From Bioreactors To Elevated Temperature Landfills: How Warm Do Florida Landfills Get And How Do We Control

2025 SWANA FL Winter Conference

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My Gratitude to HCSHWM

- 20 Projects
- 34 Students
- 38 Papers

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Presentation

- Overview of causes of elevated temperatures in landfills
- Subsurface ETLFs
- Air Induced ETLFs

Conditions for Elevated Temperatures

- Requisite conditions for elevated temperatures include the availability of the following:
  - Fuel (waste)
  - Moisture
  - Energy Input (heat generation)
- Heat is generated when chemicals are oxidized or broken down into simpler molecules (biotic or abiotic)
  - Aerobic or anaerobic biotic degradation of waste
  - Oxygen adsorption, chemical reactions, oxidative degeneration of fuel (slow pyrolysis), oxidation of pyrolytic byproducts
  - Condensation of evaporated water

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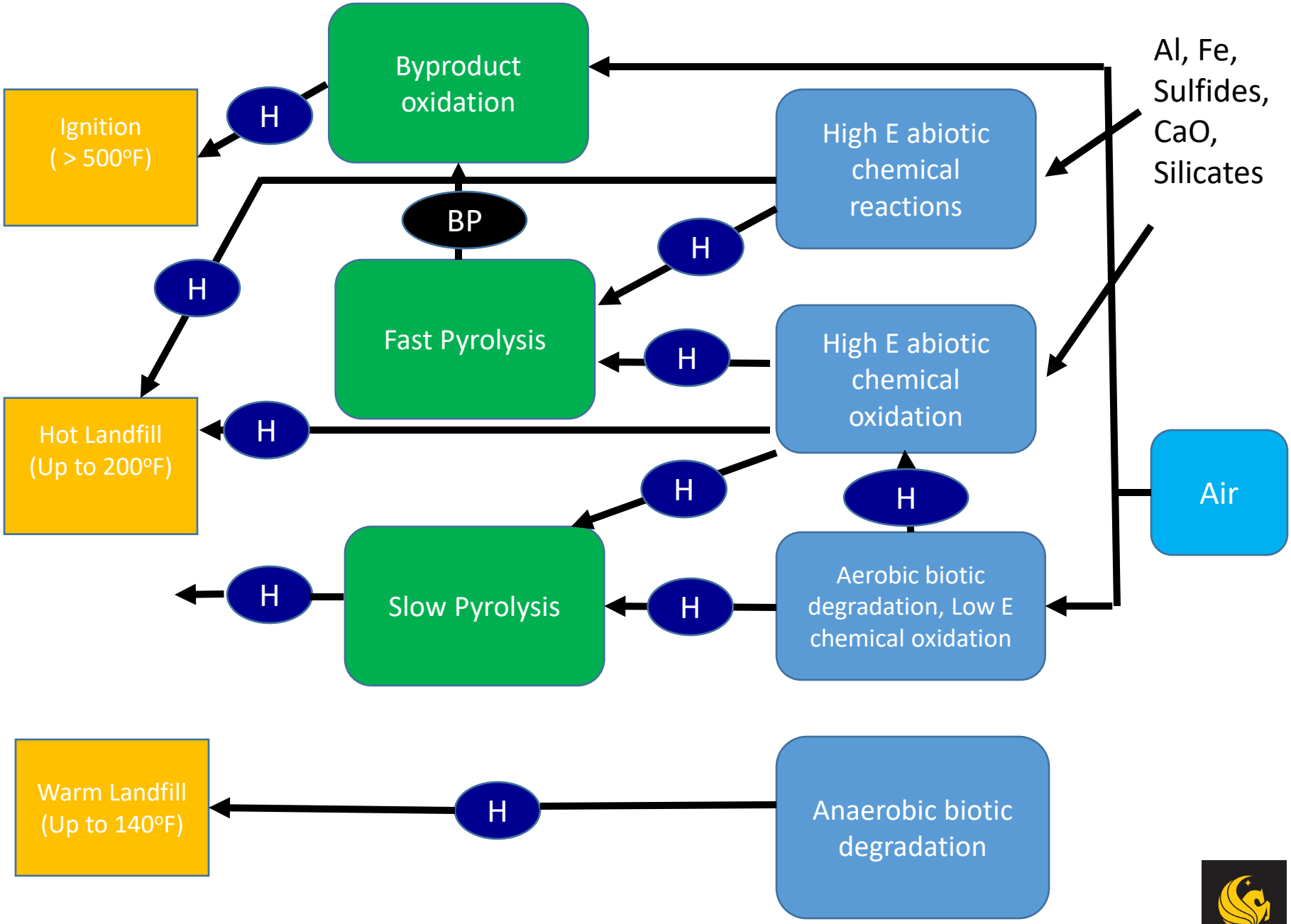
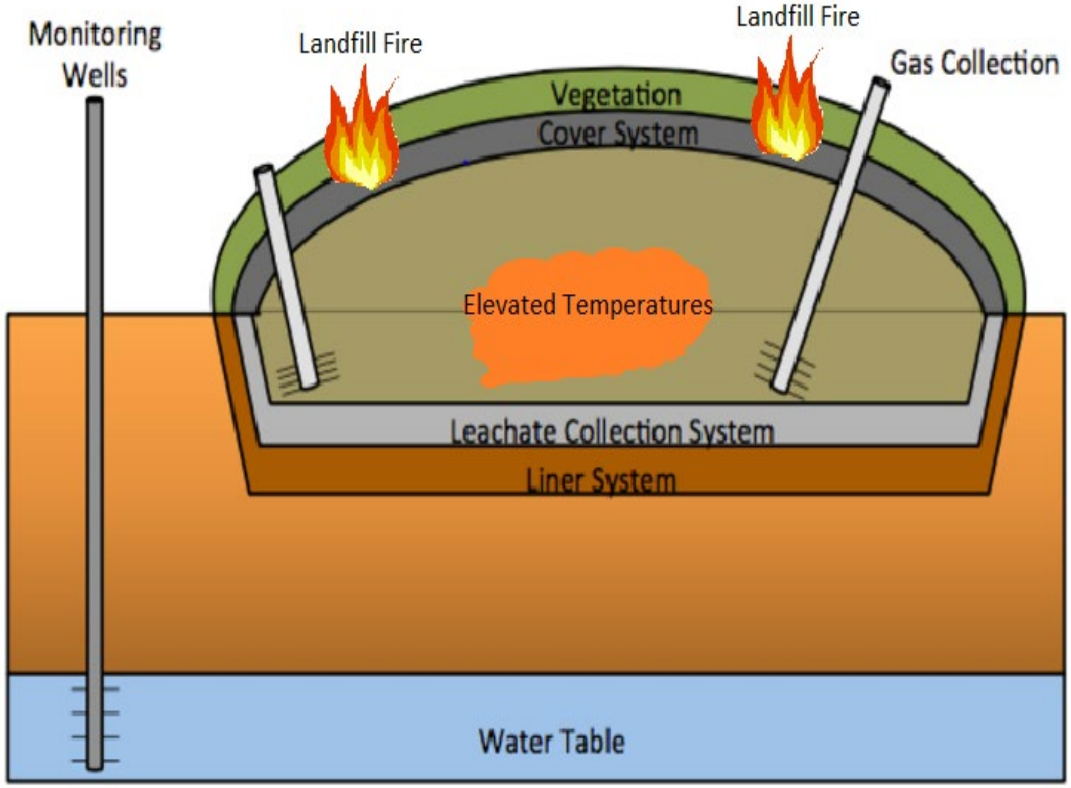
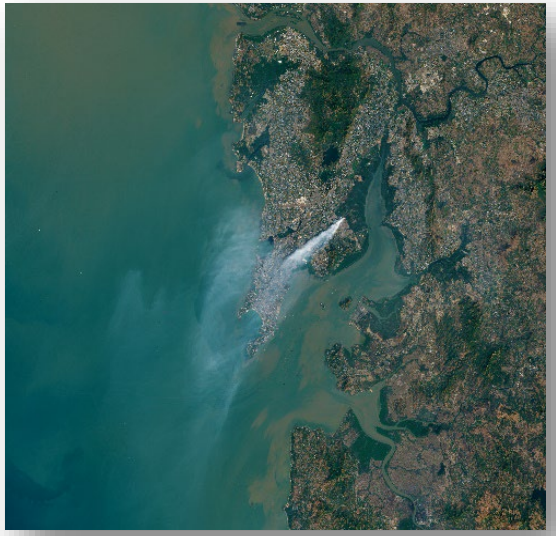

Byproduct oxidation
Ignition (> 500°F)
H
High E abiotic chemical reactions
Al, Fe, Sulfides, CaO, Silicates
BP
H
H
Fast Pyrolysis
H
High E abiotic chemical oxidation
Hot Landfill (Up to 200°F)
H
H
H
Air
Slow Pyrolysis
H
H
Aerobic biotic degradation, Low E chemical oxidation
Warm Landfill (Up to 140°F)
H
Anaerobic biotic degradation

Near Surface Fires vs Subsurface ET Events





Picture of Mumbai Deonar Landfill fire captured by sensors on the Terra, Aqua, and Suomi NPP satellites

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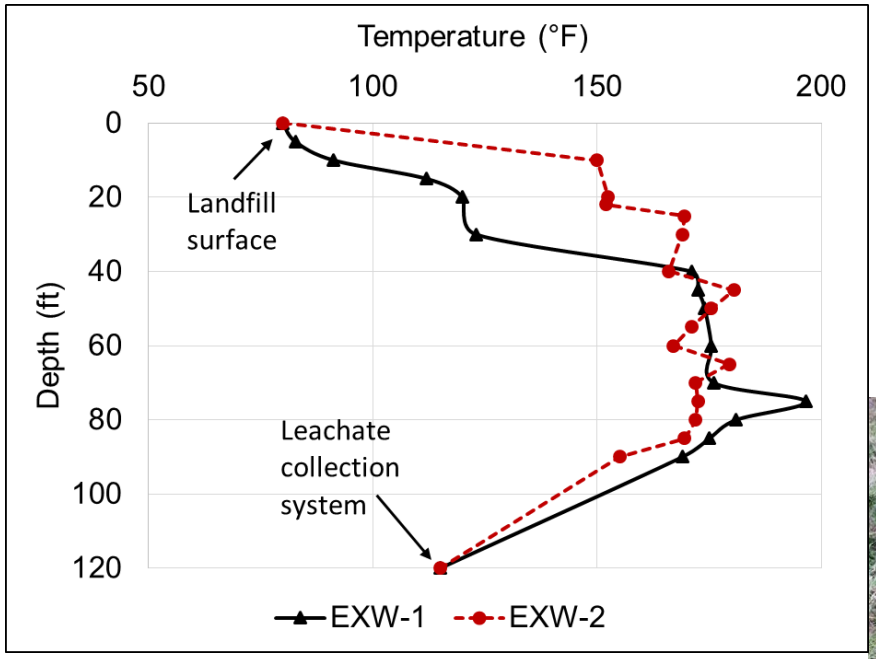
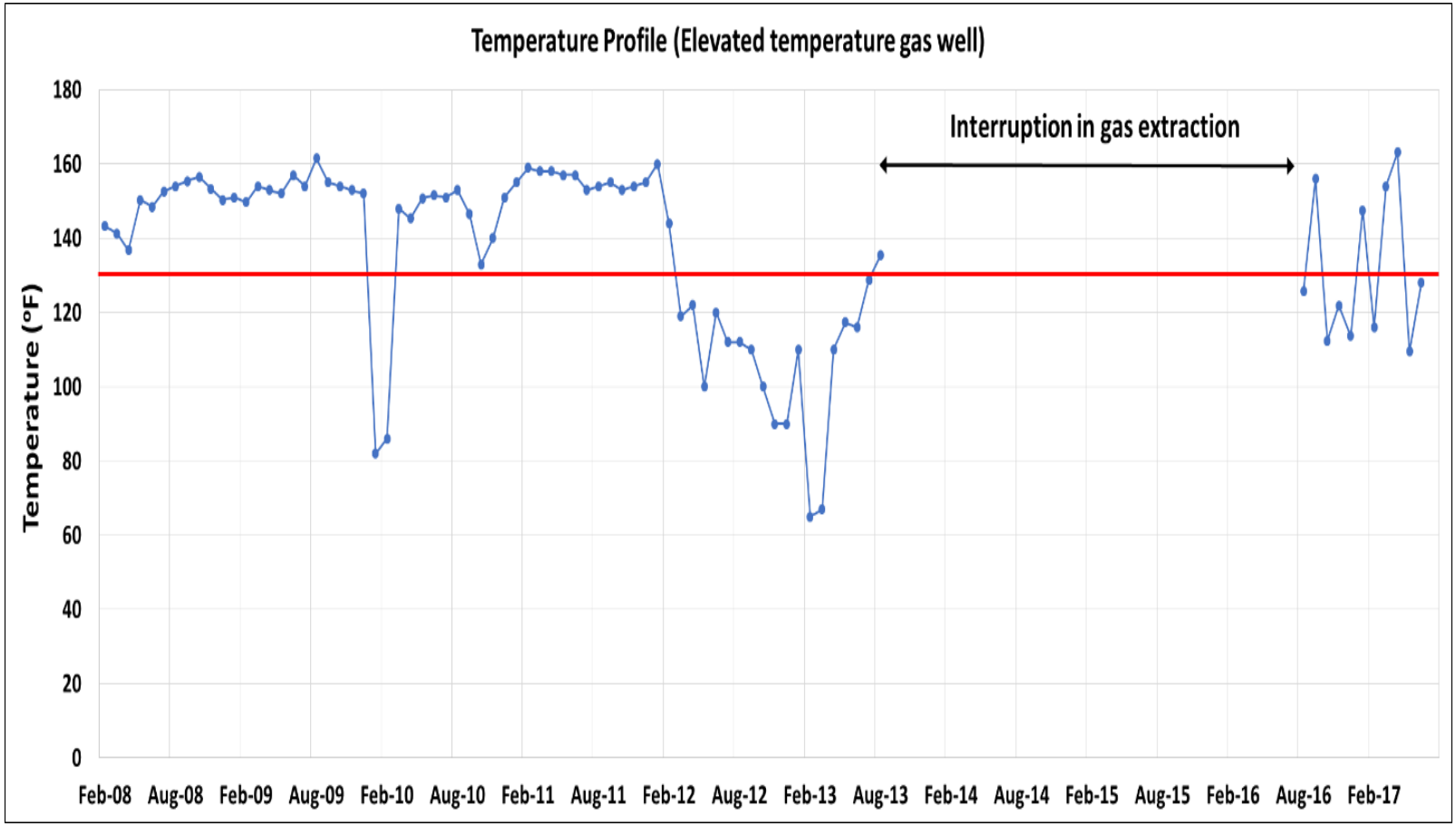
Subsurface ETLFs

Temperature at Various Depths of ETLF



Elevated Temperature Gas Well



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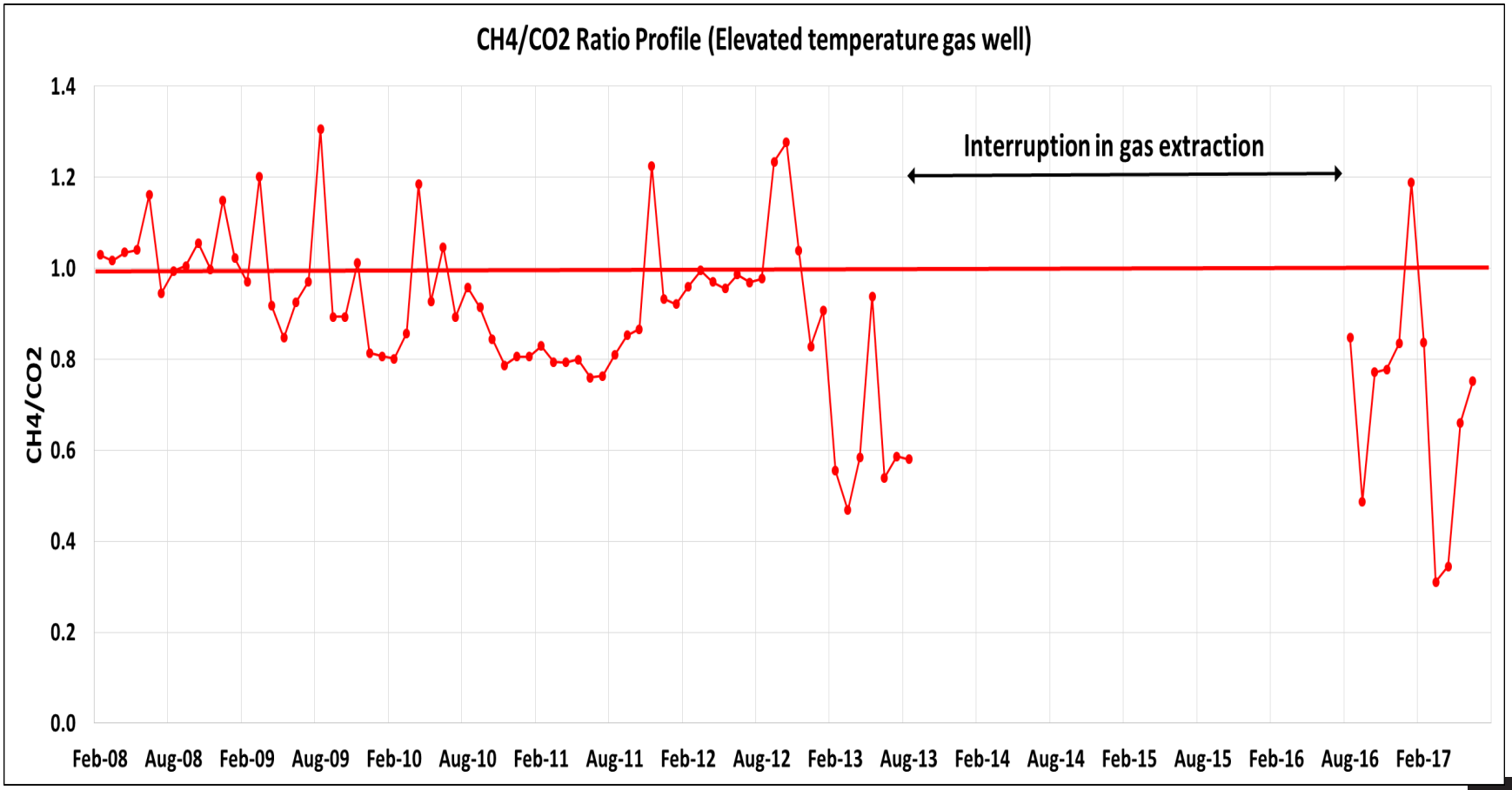
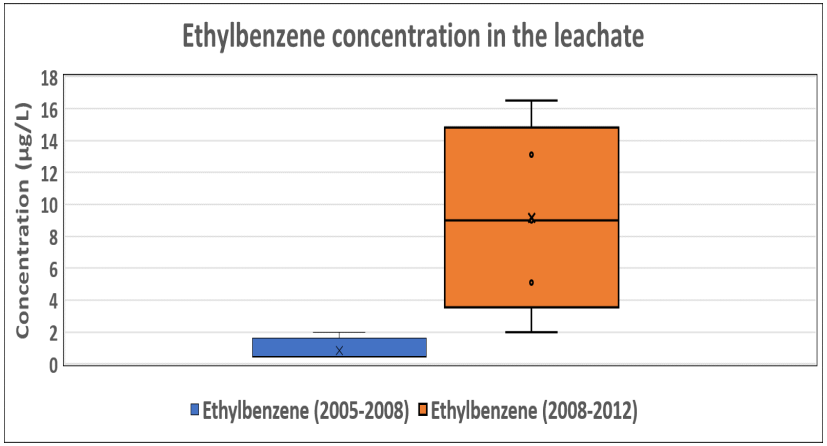
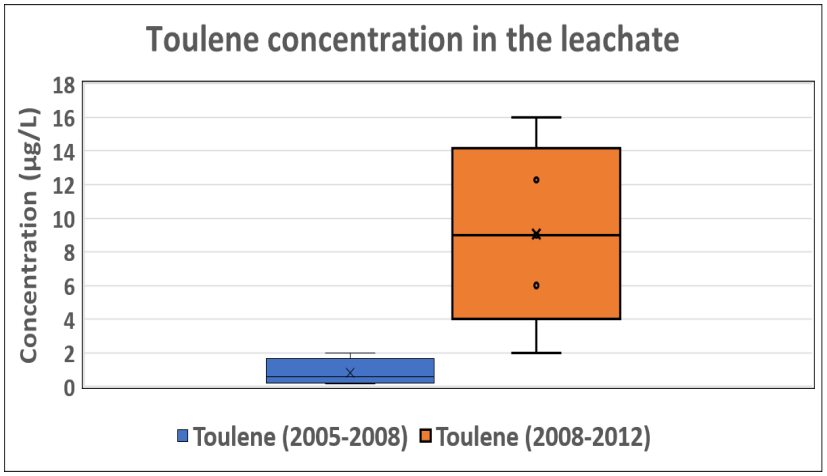
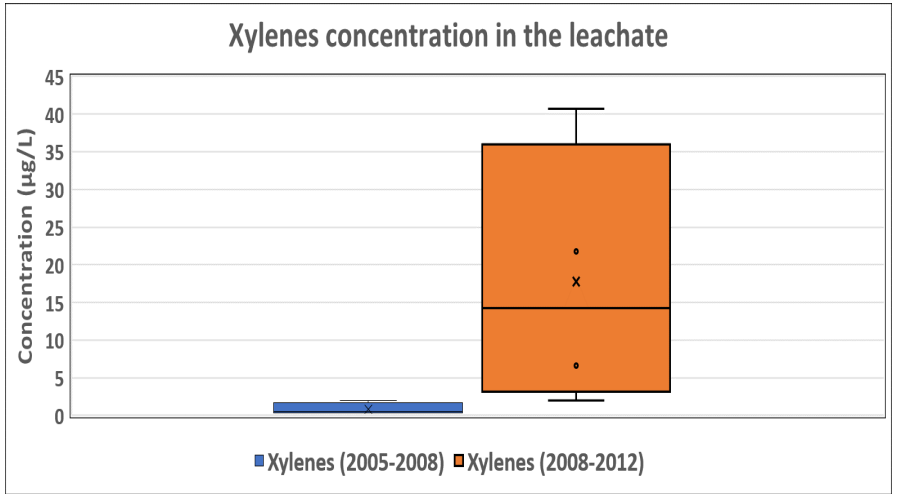
Elevated Temperature Gas Well (Temperature & CH_4/CO_2)



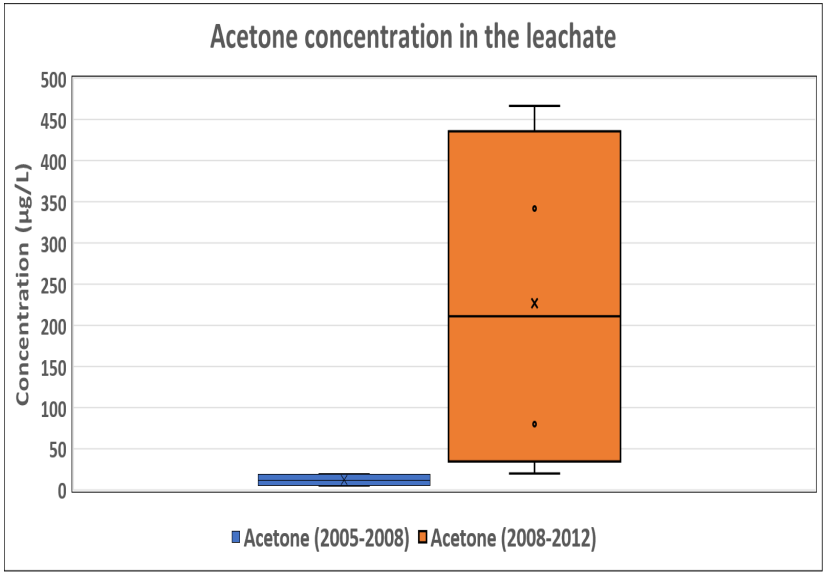
Leachate Characteristics (Aromatics)

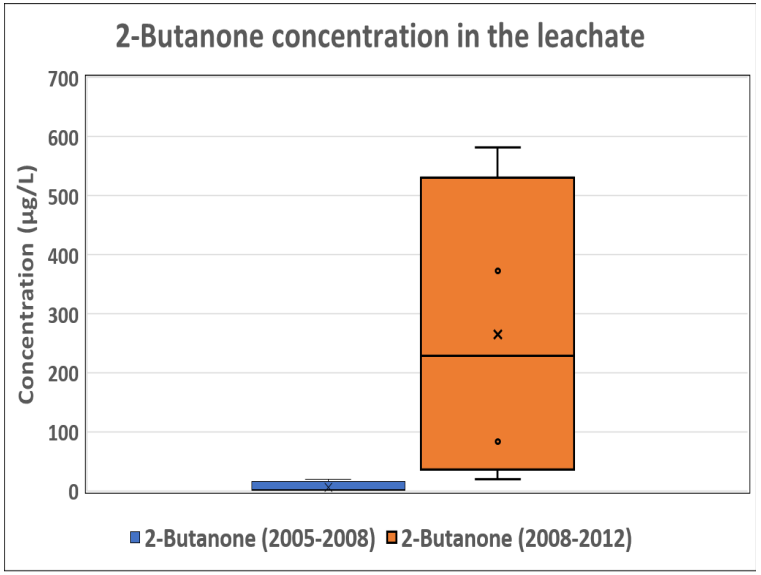






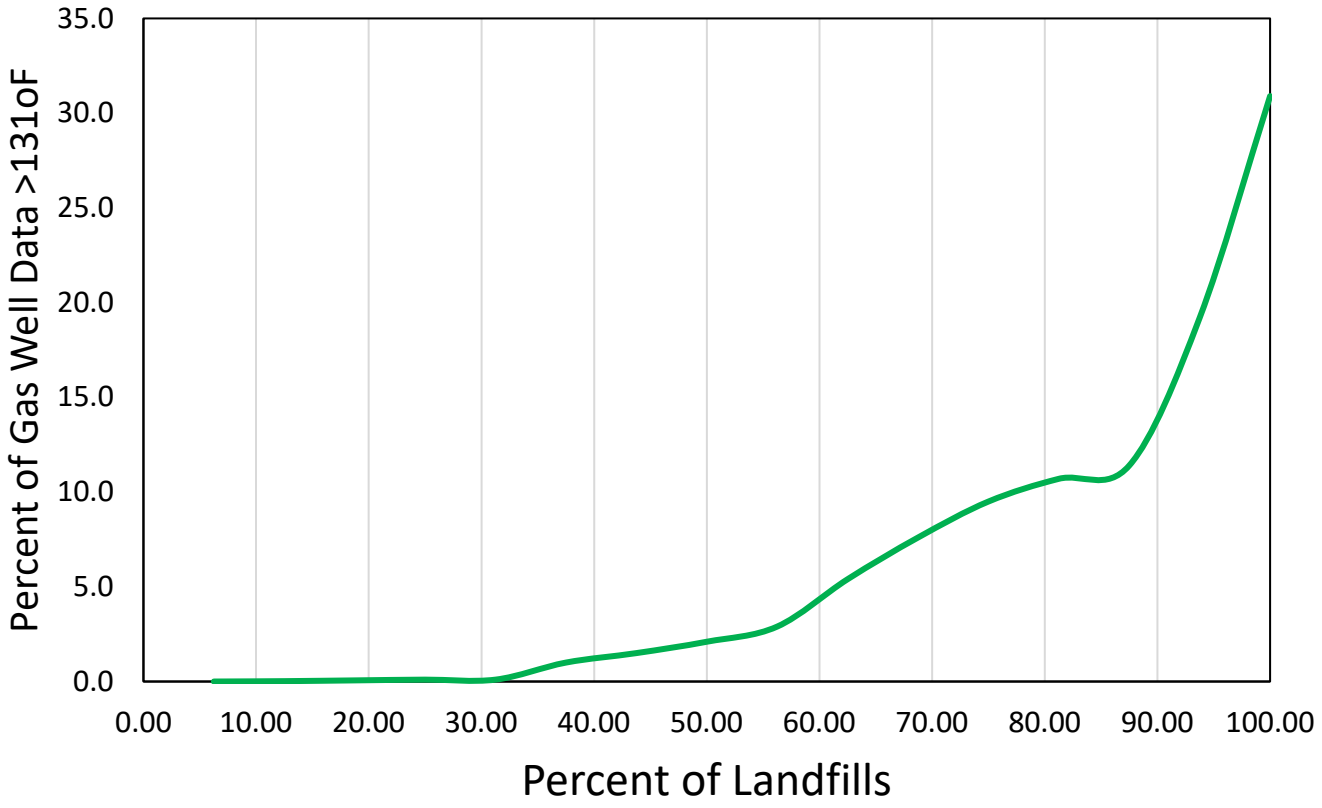
Leachate Characteristics (Ketones)





HCSHWM Florida Landfill Temperature Study

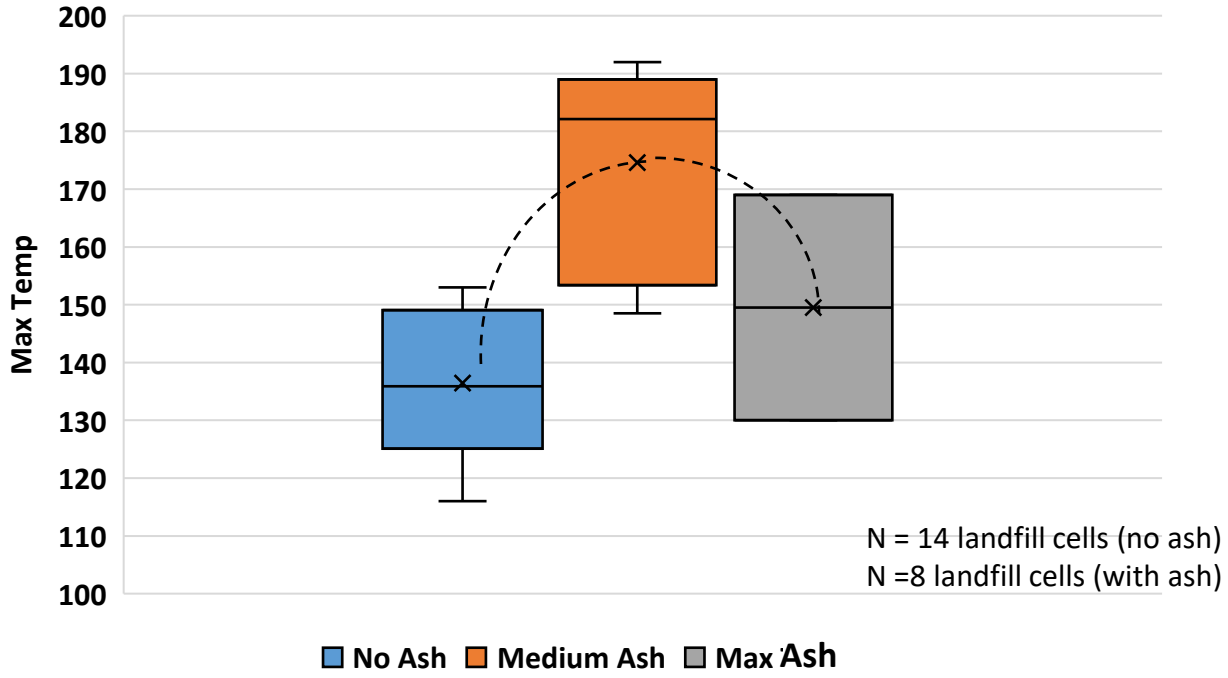
Historical Florida Landfill Gas Temperature Data For 22 Landfills



Elevated Temperature Landfill Observations

- 14 (64%) landfills had elevated temperatures.
- 8 reported history of accepting ash.
- 7 of these 8 landfills with ash report elevated temperatures (88%)
- Hydrolysis reactions with the metal oxides can generate significant energy by producing CO_2 and H_2 gases

Effect of Ash Disposal On Maximum Temperature



Why Ash?

- Reactions promoted by highly alkaline pH of incinerator ashes (pH>10)
- Glassy calcium silicate phases like Fe and Al and are subject to exothermic dissolution and corrosion reactions.
- If all other conditions are held constant, coal combustion ash may be more reactive than MSWIAs when co-disposed with MSW

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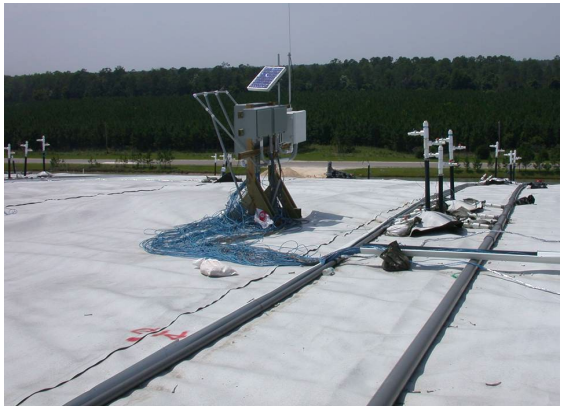
Air Induced ETLFs

Source of Air

- Near surface air intrusion
  - Overpulling on landfill gas wells
  - Wind, barometric pressure
  - Triggered by low moisture content, ignitable wastes, or smoldering waste
- Intentional injection of air – aerobic landfills



New River Regional Landfill Bioreactor Demonstration Project

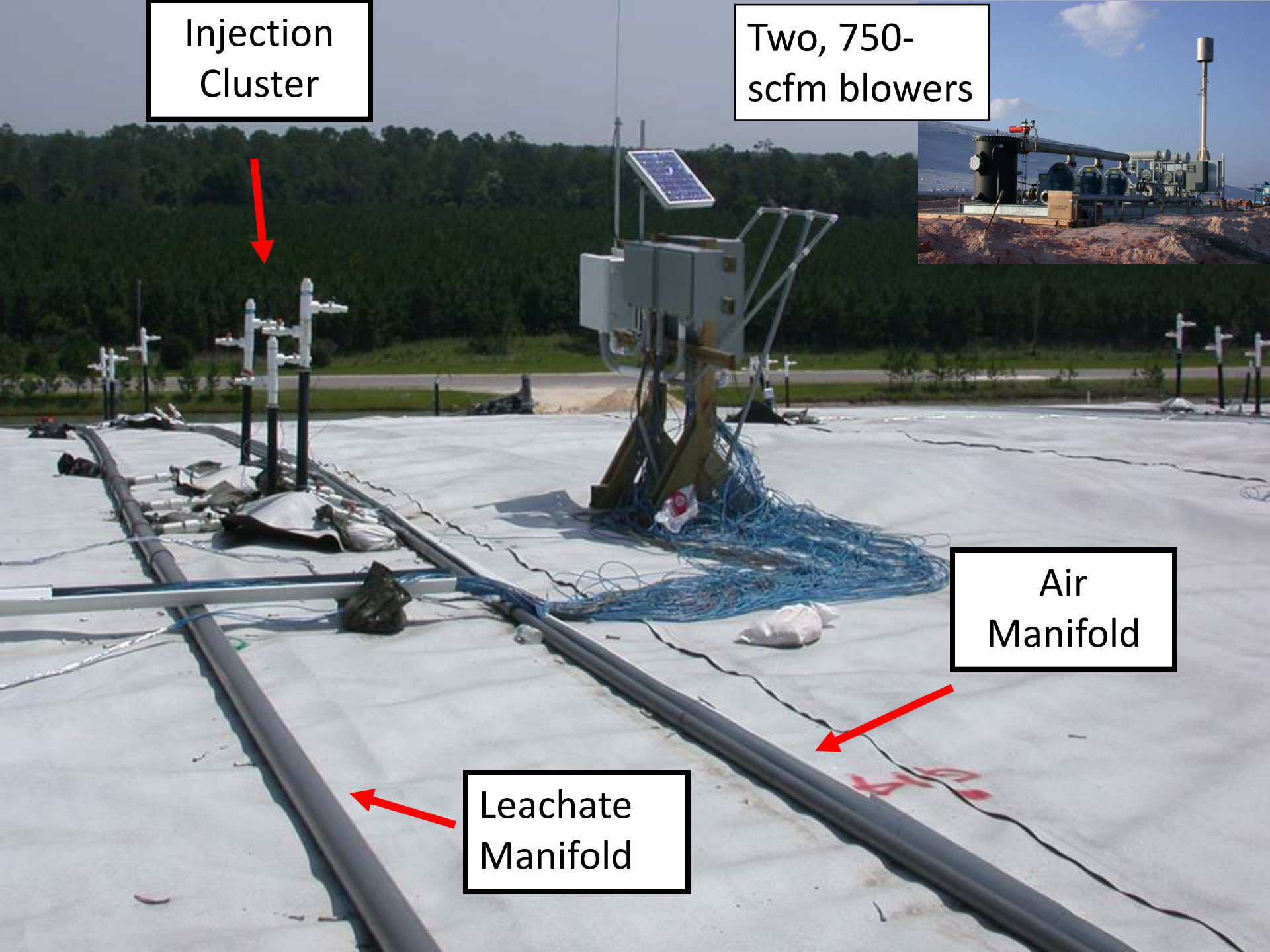

NEW R
SOLID W

New River Regional Landfill

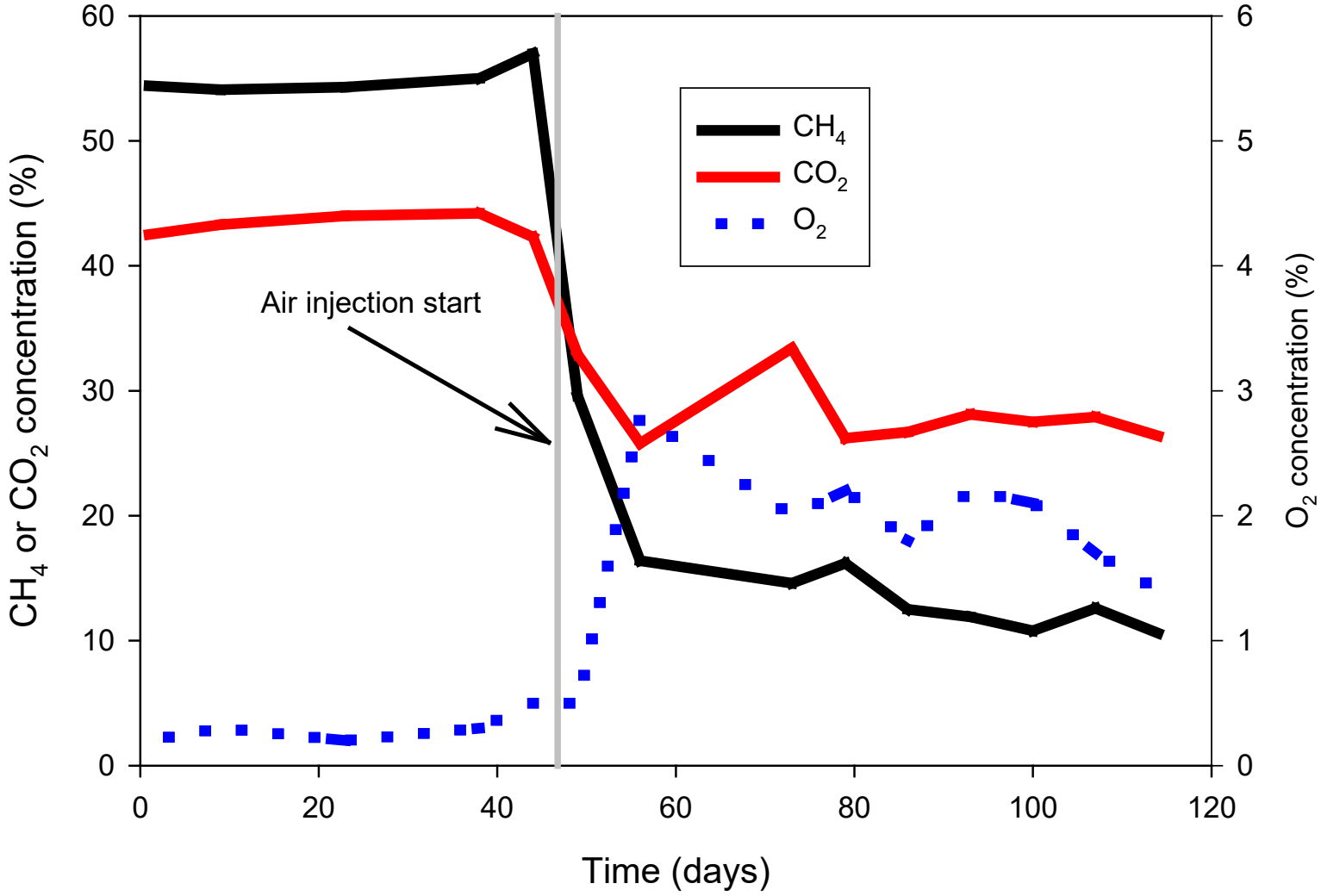
- 4-ha bioreactor demonstration cell
- 134, 5-cm diameter vertical injection well clusters (6, 12, and 18 m deep)
- Exposed geomembrane cover
- Air injection has been practiced periodically since 2003

Advantages of Aerobic Operation

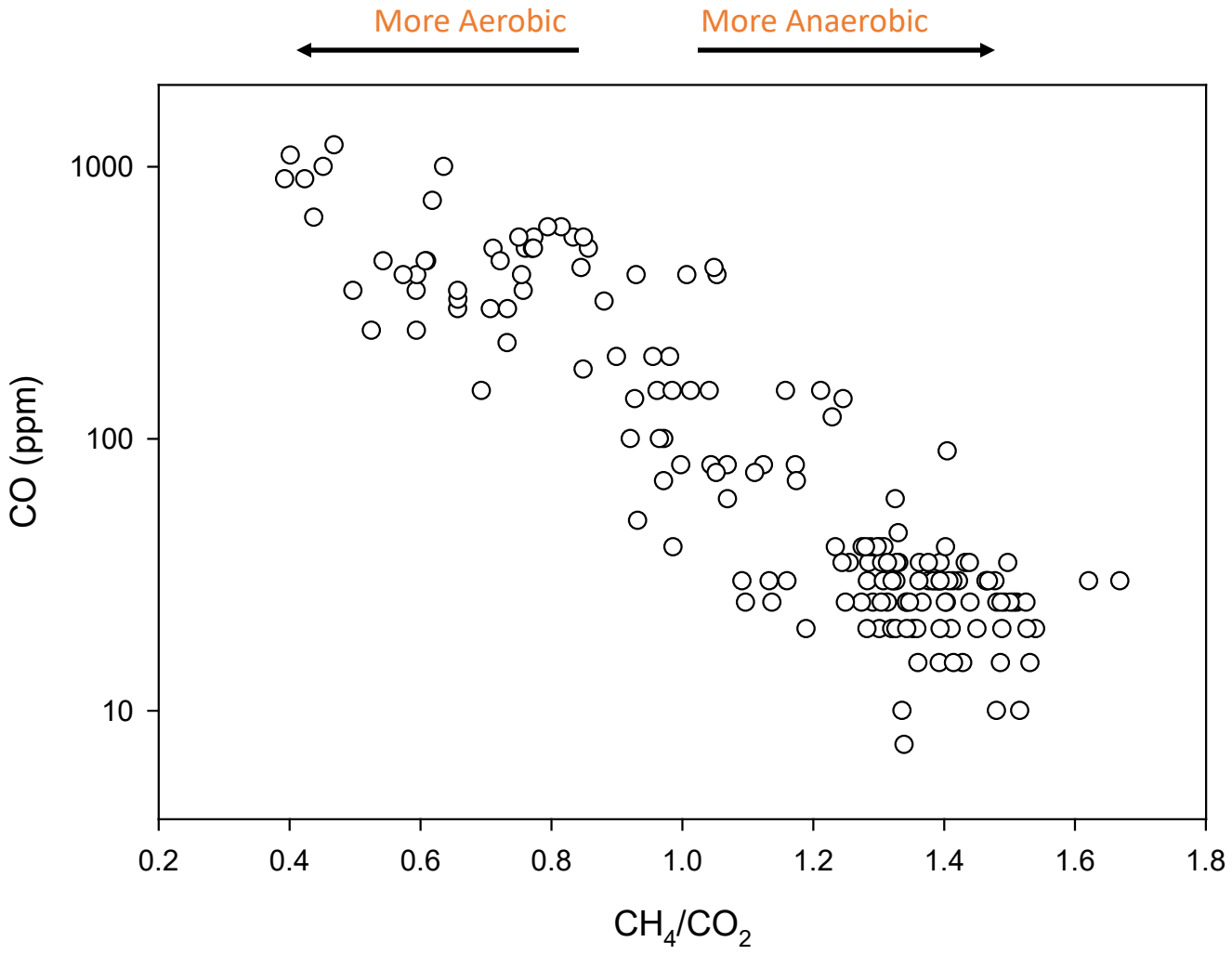
- Enhance waste degradation
- Mitigate odor and methane emissions
- Increase settlement/airspace recovery
- Reduce leachate management liability and costs
- Removal of anaerobically recalcitrant compounds (i.e. ammonia-nitrogen)
- Reduce environmental risk


Injection Cluster
Two, 750-scfm blowers
Air Manifold
Leachate Manifold

Consider Results from New River



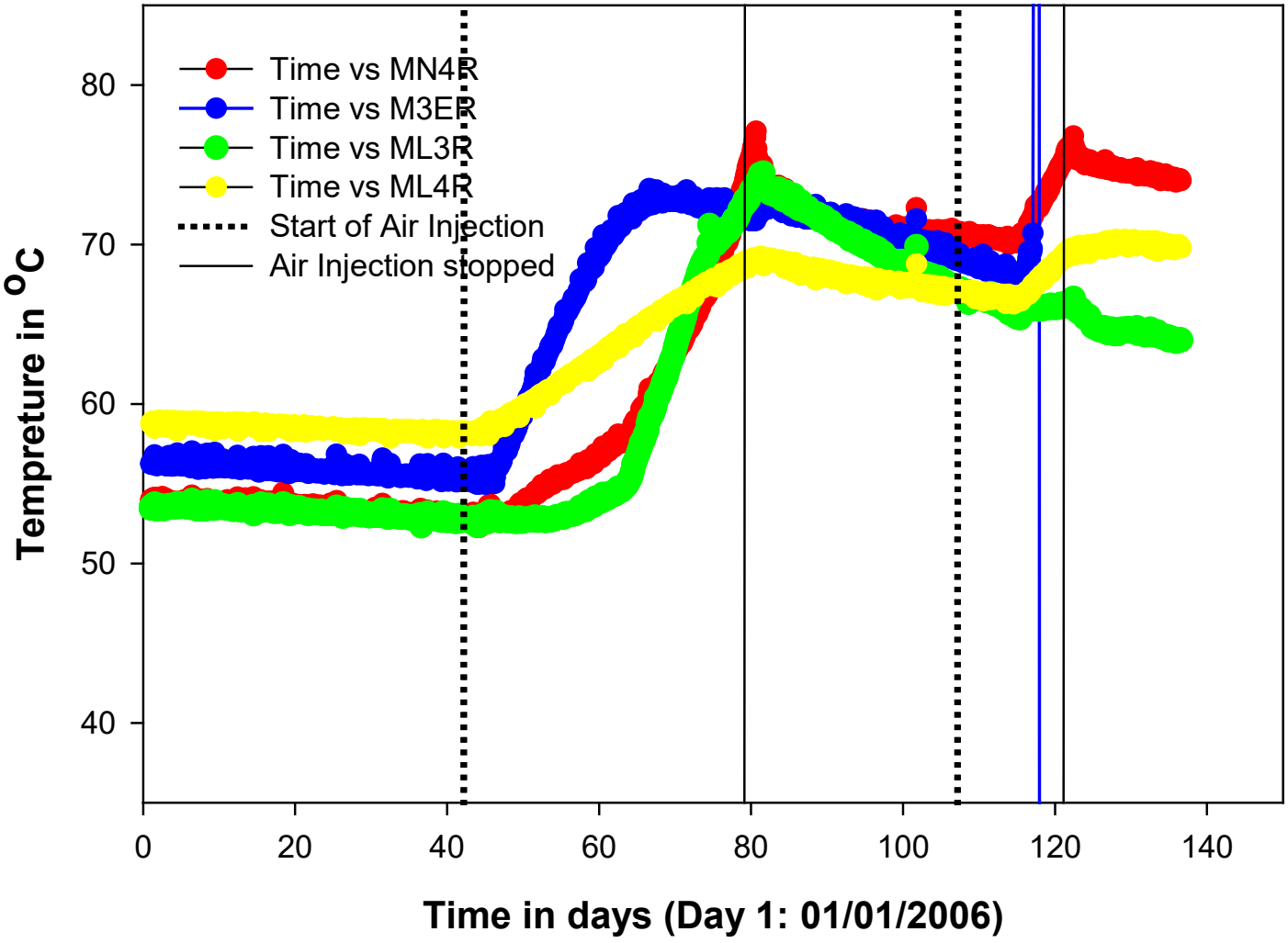
CO Results


More Aerobic
More Anaerobic
1000
100
10
CO (ppm)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
CH_4/CO_2

Other LFG Impacts

- No change in volatile organic compounds (VOCs) or BTEX
- Volatilization or air stripping of VOCs from waste
- Dilution of contaminants expected by higher gas flows
- Aerobic degradation of VOCs possible

Effect of Air on Temperatures



Conclusions - Controlling Elevated Temperatures in Landfills

- Heat transfer and liquid control are more critical, therefore aerobic landfills need more control and monitoring
- Important to introduce liquids ahead of air injection
- Avoid accepting reactive materials, particularly at depth
- Monitor landfills carefully for signs of elevated temperatures. If ETs occur keep liquid and gas moving
- LFG wells should be pumped to remove liquid if they become watered in and replaced if not remediable.

Questions?

Image Courtesy of Google Images