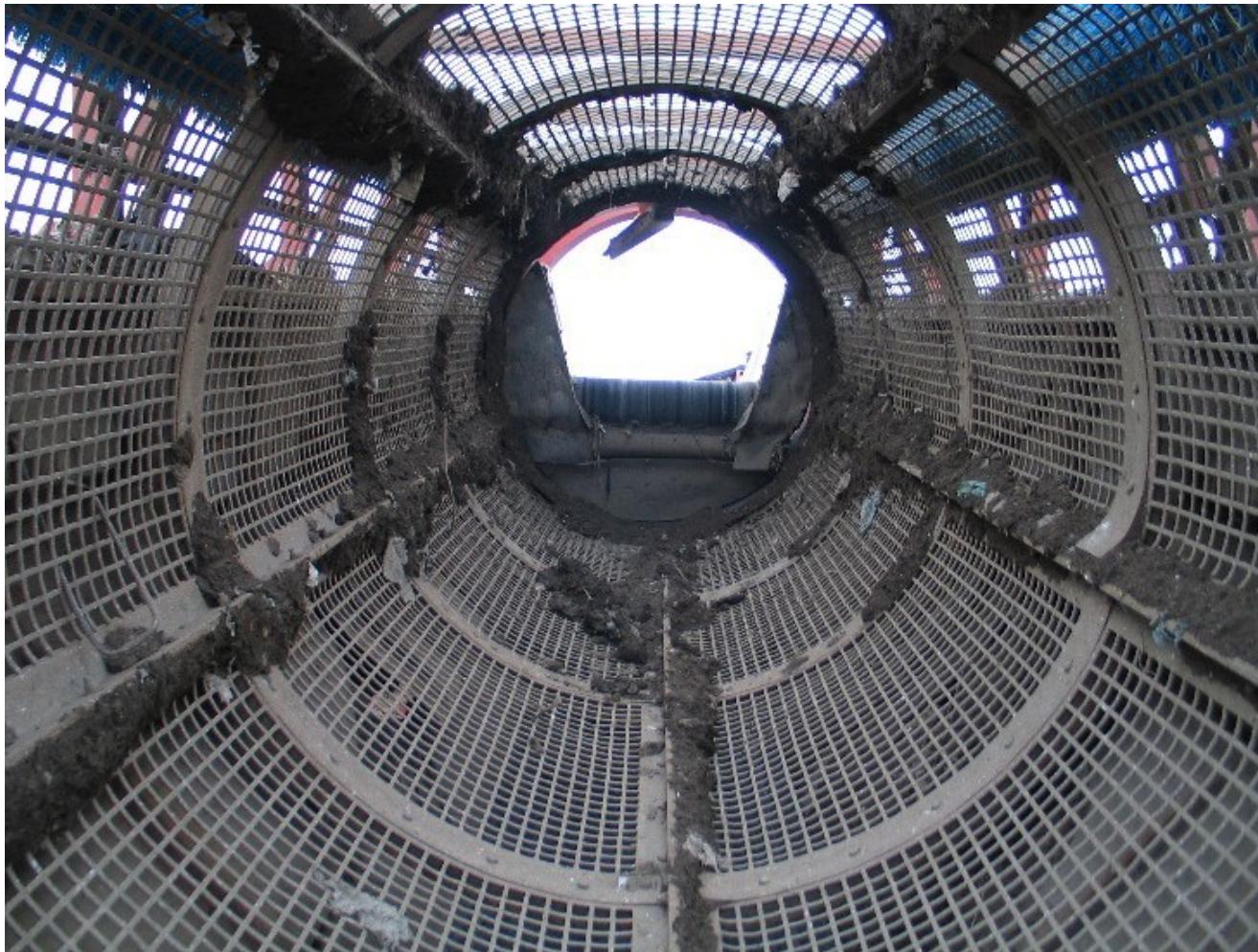
Shear Shredders



Trommel Screen



Trommel Screen



Source: <http://www.graepel.ie/index.cfm/page/casestudy/applicationID/24/casestudyID/20>

Air Classifiers

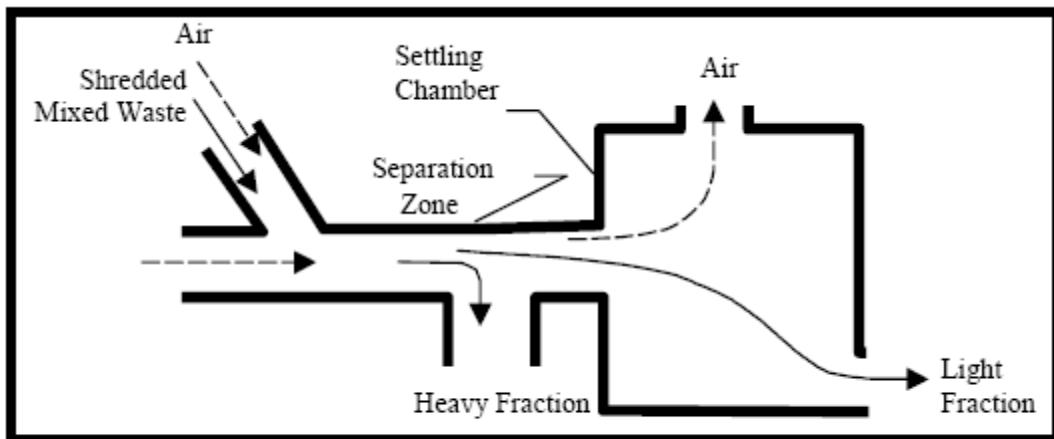
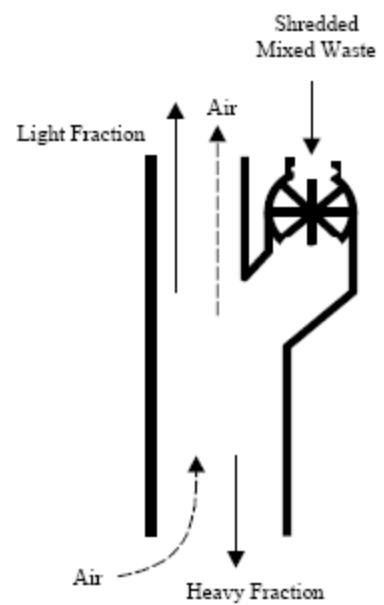
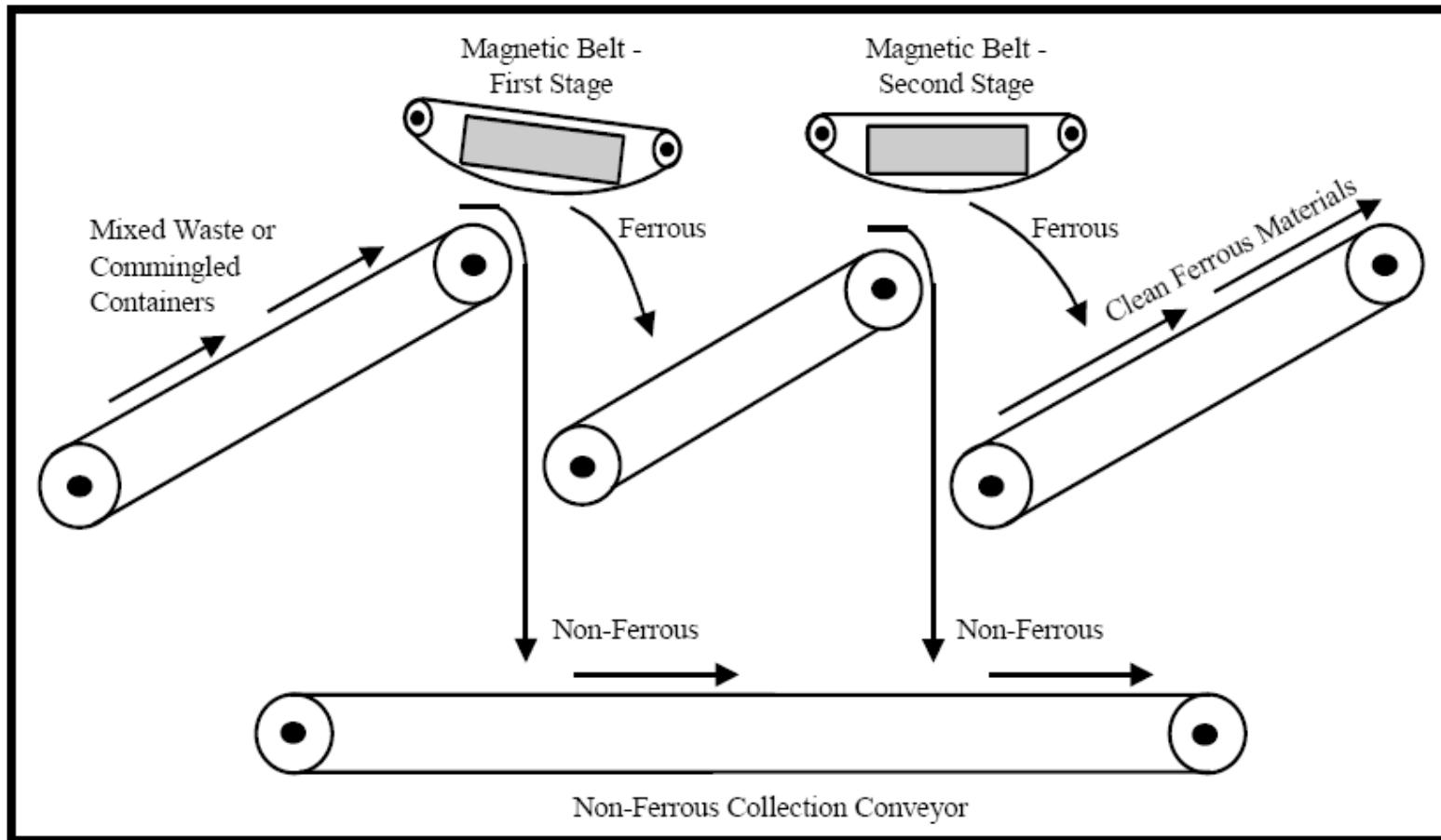


Figure VI-10. Horizontal air classifier



Magnetic Separation

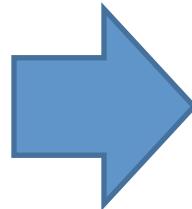
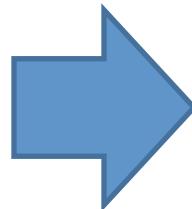


Biological Process

AEROBIC STABILIZATION: COMPOSTING



Food scraps



COMPOSTING: ADVANTAGES

- Transformation of biodegradable waste into biologically stable matter using micro organisms.
- Reduces the volume of waste.
- Destroy pathogens/insects.
- End product is a humus like material called compost that is rich in nutrients. Compost can be used to support plant growth and as a soil amendment.

COMPOSTING

- Conventional
- Vermicomposting
- High Rate: Rotary Drum Composting

Windrow Composting



Source <http://www.grand-island.com/index.aspx?page=173>



