AMERICAN ENVIRONMENTAL

A Renewable Energy Landfill

How a Landfill Works

Presented by:
American Environmental Landfill, Inc.
1420 W. 35th Street, Suite B
Tulsa, OK 74107
Phone: 918-245-7786
Fax: 918-245-7774

How a Landfill Works

So you have just finished your meal at a fast food restaurant and you throw your uneaten food, food wrappers, drink cup, utensils and napkins into the trash can. Odds are you don't think about that waste again. On trash pickup day in your neighborhood, you push your can out to the curb, and workers dump the contents into a big truck and haul it away. You don't have to think about that waste again, either. But maybe you have wondered, as you watch the trash truck pull away, just where that garbage ends up.

Americans generate trash at an astonishing rate of four to seven pounds per day per person, which translates to at least 600,000 tons per day or at least 210 million tons per year! This is almost twice as much trash per person as most other major countries. What happens to this trash? Some gets recycled or recovered and some is burned, but the majority is buried in landfills. In this overview of how a landfill works, we will examine how a landfill is made, what happens to the trash in landfills, what risks are associated with a landfill and how these risks are solved.

How is Trash Disposed of?

The trash production in the United States has almost tripled since 1960 (Figure 2). This trash is handled in various ways. About 27 % of the trash is recycled or composted, 16% is burned and 57% is buried in landfills. The amount of trash buried in landfills has doubled since 1960. The United States ranks about in the middle of the major countries (United Kingdom, Canada, Germany, France and Japan) in landfill disposal. The United Kingdom ranks highest, burying about 90 percent of its solid waste in landfills.

What is a Landfill?

There are two ways to bury trash:

- Dump - an open hole in the ground where trash is buried, often full of various pests and animals including rats, mice and birds. (This is most people's idea of a landfill!)
- Landfill - carefully designed structure built into or on top of the ground in which trash is isolated from the surrounding environment (groundwater, air, rain). This isolation is accomplished with a bottom liner and daily covering of soil.
- Sanitary landfill - landfill that uses a clay liner to isolate the trash from the environment.
- Municipal solid waste (MSW) landfill - uses a synthetic (plastic) liner to isolate the trash from the environment.

The purpose of a landfill is to bury he trash in such a way that it will be isolated from groundwater, will be kept dry and will not be in contact with air. Unlike a compost pile, a landfill is designed to keep the trash away from people, but does not allow it to decompose quickly.

Proposing the Landfill

For a landfill to be built, the operators have to make sure that they follow certain steps. In most parts of the world, there are regulations that govern where a landfill can be placed and how it can operate. The whole process begins with someone proposing the landfill.

In the United States, taking care of trash and building landfills are local government responsibilities. Before a city or other authority can build a landfill, an environmental impact study must be done on the proposed site to determine:

- The area of land necessary for the landfill
- The composition of the underlying soil and bedrock
- The flow of surface water over the site
- The impact of the proposed landfill on the local environment and wildlife
- The historical or archaeological value of the proposed site

Once the environmental impact study has been completed, permits must be obtained from the local, state and federal governments. In addition, money will have to be raised from taxes or municipal bonds to build and operate the landfill if it is owned by the government. In that case, funding will come from some public source; therefore public approval must be obtained through local governments or a referendum. Otherwise, landfills have to be constructed and managed by free enterprise and small business owners.

Building the Landfill

Once the environmental impact study is complete, the permits are granted and the money has been raised (be it public or private funds), construction begins. First, access roads to the landfill site must be built if they do not already exist. These roads will be used by construction equipment, sanitation services and the general public. After roads have been built, then the landfill can be excavated.

Parts of a Landfill

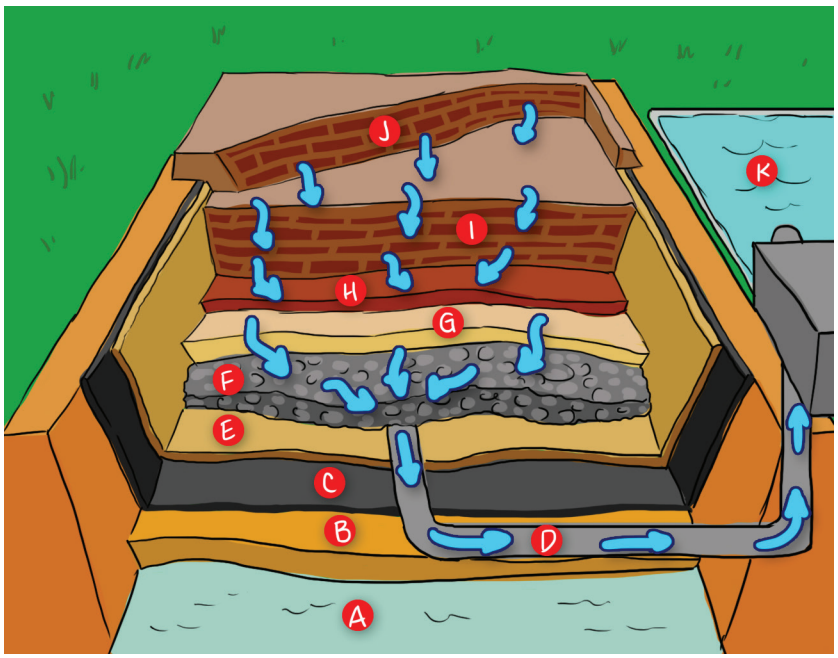
This cross-section drawing shows the structure of a municipal solid waste landfill. The arrows indicate the flow of leachate, which is contaminated substances.

The basic parts of a landfill, as shown in Figure 1, are:

- Bottom liner system - separates trash and subsequent leachate from groundwater
- Cells (old and new) - where the trash is stored within the landfill
- Storm water drainage system - collects rain water that falls on the landfill
- Leachate collection system - collects water that has percolated through the landfill itself and contains contaminating substances (leachate)
- Methane collection system - collects methane gas that is formed during the breakdown of trash
- Covering or cap - seals off the top of the landfill

Figure 1 Structure of a Municipal Solid Waste Landfill; the arrows indicate the flow of leachate

Each of these parts is designed to address specific risks that are encountered in a landfill. So, as we discuss each part of the landfill, we'll explain what risk is solved.



A Ground Water
B Compacted Clay
C Plastic Liner
D Leachate Collection Pipe
E Geotextile Mat
F Gravel
G Drainage Layer
H Soil Layer
I Old Cells
J New Cells
K Leachate Pond

Figure 1 Structure of a Municipal Solid Waste Landfill; the arrows indicate the flow of leachate

Bottom Liner System

A landfill's major purpose and one of its biggest challenges is to contain the trash so that the trash doesn't cause problems in the environment. The bottom liner prevents the trash from coming in contact with the outside soil, particularly the groundwater. In MSW landfills, the liner is usually some type of durable, puncture-resistant synthetic plastic (polyethylene, high-density polyethylene, polyvinylchloride). It is usually 30-100 mils thick. The plastic liner may be also be combined with compacted clay soils as an additional liner and surrounded on either side by a fabric mat (geotextile mat) that will help to keep the plastic liner from tearing or puncturing from the nearby rock and gravel layers.

Cells (Old and New)

Perhaps, the most precious commodity and overriding risk in a landfill is air space. The amount of space is directly related to the capacity and usable life of the landfill. If you can increase the air space, then you can extend the usable life of the landfill. To do this, trash is compacted into areas, called cells, that contain only one day's amount of trash. Trash within cells are compressed by using heavy equipment (tractors, bulldozers, rollers and graders) that go over the mound of trash several times). Once the cell is made, it is covered with six inches of soil and compacted further. Cells are arranged in rows and layers of adjoining cells (lifts).

In addition to compressing the trash into cells, space is conserved by excluding bulky materials, such as carpets, mattresses, foam and yard waste, from the landfill.

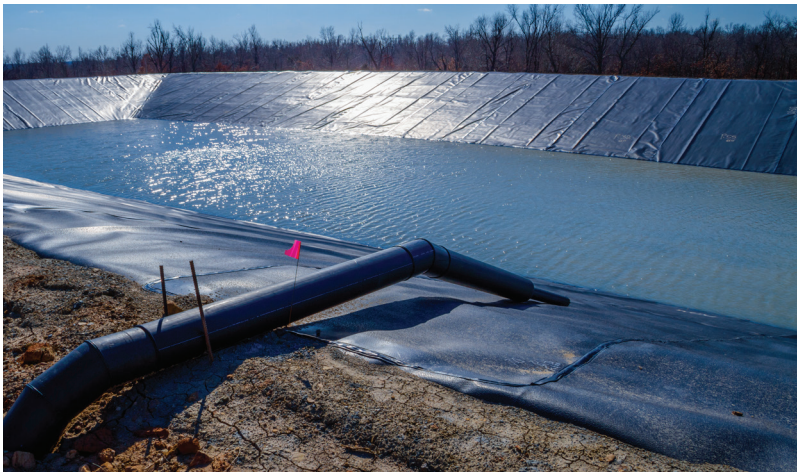
Storm Water Drainage

It is important to keep the landfill as dry as possible to reduce the amount of leachate. This can be done in two ways:

- Exclude liquids from the solid waste. Solid waste must be tested for liquids before entering the landfill. This is done by passing samples of the waste through standard paint filters. If no liquid comes through the sample after 10 minutes, then the trash is accepted into the landfill.
- Keep rainwater out of the landfill. To exclude rainwater, the landfill has a storm drainage system. Plastic drainage pipes and storm liners collect water from areas of the landfill and channel it to drainage ditches surrounding the landfill's base.

The ditches are either concrete or gravel-lined and carry water to collection ponds to the side of the landfill. In the collection ponds, suspended soil particles are allowed to settle, and the water is tested for leachate chemicals. Once settling has occurred and the water has passed tests, it is then pumped or allowed to flow off-site.

Leachate Collection System



No system to exclude water from the landfill is perfect and water does get into the landfill. The water percolates through the cells and soil in the landfill much as water percolates through ground coffee in a drip coffee maker. As the water percolates through the trash, it picks up contaminants (organic and inorganic chemicals, metals, biological waste products of decomposition) just as water picks up coffee in the coffee maker. This water with the dissolved contaminants is called leachate and is typically acidic.

To collect leachate, perforated pipes run throughout the landfill. These pipes then drain into a leachate pipe, which carries leachate to a collection pond. Leachate can be pumped to the collection pond or flow to it by gravity.

The leachate in the pond is tested for acceptable levels of various chemicals (biological and chemical oxygen demands, organic chemicals, pH, calcium, magnesium, iron, sulfate and chloride) and allowed to settle. After testing, the leachate must be treated like any other sewage/wastewater; the treatment may occur on-site or off-site. Some landfills recirculate the leachate and later treat it. This method reduces the volume of leachate from the landfill, but increases the concentrations of contaminants in the leachate.

Methane Collection System

Bacteria in the landfill break down the trash in the absence of oxygen (anaerobic) because the landfill is airtight. A byproduct of this anaerobic breakdown is landfill gas, which contains approximately 50 percent methane and 50 percent carbon dioxide with small amounts of nitrogen and oxygen. This presents a hazard because the methane can explode and/or burn. So, the landfill gas must be removed. To do this, a series of pipes are embedded within the landfill to collect the gas. In some landfills, this gas is vented or burned.

More recently, it has been recognized that this landfill gas represents a usable energy source. The methane can be extracted from the gas and used as fuel.

Trash to Energy

Today, there are some innovative approaches for using non-recyclable trash residue at a landfill to produce renewable energy and power homes. AEL has just implemented such a project which is producing electricity for the surrounding community and other nearby counties.

Our process starts by capturing methane gas from decomposing trash at our very own landfill through a series of strategically drilled wells. This allows us to collect the gas and convert it via three generators into electricity. We're then able to deliver that electricity to a local power plant to power over 4800 homes around our landfill area.

It's our way of squeezing every bit of use out of the disposal process—creating new sources of renewable energy—while also benefitting our community.

Covering or Cap

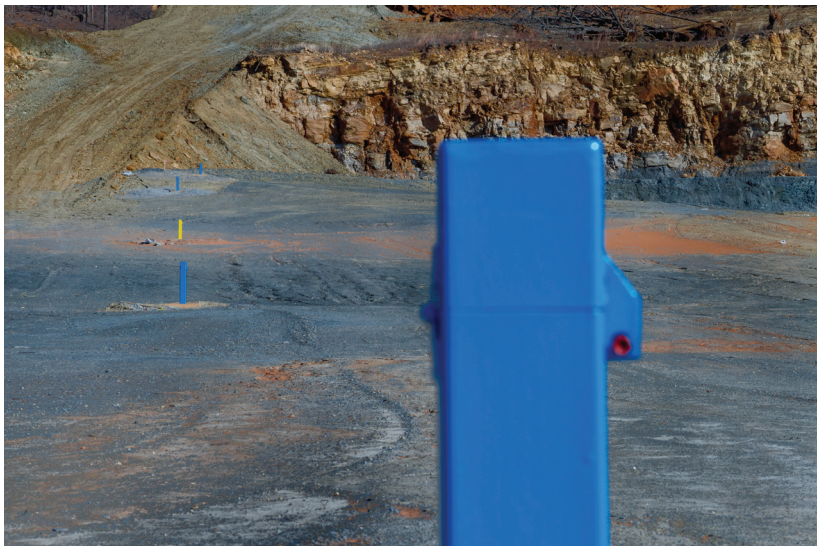
As mentioned above, each cell is covered daily with six inches of compacted soil. This covering seals the compacted trash from the air and prevents pests (birds, rats, mice, flying insects, etc.) from getting into the trash. This soil takes up quite a bit of space. Because space is a precious commodity, many landfills are experimenting with tarps or spray coverings of paper or cement/paper emulsions. These emulsions can effectively cover the trash, but take up only a quarter of an inch instead of 6 inches!

When a section of the landfill is finished, it is covered permanently with a polyethylene cap (40 mil). The cap is then covered with a 2-foot layer of compacted soil. The soil is then planted with vegetation such as grass or kudzu to prevent erosion of the soil by rainfall and wind. No trees, shrubs or plants with deep penetrating roots are used because their plant roots would contact the underlying trash and allow leachate out of the landfill.

Occasionally, leachate may seep through a weak point in the covering and come out on to the surface. It appears black and bubbly. Later, it will stain the ground red. Leachate seepages are promptly repaired by excavating the area around the seepage and filling it with well-compacted soil to divert the flow of leachate back into the landfill.

Groundwater Monitoring

At many points surrounding the landfill are groundwater monitoring stations. These are pipes that are sunk into the groundwater so water can be sampled and tested for the presence of leachate chemicals. The temperature of the groundwater is measured. Because the temperature rises when solid waste decomposes, an increase in groundwater temperature could indicate that leachate is seeping into the groundwater. Also, if the pH of the groundwater becomes acidic, that could indicate seeping leachate.



What Happens to Trash in a Landfill?

Trash put in a landfill will stay there for a very long time. Inside a landfill, there is little oxygen and little moisture. Under these conditions, trash does not break down very rapidly. In fact, when old landfills have been excavated or sampled, 40-year-old newspapers have been found with easily readable print. Landfills are not designed to break down trash, merely to bury it. When a landfill closes, the site, especially the groundwater, must be monitored and maintained for up to 30 years!

How is a Landfill Operated?

A landfill, such as American Environmental Landfill, must be open and available every day. Customers are typically municipalities and construction/demolition companies, although residents may also use the landfill. A layout of a typical landfill with supporting structures is shown in Figure 2.

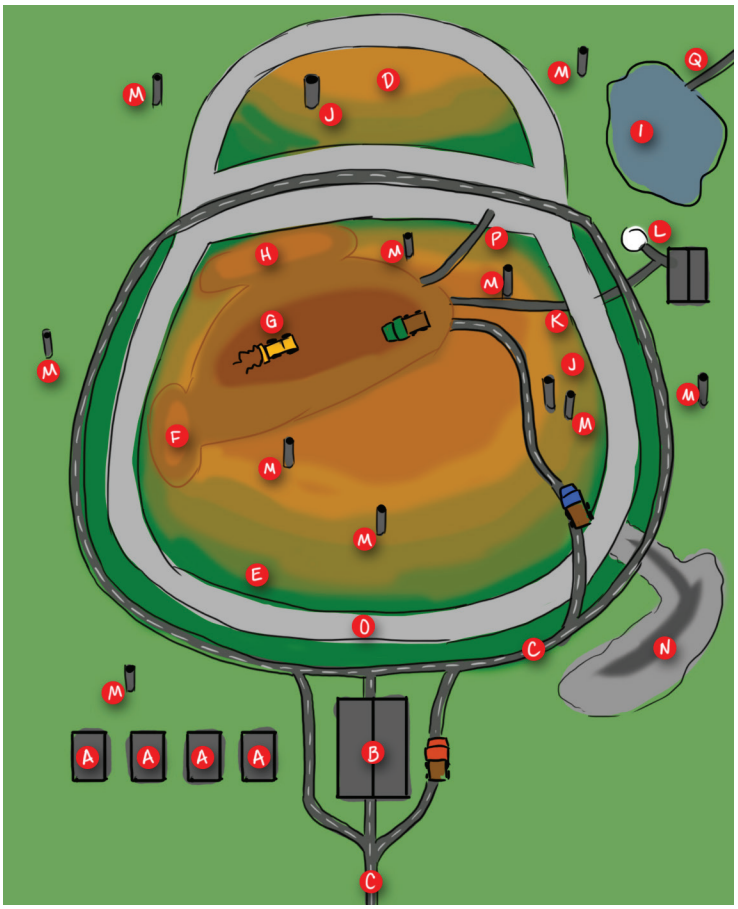


Figure 2 Typical Landfill Layout

Oftentimes near the entrance of the site is a recycling center where residents can drop off recyclable materials (aluminum cans, glass bottles, newspapers, blend paper, corrugated cardboard). This helps to reduce the amount of material in the landfill. Some of these materials are banned from landfills by law because they can be recycled.

A Recycling Centers
B Scale House
C Access Road
D Sanitary Landfill-Closed (no line-clay bottom)
E MSW Landfill (liner present)
F New Cell Prep Area
G Cell Being Filled
H Storm Drainage Collection
I Leachate Collection Pond
J Methane Vent
K Methane Piper
L Methane Station
M Monitoring Station
N Run-off Collection Basin
O Storm Drainage Basin
P Storm Water Pipe
Q To City Water Treatment

As customers enter the site, their trucks are weighed at the scale house. Customers are charged tipping fees for using the site. The tipping fees vary from $10 to $40 per ton. These fees are used to pay for bonds or operational costs.

Along the site, there are drop-off stations for materials that are not wanted or legally banned by the landfill. A multi-material drop-off station is used for tires, motor oil, lead-acid batteries and drywall. Some of these materials can be recycled.

In addition, there is a household hazardous waste drop-off station for chemicals (paints, pesticides, other chemicals) that are banned from the landfill. These chemicals are disposed of by private companies. Some paints can be recycled and some organic chemicals can be burned in incinerators or power plants.

Other structures alongside the landfill are the borrowed area that supplies the soil for the landfill, the runoff collection pond, leachate collection ponds, and methane station.
Landfills are intelligent structures that, when properly designed and managed, serve an important purpose and provide unlimited benefits to the communities they serve.