Moisture Management at Bioreactor Landfills
Moisture Management at Bioreactor Landfills

- The primary mechanism for increasing the rate of waste decomposition is the increase in moisture content of the solid waste.
- This can be accomplished by:
  - Recirculation of leachate
  - Addition of water
  - Addition of other bulk liquids
Moisture Management at Bioreactor Landfills

• How do you get the liquids in?

• Leachate recirculation systems
  – Surface Systems vs Subsurface Systems
  – Retrofit vs As-built
Leachate Recirculation Method

• The method used will depend on several items:
  – Current condition of landfill (new? completed?)
  – Sources of liquids
  – Goals of the owner/operator
  – Available equipment
  – Cost
  – Interference with landfill operations
  – Regulatory concerns
As-Built vs Retrofit

As-Built
• Surface application methods as waste is filled up. Focus on working face.
• **Horizontal trenches** buried in the landfill as waste is deposited.
• Surface systems when complete.

Retrofit
• Surface systems on completed waste fill.
• **Vertical wells**.
• Shallow subsurface horizontal trenches.
Leachate Recirculation Methods

- Leachate (or other liquids) can be added to the waste in a variety of methods.

- Surface application
  - Systems prior to capping
  - Systems after caps have been in place

- Subsurface application
  - Horizontal trenches or galleries
  - Vertical wells
  - Combination systems
Methods of Surface Application of Leachate

- Methods that can be used while the landfill is still operating.
  - Direct wetting of the working face.
  - Spray or drip irrigation.
  - Infiltration ponds.
Methods of Surface Application of Leachate

**Direct Wetting of the Working Face**

- Leachate can be sprayed or pumped onto the waste as it is tipped and compacted.
- Provides good means of moisture distribution.
- Potential concerns:
  - Working conditions
  - Exposure to workers
  - Runoff
Methods of Surface Application of Leachate

Spray or Drip Irrigation

• Leachate can be dripped or sprayed onto the waste or an area of daily or intermediate cover.

• Depending on weather conditions, spray irrigation provides a means of achieving large evaporation rates. This may be counterproductive depending on the needs of the landfill.

• Potential concerns:
  – Exposure to workers (spray)
  – Runoff
  – Recirculation limited to dry weather
Methods of Surface Application of Leachate

**Infiltration Ponds**

- An area can be excavated or bermed off and leachate can be ponded.
- Provides an easy method for attaining good moisture distribution (in area under ponds).
- Potential concerns:
  - When evaporation and infiltration are less than rainfall and runoff, water accumulates.
  - Floating waste.
  - Interference with operations.
Methods of Surface Application of Leachate

• Methods that can be used after the landfill has been capped.
  – Leach fields
  – Trenches
  – Drip Irrigation

• These methods are distinguished from subsurface methods in that leachate is added under low pressures (gravity drainage).
Methods of Surface Application of Leachate

• Leach Fields
Methods of Surface Application of Leachate

• Trenches
Methods of Subsurface Application of Leachate

• Subsurface methods are often preferred because:
  – The allow moisture distribution within the waste.
  – Leachate can be added under pressure to achieve better distribution.
  – They can be operated under wet weather conditions.
Subsurface Methods

- **Vertical Injection Wells**
- **Horizontal Trenches**
- **Buried Infiltration Galleries**
Focus on Two Subsurface Methods

• Horizontal Trenches
  – Shallow systems
  – Deep systems

• Vertical Injection Wells
  – Large diameter systems
  – Small diameter systems
1. Existing Landfill at Grade

Shallow Horizontal Trenches

MSW

Liner and Leachate Collection System

50+ ft
2. Excavate Trench and Install Bedding and Pipe

Shallow Horizontal Trenches

MSW

Liner and Leachate Collection System

3 - 15 ft
Shallow Horizontal Trenches

3. Backfill
4. Additional Trenches

50 – 200 ft

MSW

Liner and Leachate Collection System
Shallow Horizontal Trenches

5. Recirculate

MSW

Liner and Leachate Collection System
Shallow Horizontal Trenches

5. Recirculate

MSW

Liner and Leachate Collection System
1. Install Horizontal Trenches on Lower Lifts

Deep Horizontal Trenches

Liner and Leachate Collection System

50 – 200 ft

15 ft
Deep Horizontal Trenches

2. Continue Installing

Liner and Leachate Collection System

MSW
Deep Horizontal Trenches

3. Continue Installing

Liner and Leachate Collection System
Deep Horizontal Trenches

4. Recirculate Leachate
Deep Horizontal Trenches

4. Recirculate Leachate

Liner and Leachate Collection System
Materials of Construction

• Preferred piping material is HDPE
• Typical pipe size is 3 to 4 inches (perhaps larger if gas collection is desired)
• Typical trench width is 3 to 5 ft
• Typical hole diameter (3/8 – ¾ inch)
• Bedding materials:
  – Chipped tires
  – Stone
  – Other? (crushed brick, crushed glass)
  – None?
Construction Issues

• Where do you construct the pipe?
• Issues from excavation of waste
  – Odors
  – Exposed garbage
  – Disruption of operations
• Who performs the construction?
• Where do you stop perforations?
• How can you minimize future seepage?
• How do you connect pipe up in the future?
Installation of Horizontal Injection Lines at ACSWL
Installation of Horizontal Injection Lines at ACSWL
Leachate injection lines are installed in the waste as the landfill is filled up.
Hands-on Training
Clay plug.
Exploring Crushed Glass as a Drainage Media
Horizontal Injection Line Installation Progress at Polk County NCLF

Phase I: Existing Horizontal Leachate Injection Lines
Phase II: Lines Installed Fall/Winter 2003/04
Present Waste Extent
Horizontal Injection Line Installation Progress at Polk County NCLF

Subcell 1 2 3 4 5 6 7 8

Phase I
Installed Horizontal Leachate Injection Lines
Present Waste Contours

Installed Fall/Winter 2003/2004
LCS Trench Divide
LCS Pipe
Lines Installed Fall/Winter 2003/2004
Vertical Injection Wells

• Two major types
  – Large diameter wells
  – Small diameter wells

• Many of the early leachate recirculation attempts used large diameter wells

• Most new designs use small diameter wells
Large Diameter Vertical Leachate Injection Well

Construct as you go →
Large Diameter Bucket Auger
Potential Disadvantage of Vertical Wells

• The greatest hydraulic pressure will be at the bottom of the well.

• This might result in more leachate distribution on the bottom of the landfill.
Vertical Injection Cluster Wells

Use multiple small diameter wells.

Since more wells are needed, installation must not be cost prohibitive.
Installation of Small Diameter Recirculation Wells: Direct Push Technology
Installation of Small Diameter Recirculation Wells: Open Flight Auger
Design and Operation of Leachate Recirculation Systems

• Design issues will be discussed tomorrow.

• Operation
  – Need proper training of operators
  – Need to have routine inspections and record keeping
  – Seeps are a common occurrence at wet landfills that must be dealt with promptly and appropriately
  – Track leachate injection amounts, depths/pressures
  – Track leachate production
Moisture Balance in the Landfill

- Water balance

- Collect waste samples and measure gravimetrically

- In situ methods
Water Balance

- Track moisture into and out of landfill
In-Situ Measurement

• Several devices are still being evaluated of in-situ measurement of moisture

• These will be discussed in “Instrumentation and Process Control”