B.Sc. Course(First Semester)

University of Babylon-College of Engineering

Environmental Engineering Department

Chapter Two (Solid Waste Management)

Sources, Types, And Compostion Of Municipal Solid Wastes

Solid wastes include all solid or semisolid materials that the possessor longer considers of sufficient value to retain.

2.1 Sources of solid wastes

Sources of solid wastes in a community are, in general, related to land use and zoning. Although any number of source classifications can be developed, the following categories are useful:

1. Residential,
2. Commercial,
3. Institutional,
4. Construction and demolition,
5. Municipal services,
6. Treatment plant sites,
7. Industrial, and
8. Agricultural.

Typical waste generation facilities, activities, or locations associated with each of these sources are reported in Table 2.1, where municipal solid waste (MSW) is normally assumed to include all community wastes with the exception of industrial process wastes and agricultural wastes.

TABLE 3-1
Sources of solid wastes within a community[a]

Source	Typical facilities, activities, or locations where wastes are generated	Types of solid wastes
Residential	Single family and multifamily detached dwellings, low-, medium-, and high-rise apartments, etc.	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, tin cans, aluminum, other metals, ashes, street leaves, special wastes (including bulky items, consumer electronics, white goods, yard wastes collected separately, batteries, oil, and tires), household hazardous wastes
Commercial	Stores, restaurants, markets, office buildings, hotels, motels, print shops, service stations, auto repair shops, etc.	Paper, cardboard, plastics, wood, food waste, glass, metals, special wastes (see above), hazardous wastes, etc.
Institutional	Schools, hospitals, prisons, governmental centers	As above in commercial
Construction and demolition	New construction sites, road repair/renovation sites, razing of buildings, broken pavement	Wood, steel, concrete, dirt, etc.
Municipal services (excluding treatment facilities)	Street cleaning, landscaping, catch basin cleaning, parks and beaches, other recreational areas	Special wastes, rubbish, street sweepings, landscape and tree trimmings, catch basin debris, general wastes from parks, beaches, and recreational areas
Treatment plant sites; municipal incinerators	Water, wastewater, and industrial treatment processes, etc.	Treatment plant wastes, principally composed of residual sludges
Municipal solid waste[b]	All of the above	All of the above
Industrial	Construction, fabrication, light and heavy manufacturing, refineries, chemical plants, power plants, demolition, etc.	Industrial process wastes, scrap materials, etc. Non-industrial wastes including food wastes, rubbish, ashes, demolition and construction wastes, special wastes, hazardous wastes
Agricultural	Field and row crops, orchards, vineyards, dairies, feedlots, farms, etc.	Spoiled food wastes, agricultural wastes, rubbish, hazardous wastes

[a] For comparison, the sources of waste and waste classifications used in the early 1900s are given in Table 3-12.

[b] The term *municipal solid waste* (MSW) normally is assumed to include all of the wastes generated in a community with the exception of industrial process wastes and agricultural solid wastes.

2.2 Types of solid wastes

The following definitions are intended to serve as a guide and are not meant to be precise in a scientific sense.

Residential and Commercial

Residential and commercial solid wastes, excluding special and hazardous wastes discussed below, consist of the organic (combustible) and inorganic (noncombustible) solid wastes from residential areas and commercial establishment.

The organic fraction of residential and commercial solid waste consists of materials such as food waste (also called garbage), paper of all types, cardboard (also known as paperboard and corrugated paper), plastics of all types, textiles, rubber, leather, wood, and yard wastes.

The inorganic fraction consists of items such as glass, crockery, tin cans, aluminum, ferrous metals. If the waste components are not separated when discarded, then the mixture of these wastes is also known as commingled residential and commercial MSW.

Wastes that will decompose rapidly, especially in warm weather, are also known as **putrescible waste**. The principal source of putrescible wastes is the handling, preparation, cooking, and eating of foods. Often, decomposition will lead to the development of offensive odors and the breeding of flies.

Although there are more than 40 classifications **for paper**, the waste paper found in MSW is typically composed of newspaper, books and magazines, commercial printing, office paper, other paperboard, paper packaging, other non-packaging paper, tissue paper and towels, and corrugated cardboard.

The **plastic materials** found in MSW fall into the following seven categories:

- ❖ Polyethylene terephthalate (PETE/I)
- ❖ High-density polyethylene (HDPE/2)
- ❖ Polyvinyl chloride (PVC/3)
- ❖ Low-density polyethylene (LDPE/4)
- ❖ Polypropylene (PP/5)
- ❖ Polystyrene (PS/6)
- ❖ Other multilayered plastic materials(7)

The type of plastic container can be identified by number code (1 through 7) molded into the bottom of the container (see Fig. 2.1)

Figure. 2.1 Code designation used for various types of plastics

Mixed plastic is the term used for the mixture of the individual types of plastic found in MSW. **Special Wastes** from residential and commercial sources include bulky items, consumer electronics(such as radios, stereos, and television sets), white goods (such as stoves, refrigerators, dishwashers, and clothes washers and dryers), batteries, oil, and tires.

These wastes are usually handled separately from other residential and commercial wastes. **Bulky items** are large worn-out or broken household, commercial, and industrial items such as furniture, lamps, bookcases, filing cabinets, and other similar items.

Household batteries come in a variety of types, including alkaline, mercury, silver, zinc, nickel, and cadmium. The metals found in household batteries can cause groundwater contamination by their presence in leachate; they can also contaminate air emissions and ash from waste combustion facilities. many states now prohibit the land filling of household batteries. Automobiles use lead-acid batteries, each of which contains approximately 18 pounds of lead and a gallon of sulfuric acid, both hazardous materials.

The principal source of used oil is from the servicing of automobiles and other moving vehicles by their owners. Waste oil, not collected for recycling, is often poured onto the ground; down sanitary, combined, and storm water sewers; or into trash containers.

Waste oil discharged onto the ground or into municipal sewers often contaminates surface water and groundwater as well as the soil. Waste oil placed in the same container as other solid waste components tends to contaminate the waste components and thus reduces their value as recycled materials.

Because tires do not compact well, their disposal in landfills is expensive and wasteful of space. Stockpiling of tires also poses serious aesthetic, as well as environmental problems. Large, difficult-to-extinguish fires have occurred in a number of stockpiles.

Hazardous wastes

Wastes or combinations of wastes that pose a substantial present or potential hazard to human health, or living organisms have been defined as hazardous wastes.

Institutional

Institutional sources of solid waste include government centers, schools, prisons, and hospitals. Excluding manufacturing wastes from prisons and medical wastes.

Construction and demolition

Wastes from the construction, remodeling, and repairing of individual residences, commercial buildings, and other structures are classified as construction wastes. The quantities produced are difficult to estimate. The composition is variable but may include dirt; stones; concrete; bricks; plaster; lumber; shingles; and plumbing, heating, and electrical parts. The composition of demolition wastes is similar to construction wastes, but may include broken glass, plastics, and reinforcing steel.

Municipal services

Other community wastes, resulting from the operation and maintenance of municipal facilities and the provision of other municipal services, include street sweepings, road side litter, wastes from municipal litter containers, landscape and tree trimmings, catch-basin debris, dead animals, and abandoned vehicles. Because it is impossible to predict where dead animals and abandoned automobiles will be found, these wastes are often identified as originating from **nonspecific diffuse sources**, wastes from nonspecific diffuse sources can be contrasted to that of the **residential sources**, which are also diffuse but specific in that the generation of, the wastes is a recurring event.

Treatment plant wastes and other residues

The solid and semisolid wastes from water, wastewater, and industrial waste treatment facilities are termed treatment plant wastes. Wastewater treatment plant sludge's are commonly co-disposed with MSW in municipal landfills. In the future, the disposal of treatment plant sludge's will likely become a major factor in any solid waste management plan.

2.3 Composition of solid wastes

Composition is the term used to describe the individual components that make up a solid waste stream and their relative distribution, usually based on percent by weight. For example, if the solid wastes generated at a commercial facility consist of only paper products, the use of special processing equipment, such as shredders and balers, may be appropriate.

Note that the values given in 1990 for food waste, plastics, and yard wastes are considerably different from the values given in the text, published in 1977. The differences are due largely to:

1. Improved food processing techniques and the increased use of kitchen food waste grinders,
2. The increased use of plastics for food packaging and other packaging, and
3. The fact that burning of yard wastes is no longer allowed in most communities.

2.4 Determination of the composition of MSW in the field

Because of the heterogeneous nature of solid wastes, determination of the composition not an easy task. Strict statistical procedures are difficult, if not impossible to implement. For this reason, more generalized field procedures, based on common sense and random sampling techniques, have evolved for determining composition.

Residential MSW

The procedure for residential MSW involves unloading and analyzing a quantity of residential waste in a controlled area of a disposal site that is isolated from winds and separate from other operations. A representative residential sample might be a truckload resulting from a typical weekday collection route in a residential area. Common sense is important in selecting the load to be sampled. To ensure that the results obtained are representative, a large enough sample must be examined. To obtain a sample for analysis, the load is first quartered. One part is then selected for additional quartering until a sample size of about 200 Ib is obtained. It is important to maintain the integrity of each selected quarter, regardless of the odor or physical decay, and to make sure that all the components are measured. Only in this way can some degree of randomness and unbiased selection be maintained.

Commercial and industrial MSW

The field procedure for component identification for commercial and no process industrial solid wastes involves the analysis of representative waste samples taken directly from the source not from a mixed waste load in a collection vehicle.

2.5 Materials commonly separated from MSW

The most common materials that are separated from MSW:

Aluminum: Aluminum recycling is made up of two sectors: aluminum cans and secondary aluminum. Secondary aluminum includes window frames, storm doors, siding, and gutter.

Because secondary materials are of different grades, specifications for recycled aluminum should be checked to recover the maximum value when selling separated materials to brokers. The demand for recycled aluminum cans is high as it takes 95 percent less energy to produce an aluminum can from existing can than from ore.

Paper: The principal types of waste paper that are recycled are old newspaper cardboard, high-grade paper and mixed paper.

Plastics: plastics can be classified into two general categories, clean commercial grade scrap and post-consumer scrap. The two types of post-consumer plastics that are now most commonly recycled are polyethylene terephthalate (PBTE/1), which is used for the manufacture of soft-drink bottles, and high-density polyethylene (HDPE/2), used for milk and water containers and detergent bottles.

Glass: Glass is also a commonly recycled material. Container glass (for food and beverage), flat glass (e.g., window glass), and pressed or amber and green glass are the three principal types of glass found in MSW. Glass to be reprocessed is often separated by color into categories of clear, green, and amber.

Ferrous Metals(Iron and Steel): The largest amount of recycled steel has traditionally come from large items such as cars and appliances.

Nonferrous Metals: Recyclable nonferrous metals arc recovered from common household items (outdoor furniture, kitchen cookware and appliances, I adders, tools, hardware); from construction and demolition projects (copper wire, pipe and plumbing supplies, light fixtures, aluminum siding, gutters and downspouts. Doors, windows); and from large consumer, commercial, and industrial products (appliances, automobiles, boats, trucks, aircraft, machinery). Virtually all nonferrous metals can be recycled if they are sorted and free of foreign materials such as plastics, fabrics, and rubber.

Yard Wastes Collected Separately: In most communities yard wastes are collected separately. The composting of yard wastes has become of great interest as cities and town seek to find ways in which to achieve mandated diversion goals. Leaves, grass, and bush clipping and brush are the most commonly composted yard wastes stumps and wood are also compostable, but

only after they have been chipped to produce a smaller more uniform size. Composting of the organic fraction of MSW is also becoming more popular.

Construction and Demolition Wastes: In many locations construction and demolition (C&D) wastes are now being processed to recover marketable items such as wood chips for use as a fuel in biomass combustion facilities.

2.6 Future changes in waste components

In planning for future waste management systems, it will be important to consider the changes that may occur in the composition of solid waste with time. Four waste components that have an important influence on the composition of the wastes collected are food waste, paper and cardboard, yard waste and plastics.

Food Wastes: The quantity of residential food wastes collected has changed significantly over the years as a result of technical advances and changes in public attitude. Two technological advances that have had a significant effect are the development of the food processing and packaging industry and the use of kitchen food waste grinders. The percentage of food waste, by weight, has decreased from about 14 percent in the early 1960s to about 9 percent in 1992.

Paper and Cardboard: The percentage of paper and cardboard (also known as paperboard and corrugated paper) found in solid wastes has increased greatly over the past half century, rising from about 20 percent in the early 1940s to about 40% in 1992. It is expected that use of paper and cardboard will remain stable for the next few years.

Yard Wastes: (The percentage of yard wastes in MSW has also increased significantly during the past quarter century, due primarily to passage of laws that prohibit burning of yard wastes. By weight, yard waste currently accounts for about 16 to 24 percent of the waste stream. Environmental conditions such as droughts have also affected the quantities of yard wastes collected in certain locations.