Black Goo and Florida Landfills: What Is It and What Do We Do About It?

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2025 SWANA FL Winter Conference
February 25th

FAU FLORIDA ATLANTIC UNIVERSITY

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UCF

Project: Emerging Challenges in Leachate Management at Florida Landfills: Addressing Mysterious Black Goo

PIs

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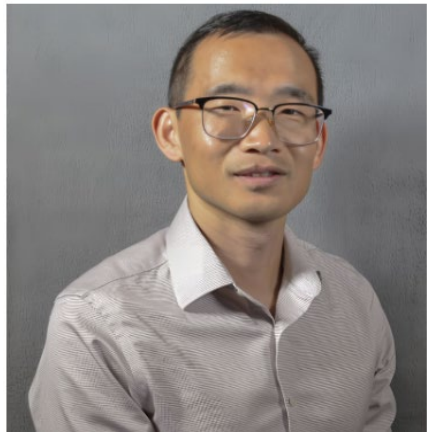

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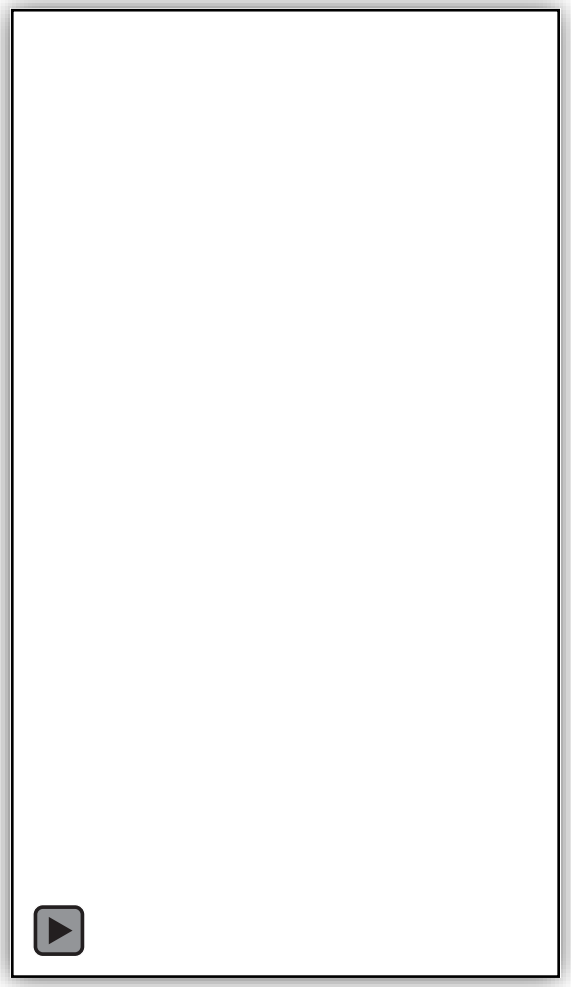
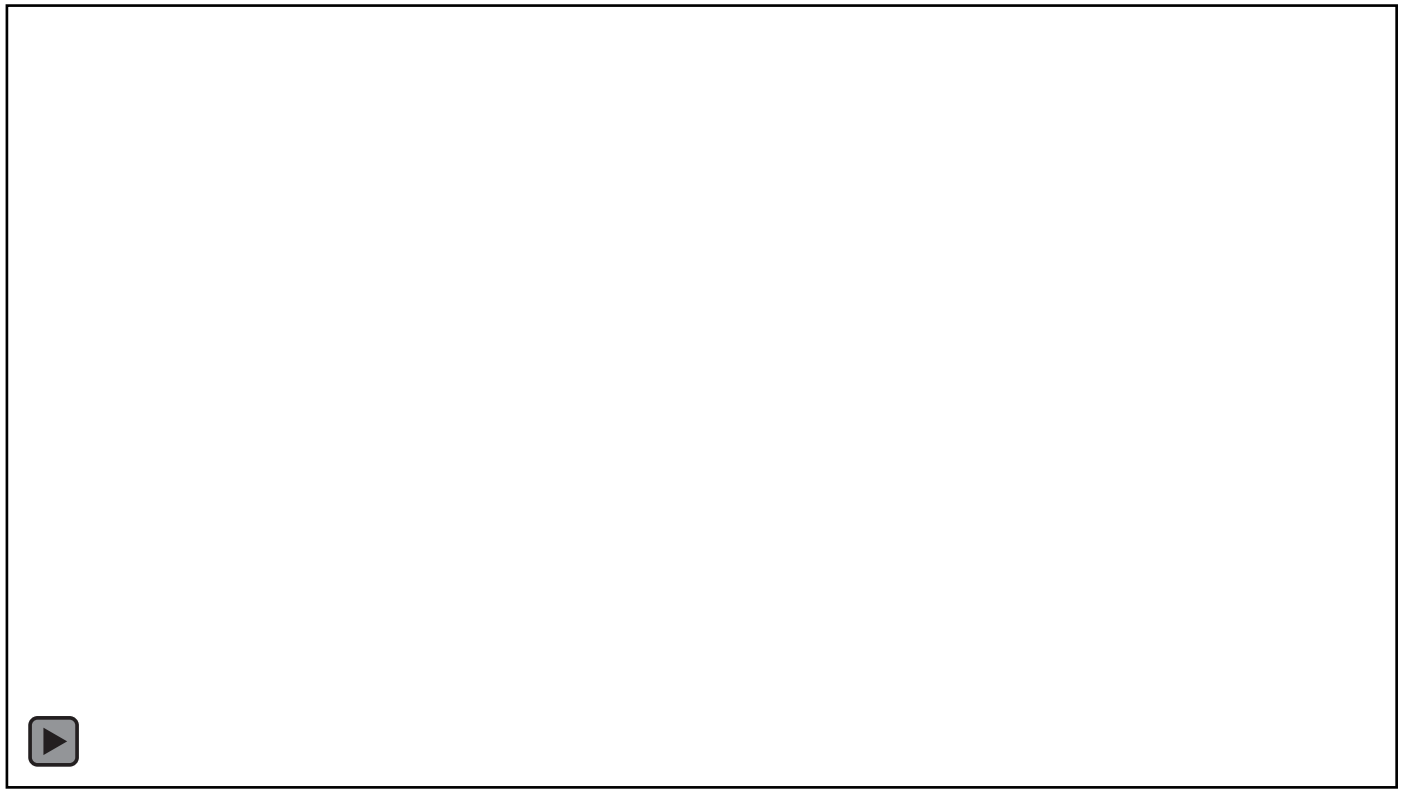
What is Black Goo?

Challenges of Black Goo



Leachate Pump Intake Screen



Samples collected at the bottom of leachate collection manhole

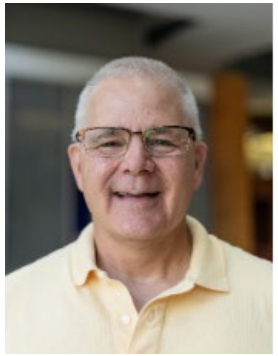
Courtesy of Brittney Crawford

Challenges of Black Goo

- Operational challenges
  - Leachate collection systems
  - Gas extraction systems
  - Obstruct equipment

- Maintenance challenges
  - Frequent and costly maintenance
  - Problem reoccurs quickly
  - Some points inaccessible

Previous Research



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Sample Collection:
29 MSW Landfills, 1 Industrial Waste Landfill

Characteristics of Black Goo From Leachate Collection Systems at Two North American Landfills

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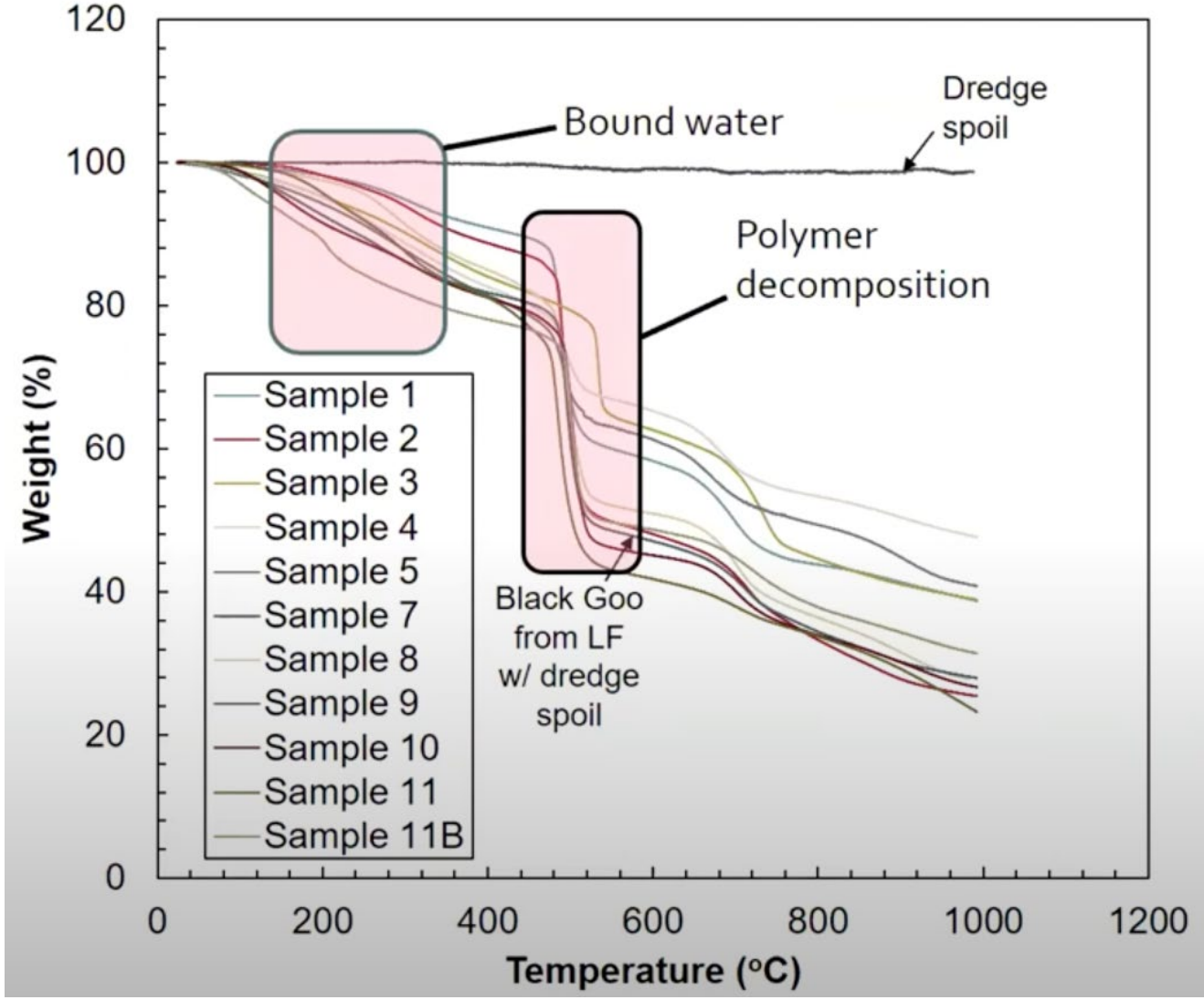
Previous Research

- Weight loss at around 550°C indicates synthetic polymeric structures
- Polymer content varies from 12% to 40%

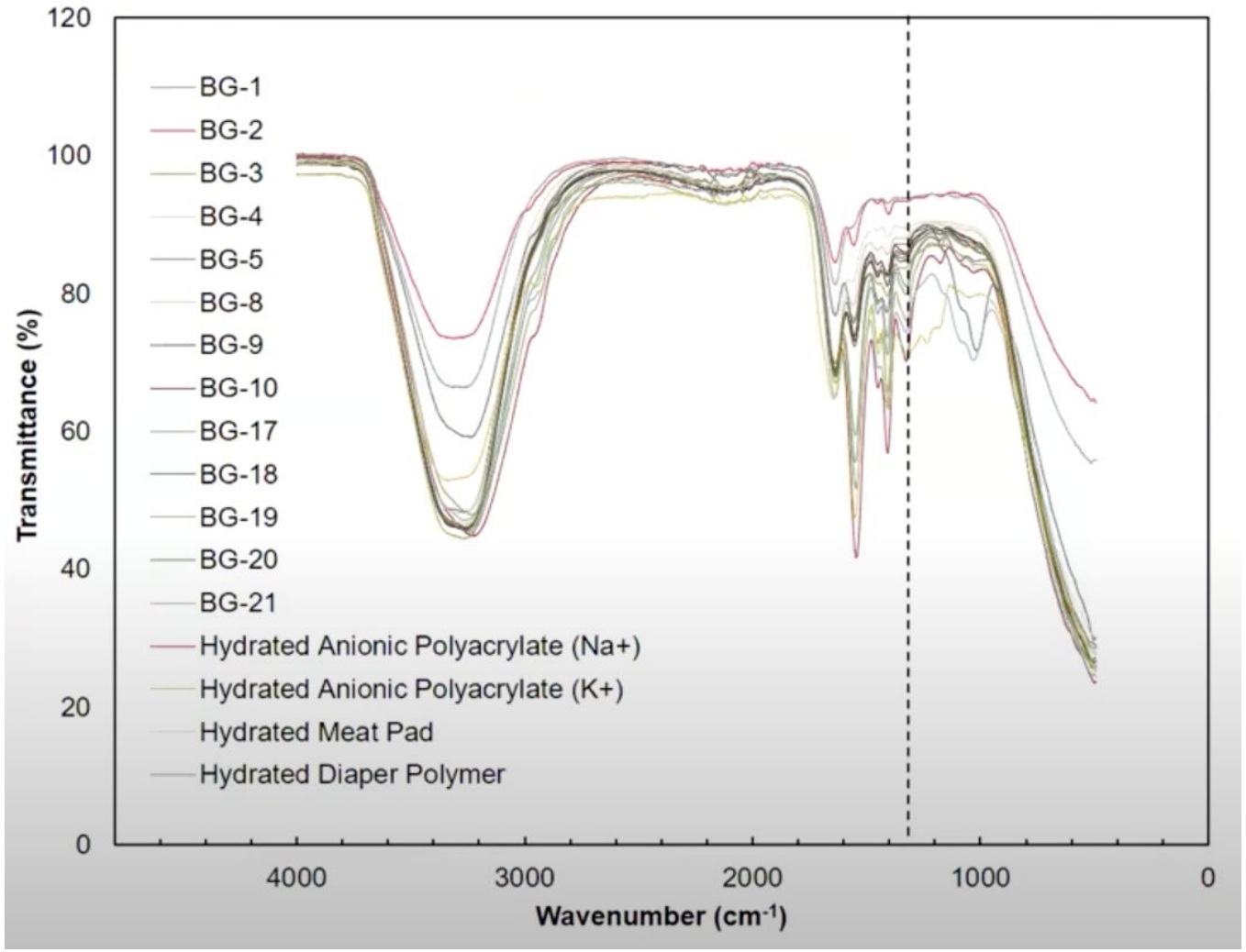


Thermogravimetric Analysis (TGA)

Previous Research

- Polyacrylate applications
  - Diapers, meat pads, hygienic pad
  - Dewatering agent
  - Personal care products (e.g., hair styling products)
  - Drilling slurry

- Very similar spectra observed for Black Goo and polyacrylate



Fourier Transform Infrared (FTIR) Spectroscopy

Unknows

- Different from other clogging?

- Composition variations
  - Different landfills (e.g., ash, MSW)
  - Same landfill different locations

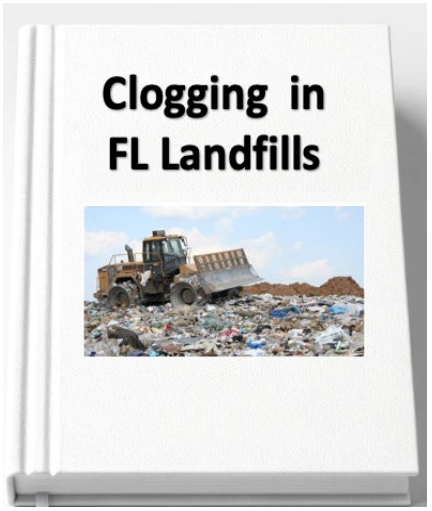
- Conditions leading to formation?
  - Waste accepted?
  - Characteristics of leachate?
  - Type of leachate collection system?
  - Operation and maintenance procedures?

Project Objectives

- **Established a foundational understanding** of Black Goo issues
- **Identify and analyze patterns** in Black Goo formation
- **Understand the impact** of Black Goo on landfill operations in FL
- **Provide waste decision makers in FL** with recommendations for management strategies

Project Tasks

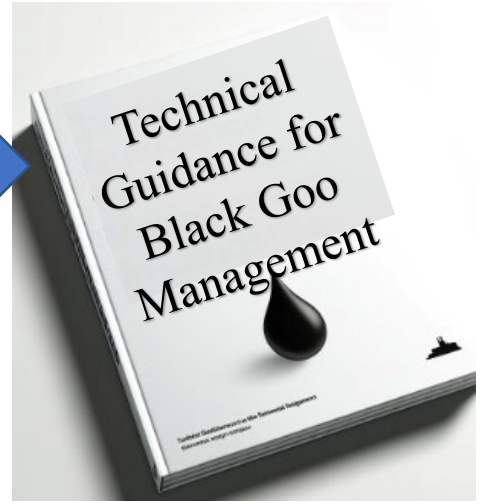
Review Literature Regarding Clogging in Landfills



FL Landfill Survey Regarding Black Goo Issues

Characterization of Leachate and Black Goo

Development of Technical Guidance Document



Task 1. Old Clogging Problems

- Mineral Precipitation
  - Calcium carbonate
  - Iron sulfide
  - Treatment: acid flushing
- Particulate Clogging
  - Fine particle, suspended solids accumulate in landfill leachate collection systems
  - Treatment: proper filter media; increase flow velocity to flush out suspended particles
- Biological Clogging (biofilm & EPS formation)
  - Bacteria form sticky extracellular polymeric substances (EPS)
  - EPS are sticky, gel-like materials to help microorganisms adhere to surfaces and form biofilm (polysaccharides)
  - Treatment: hydrogen peroxide, biocides, high-pressure water jetting

Courtesy of Steven Carl and Manuel Hernandez

Task 2. Statewide Landfill Survey

- Occurrence, management practices, and environmental conditions associate with Black Goo in FL landfills
- Include a variety of landfill sites: MSW, ash, active, closed
- Statistical analysis

Review Literature Regarding Clogging in Landfills

Survey Questionnaire

- General Facility Information
  - Type of waste received (MSW, CDD)
  - Status of the landfill (active, closed)
  - Annual tonnage of waste processed at the facility
  - Age of the landfill, how long has the leachate collection system been in operation
- Waste Stream Composition
  - Does the facility accept any special waste (e.g., wastewater treatment plant sludge, dredge spoils)
  - Has your facility seen an increase in the volume of any particular waste stream over the past decade
- Leachate Collection Systems Characteristics
  - What type of leachate collection system is used (e.g., gravel drainage layer, synthetic drainage layer)
  - How frequently is leachate collected and treated
- Operation & Maintenance Procedure
  - How frequently does your facility perform routine maintenance on leachate collection systems
  - What specific maintenance activities are performed?
- Landfill Temperature and Heat Management
  - What are typical temperature ranges in your landfill cells?
  - Have you observed higher black goo occurrence in areas with elevated temperatures within the landfill
  - Does black goo tend to form more frequently during specific seasons or after extreme temperature events
- Black Goo Occurrence
  - Have you observed the presence of black goo at your facility?
  - Where does it primarily form (pipes, pump, drainage layers)
  - How has the presence of black goo affected your facility’s operation?
  - What remediation techniques have you used to address the problem? How effective? How much?

Survey Results

- 10 landfills interviewed
  - 5 without Black Goo
  - 5 with Black Goo (3 from FL)
- 5 without Black Goo
  - 2 are slurry-wall landfills
  - 1 ash monofill
  - 1 MSW landfill
- 5 with Black Goo
  - All accept sewage sludge; one landfill started to observe Black Goo after a spike sludge disposal 5 years ago

Survey Results

Landfill	Status	Year Black Goo First Observed	Location & Spread	Current Impact	Treatment
1	Active	2023	A specific gas well	Gas well not in use	-Muriatic acid temporarily removed blackgoo, returned in a week
2	Active	Around 2019-2020	A few gas wells & condensation pipes	Not observed recently	-Chemical flush by a consulting firm
3	Active	Around 10 years ago	All leachate sumps	Annual maintenance	-Jetting & acid treatment for other clogging
4	Active	2019	All over leachate sump station	Major operational issues	-H_2O_2 dissolved Black Goo in the lab (not practical) -Raising leachate level from 3ft to 6ft in the sump significantly reduced clogging
5	Active	2012	All over leachate sump	Increased maintenance but no major operational issue	-Increased hot water flush, chemical treatment

Task 3: Characterization of Leachate and Black Goo

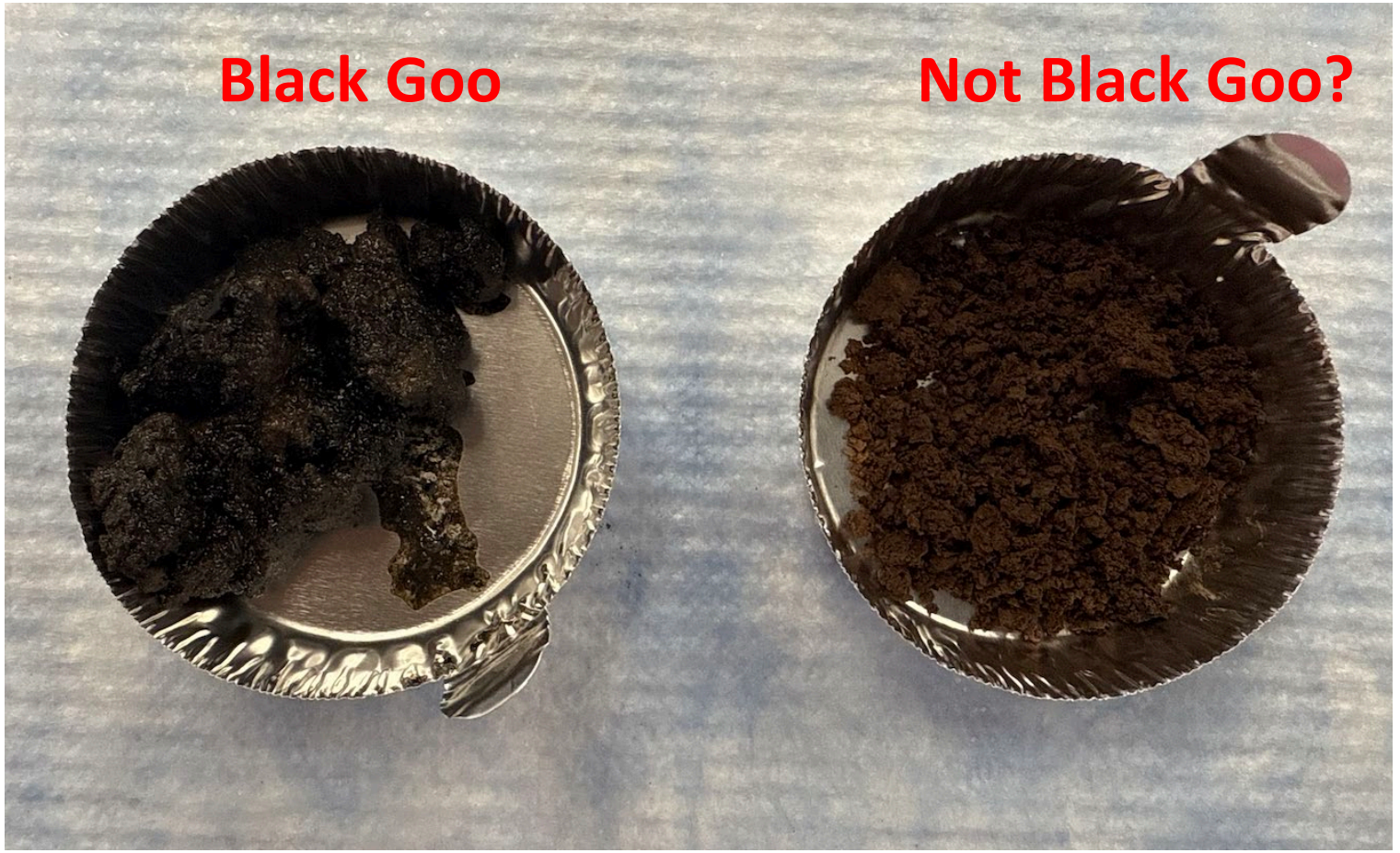
- Collect and analyze leachate from both impacted and nonimpacted sites
  - Physical parameters (e.g., pH, temperature)
  - Chemical parameters (e.g., COD, BOD, TDS, alkalinity)
- Collected and analyze Black Goo from impacted sites
  - Physical parameters (e.g., moisture, density)
  - Chemical parameters (organic content, organic composition, elemental composition, polymer identification)
- Collect other types of clogging
  - Mineral
  - Biofilm
  - Particulate

Characterization of Leachate and Black Goo

Black Goo & Other Clogging Chemical Characterization

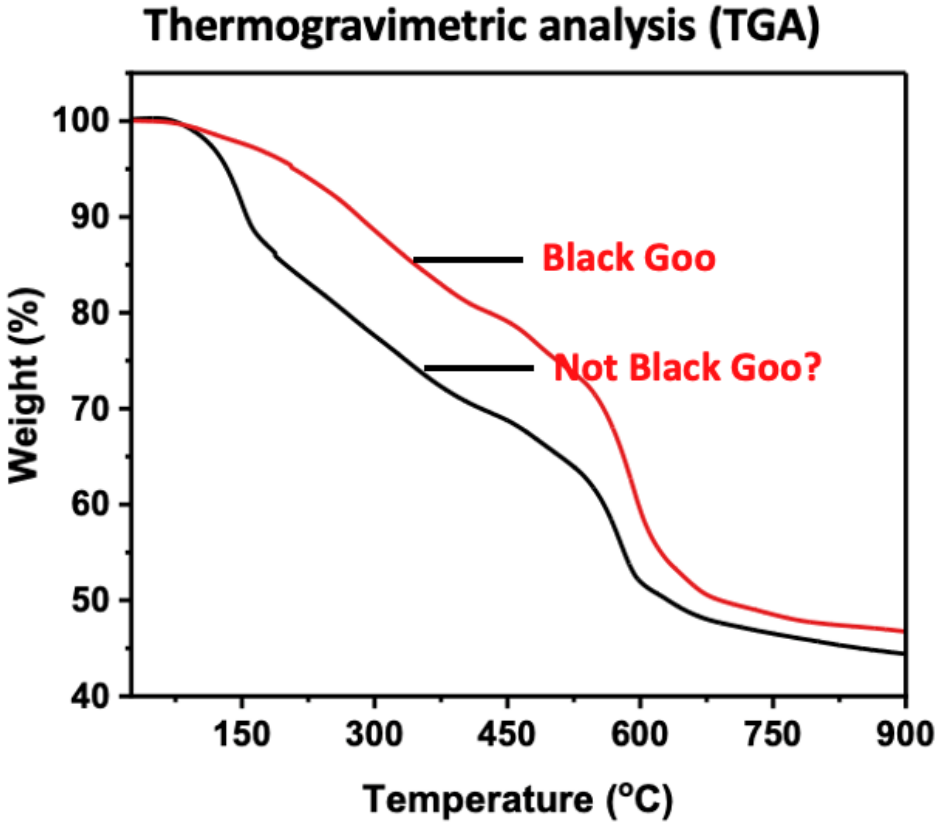
- A combination of techniques will be used
  - Fourier Transform Infrared Spectroscopy (FTIR)
  - Nuclear Magnetic Resonance (NMR)
  - X-ray Fluorescence (XRF)
  - Scanning electron microscopy (SEM)
  - Thermogravimetric Analysis (TGA)

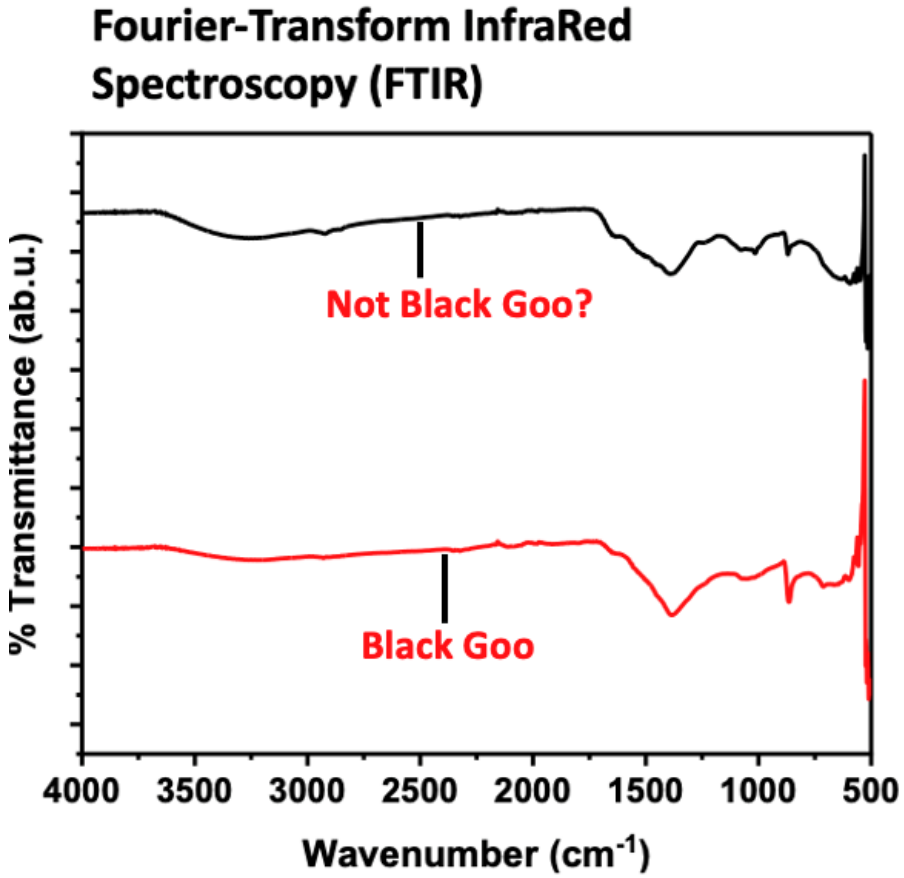
Preliminary Results



Preliminary Results

- Weight loss at around 550°C indicates synthetic polymeric structures in both samples
- FTIR suggests similar bonds





Next Steps

- Expand interviews with landfill operators
- Collect and analyze leachate
- Collect and analyze Black Goo and other clogging samples
  - Is it related to hard scaling
  - Is it related to bio-clogging (EPS)
  - Is it related to taffy-like tar
- Development of the technical guidance document
- Begin exploring treatment strategies
  - Which cleaning method works the best based on Black Goo composition
- Black Goo and PFAS

Thank you and please connect with us!

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Florida Atlantic University