



Operating Landfills as Bioreactors to Decompose and Stabilize Solid Waste

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Topics

- Bioreactor landfill fundamentals
- Application to Lined Landfills
 - Methods
 - Challenges
 - Aerobic bioreactors
 - Case studies in Florida
- Application to Unlined Landfills

Bioreactor Landfill Fundamentals

Definition

A sanitary landfill operated for the purpose of rapid stabilization of the decomposable organic waste constituents by purposeful control of biological processes

Bioreactor Landfill Fundamentals

Potential Benefits

- Increase disposal capacity
- Provides flexibility in leachate management
- Enhances feasibility of landfill gas to energy projects
- May possibly reduce long term costs
- Promotes more sustainable waste management

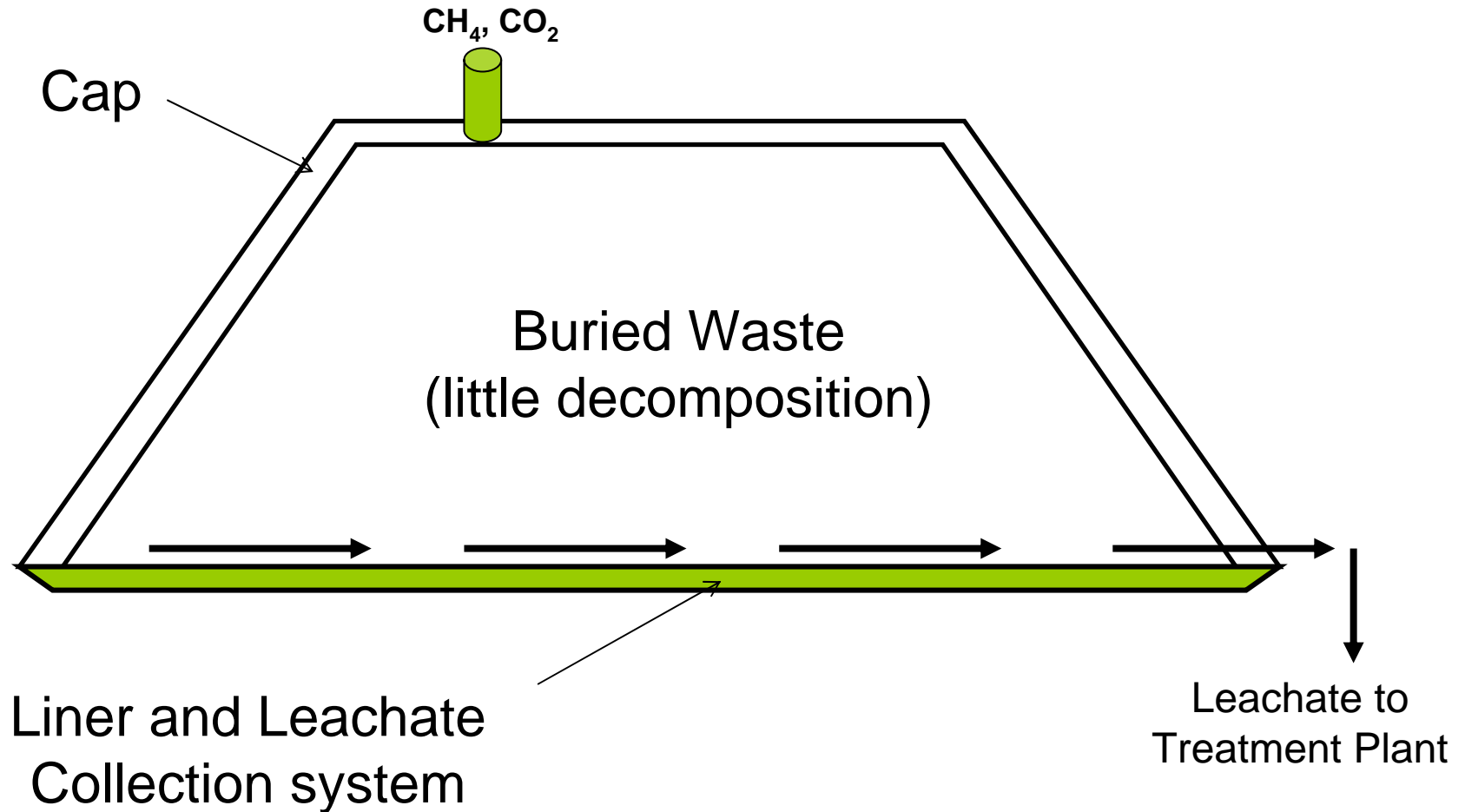
Bioreactor Landfill Fundamentals

Methods

- Create conditions for waste degrading organisms to thrive
- Most typically performed by increasing moisture content
 - Leachate recirculation
 - Water addition
- The addition of air is being explored

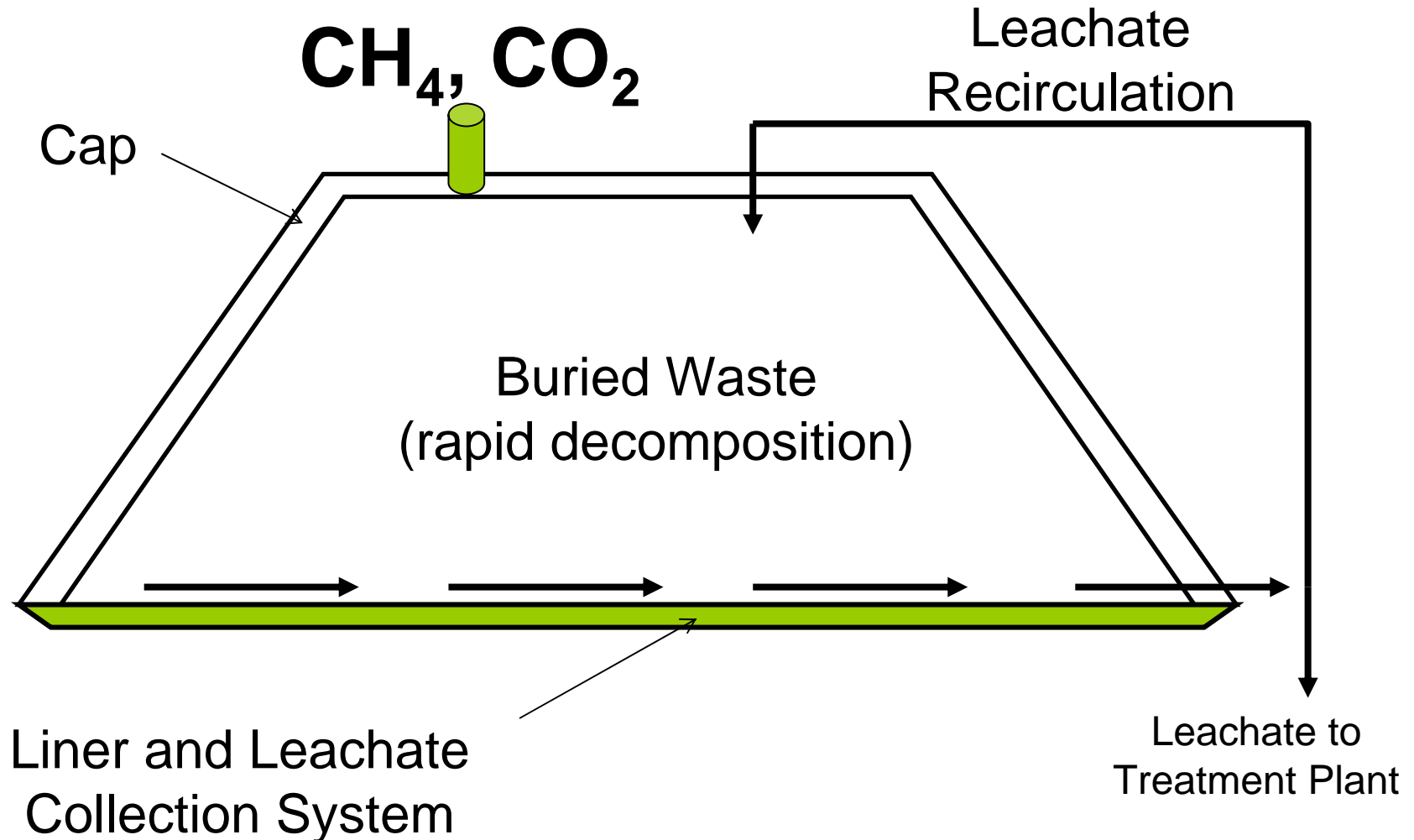
Traditional Landfill

Goal: Keep Liquids Out



Bioreactor Landfill

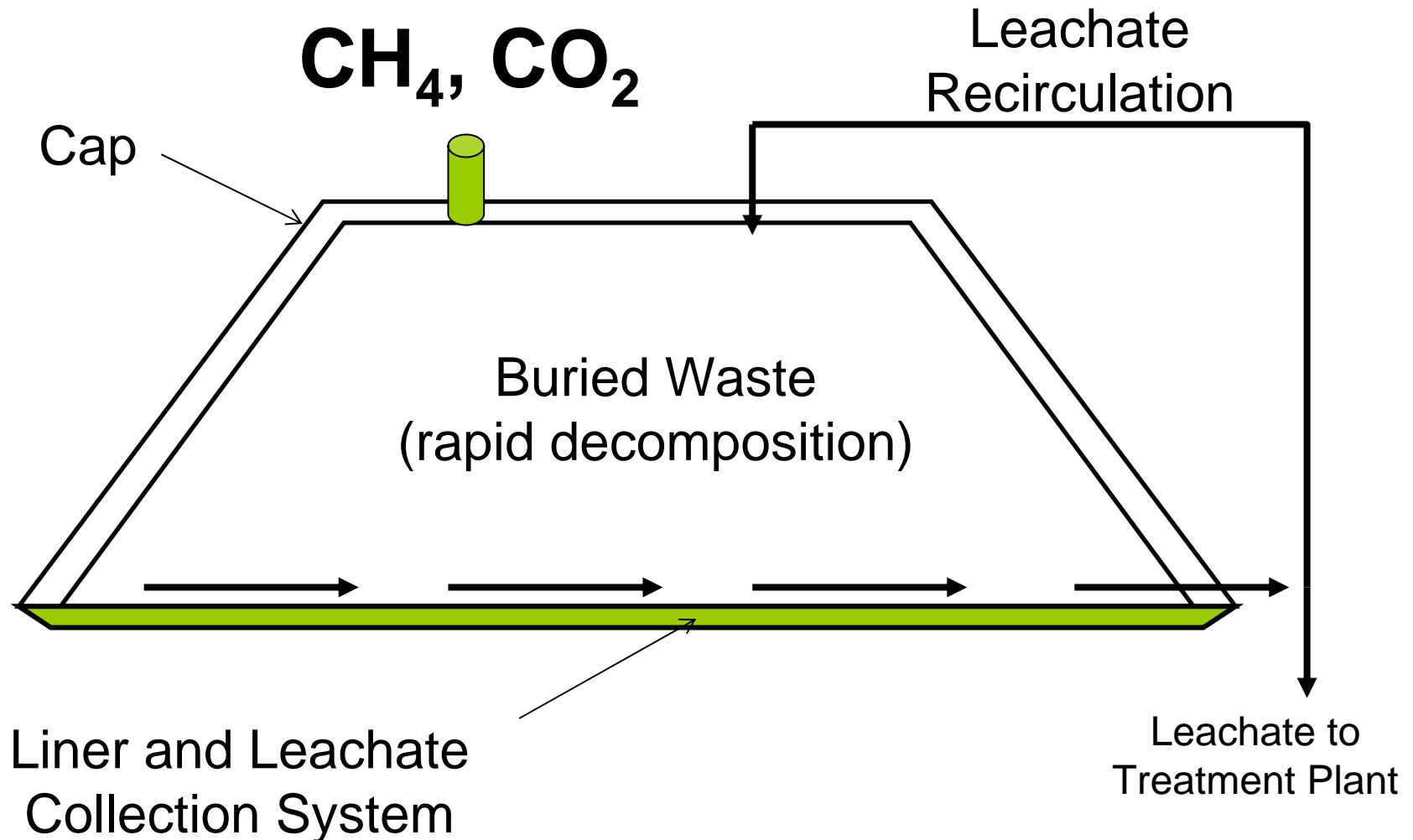
Goal: Add Liquids



Schematic Shows Anaerobic Operation

Bioreactor Landfill

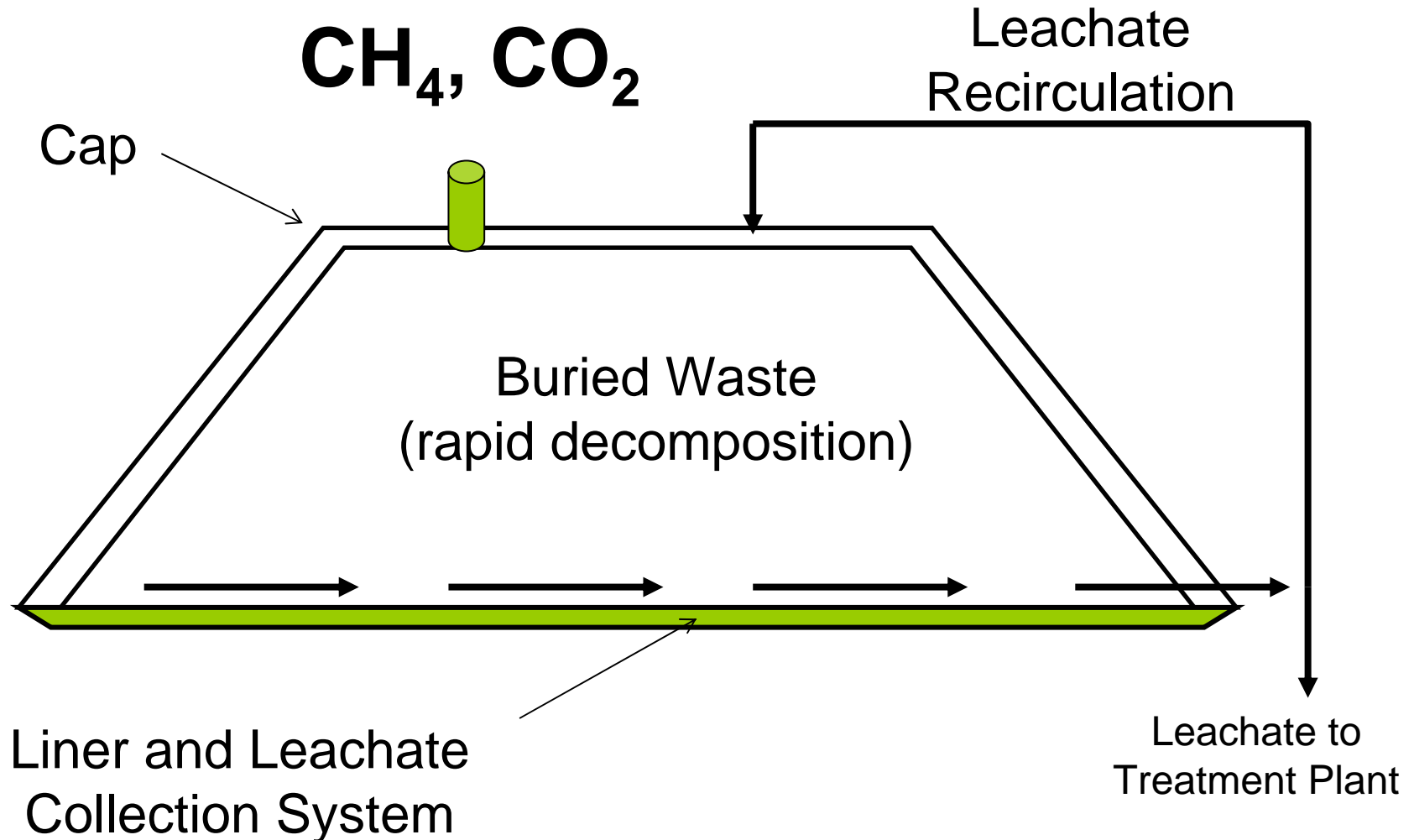
Goal: Rapid Stabilization



Schematic Shows Anaerobic Operation

Bioreactor Landfill

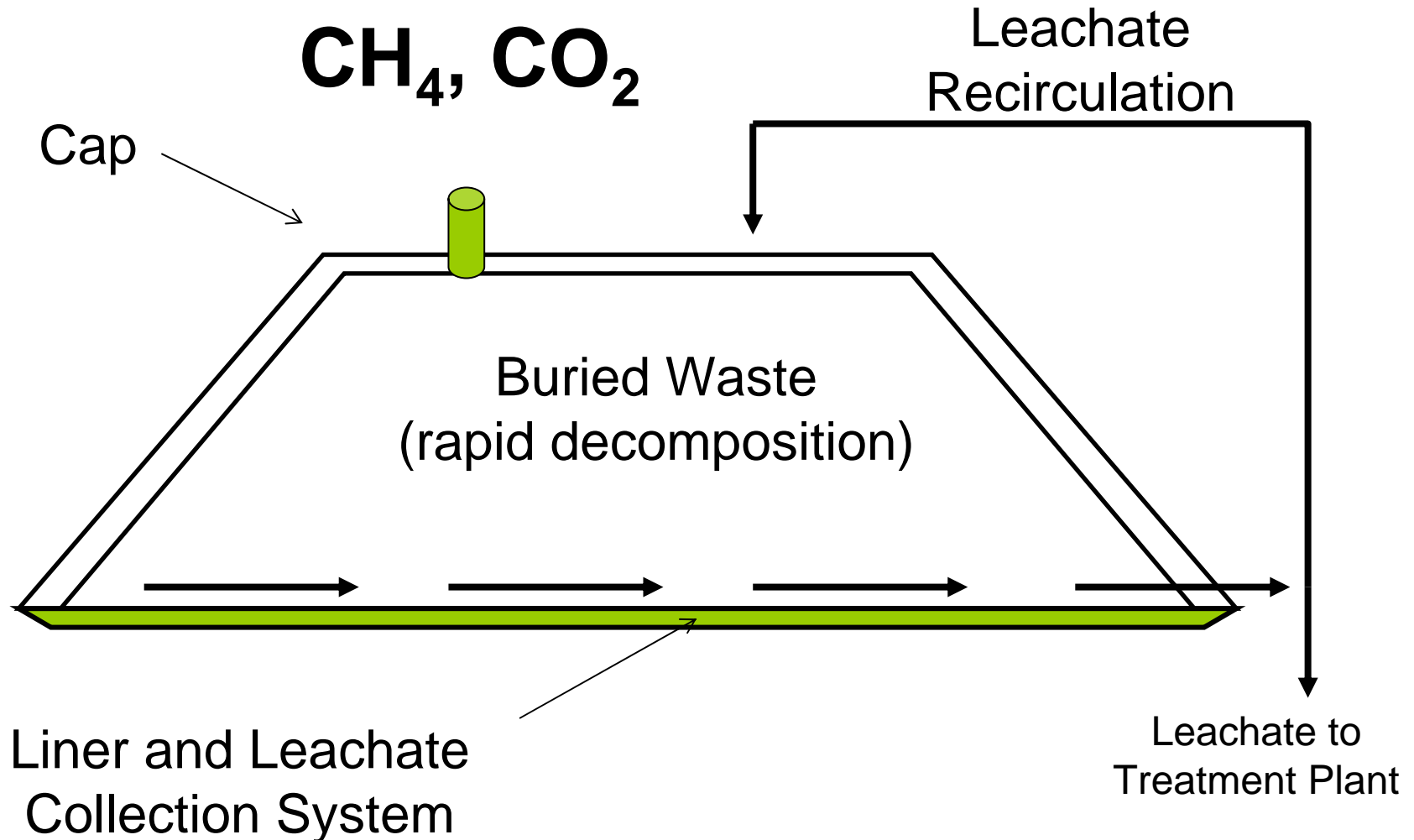
Goal: Rapid Stabilization



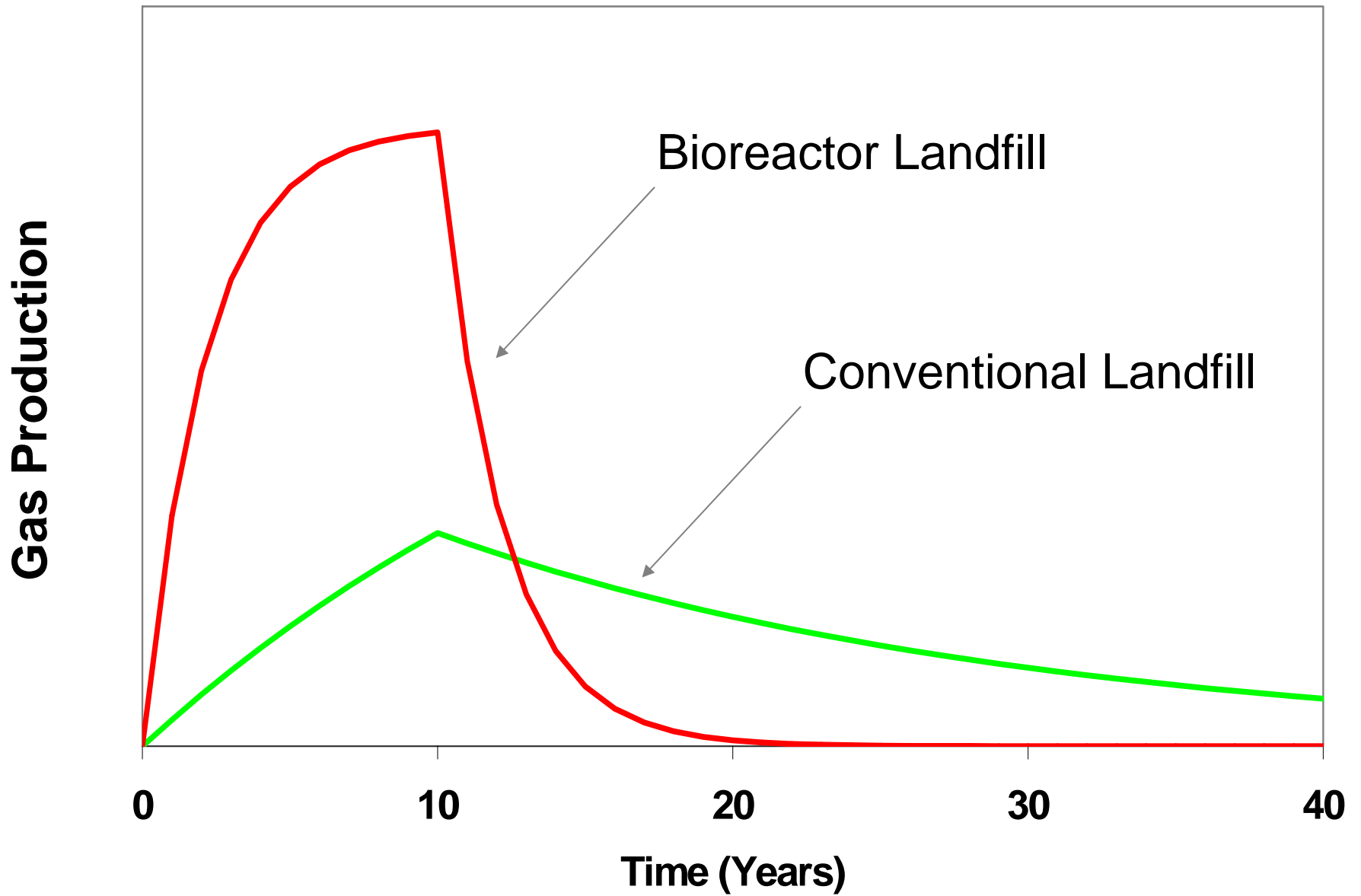
Schematic Shows Anaerobic Operation

Bioreactor Landfill

Goal: Rapid Stabilization



Schematic Shows Anaerobic Operation



Application to Lined Landfills

- Conventional practice of this technology in the US is at lined landfills.
- Leachate is recirculated back to the waste.
- Water or other liquids may be added as well.



Application to Lined Landfills

- **Methods of leachate recirculation**
 - Spray irrigation
 - Surface ponding
 - Vertical wells
 - Horizontal trenches

Application to Lined Landfills

- **Challenges**

- Getting the moisture to the right place
- Waste heterogeneity
- Monitoring progress and determining completion
- Collecting gas
- Avoiding problems caused by too much moisture
- Slope stability

Aerobic Bioreactors

- Relatively new technique
- Air is added to the waste
- Aerobic stabilization is much quicker
- Concerns
 - Fire potential
 - Explosive gas mixtures
 - Air emissions
 - Cost

Bioreactor Landfill Research in Florida

- Research is being conducted at several sites
- Discussion follows on two particular sites
 - Alachua County Southwest Landfill
 - New River Regional Landfill

Alachua County Southwest Landfill

- Line landfill
- Leachate recirculation started in 1990
- Currently closed and capped. Collected gas is converted to energy



Early Surface Infiltration Systems



Early Surface Infiltration Systems



Early Surface Infiltration Systems



Early Surface Infiltration Systems

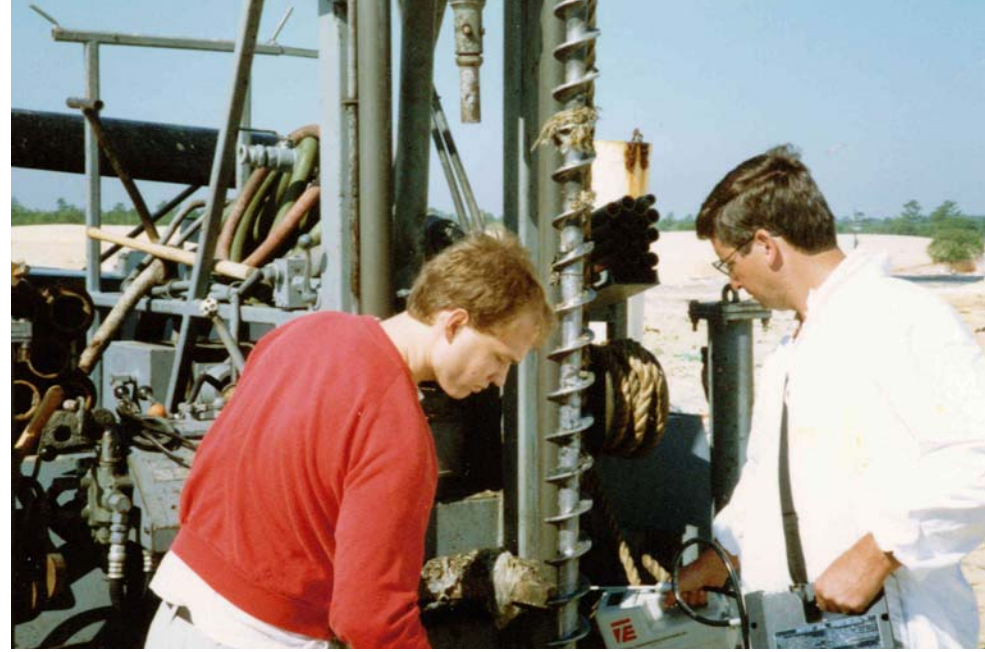


Horizontal Trenches for Leachate Recirculation

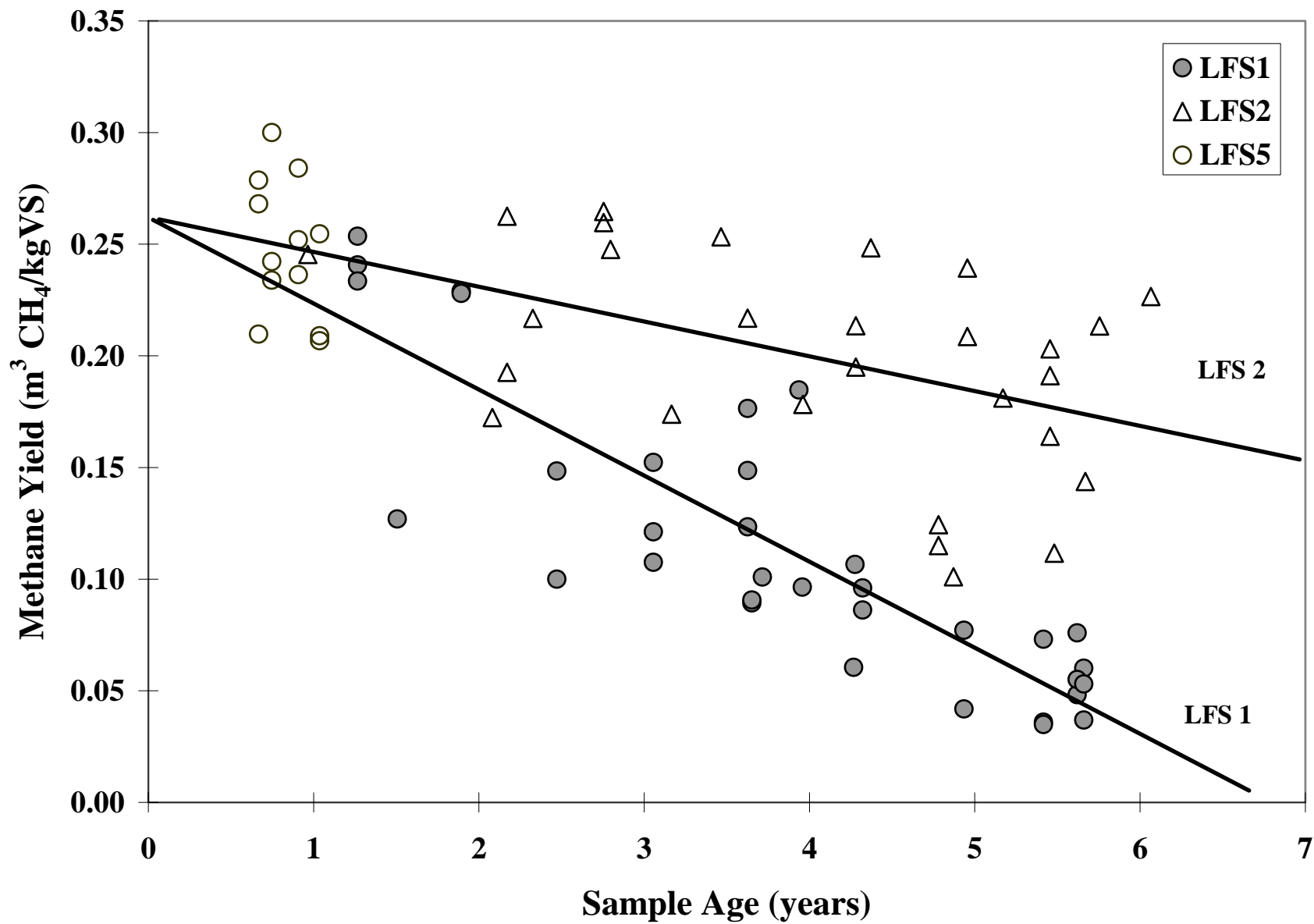


Horizontal Trenches for Leachate Recirculation





Samples of Waste
Were Collected and
Analyzed





**Current Leachate Recirculation:
Under the Cap**



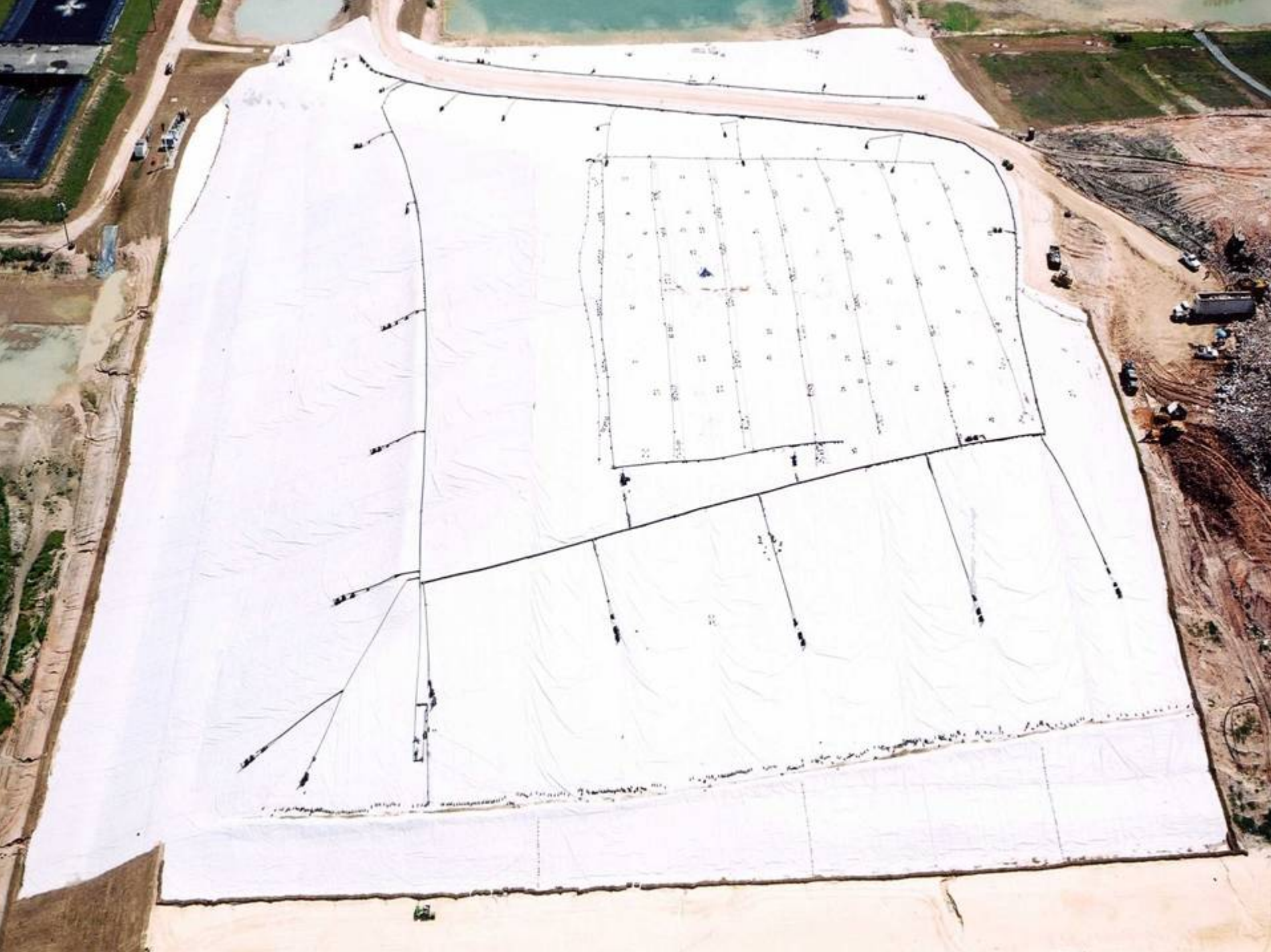
Gas is converted to “green” energy

New River Regional Landfill

- Lined Landfill
- Manages waste from several North Florida Counties (approximately 800 tons per day)





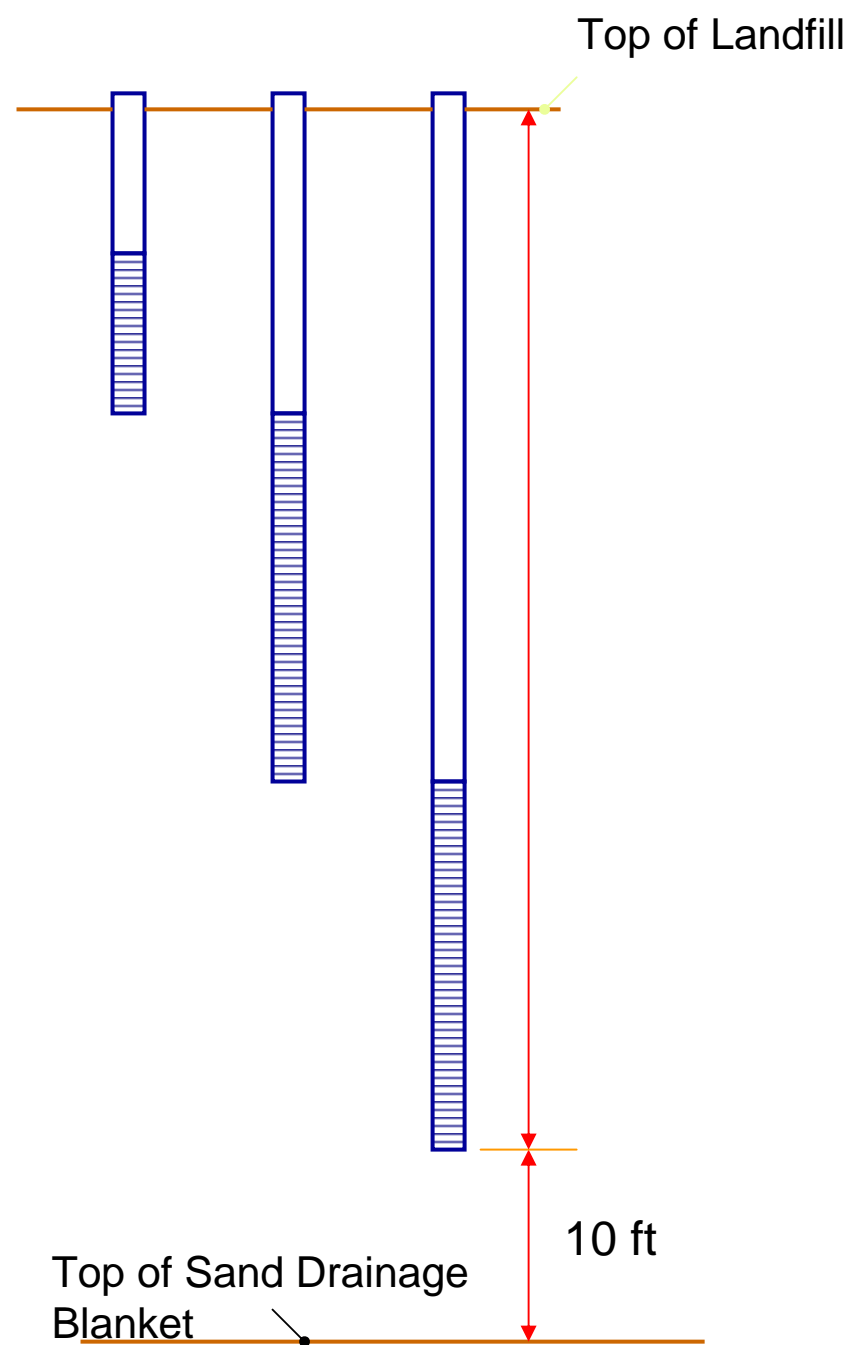


Bioreactor Features

- Vertical Injection Wells (small diameter cluster wells)
- Half of the landfill currently is set up for air injection if desired
- Exposed Geomembrane Cap
- Gas collection from the EGC and the leachate collection system
- Moisture and temperature instrumentation
- Segregated leachate collection system

Vertical Injection Cluster Wells

Use multiple small
diameter wells.





Installation of
Small Diameter
Recirculation Wells:
Open Flight Auger

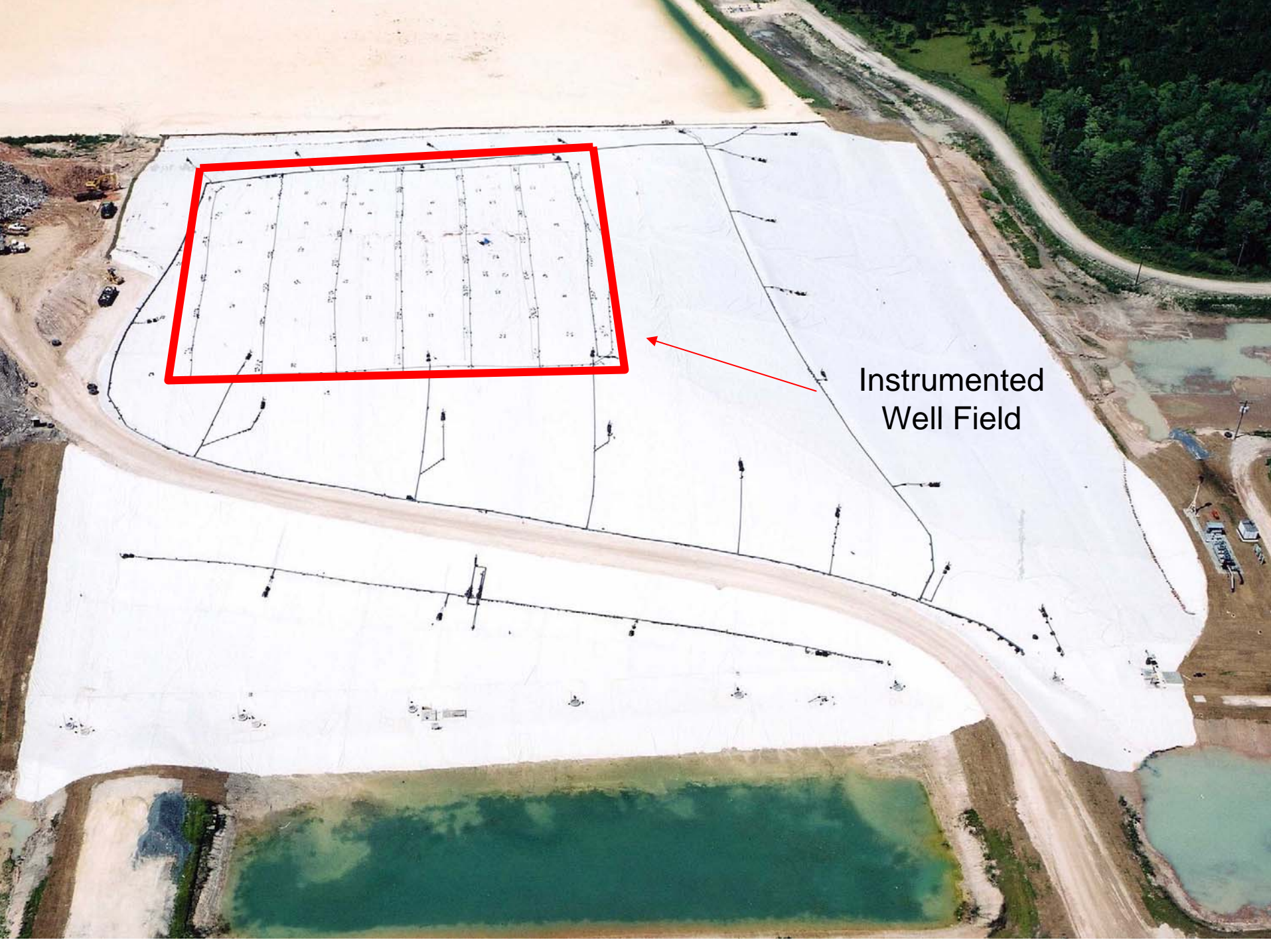




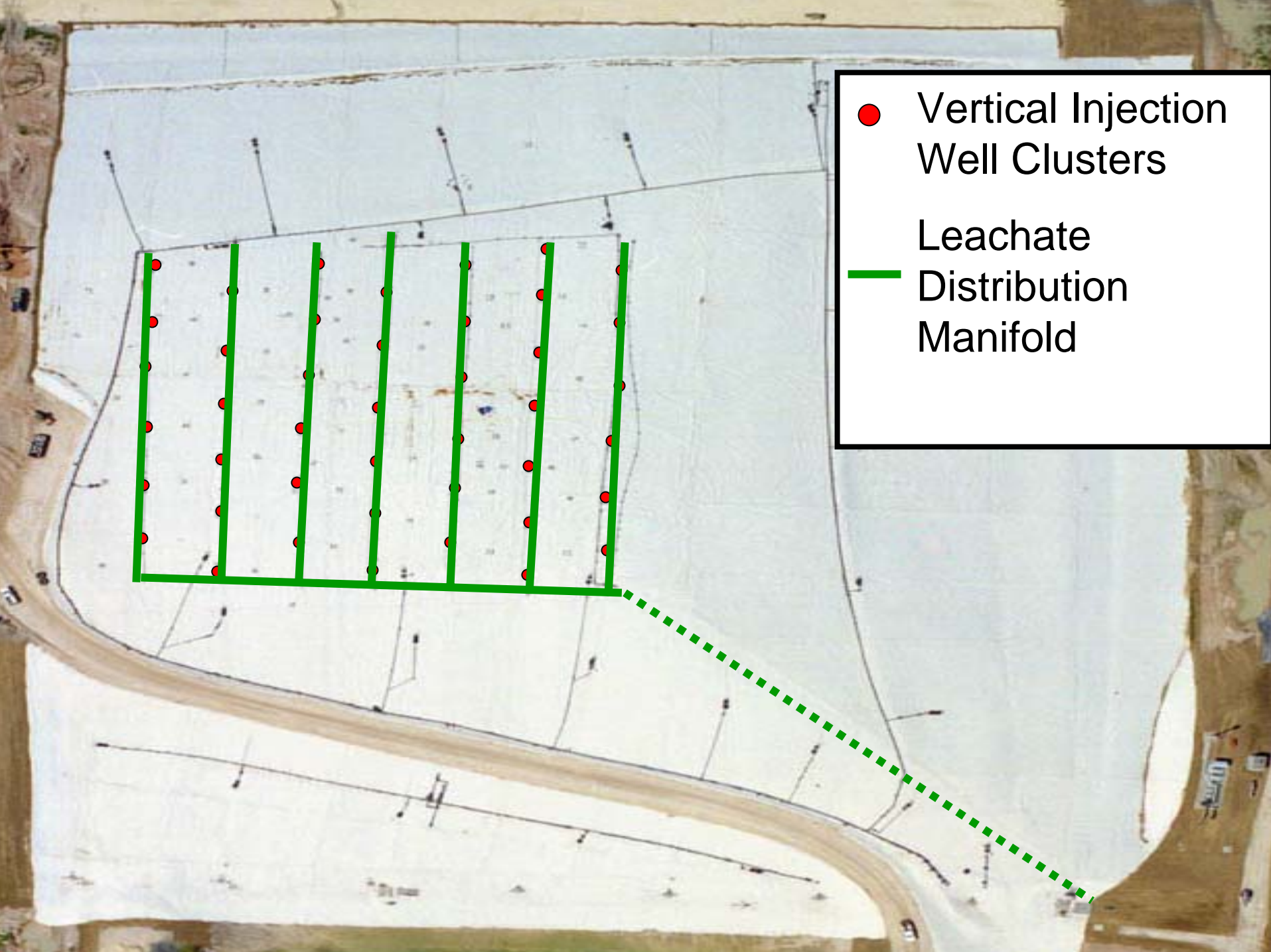




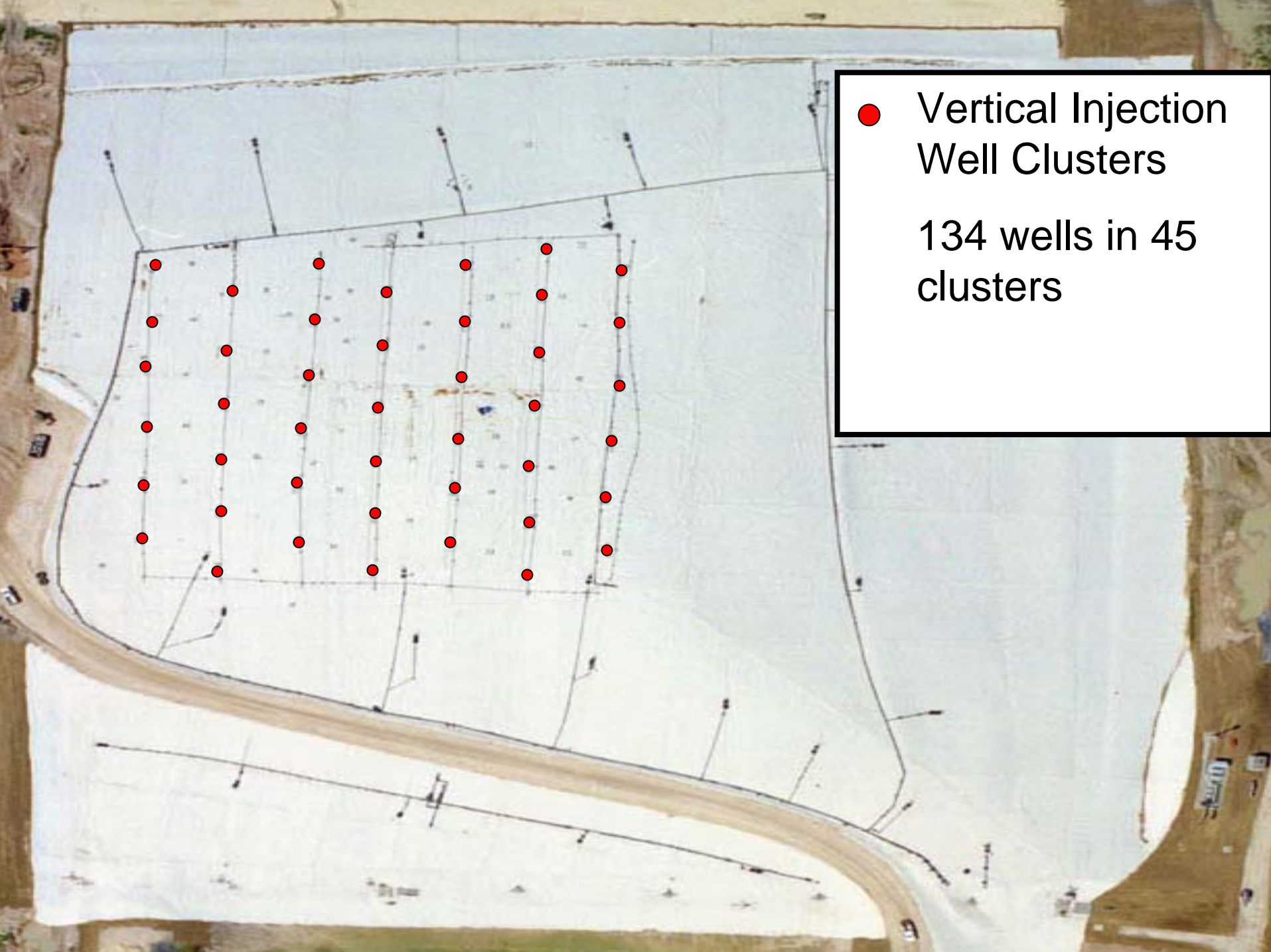




Instrumented
Well Field

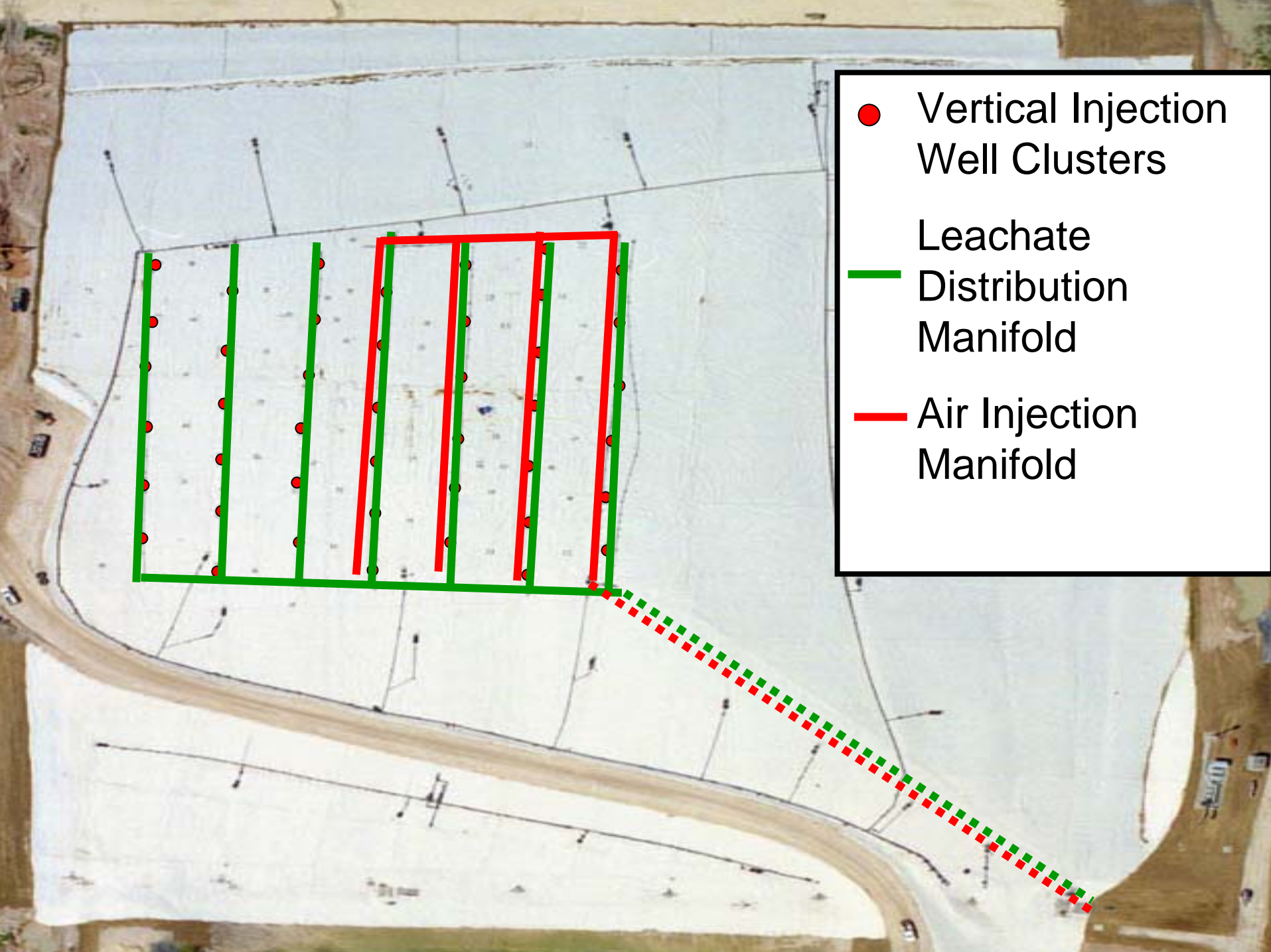


- Vertical Injection Well Clusters
- Leachate Distribution Manifold



● Vertical Injection Well Clusters

134 wells in 45 clusters



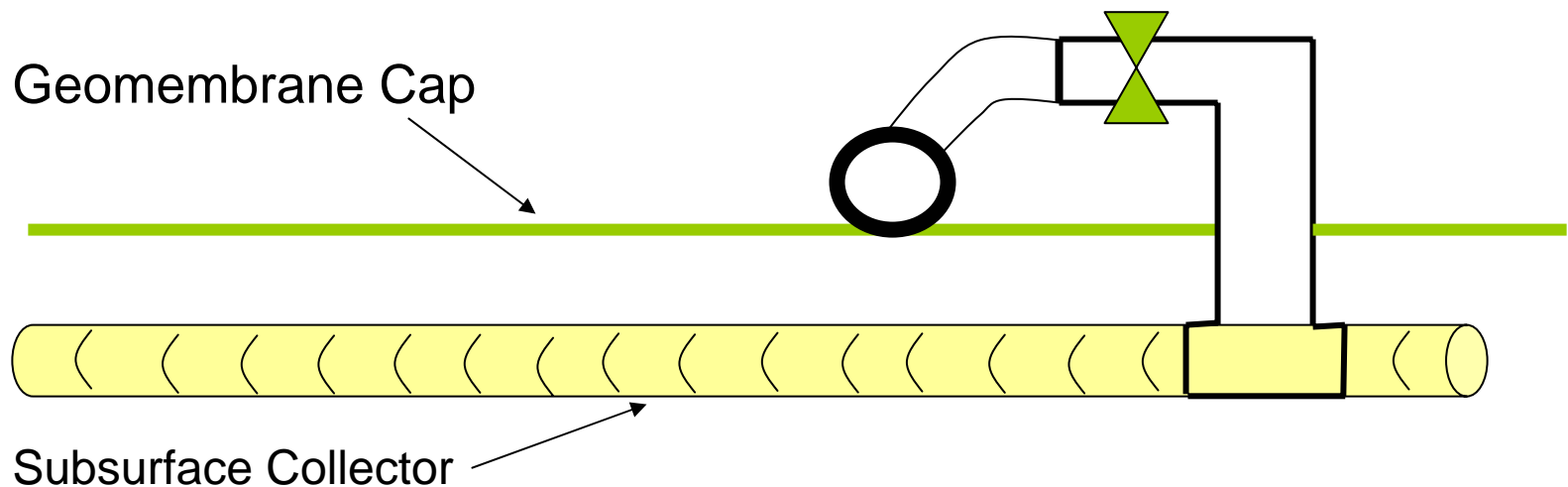
● Vertical Injection Well Clusters

— Leachate Distribution Manifold

— Air Injection Manifold

NRRL Gas Extraction System

- Gas is collected from the horizontal trenches underneath the exposed geomembrane cap

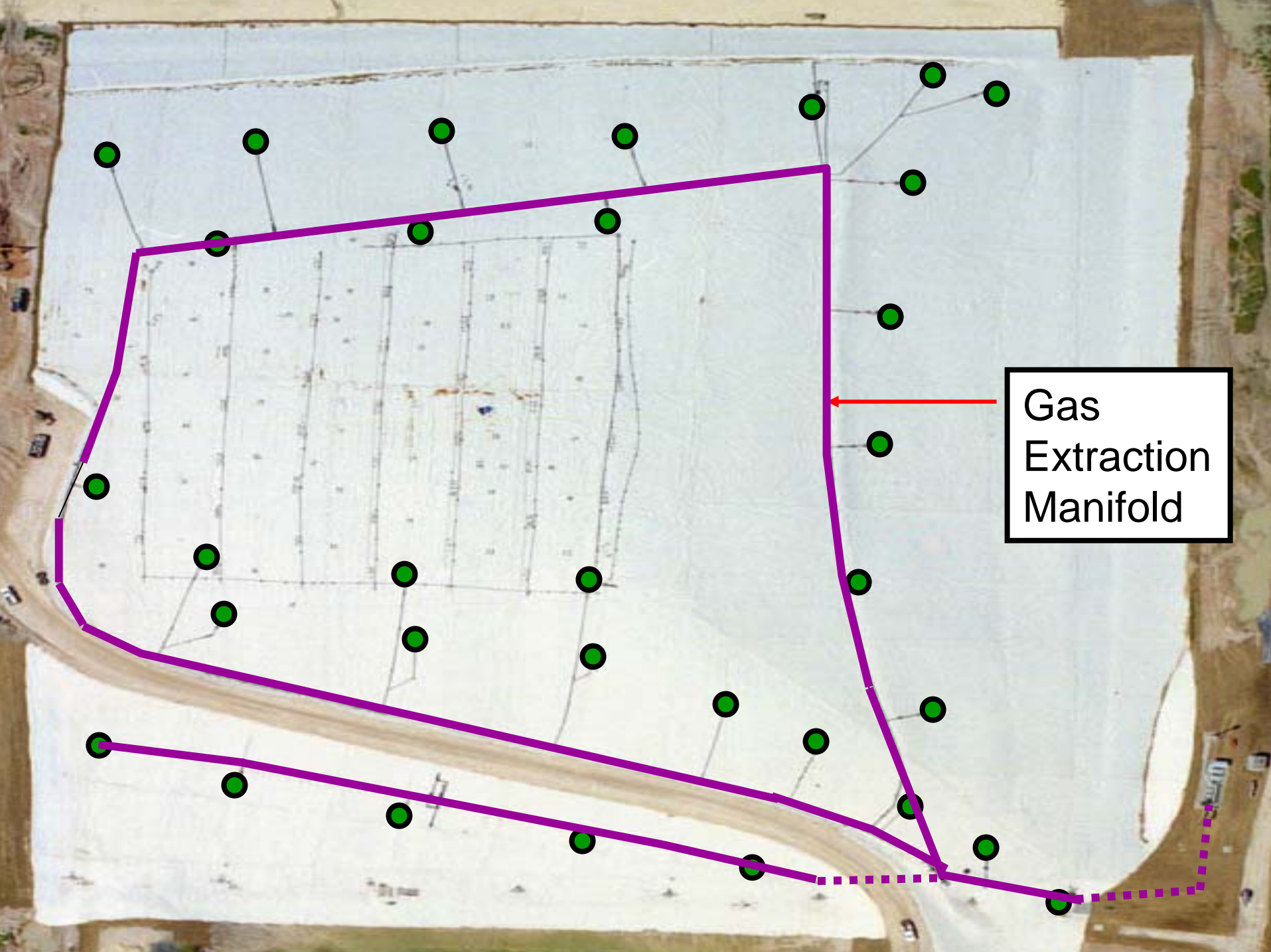




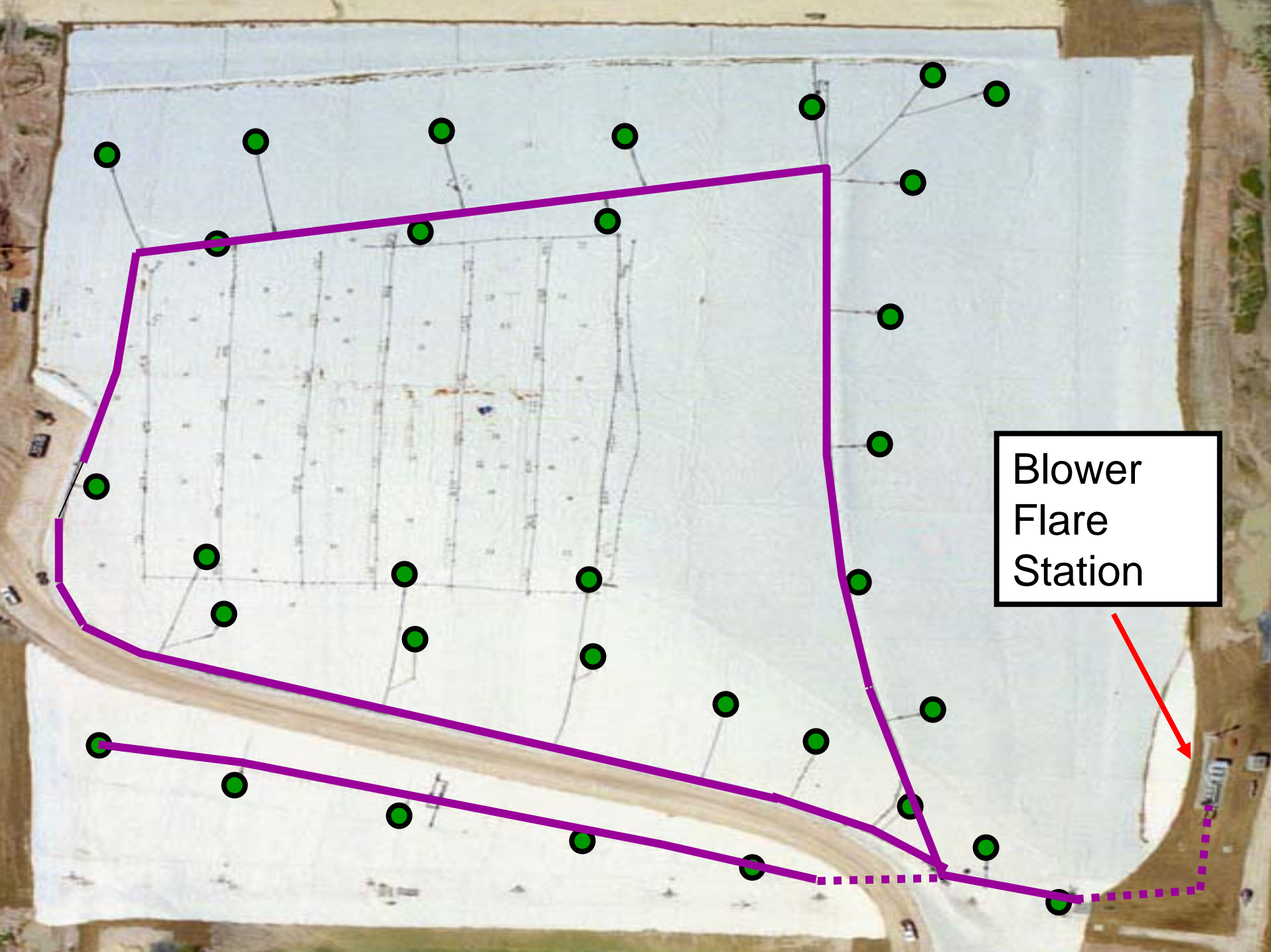




Gas
Extraction
Wells



Gas
Extraction
Manifold



Blower
Flare
Station



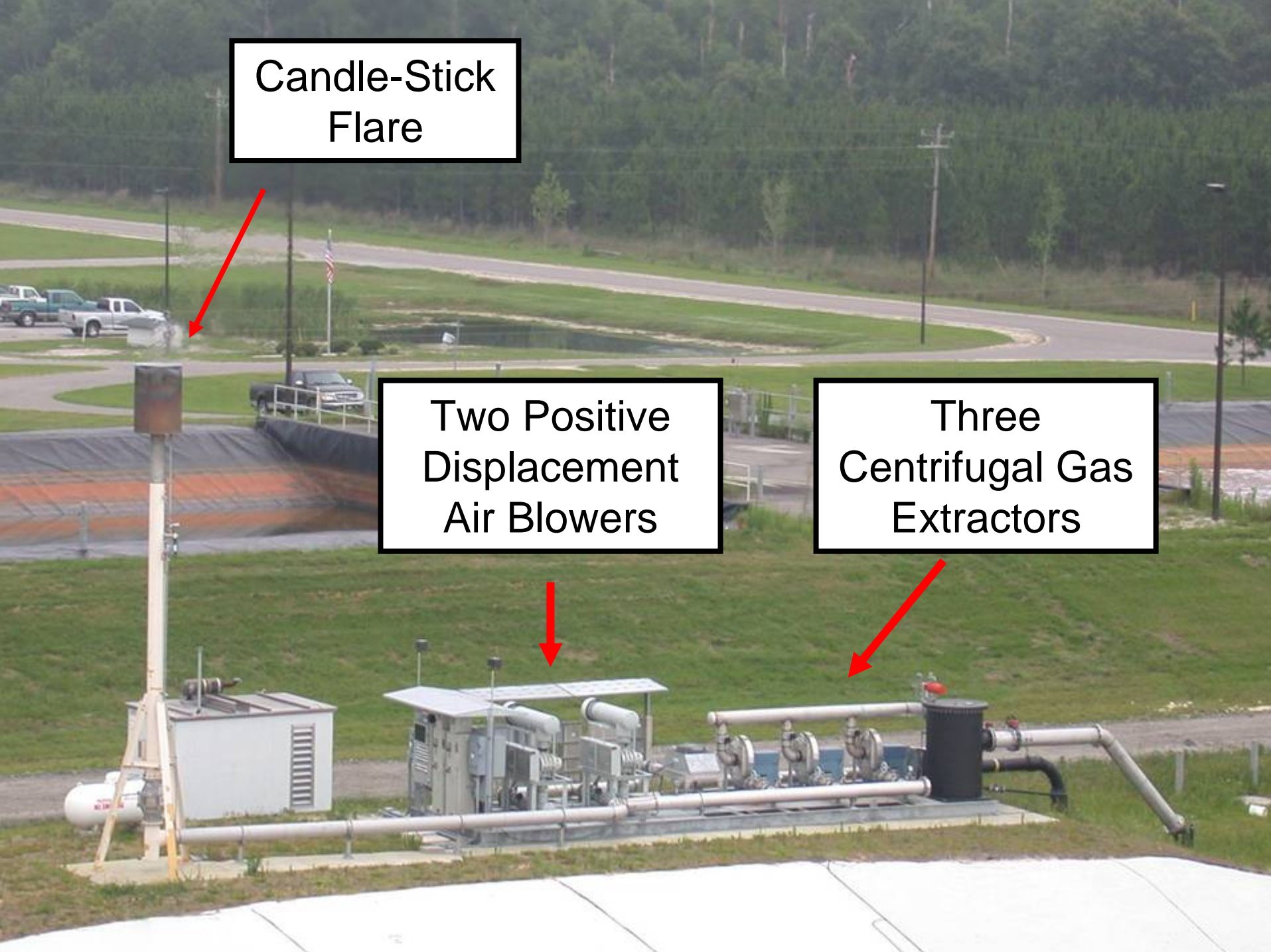
Candle-Stick
Flare



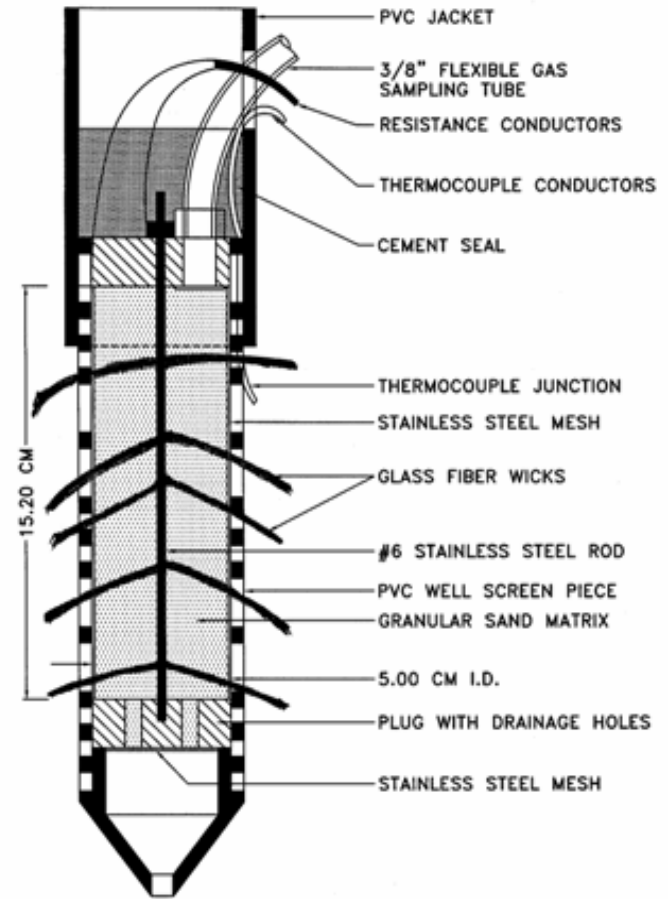
Two Positive
Displacement
Air Blowers



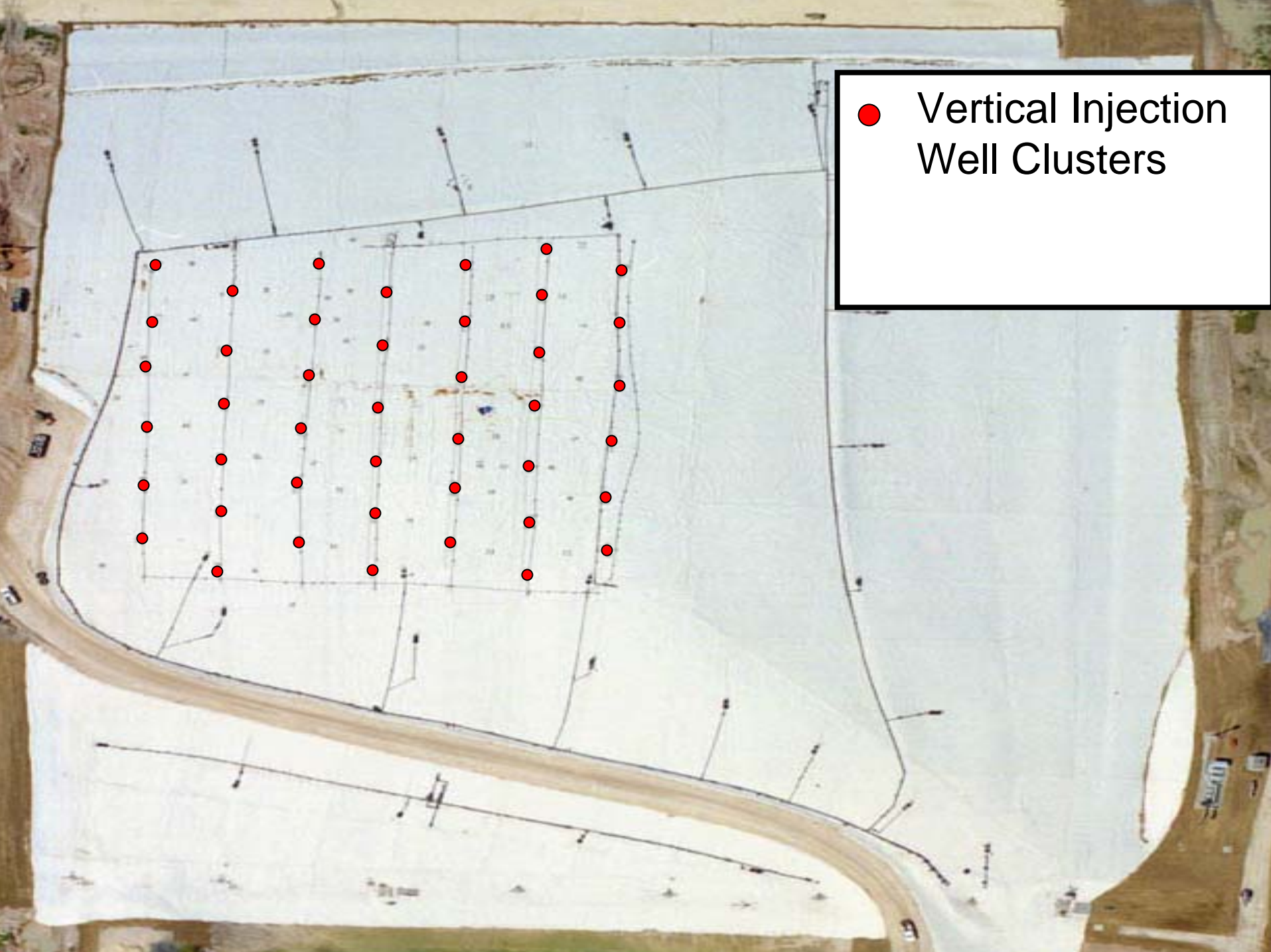
Three
Centrifugal Gas
Extractors

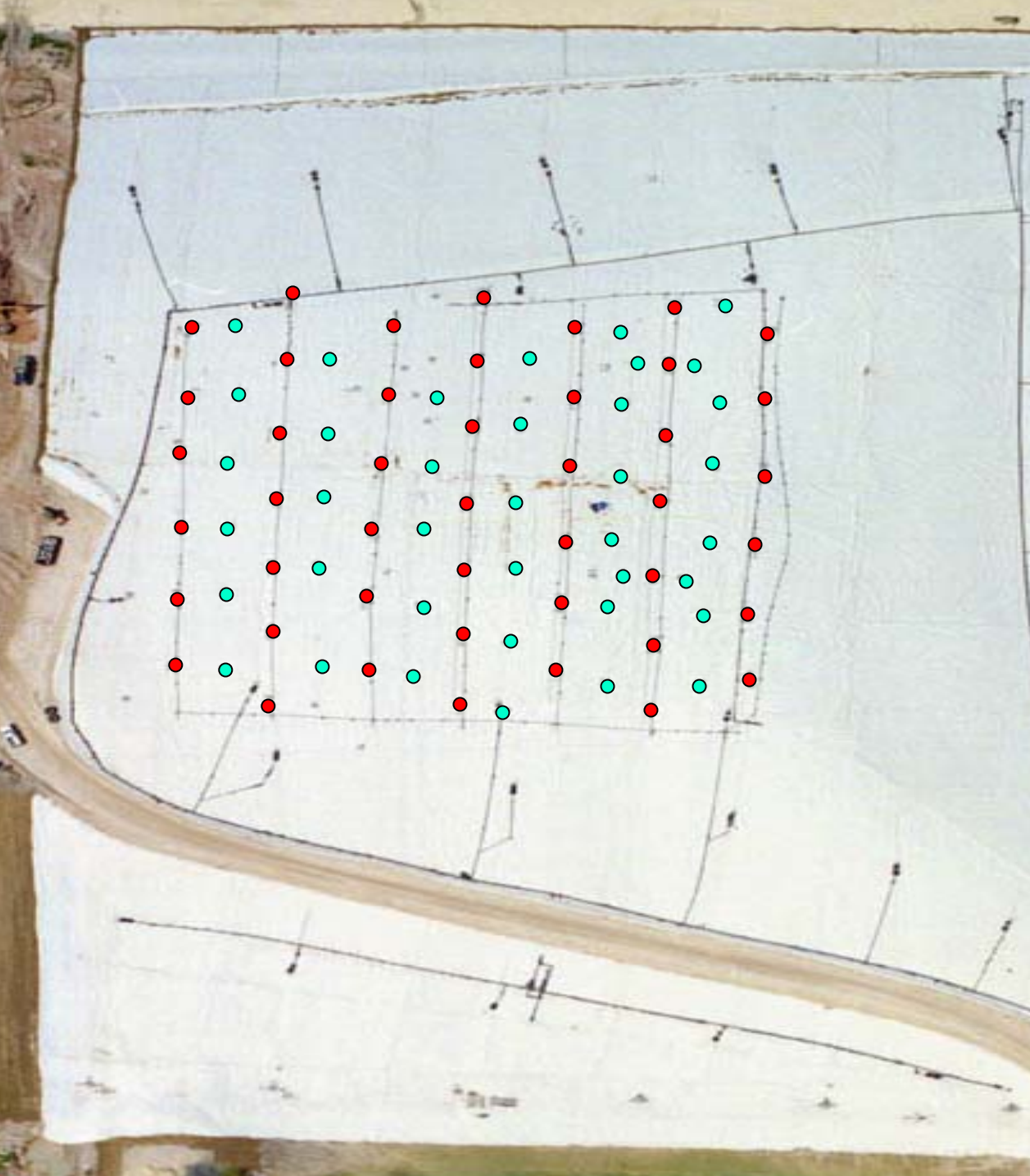


Resistivity Probe For Moisture Measurements



● Vertical Injection Well Clusters





- Vertical Injection Well Clusters
- Instrumentation Cluster



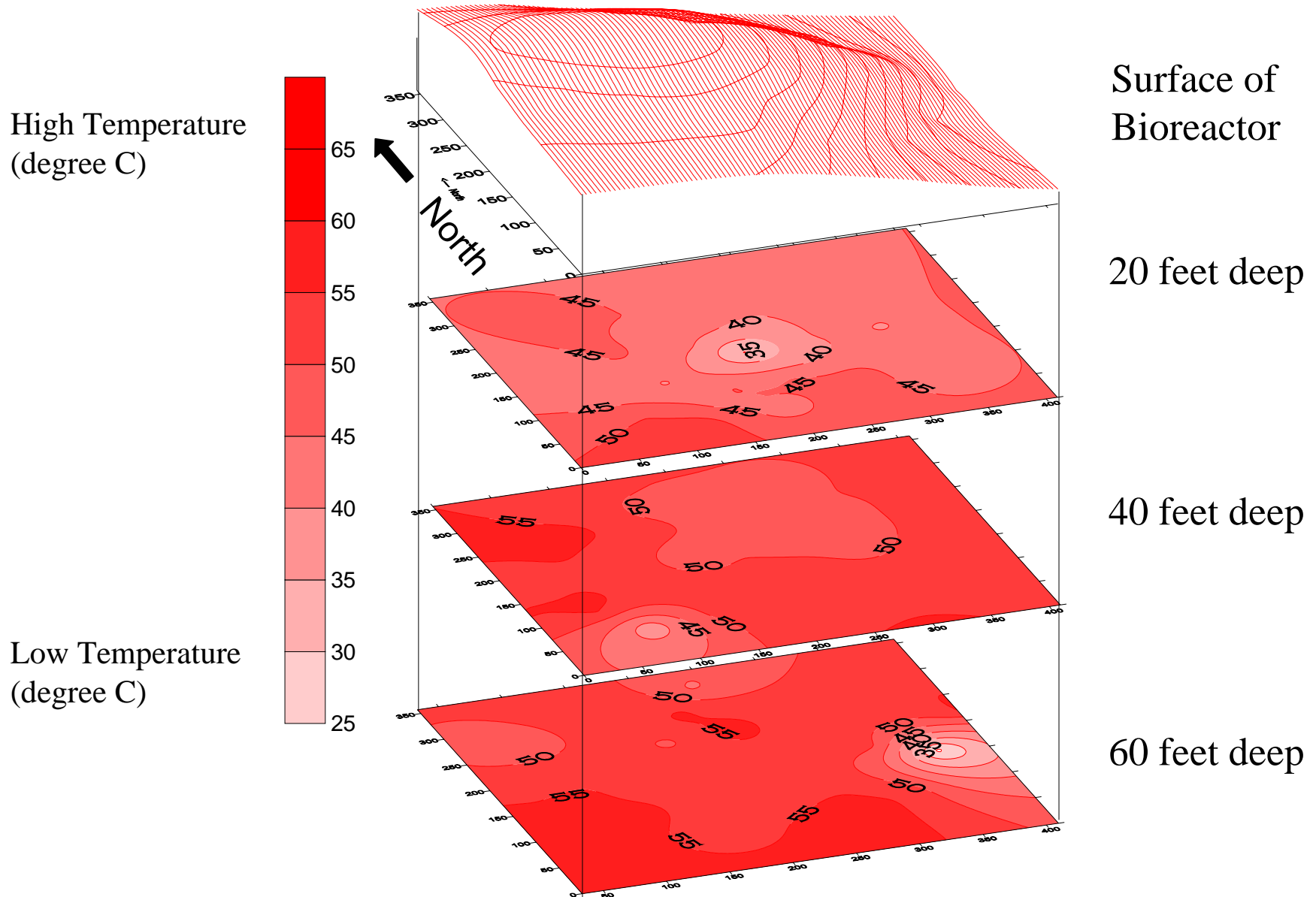
Instrumentation in Place

- 332 thermocouples
- 138 resistivity sensors
- 45,000 ft of thermocouple wire
- 20,000 ft of resistivity wire

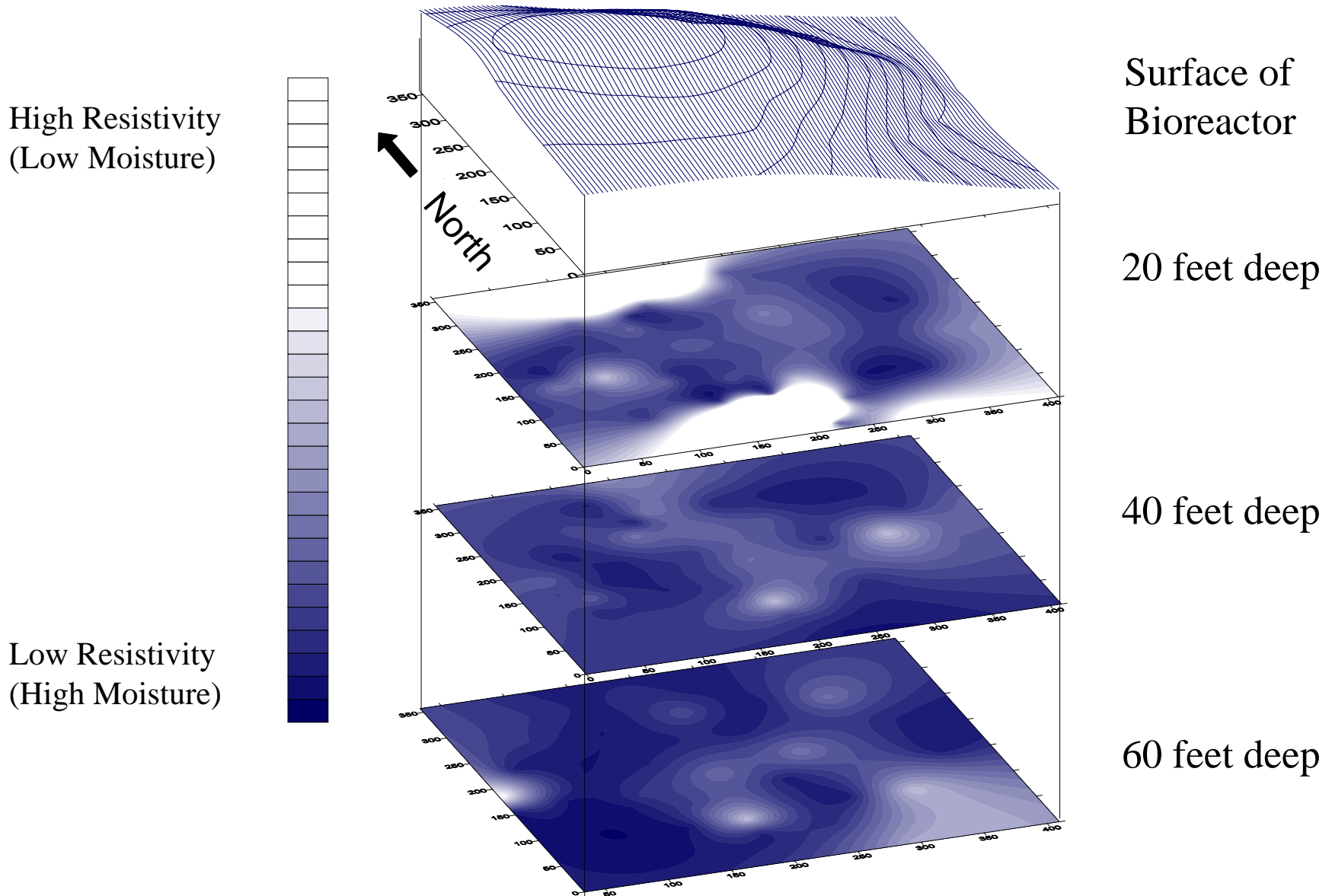




Temperature distribution inside NRRL Bioreactor, 12/18/02



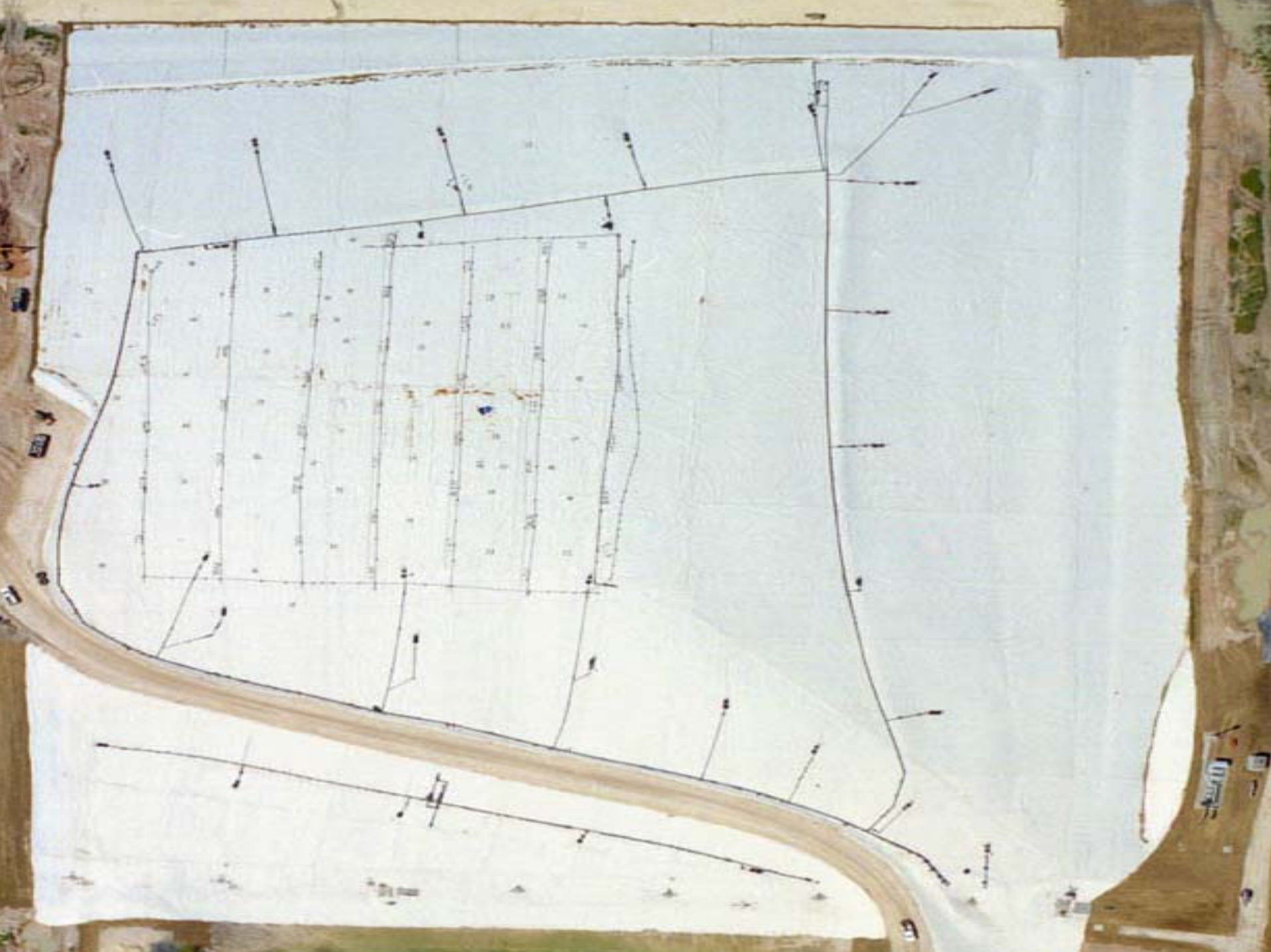
Resistivity distribution inside NRRL Bioreactor, 12/18/02

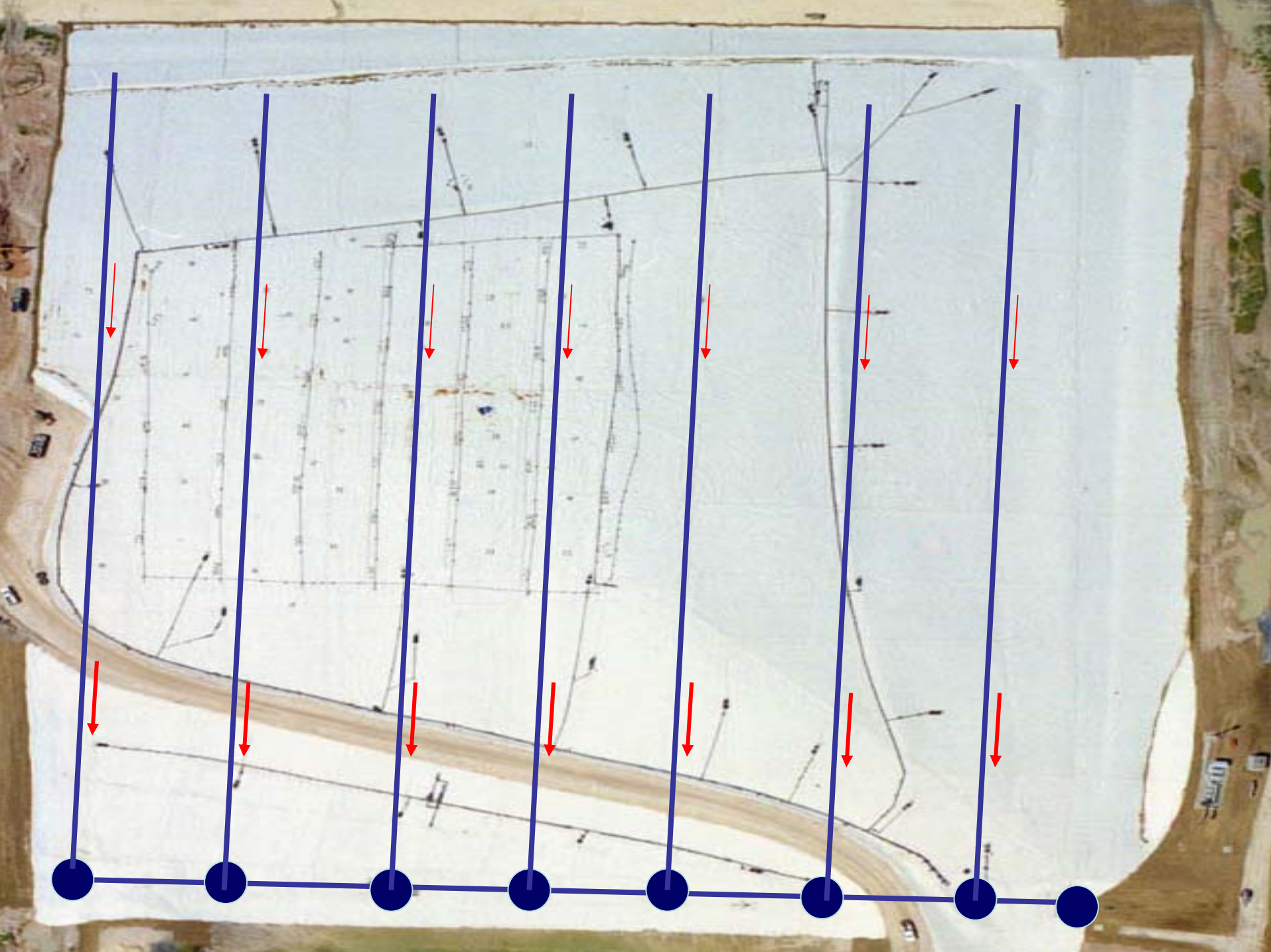


Segregated Leachate Collection at Manholes

- Leachate collection pipes were retrofitted with weir boxes to measure flow and leachate quality from different areas of the landfill







Current Status

- Nearly 3 million gallons of leachate has been recirculated
- Extensive research is being conducted on the hydraulics of the landfill, the use of in-situ sensors, gas emissions, and other bioreactor operations issues
- Aerobic technology is being explored

Application to Unlined Landfills

- Not a common practice
- Offers a potential remediation technique
- Aerobic stabilization has been proposed for older unlined landfills
- Issues:
 - Hydraulic control
 - Gas emissions

For More Information

- Email: ttown@ufl.edu
- Florida Center for Solid and Hazardous Waste Management
- John Schert: jschert@ufl.edu
- www.bioreactor.org
- www.floridacenter.org