Solid Waste Management:

Landfill Design

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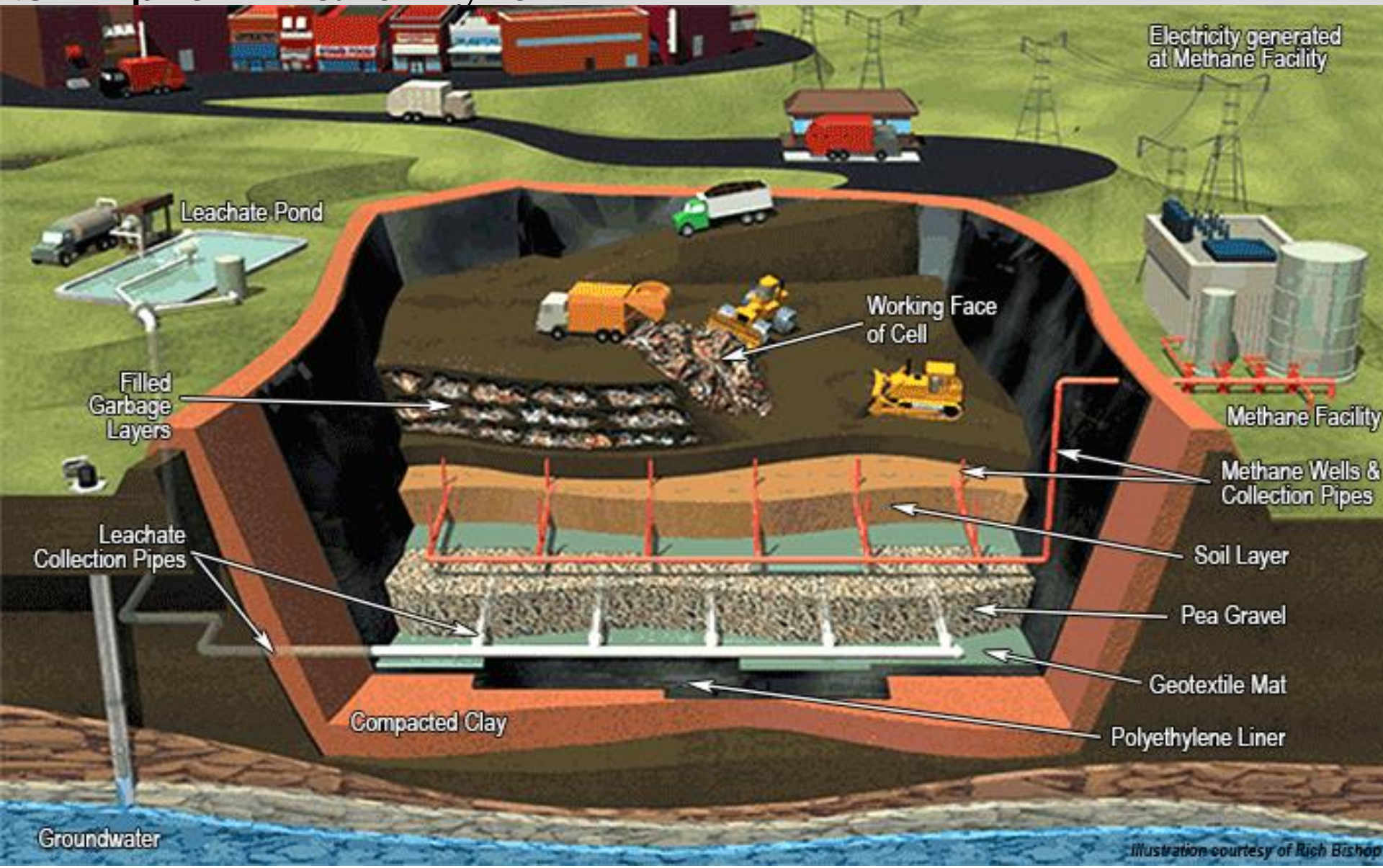
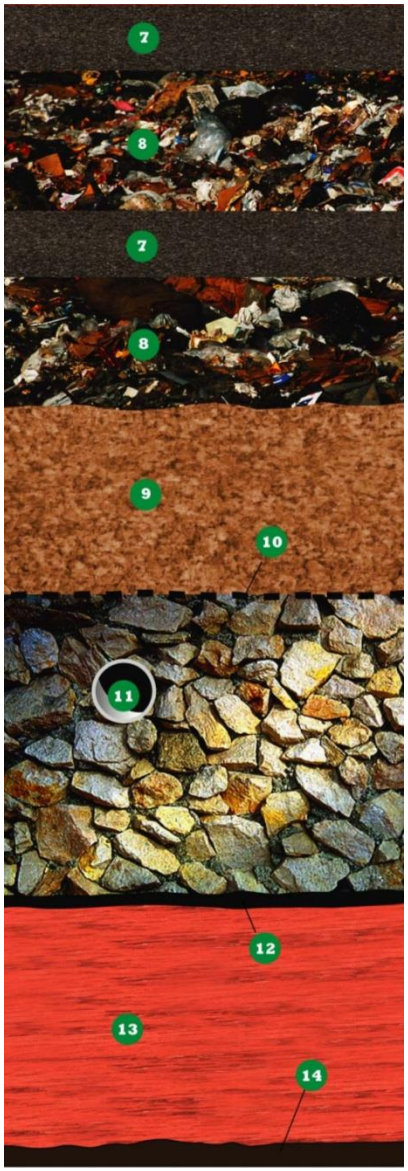
Simple Anatomy of LF



Bottom of LF



Daily Cover

At the end of each day, waste is covered with 6-12 inches of soil.

- **reduces odors**
- **keeps litter from blowing away**
- **deters scavengers/animals/rodents**

Waste

Waste is compacted in layers to reduce its volume.

Sand/Gravel Layer

Collects leachate (liquid produced from waste) and funnels it to leachate pipe system below.

Leachate Pipe System

Pipes collect leachate and pump it out of the landfill and to a water treatment plant, retention pond, or another proper method of disposal.

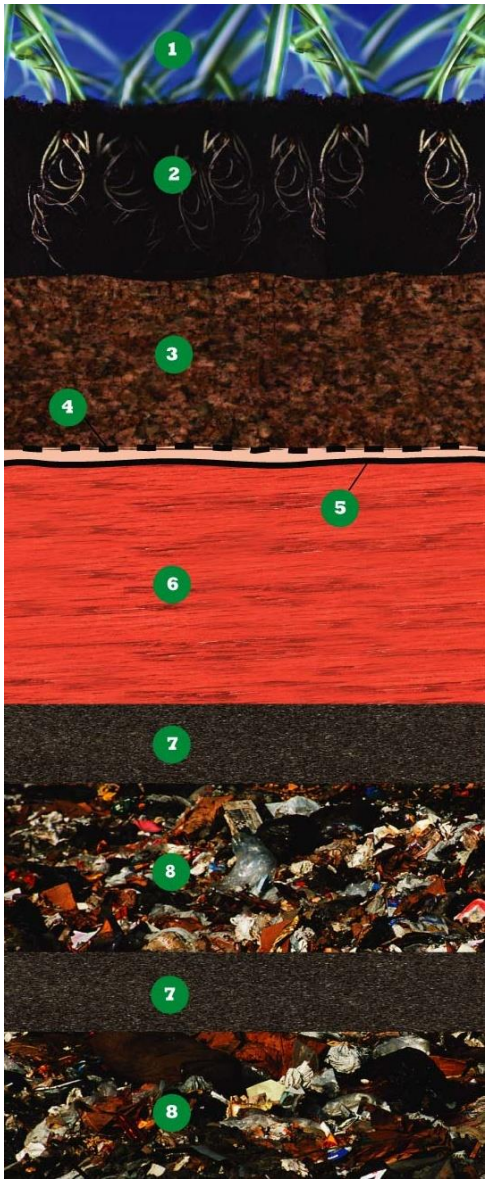
Geomembrane – Plastic Layer

A thick plastic layer lines the landfills and prevents leachate from entering the ground. The plastic is made from high-density polyethylene which is tough and impermeable.

Clay Layer

Compacted Clay is first laid in the landfill space to form a barrier to prevent leachate leaks to protect the soil and hold the trash in place. Clay is used due to its moldable and impermeability qualities.

Top of LF



Protective Cover

Cover Vegetation – when landfills are full they are covered with native grasses and shrubs and used as recreation areas.

Top Soil & Cover Soil – supports and maintains the growth of vegetation and protects the landfill cap.

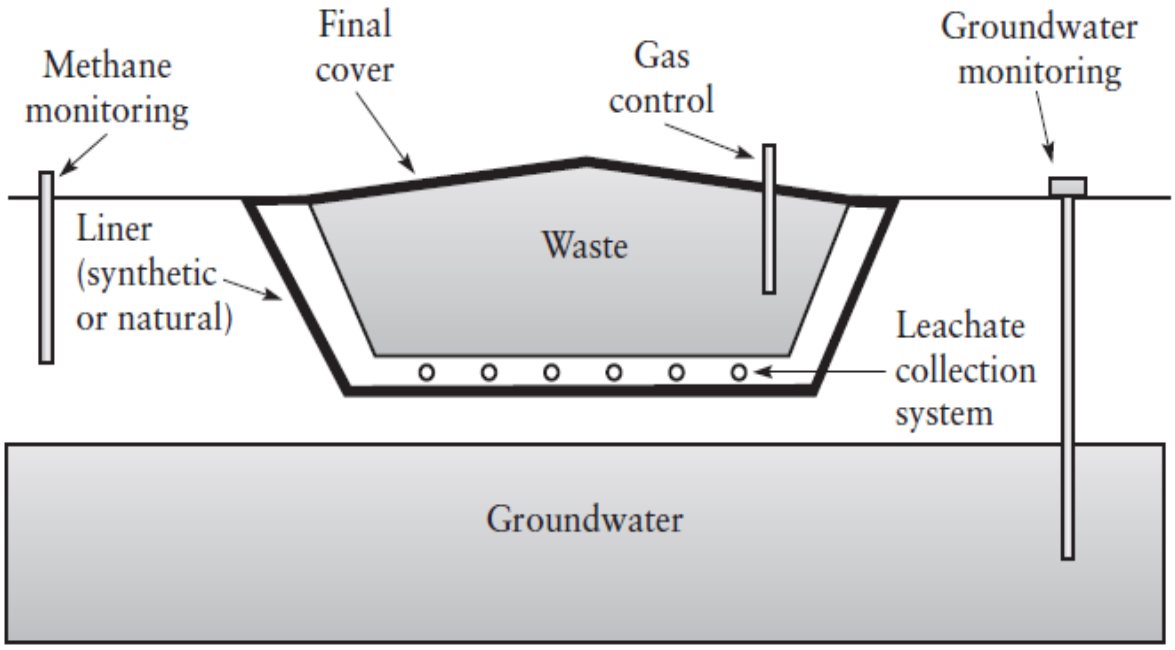
Protective Cover

Geo-membrane and Clay – Compacted clay and a thick plastic layer forms a ‘cap’ that prevents excess precipitation from entering landfill and prevent the escape of landfill gas.

Soil and Trash Layers of Working Landfill

LF Design

- **Liners**
- **the leachate-collection and management system,**
- **Gas management facilities,**
- **the final cap**



Liners

- The liner system is required to prevent migration of leachate from the landfill and to facilitate removal of leachate.
- It generally consists of multiple layers of natural material and/or geo-membranes selected for their low permeability.
- Soil liners usually are constructed of natural clays or clayey soils. If natural clay materials are not readily available, commercial clays (bentonite) can be mixed with sands to produce a suitable liner material.
- Geo-membranes are impermeable (unless perforated) thin sheets made from synthetic resins, such as polyethylene, polyvinyl chloride, or other polymers.
- High-density polyethylene (HDPE) tends to be used in MSW landfill liners most commonly, because it is resistant to most chemicals found in landfill leachates.
- Landfills may be designed with single, composite, or double liners.
- The bottom is a clay material and the top layer is a geo-membrane. The two layers of a composite liner are in intimate contact to minimize leakage. A double liner may be either two single liners or two composite liners (or even one of each).
- Each liner is provided with a leachate collection system. The collection system separating the two liners is a leak detection system—a series of pipes placed between the liners to collect and monitor any leachate that leaks through the top liner.

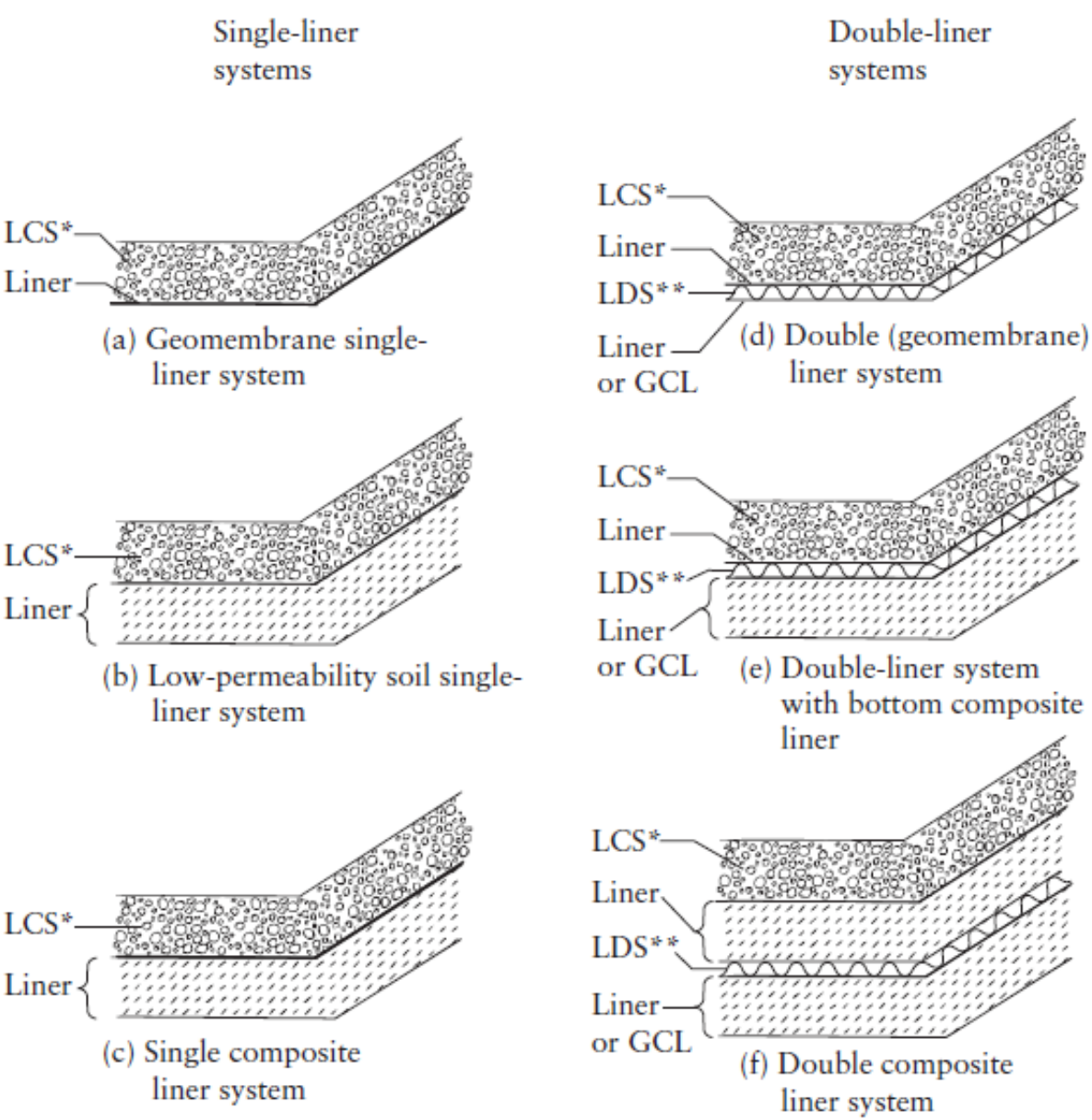


Figure 4-9 Examples of liner systems in municipal solid waste landfills. LCS = leachate-collection system, GCL = geosynthetic clay liner, and LDS = leachate-detection system.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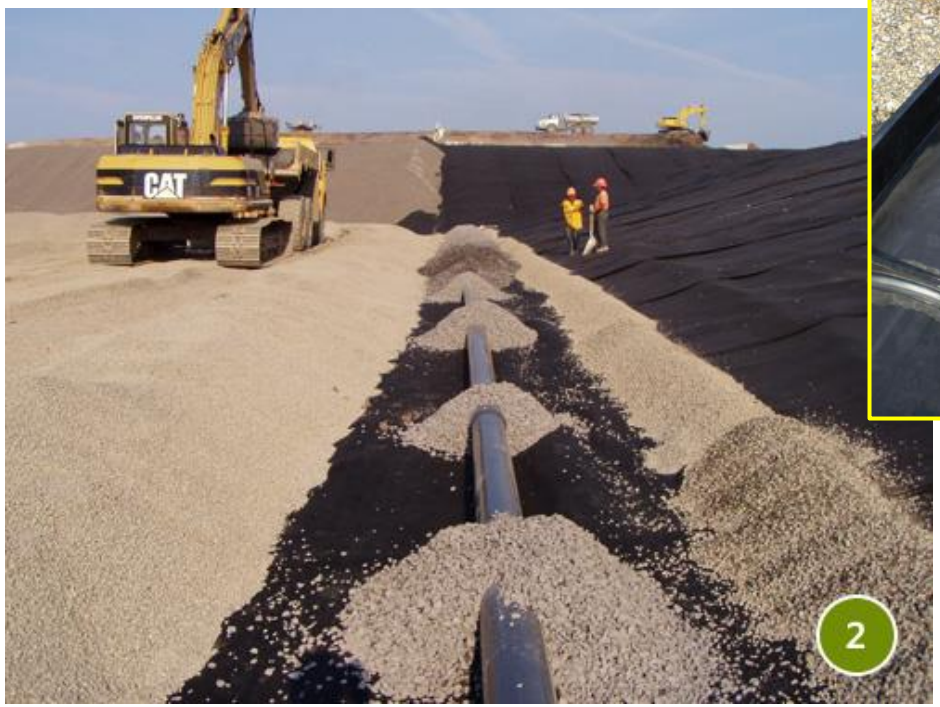
Mike Kleist | Dreamstime.com

Leachate Collection, Treatment, and Disposal

- Leachate is directed to low points at the bottom of the landfill through the use of an efficient drainage layer composed of sand, gravel, or a geo-synthetic material. Perforated pipes are placed at low points to collect leachate and are sloped to allow the moisture to move out of the landfill.



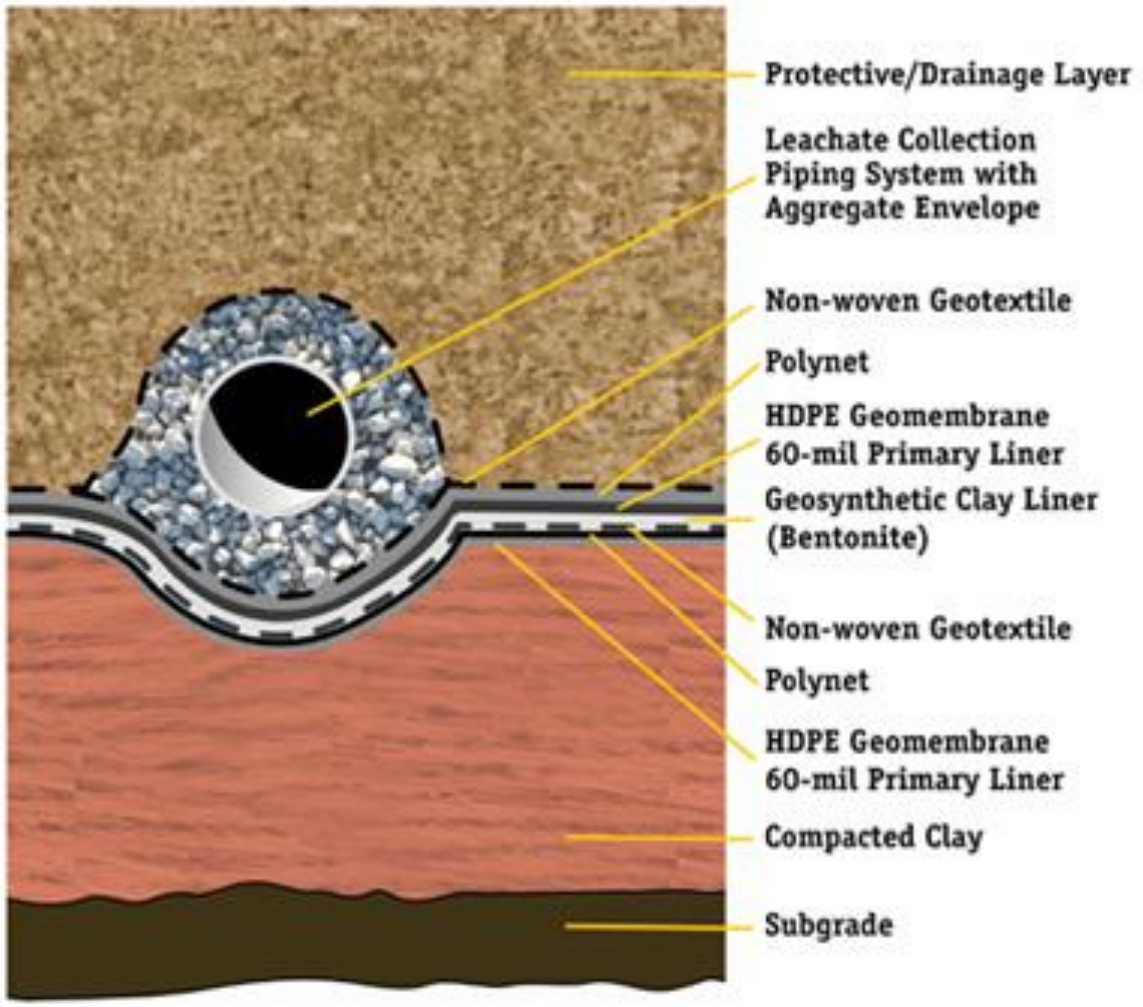
Leachate Collection and Storage

The primary purpose of lining a landfill cell is to minimize the potential for groundwater contamination.

The liner serves as a barrier between the buried waste and the groundwater and forms a catch basin for leachate produced by the landfill.

The leachate that is collected within the cell must be removed from above the liner as quickly as possible.

Leachate is typically removed by two means: gravity flow or pumping.



The various components of a leachate collection system for an MSW landfill typically include the following.

- Protective and drainage layers
- Perforated collection lateral and header pipes
- Pump station sump
- Leachate pumps
- Pump controls
- Pump station appurtenances
- Force main or gravity sewer line

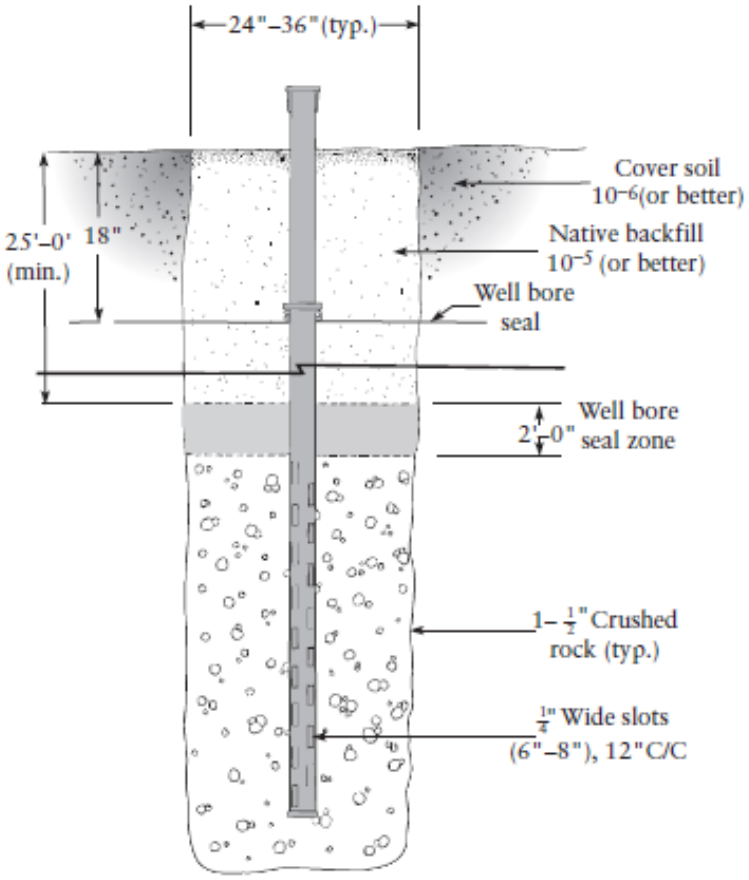
Table 4-10 Design Guidance for Leachate-Collection System Components

Parameter	Range	Median
Leachate loading rate (gpd/ac)	600–1000	750
Maximum leachate head (in.)	9–12	11
Pipe spacing (ft)	60–400	180
Collection pipe dia. (in.)	6–8	8
Collection pipe material	PVC or HDPE	HDPE
Pipe slope (%)	0.5–2	1
Drainage slope (%)	0.2–2	1

Source: Reinhart, D. R., and T. Townsend. 1998. "Assessment of Leachate Collection System Clogging at Florida Municipal Solid Waste Landfills." Report to the Florida Center for Solid and Hazardous Waste Management (April).

Landfill Gas Collection

- Gas generated within a landfill will move by pressure gradient, following paths of least resistance.
- Uncontrolled migrating gas can collect in sewers, sumps, and basements, leading to tragic consequences if explosions occur.
- To prevent gas migration, gas vents or wells must be provided.



Gas Collection & Control

➢ ***Passive collection systems:***

- collect landfill gas using vent collectors and release the gas to the atmosphere without treatment or conveyance to a common point. Passive vents are often provided using **natural convective forces** within the landfill to direct gas to the atmosphere.

- Passive vents may reach only a few feet below the cap or may reach up to 75% of the landfill depth, designed in a similar manner to the active extraction well described next.

- Typical spacing for a passive vent is one per 9000 yd3 (7500 m3).

➢ ***Active collection systems:***

- link collection wells with piping and extract the gas under **vacuum** created by a central blower. Active extraction wells may be vertical or horizontal wells, although vertical wells are more frequently employed. Vertical wells are installed in landfills using auger or rotary drills.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