

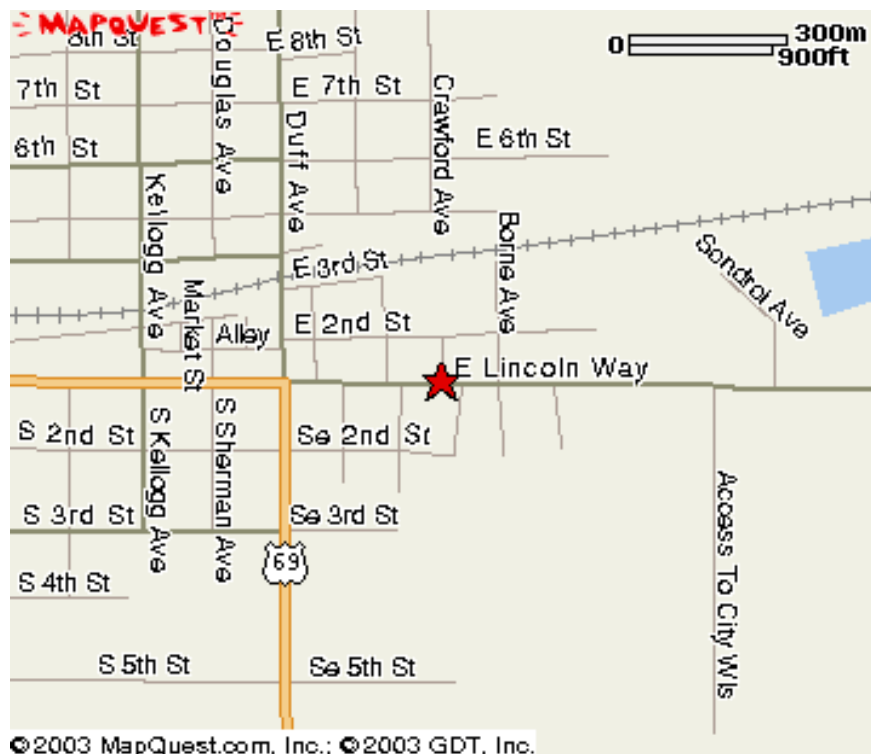
## CE 326 Principles of Environmental Engineering

### INTEGRATED SOLID WASTE MANAGEMENT

#### Field Trip:

Meet at the Ames Resource Recovery Plant at half past the hour of the scheduled lab period. The plant is located at 110 Center Avenue, off of Lincoln Way, three blocks East of Duff Ave.

Write a discussion (about one page) on the operation of the Ames Resource Recovery Plant (i.e., how does it work, what does it do, why was it built, what are its benefits, what are its disadvantages, and what are the alternatives). Include in your discussion what is meant by an integrated approach to solid waste management and how the Ames Resource Recovery Plant fits into that approach. The write-up will be due the following lab period.







# Municipal Solid Wastes

**CE 326 Principles of Environmental  
Engineering**

**Prof. Tim Ellis**

**February 4, 2008**

<http://www.pbase.com/globetrotter81/image/45798332>



# What is a solid waste

- all wastes from human and animal activities that are normally s\_\_\_\_\_ or semi-s\_\_\_\_\_ and are d\_\_\_\_\_ (includes municipal, industrial, and hazardous wastes).

<http://www.pbase.com/globetrotter81/>





# What is Solid Waste Management?

● activities involved with the

- reduction of g\_\_\_\_\_ ,
- C\_\_\_\_\_





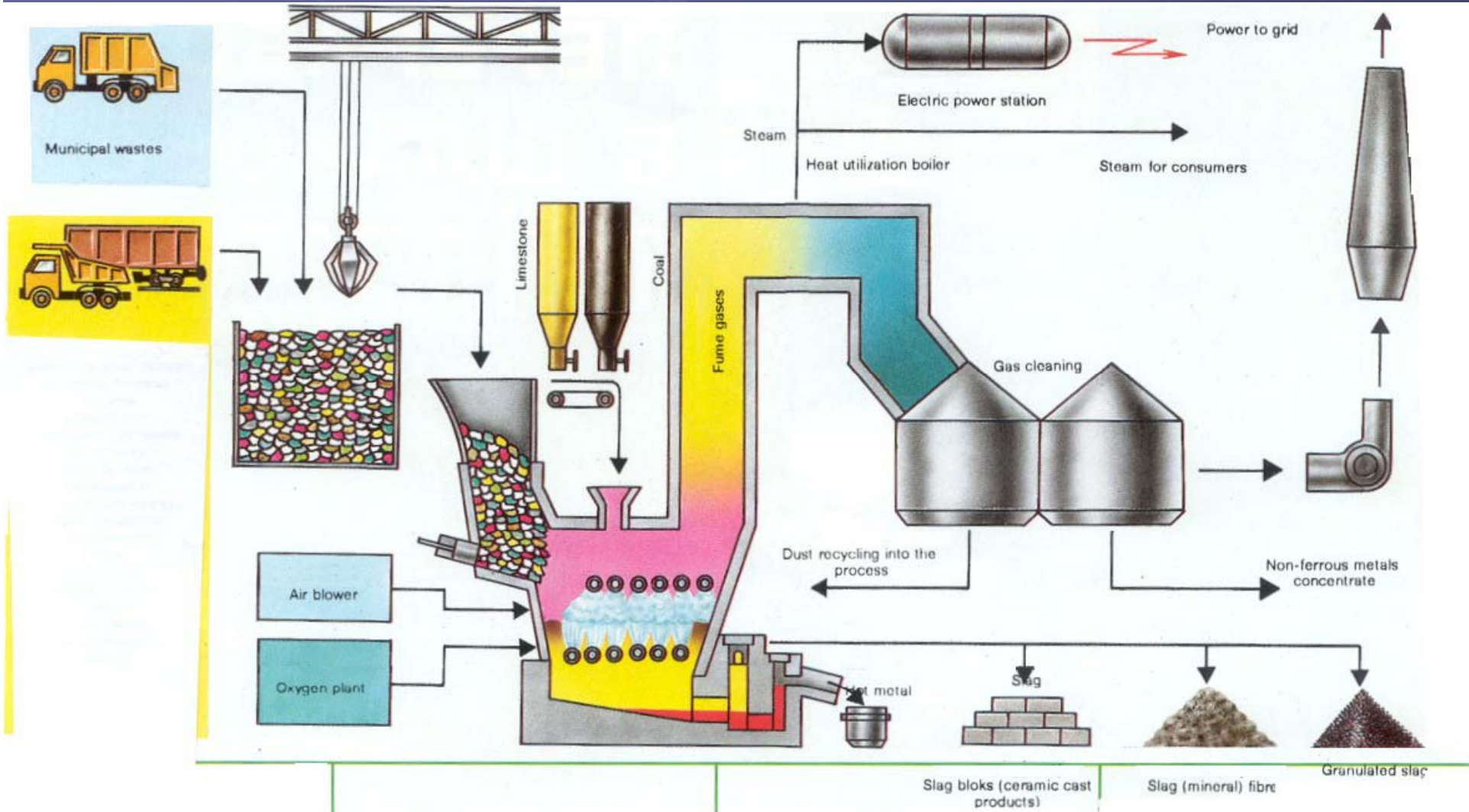
# What is Solid Waste Management?

● s \_\_\_\_\_,  
t \_\_\_\_\_, p \_\_\_\_\_,  
and d \_\_\_\_\_ of  
solid wastes.





# Trash to energy

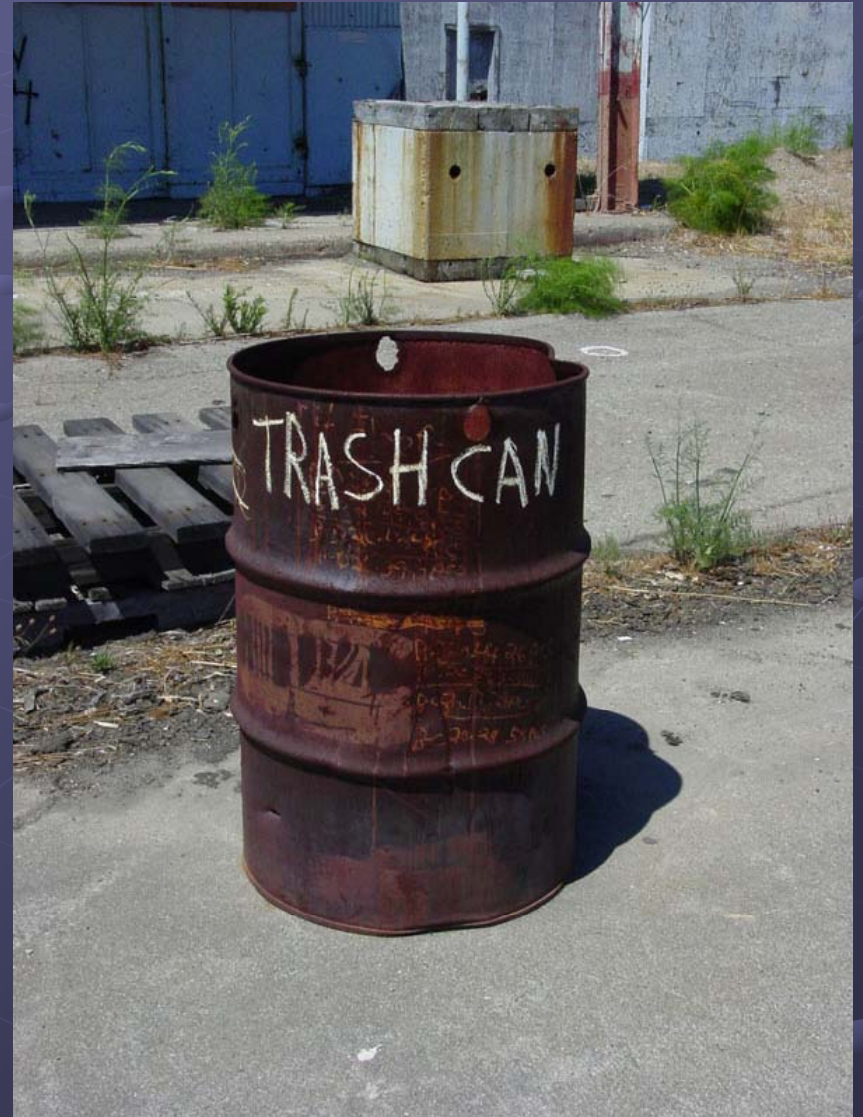




# What is Solid Waste Management?

## ● solid waste management concerns

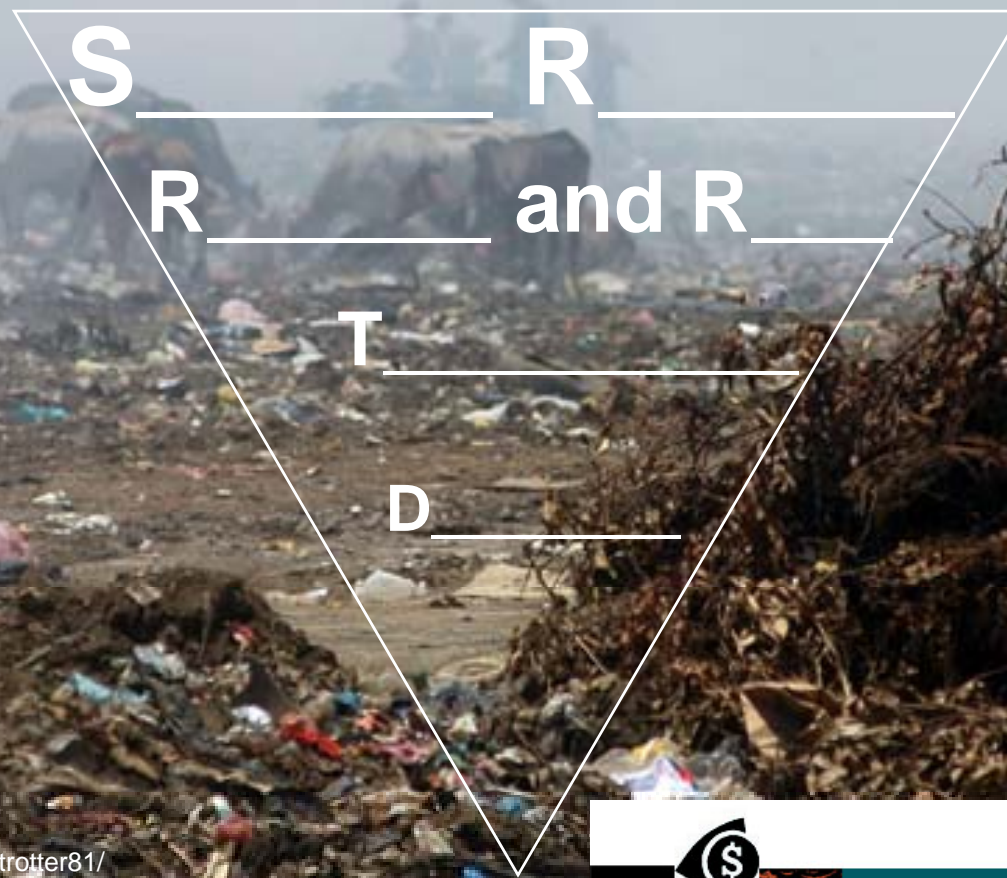
- public health \_\_\_\_\_,
- environmental \_\_\_\_\_,
- economic \_\_\_\_\_,
- conservation,
- aesthetics, and
- other environmental considerations.





# What is Integrated Solid Waste Management?

Activities designed to meet the hierarchy of MSW management objectives



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Solid Waste Management



*Waste Generation*

*Waste handling, separation, storage,  
and processing at the source:*  
•shredding, baling  
•separation for recycling

*Collection*

*Transfer Station*

*Processing Facility*  
•recycling  
•resource recovery  
•incineration  
•composting

*Ultimate Disposal*  
•landfill



# Quantities of Solid Waste Produced

- total production is approximately = \_\_\_\_\_ million tons/yr (decrease of 1.6 M tons from 2004)
- average solid waste generated per person = \_\_\_\_\_ lbs/day
- total production = \_\_\_\_\_ tons/day
  - density = \_\_\_\_\_ lbs/yd<sup>3</sup>
  - if placed in 3 foot layer, it would cover \_\_\_\_\_ sq. yds.
  - \_\_\_\_\_ sq. miles
  - if placed in 1 cu. ft. stacks, it would rise \_\_\_\_\_ miles high



# One year's worth of solid waste from a single household





# Characterization of Solid Waste

- Kind, composition, and source.
- Material
- Product category



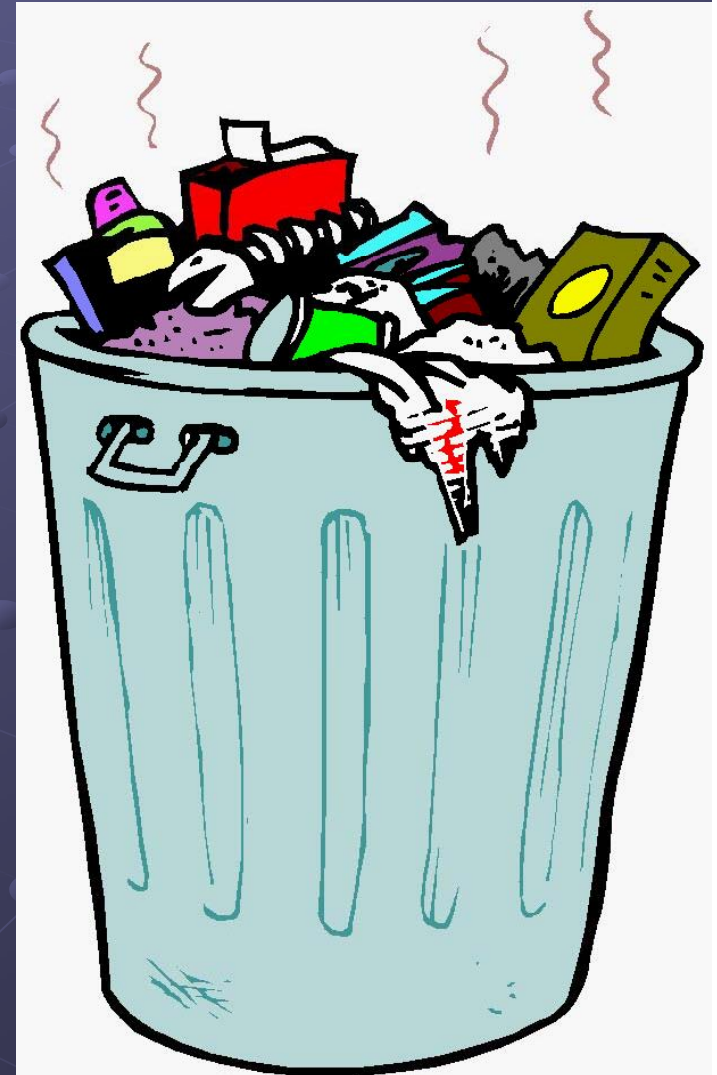


# Characterization of Solid Waste

- Two main categories:

- G\_\_\_\_\_

- animal and vegetable waste resulting from f\_\_\_\_\_ preparation, originates primarily from k\_\_\_\_\_ and r\_\_\_\_\_ large part of the putrescible matter in MSW, source of o\_\_\_\_\_





# Characterization of Solid Waste

## • R \_\_\_\_\_ :

- **combustible and non-combustible components of MSW**

### • **combustible fraction includes:**

- p \_\_\_\_\_, r \_\_\_\_\_, cartons, boxes, furniture, tree branches, etc.
- T \_\_\_\_\_ is synonymous with combustible portion of rubbish

### • **Noncombustibles**

- includes i \_\_\_\_\_ portion of rubbish:
  - tin cans,
  - metals,
  - glass, etc.



# Other categories

- A\_\_\_\_\_
- S\_\_\_\_\_ Refuse
- Dead A\_\_\_\_\_
- Abandoned v\_\_\_\_\_
- I\_\_\_\_\_ Wastes (food processing wastes, lumber and metal scraps, shavings)
- D\_\_\_\_\_ Wastes (lumber, pipes, bricks, masonry)
- C\_\_\_\_\_ Wastes (lumber, pipe, scraps)
- Special Wastes (includes hazardous substances, explosives, radioactive materials)
- W\_\_\_\_\_ Treatment Plant Residues (includes screenings and grit)



# MSW Composition by Material

- p\_\_\_\_\_ and paperboard
- g\_\_\_\_\_
- m\_\_\_\_\_ (steel, aluminum, other nonferrous metals)
- p\_\_\_\_\_
- r\_\_\_\_\_ and leather
- t\_\_\_\_\_
- w\_\_\_\_\_
- other m\_\_\_\_\_



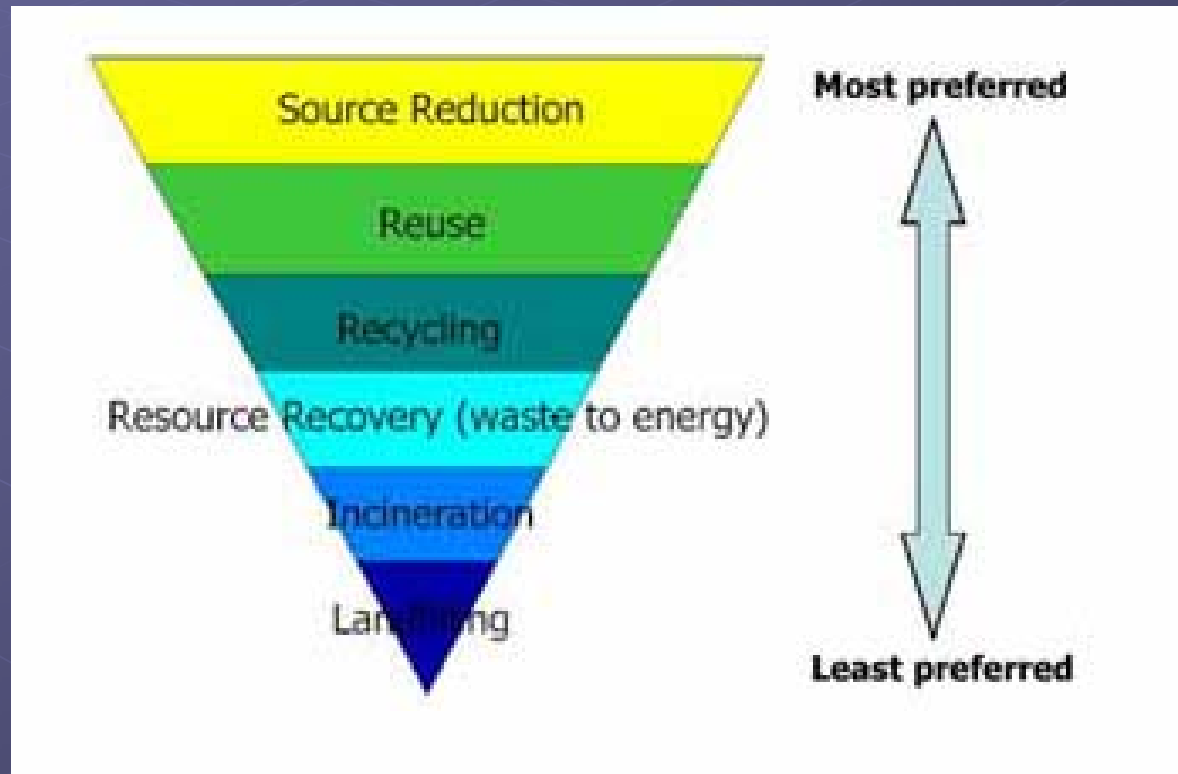
# MSW Composition by Product Category

- c\_\_\_\_\_ and packaging
- n\_\_\_\_\_ goods (e.g., newspapers, “selected consumer electronics”)
- d\_\_\_\_\_ goods (e.g., appliances)
- y\_\_\_\_\_ trimmings
- f\_\_\_\_\_ scraps
- other



# Integrated Solid Waste Management

● Priority is on s\_\_\_\_\_r\_\_\_\_\_





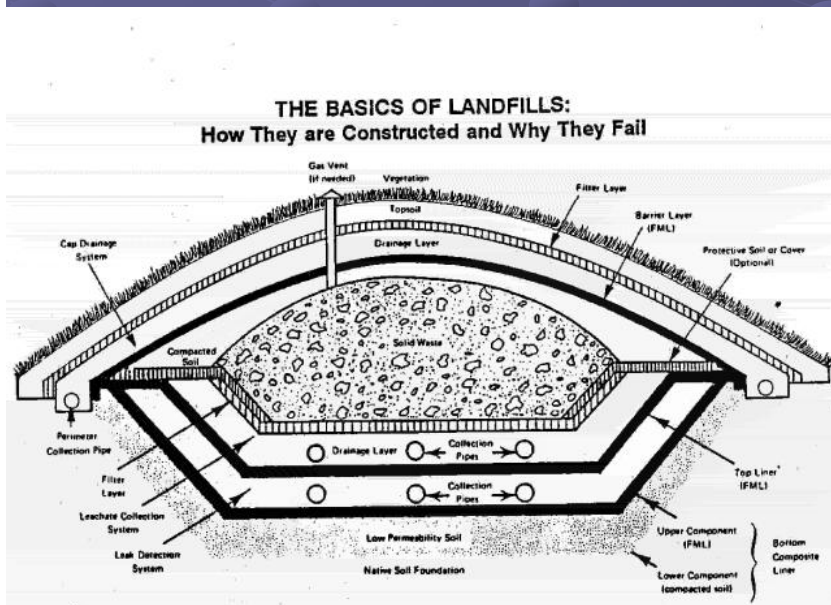
## Second Priority following Source Reduction is Recycling and Reuse.

- \_\_\_\_\_% recycling rate in 1999 (64 M tons) vs. 32% in 2005 (58.4 M tons MSW + 20.6 M tons compost)
- \_\_\_\_\_ curbside recycling programs in 1998 vs. 8,550 in 2005
- \_\_\_\_\_ yard trimmings and composting programs in 1997 vs. 3,470 in 2005
- combusted for energy recovery
  - 2.7 M tons 1980
  - 29.7 M tons 1990
  - 33.4 M tons (13.6%) 2005



# ● Least Favorable MSW Management Activity: Ultimate Disposal (e.g., landfills)

- Number of landfills in U.S. continues to decrease from about \_\_\_\_\_ in 1988 to about \_\_\_\_\_ today





## ● Landfills must:

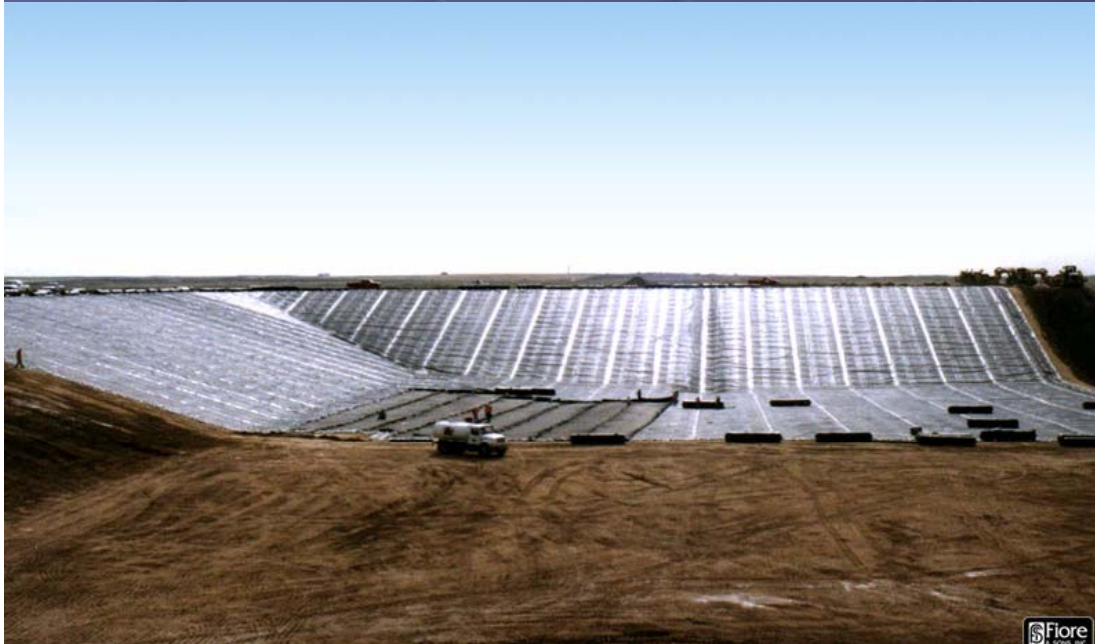
- keep out regulated h\_\_\_\_\_ w\_\_\_\_\_
- apply a d\_\_\_\_\_ c\_\_\_\_\_
- control d\_\_\_\_\_ v\_\_\_\_\_ populations (rodents, flies, mosquitoes, etc.)
- m\_\_\_\_\_ m\_\_\_\_\_ gas
- restrict p\_\_\_\_\_ a\_\_\_\_\_
- control s\_\_\_\_\_ w\_\_\_\_\_ run-on and run-off
- protect s\_\_\_\_\_ w\_\_\_\_\_ from pollutants and
- keep appropriate r\_\_\_\_\_





## ● Design Standards

- Landfills must be designed to ensure d\_\_\_\_\_ w\_\_\_\_\_ standards are not exceeded in ground water.
- Landfills must be designed with a c\_\_\_\_\_ l\_\_\_\_\_ made of synthetic material covering a two-foot c\_\_\_\_\_ l\_\_\_\_\_.





## ● Ground-water Monitoring and Corrective Action

- All landfills must have monitoring wells to detect any groundwater contamination.
- if ground-water is contaminated, the owner/operator is required to clean it up to acceptable standards to protect human health and the environment.



Monitoring Well UE-25 WT#4, Water level about 438 meters (1437 feet) deep  
Photo by USGS





## ● Closure and Post-Closure Care

- When a landfill stops accepting waste it must be covered to keep any liquid away from the buried waste.
- Once the landfill is closed, the owner/operator is responsible for
  - maintaining the final cover,
  - monitoring ground water and methane gas,
  - and continuing leachate management for 30 years.



## ● Financial Assurance

- Landfill owners/operators must show that they have f\_\_\_\_\_ mechanisms to cover the costs of closure, post-closure care, and any needed cleanups from releases.
- Financial mechanisms can include s\_\_\_\_\_ bonds, letters of credit, insurance, or guarantees, among others.



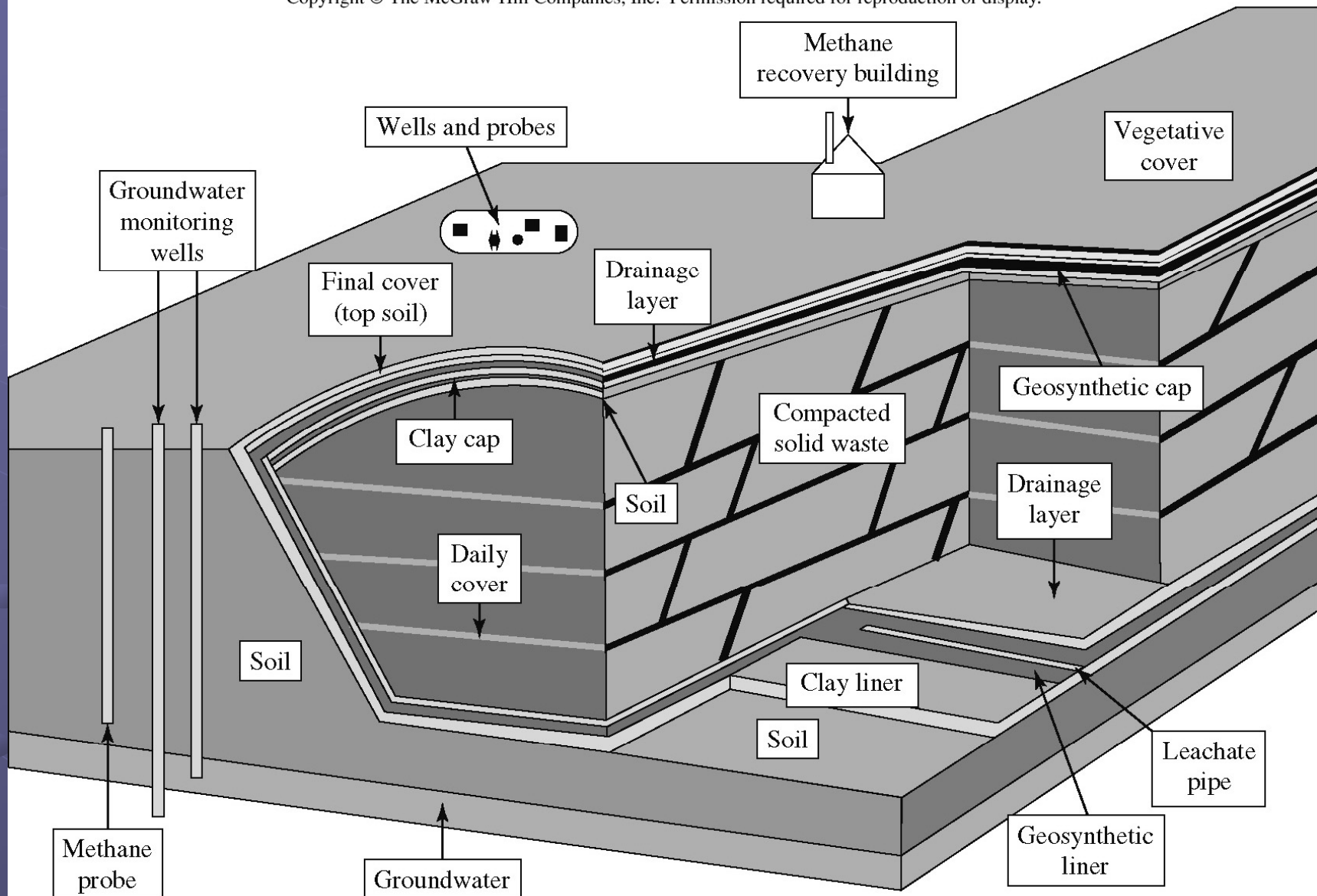
## ● Financial Assurance

- The majority of landfills are small (less than 20 tons of municipal solid waste per day) and some may qualify for an exemption from the design standards, ground-water monitoring, and corrective action requirements.
- To qualify for an exemption, a small landfill must not be causing ground-water contamination, and must be located in either a very dry climate or a very remote location.



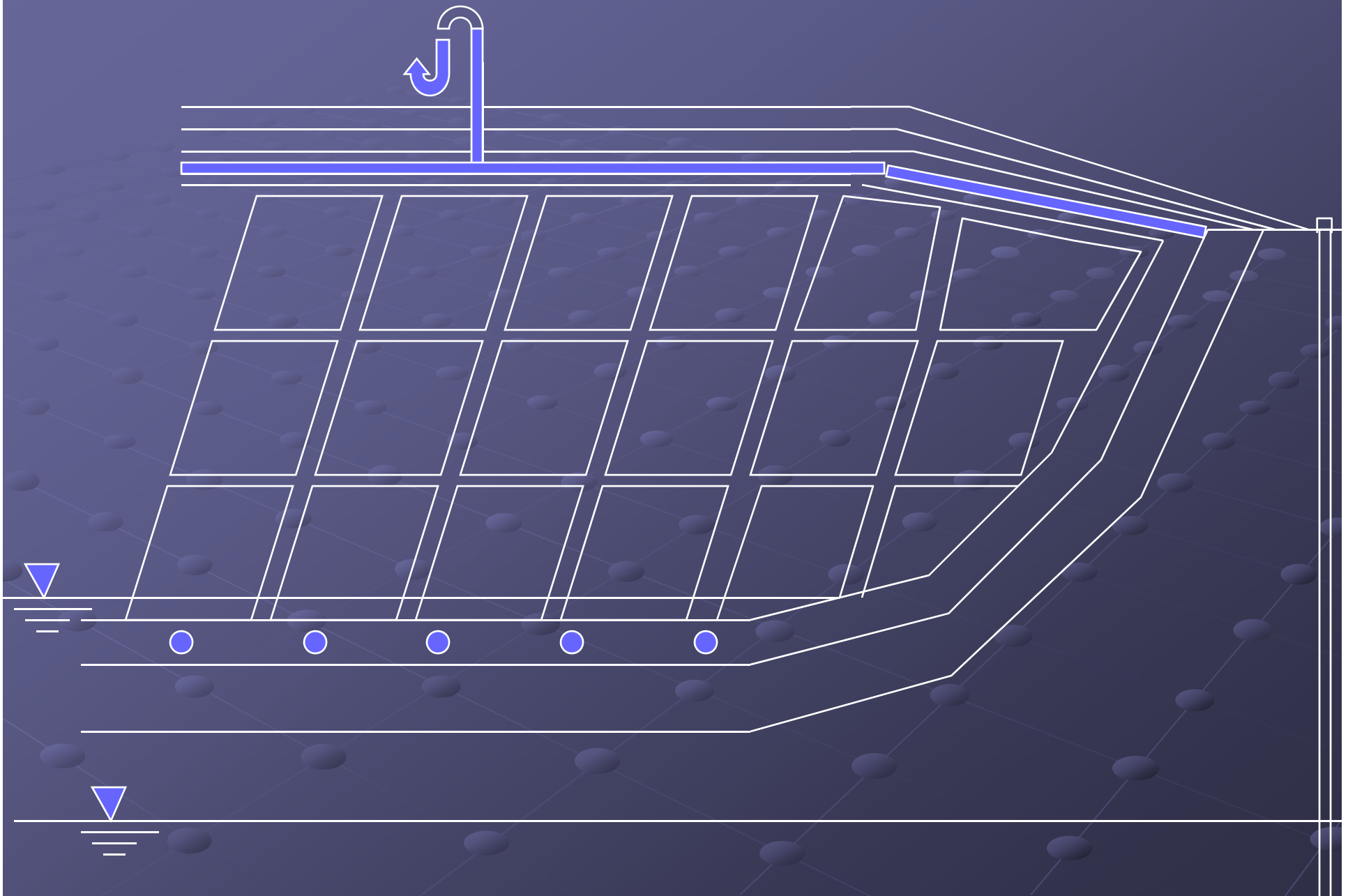
# ● Parts of a Solid Waste Landfill:

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# ● Parts of a Solid Waste Landfill:





# ● Liner:

- Composite:





- Leachate:

- LCRS:





- Cell:

- Daily Cover:

- Lift:

- • Final Lift:

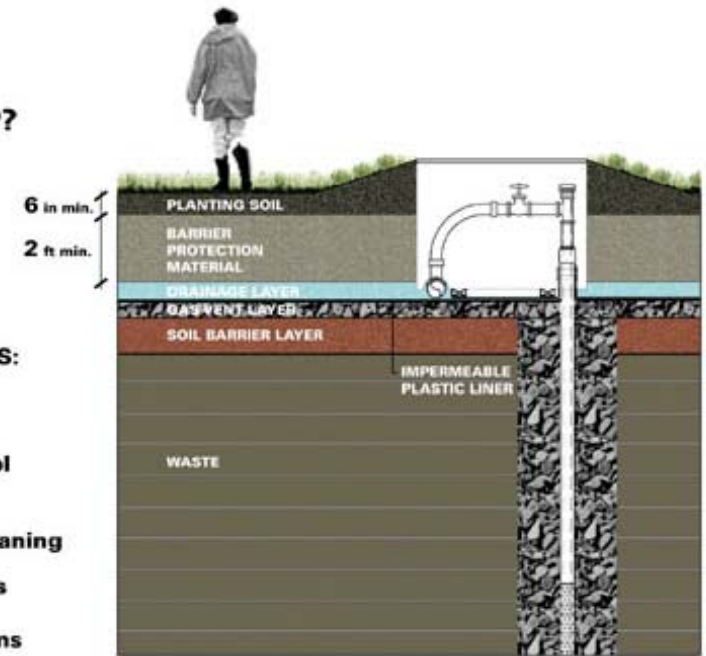




# Final Cover

## Cap

### WHAT IS A LANDFILL CAP?



### LANDFILL SYSTEMS:

- final cap
- landfill gas control collection
- leachate control collection and cleaning
- stormwater basins
- monitoring systems





# Post Closure

