

Gas Management at Bioreactor Landfills

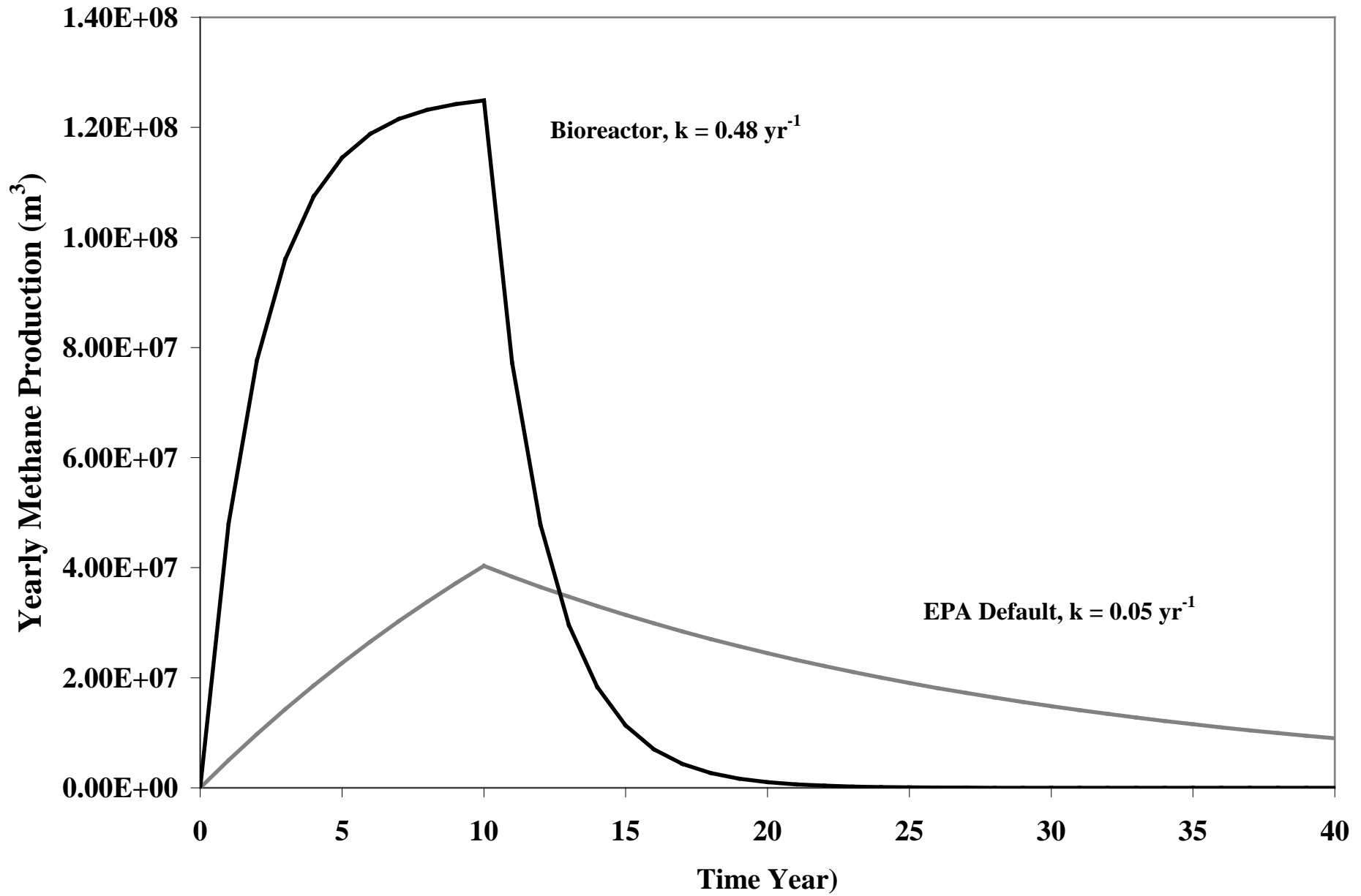
Landfill Gas Basics

- The recirculation of leachate as part of a bioreactor landfill increases the rate of gas production.



Predicting Landfill Gas Generation Rate

- Use a “k value” that is more reflective of bioreactor conditions
- Issue:
 - Lag time?



Traditional Gas Collection Systems at Landfills

- Vertical gas wells are most common method of gas collection



Problems Encountered in Wet Landfills

- Wet landfills, either bioreactors or ones that have received large amounts of rainfall, sometimes have problems with gas collection.

Vertical Wells Flood

- Leachate in a landfill will migrate to the path of least resistance.
- A zone of leachate penetrated by a vertical hole may drain into the holes.
- Gas moving in the direction of the hole may bring leachate with it.

Collection from Recirculation Devices is Difficult

- It is may be very difficult to collect gas from leachate recirculation devices (vertical wells, horizontal trenches).



Important Note

- Gas will flow in the direction of least resistance.
- The path of least resistance is not through saturated waste.

New Rule Requirements

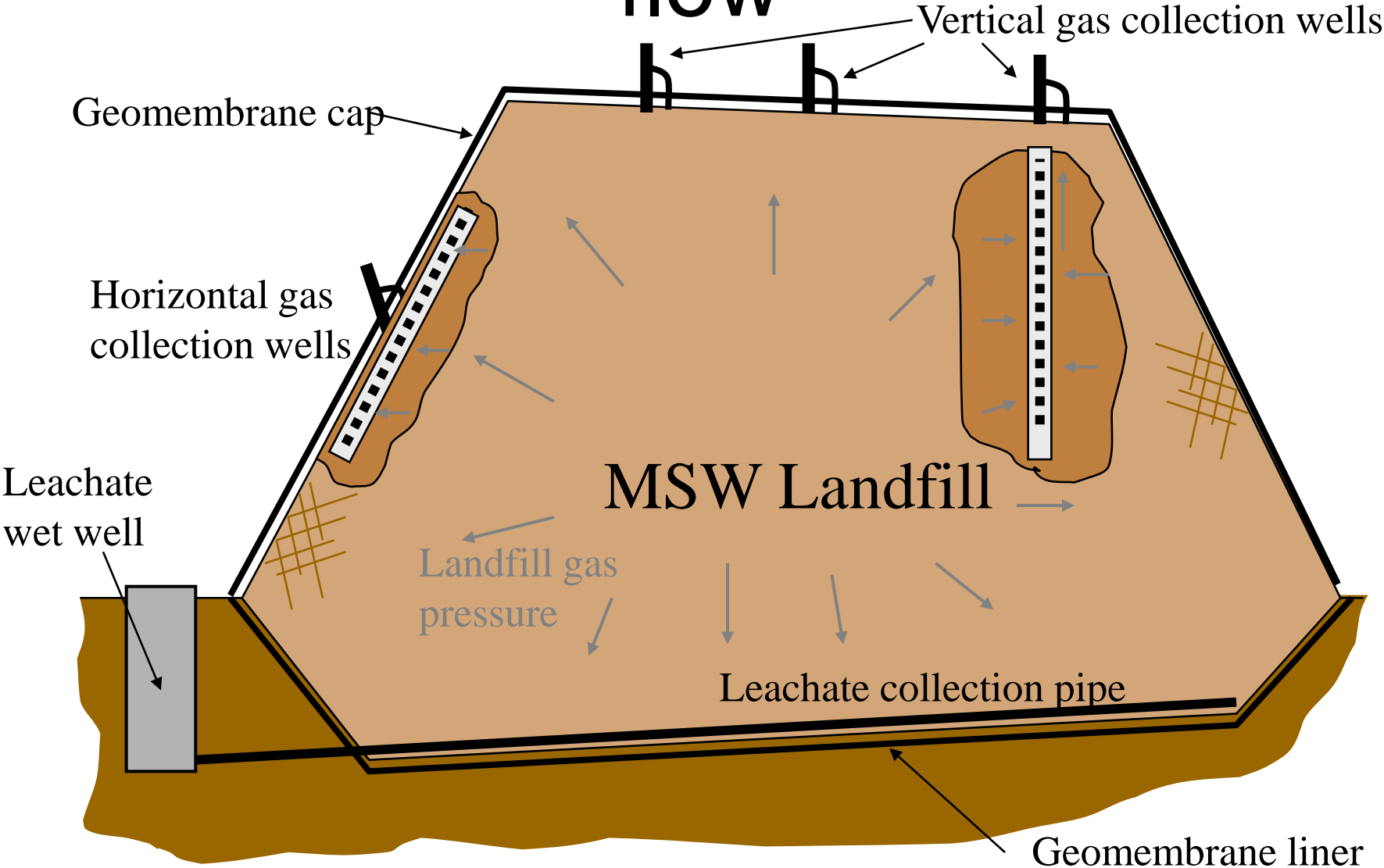
- Gas collection systems must be installed within 180 days of the addition of liquids.
- If leachate recirculation is part of operating landfill, the use of traditional gas collection systems will be difficult.

Options for Collecting Gas in Bioreactors

Let's look at several options for collecting gas from bioreactors

1. Don't recirculate until after closure
2. Use leachate collection system
3. Use the cap to biologically control chemical components
4. Let the cap serve as a primary gas collector
5. Smart of use of leachate recirculation devices

Landfill gas generation and flow

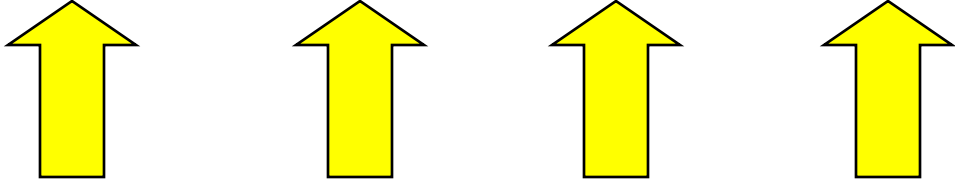


Delay Leachate Recirculation

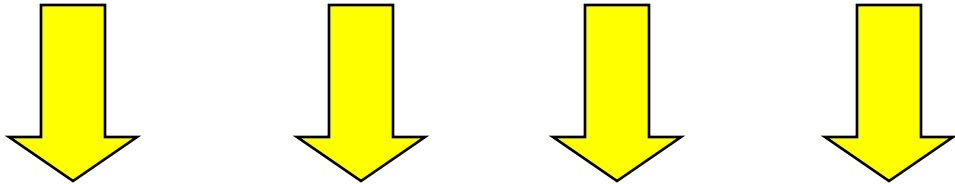
- One option would be to delay any leachate recirculation until after the landfill has reached final grade.
- Traditional systems (with modifications) can then be used.
- The operating years, however, are often the time when leachate recirculation has been as a leachate management strategy.

Use Leachate Collection System

- The leachate recirculation system can successfully be used as a gas collection system.
- The driving force of gas out of the landfill is pressure. If the pressure in the leachate collection system is near atmospheric, gas will migrate in that direction.



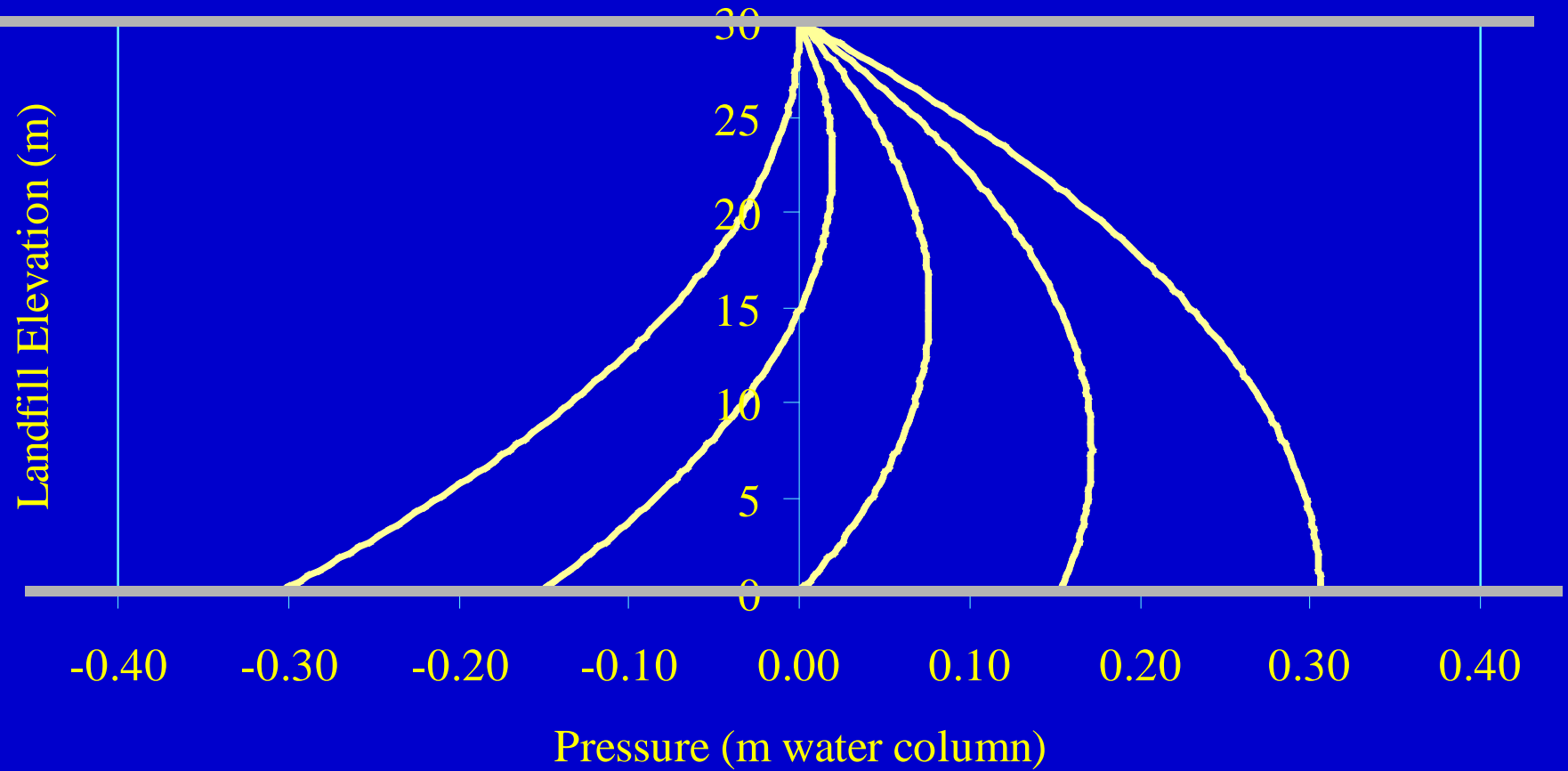
MSW



LCS



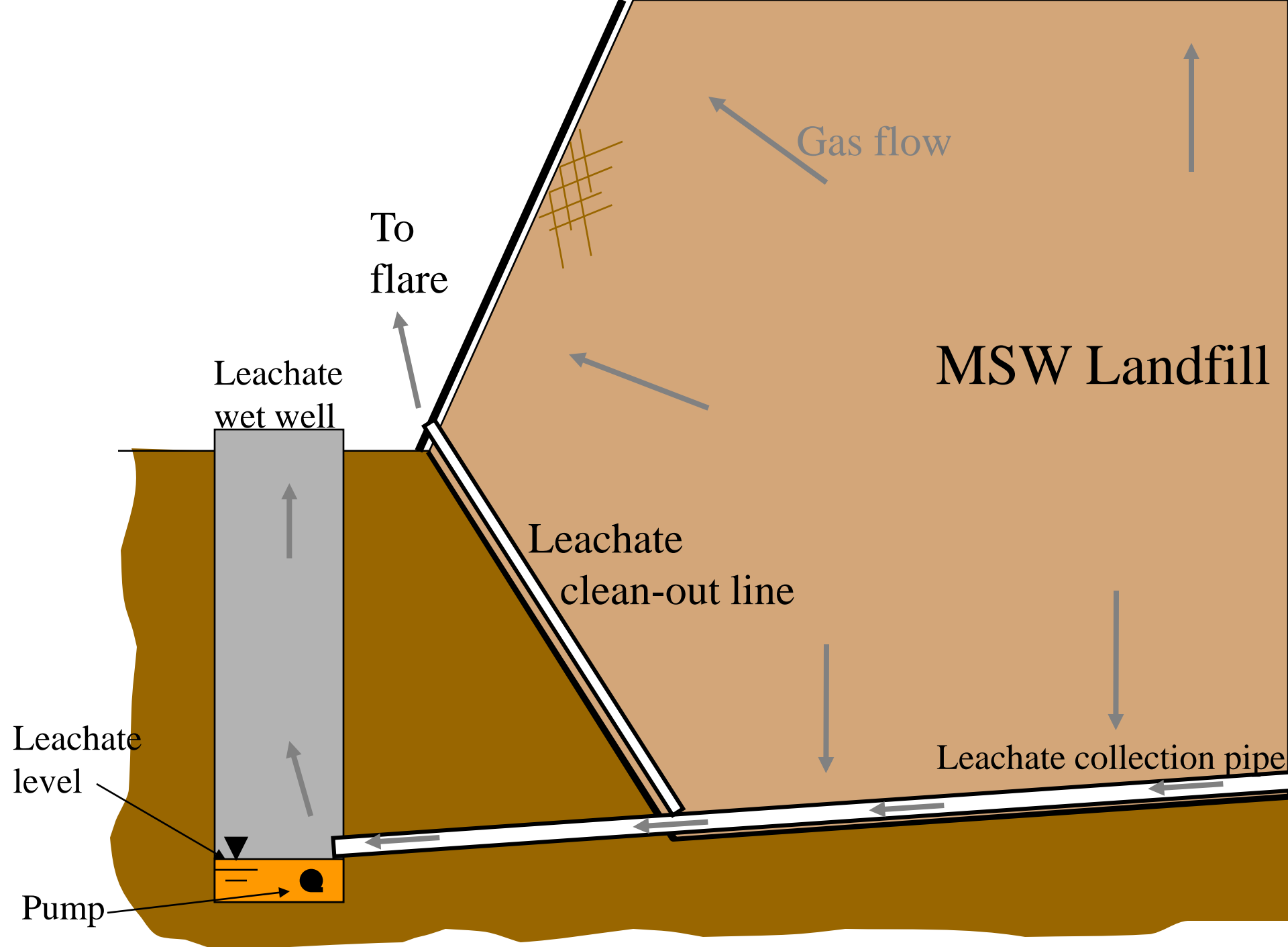
Liner

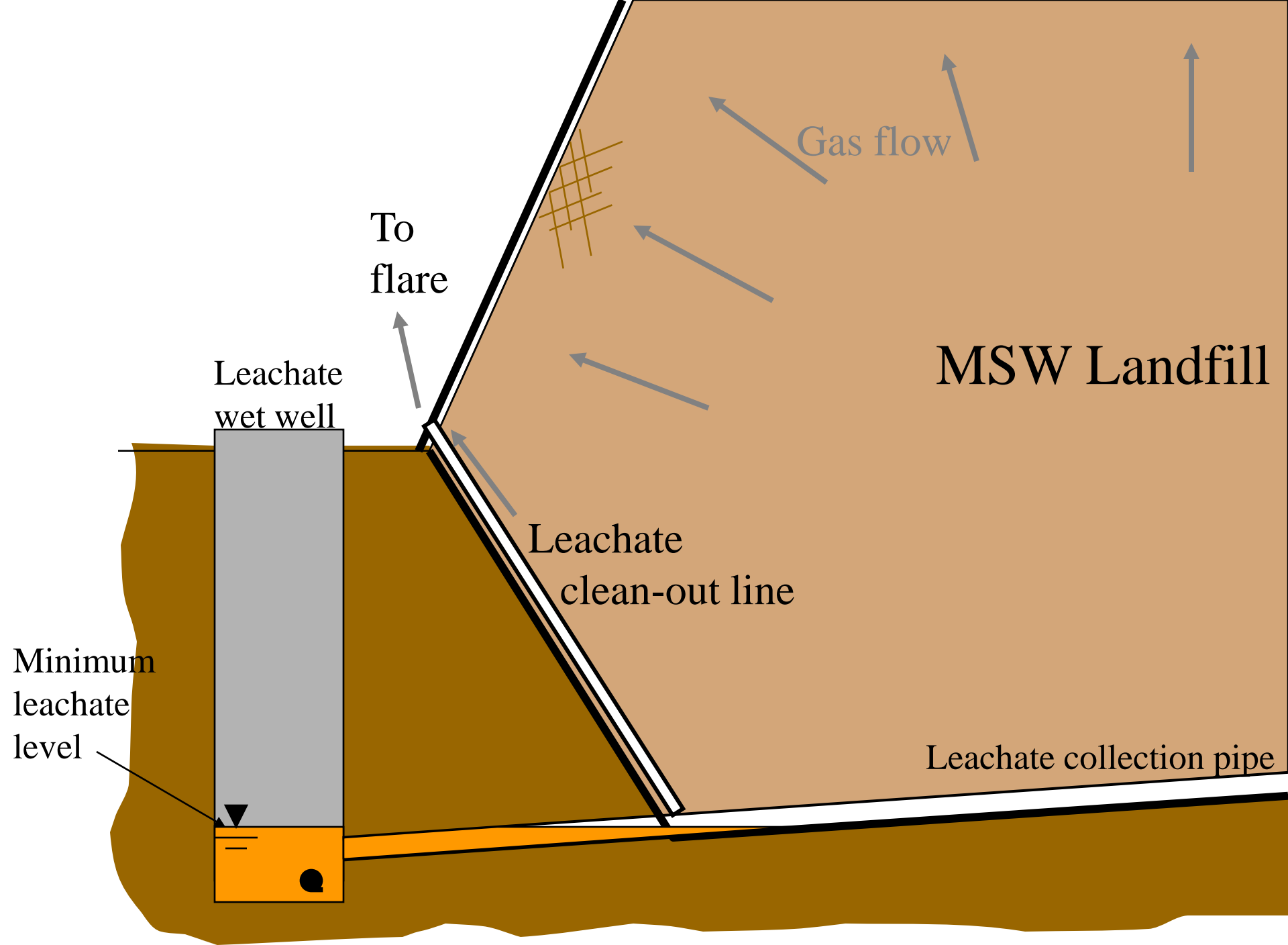


Pressure Distribution within a Landfill

Design Considerations

- The landfill should be designed from the beginning with the idea of collecting gas from the leachate collection system

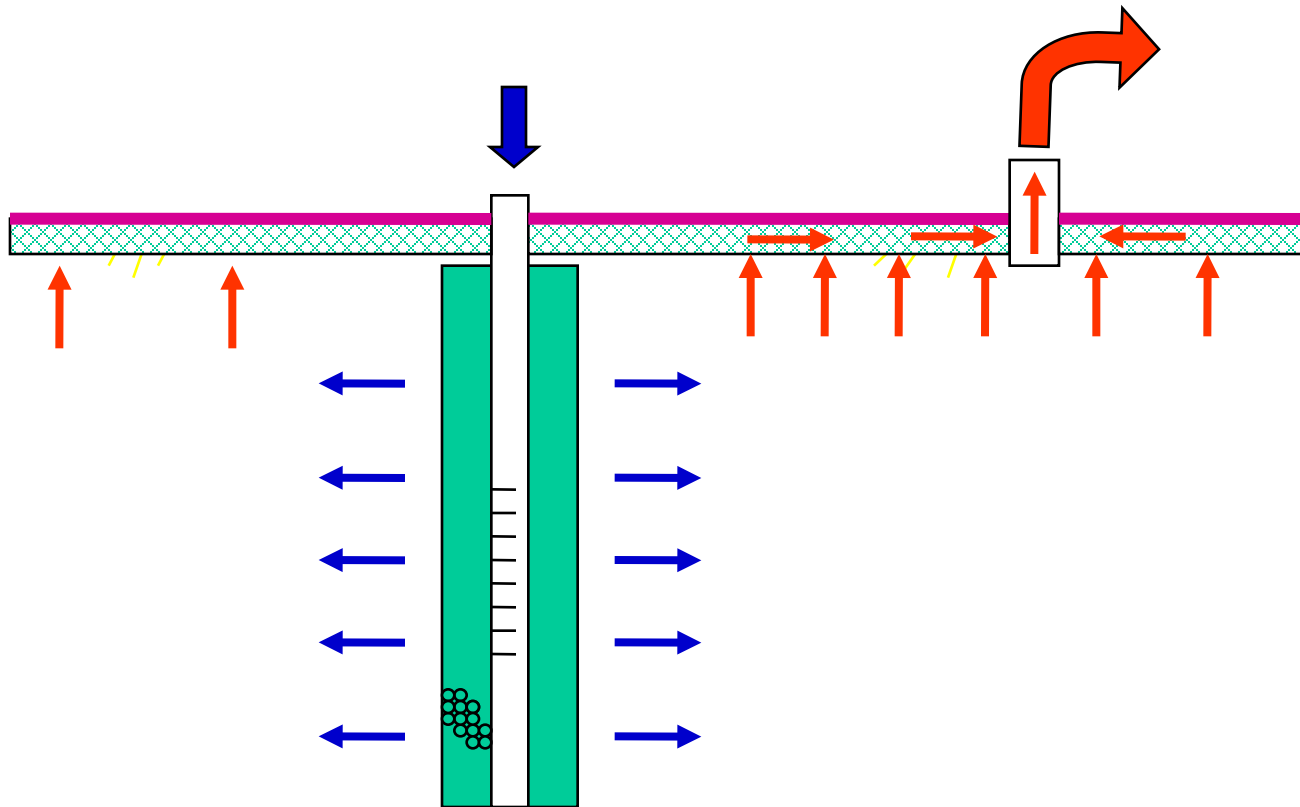




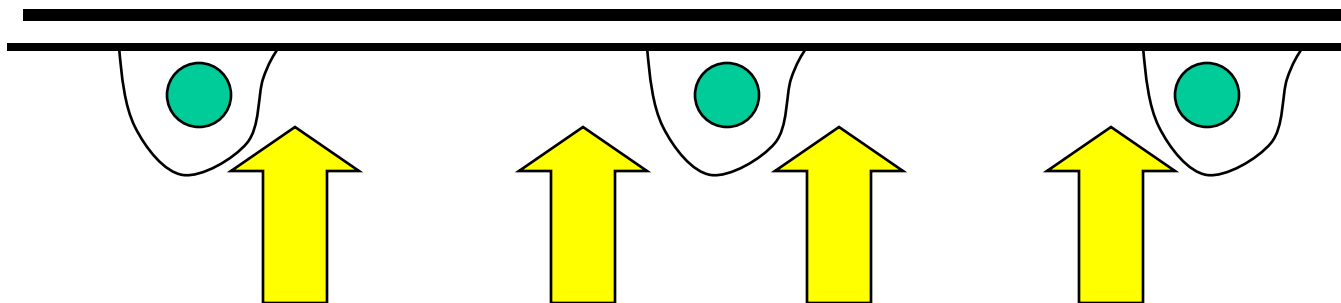
Alternative Strategies for Caps at Bioreactors

- Traditional capping system that includes a geomembrane and overlying soil.
- A bio-cap for biologically removing methane and other gases
- Exposed geomembrane cap

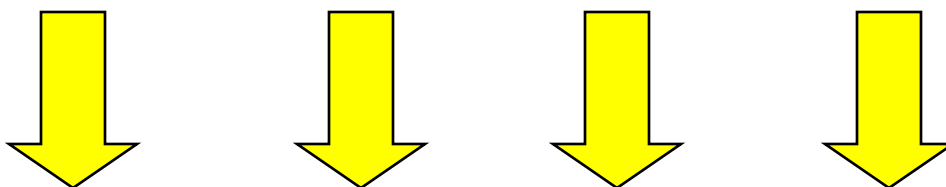
Geomembranes for Gas Collection



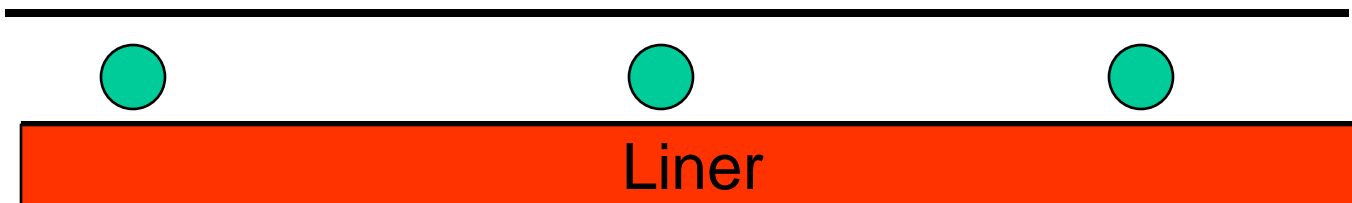
Geomembrane



MSW



LCS



Liner





Creative Use of Leachate Recirculation Devices

- Use leachate recirculation devices as gas collectors, but don't count on them as primary collectors.
- Exception: Horizontal trenches on the surface of the landfill.
- Also, use unused recirculation devices as gas collectors to collect gas being produced from other recirculated areas.

Summary Comments on Gas Issues at Bioreactor Landfills

- Alternative strategies are needed for wet landfills
- Gas collection system design needs to be integrated into the design of the bottom liner and leachate collection system

Aerobic Bioreactors

- The addition of air to bioreactors has been proposed
- In some systems, the aerobic degradation of waste is the primary goal.
- In other systems, the aerobic activity is either used early in the process or is limited to distinct levels in the landfill

Possible Benefits of Aerobic Bioreactors

- More rapid decomposition
- Degradation of some recalcitrant chemicals
- Evaporation of water
- Reduction in methane production (NMOCs?)
- Do away with need for gas extraction system? Cap?

Aerobic Bioreactor Concerns

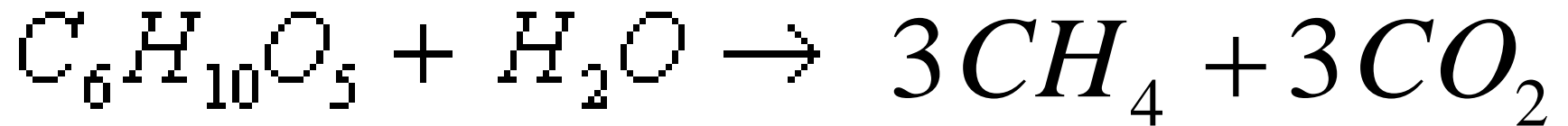
- Fires and explosive mixtures of gas
- Costs
- Efficiency for waste treatment

Design Issues

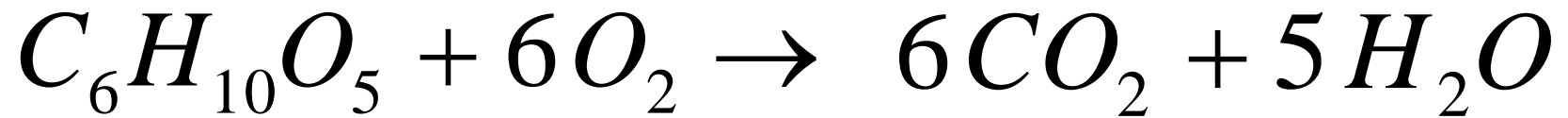
- Amount of air to inject (pipe and blower selection and design)
- Configuration, location and spacing of air addition devices
- Control of fire and explosive gas conditions



Anaerobic Decomposition



Aerobic Decomposition



Let's Consider Cellulose



Air Requirements

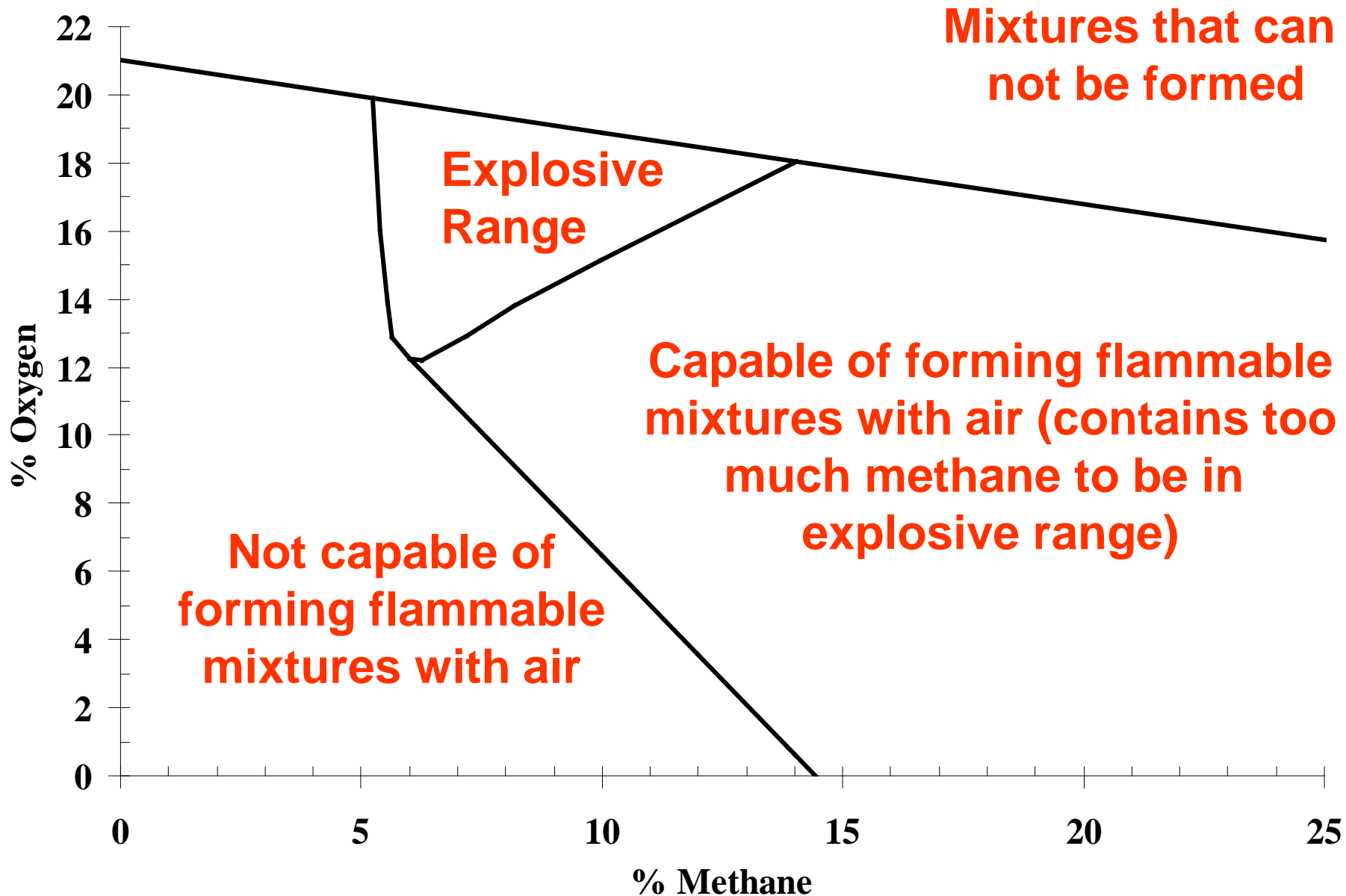
6 moles of oxygen per mole of cellulose



45,000 ft³ of air per ton of waste

Control of Fires and Explosive Gases

- Landfill fires may result from two conditions
- Spontaneous combustion of the waste
 - Control through careful operation and monitoring (temperature, CO)
- Flammable mixtures of landfill gas



Air Injection Devices

- Vertical wells
- Horizontal pipes
- Pipes in the leachate collection system

Questions that Need to be Answered

- Can you effectively get air distributed throughout the landfill? It might be difficult in deep or wet conditions.
- Is the rate of aerobic stabilization (and thus settlement) sufficiently greater than anaerobic stabilization to justify the extra cost?

Questions that Need to be Answered

- Can CH₄ and NMOC emissions be reduced to the point where gas collection systems are not needed?