



# Pathogen Indicator (Fecal Coliform) Regrowth In Biosolids Cake Update

by

Todd O. Williams, BCEE, P.E.

CH2M HILL

Richmond, Virginia

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Central States WEA

Stevens Point, Wisconsin

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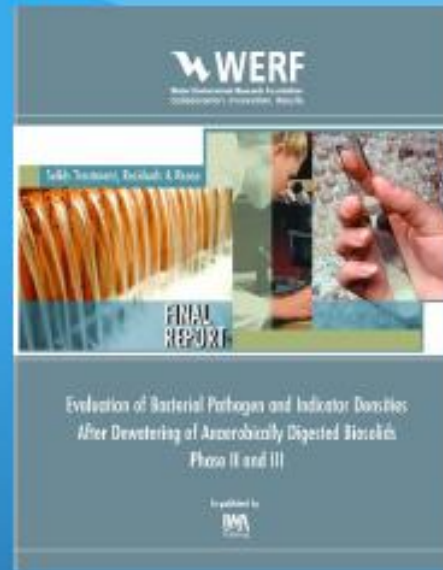


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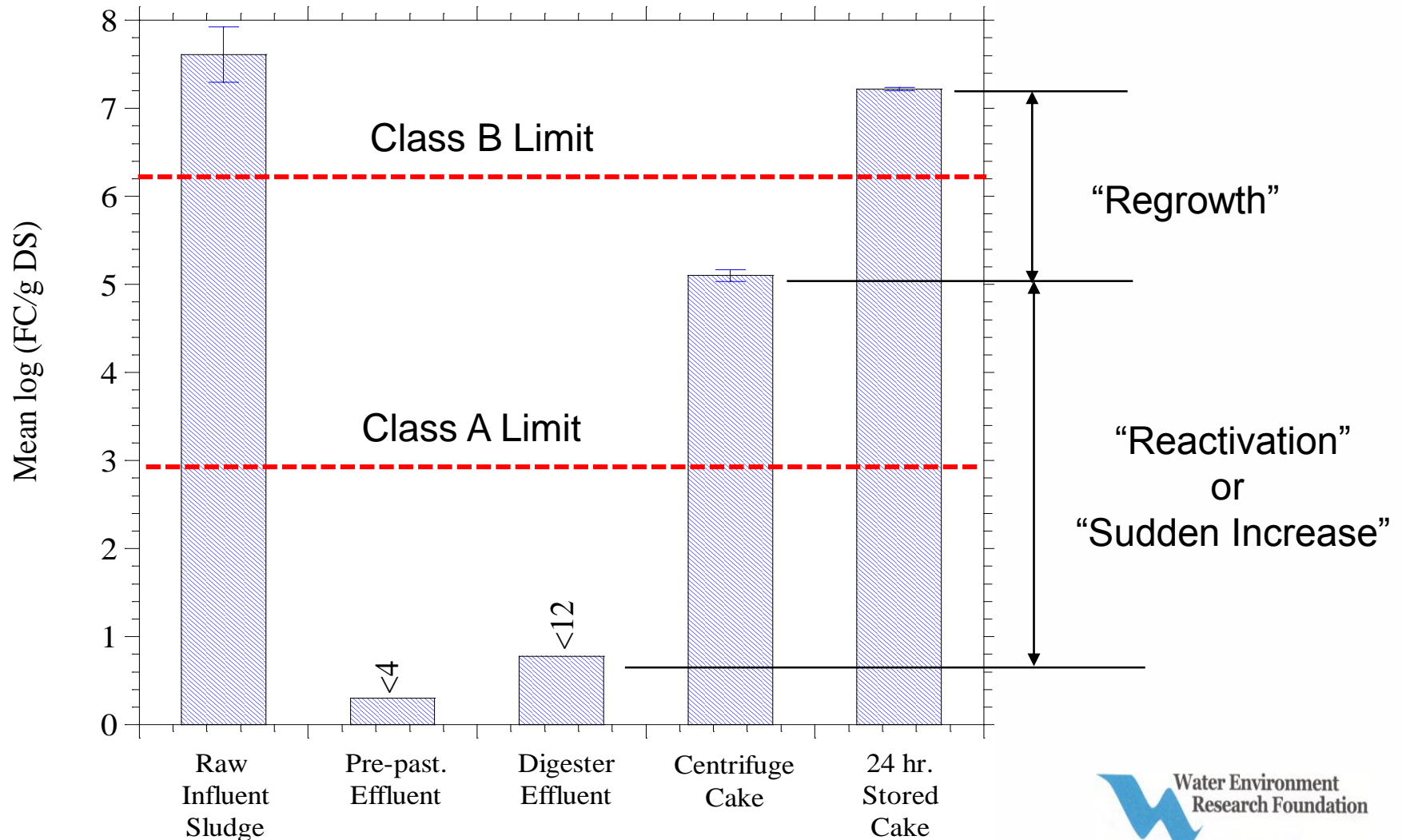


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# Sudden Increase & Regrowth – Class A Pre-pasteurization with Mesophilic Digestion



# Sudden Increase/Regrowth Definitions

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## Sudden Increase

- “Sudden increase” immediately after dewatering
- More prevalent with thermophilic processes with centrifuge dewatering
- Not a major issue for mesophilic processes

## Regrowth

- Increases during cake storage
- More prevalent with centrifuge dewatering
- Occurs with thermophilic and mesophilic processes

*Source: Higgins et al., 2011, WEFTEC*



# Why Does SI Occur?

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- Possible explanations:
  1. Floc breakup “releases” bacteria
  2. Regrowth of coliforms after dewatering
  3. Contamination
  4. Presence of non-culturable organisms that are “reactivated” after dewatering

*Source Higgins et al., 2011, WEFTEC*



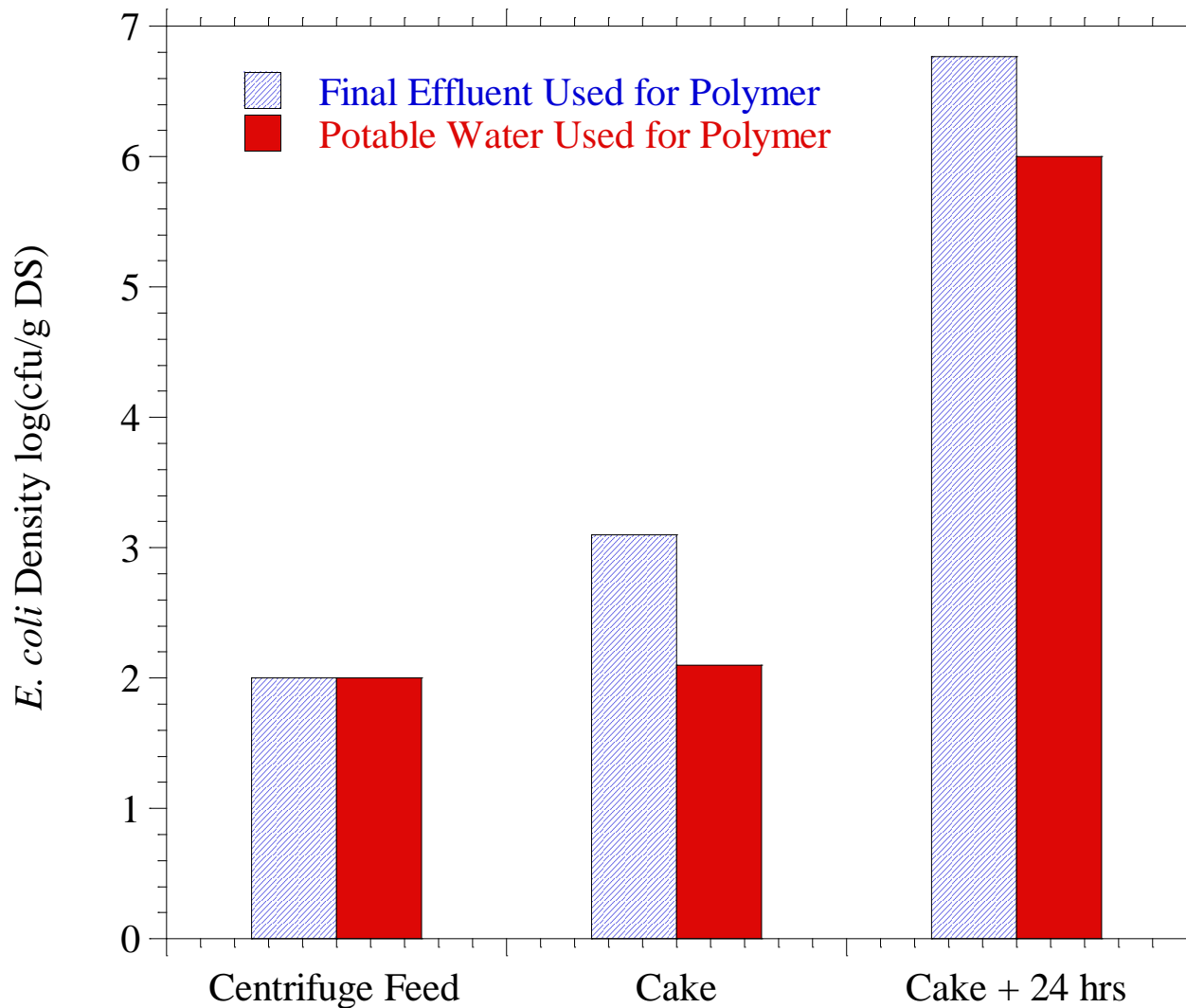
# Contamination of *E. coli*

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- Digester effluent or cake could become contaminated during dewatering process
- Sources of Contamination
  - Polymer Makeup and Dosing System
    - Water used for Polymer Make-up
    - Dilution or Carrier Water
  - Growth within the Centrifuge
  - Cake Conveyance Systems
  - Storage Site

*Source: Higgins et al., 2011, WEFTEC*

# Contamination at EEH Plant



- Reduced/eliminated SI
- Still Large Regrowth

*Adapted from Baddeley et al., 2009, European Biosolids Conference*



# Contamination Issues

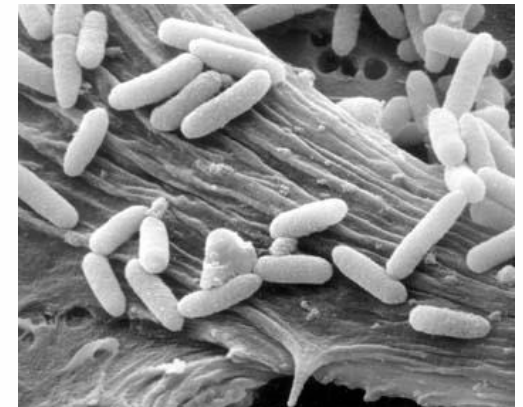
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- For Plants with SI, contamination should be ruled out first
- We've sampled polymer systems and other sources of contamination at several plants, and not seen contamination, but still get large SI
- Other possibilities for SI?

*Source: Higgins et al., 2011, WEFTEC*

# Non-culturable hypothesis

- Bacteria can become reversibly non-culturable during thermophilic treatment
- In other words, they are still present, and potentially viable, but we are not enumerating them with our standard culturing method
- Dewatering “reactivates” these bacteria, making them culturable and able to grow



*Source: Higgins et al., 2011, WEFTEC*



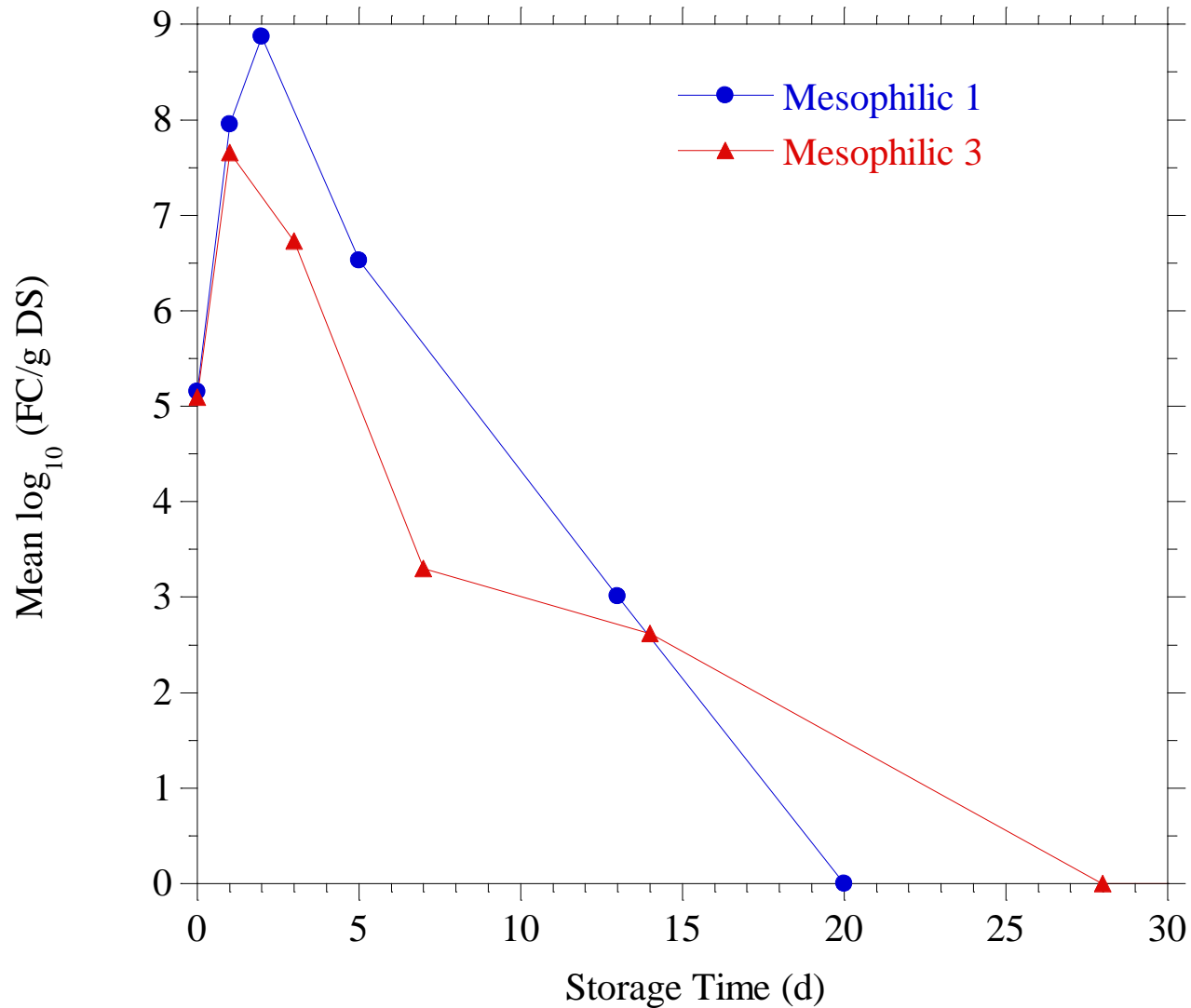
# Regrowth

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- Regrowth appears to be due to growth of bacteria fueled by available substrate and good growing conditions
- Greater amounts of shear and higher cake solids are associated with greater regrowth (centrifuges vs belt filter press)
- Occurs with both thermophilic and mesophilic processes

*Source: Higgins et al., 2011, WEFTEC*

# Regrowth for Mesophilic with Centrifuges



# Effect of Advanced Digestion Processes

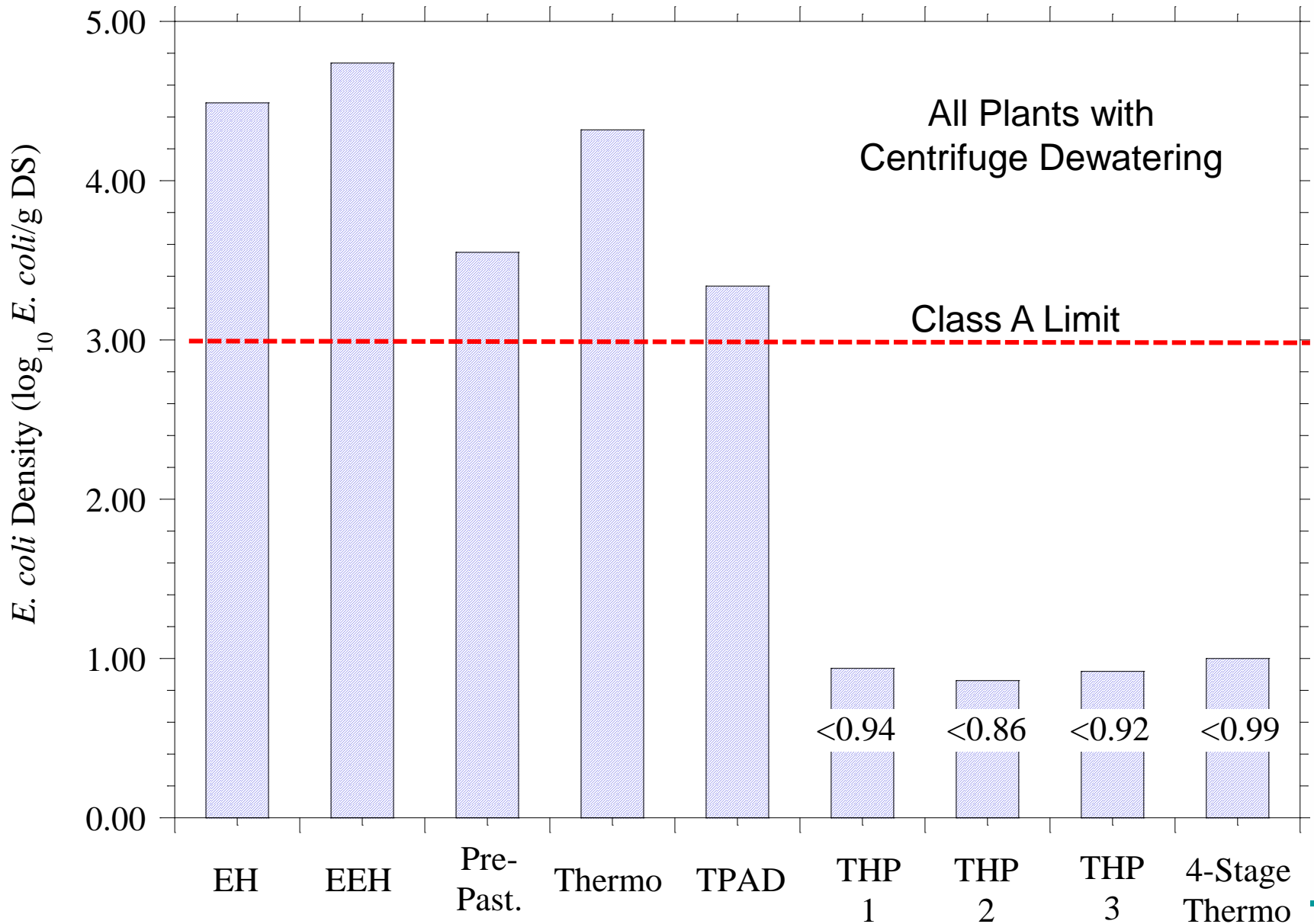
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1. Enhanced Enzymic Hydrolysis (EEH)
2. Multi-stage thermophilic digestion
3. Temperature Phased Anaerobic Digestion (TPAD)
4. Two stage advanced digestion (ATAD/TPAD)
5. Pre-pasteurization followed by mesophilic anaerobic digestion
6. Cambi thermal hydrolysis (THP) followed by mesophilic anaerobic digestion

*Source: Higgins et al., 2011, WEFTEC*

# Indicator Results – *E. coli* in the Cake



# Overview Summary and Conclusions

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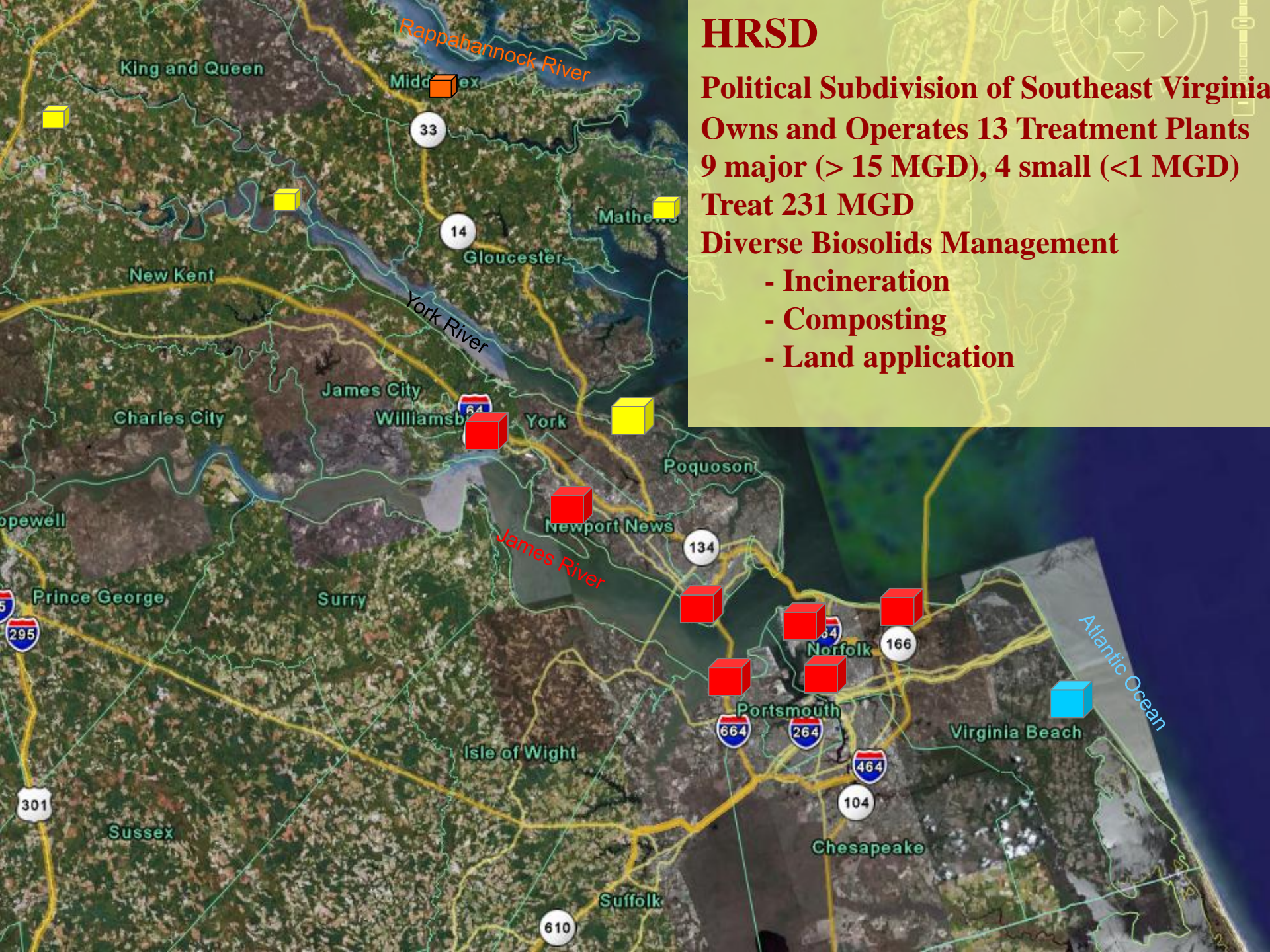
1. Sudden increase associated with thermophilic plants that have centrifuge dewatering
2. Regrowth and more odors associated with most digestion processes with centrifuge dewatering
3. Belt filter press cakes have lower odors and lower incidences of sudden increase and regrowth
4. Advanced digestion can reduce odors, but not always sudden increase and regrowth

*Source: Higgins et al., 2011, WEFTEC*



# HRSD Experience with Pathogen Indicator (FC) Regrowth at the Atlantic Plant

## CASE STUDY



# HRSD

Political Subdivision of Southeast Virginia

Owns and Operates 13 Treatment Plants

9 major (> 15 MGD), 4 small (<1 MGD)

Treat 231 MGD

Diverse Biosolids Management

- Incineration
- Composting
- Land application

# Atlantic Plant

- 54 MDG design
- Annual average flow 30 MGD
- Approximately 30,000 wet tons biosolids/ year land applied since 1980's
  - 1500 acres per year - Private Sites
  - HRSD Progress Farm



# Biosolids Processing

- Conventional two stage mesophilic anaerobic digestion to achieve Class B time and temperature
- Centrifuge dewatering with Sharples 75,000 centrifuges
- 4 hour hopper storage
- 90 day covered pad storage
- Agricultural land application



# HRSD Land Application Project Goals

- Protect Environment / Public Health
- Maintain 100% Regulatory Compliance
- Be a Good Neighbor
- Use Best Management Practices
- Operate Cost Effectively
- Uphold NBP Code of Good Practice (EMS)





## WERF 2006 Study and Impact on HRSD Operations

- Does reactivation and regrowth occur?
- Does storage on pad impact reactivation and regrowth?
- Should HRSD test for fecal coliform even though program has always been in compliance with USEPA Class B operational standards?
- If test results indicate reactivation/regrowth what should be the plan of action?



## HRSD Response to WERF Study

- Test to determine fecal coliform levels
  - WERF report indicates storage provides reduction
  - Test stored biosolids
- If fecal coliform levels are greater than 2 million MPN/gm TS what is the plan of action?
  - Temporarily suspend land application until a solution is determined
  - Implement new process enhancements



# Initial Test Results

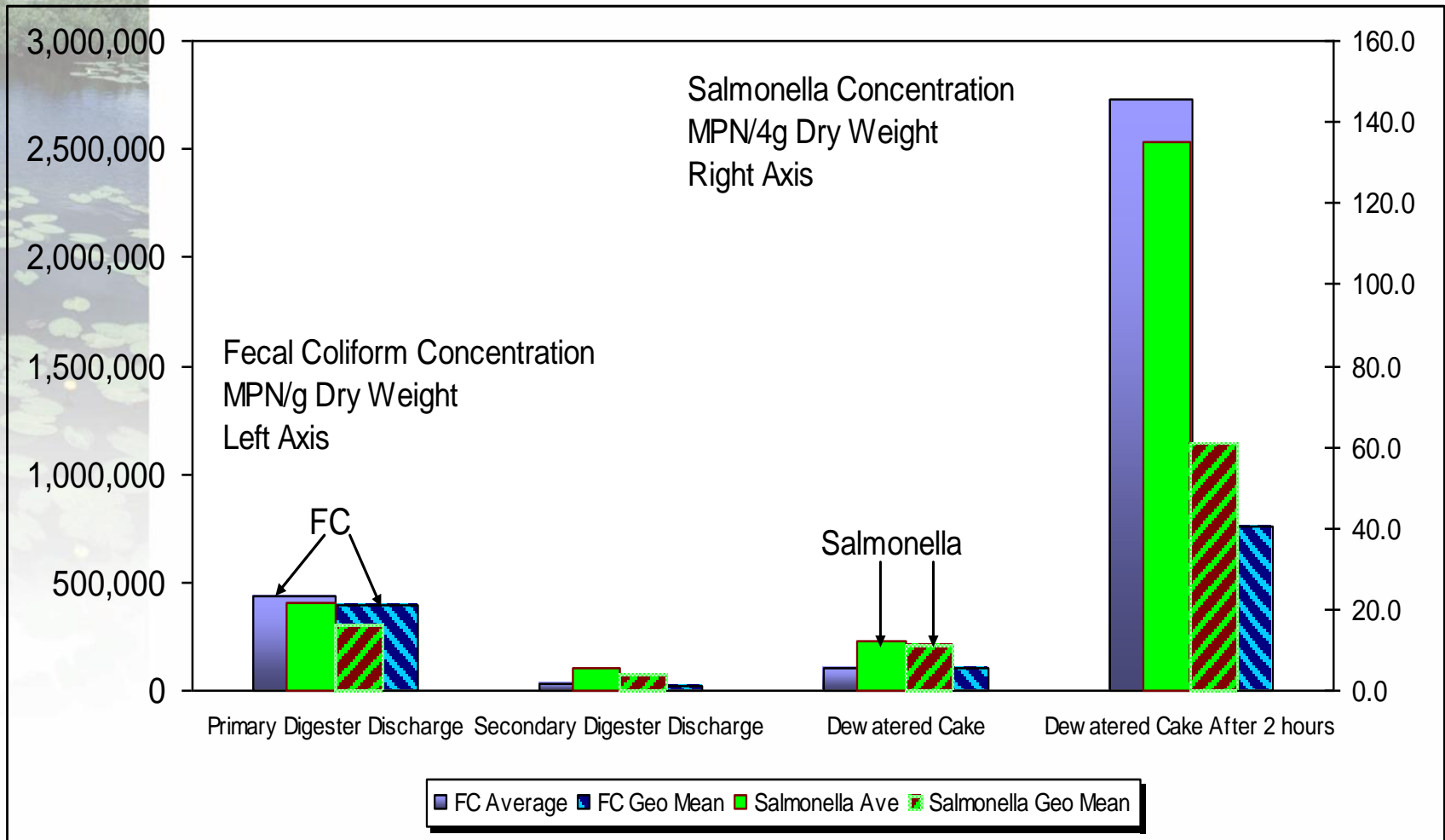
- Fecal coliform levels > 2 million MPN/gm TS in stored biosolids
- Determine strategy for reducing FC levels
- Implement strategy
- Ensure compliance with both standards
  - Operational time and temperature
  - Fecal coliform testing < 2 million MPN/gm TS



# HRSD Study Plan

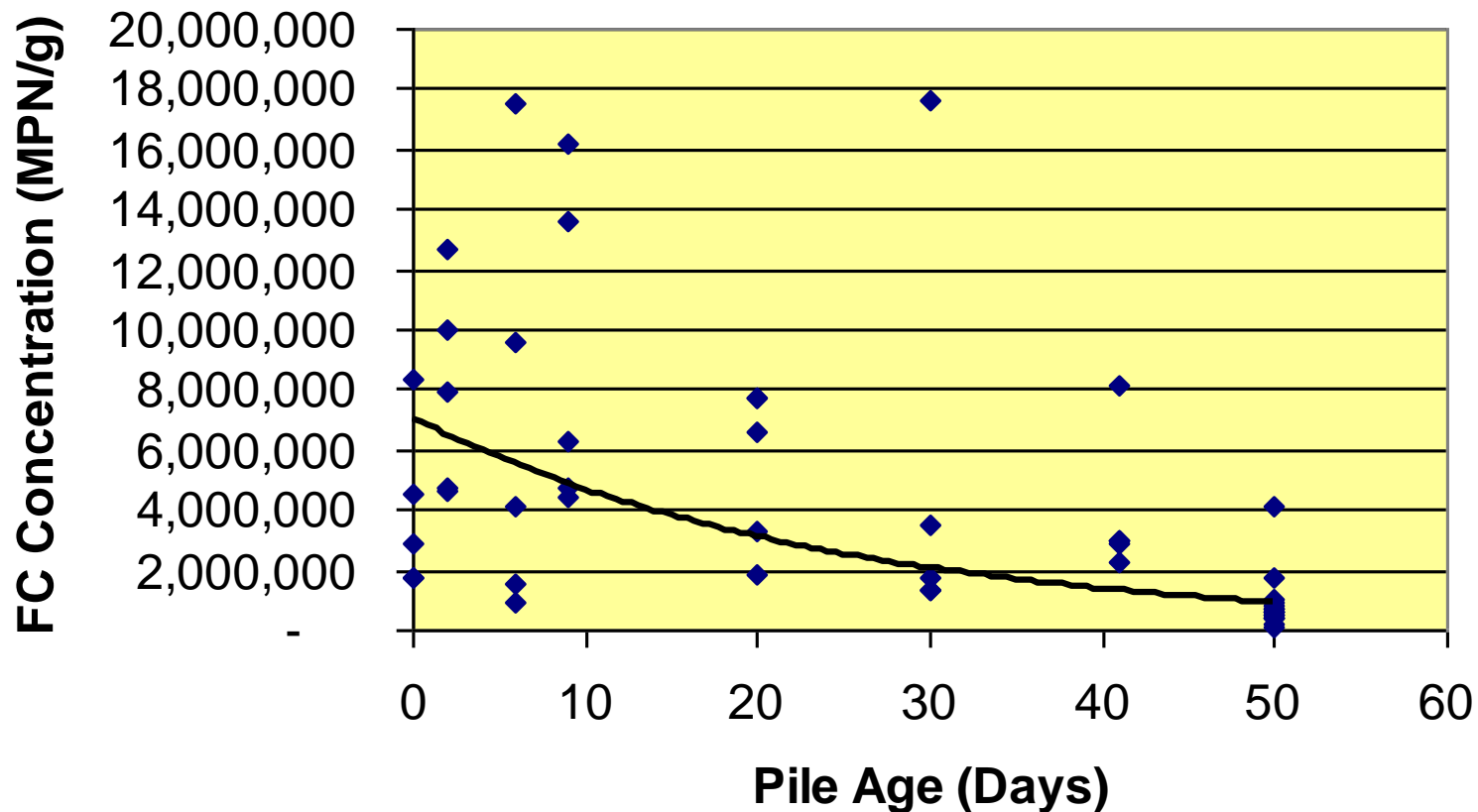
- √ Storage - testing over time
- √ Low lime dosing (1% - 9% dose rates)
- √ Testing biosolids after digestion
- √ Testing biosolids after centrifuge dewatering
- √ Testing biosolids after temporary (<4 hour) storage in hopper
- √ Belt filter dewatering compared to centrifuges
- √ Digester modifications (series vs. parallel)
- √ Odor evaluation
- √ Evaluate varying centrifuge speeds and torques
- √ Evaluate raising digester temperatures from 98°F to 104°F
- √ Evaluate effect of back-mixing
- √ Evaluate effect of storage temperatures
- √ Evaluate other technologies as they develop

# Reactivation/Regrowth Base Conditions (2006)



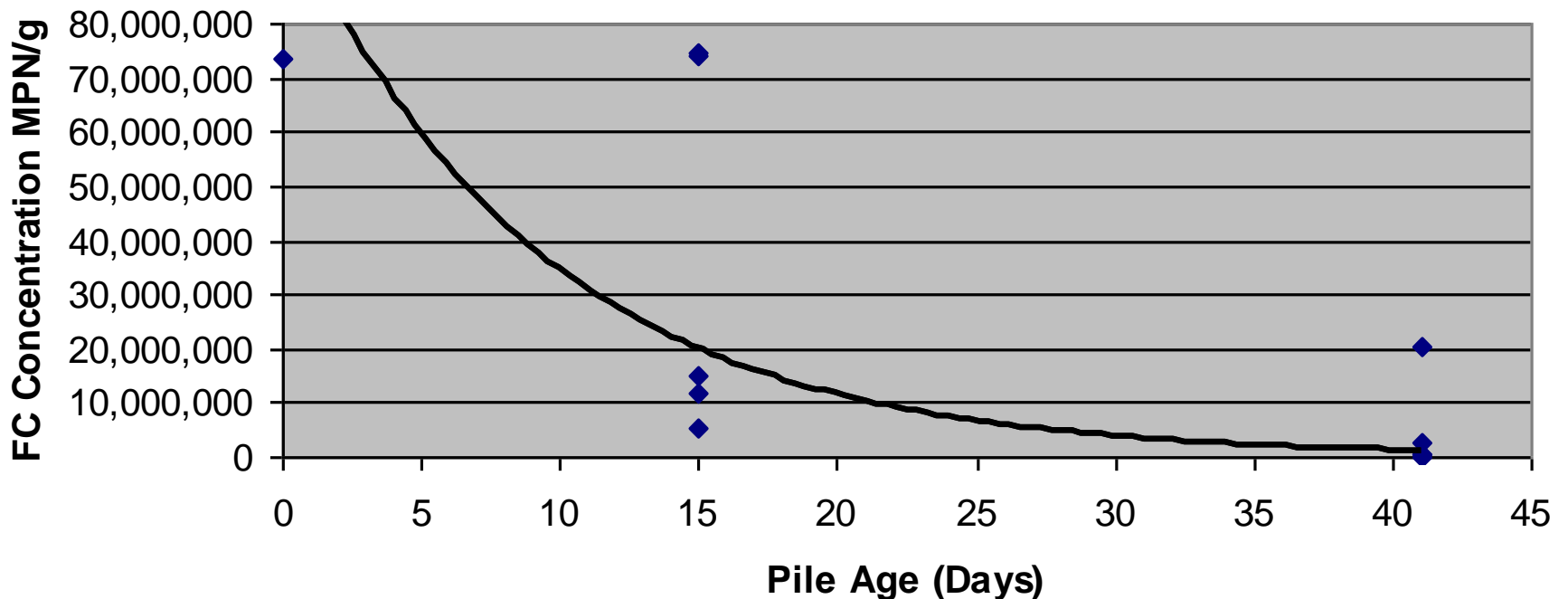
# >50 days of Storage Needed to Control FC Regrowth in Spring Conditions (56°F)

## FC vs. Pile Age Test 1



# >30 days of Storage Needed to Control FC Regrowth in Summer Conditions (77°F)

### FC vs. Pile Age Test 2

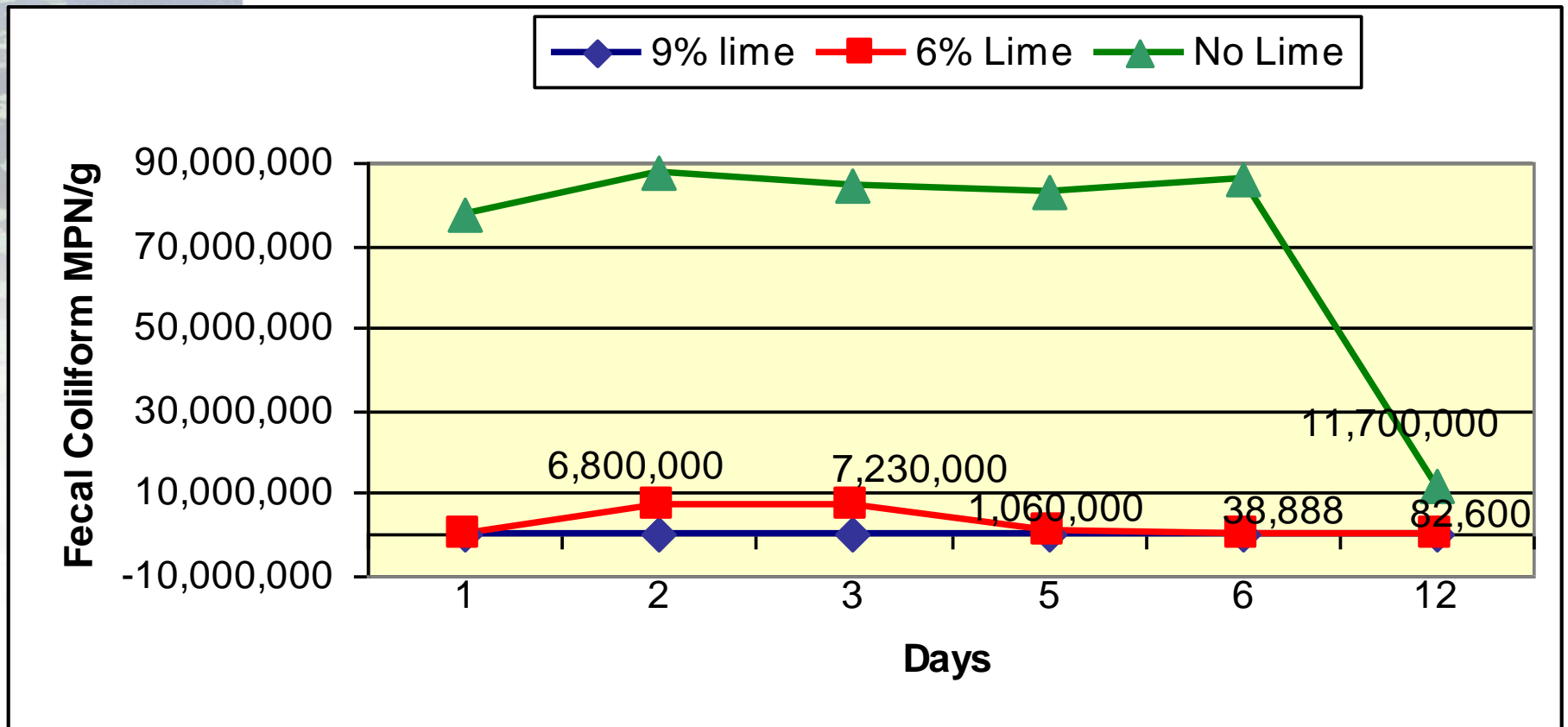


# Field Studies with Low Level Lime Dosing



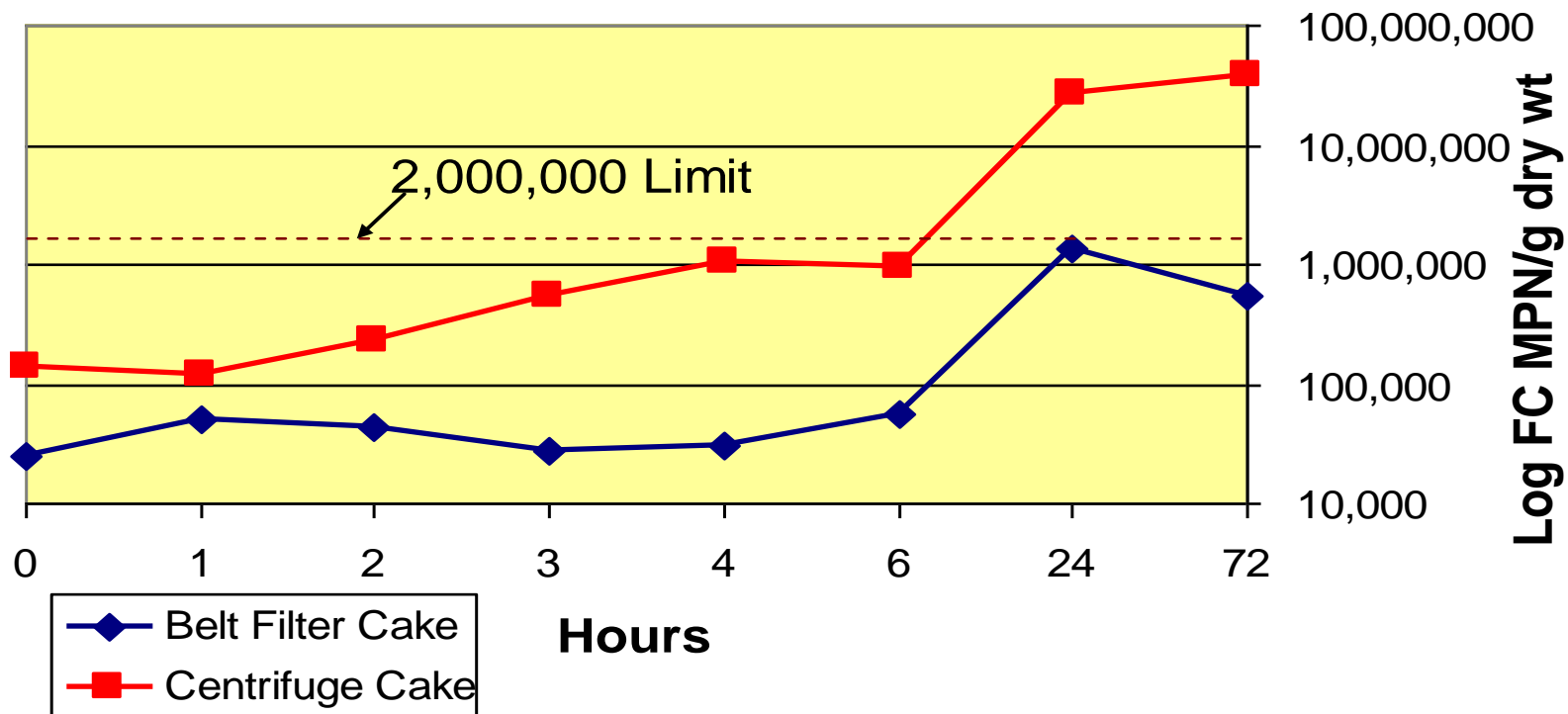
# Low Level Lime Dosing Trial Results

- 9% lime addition required to control FC regrowth

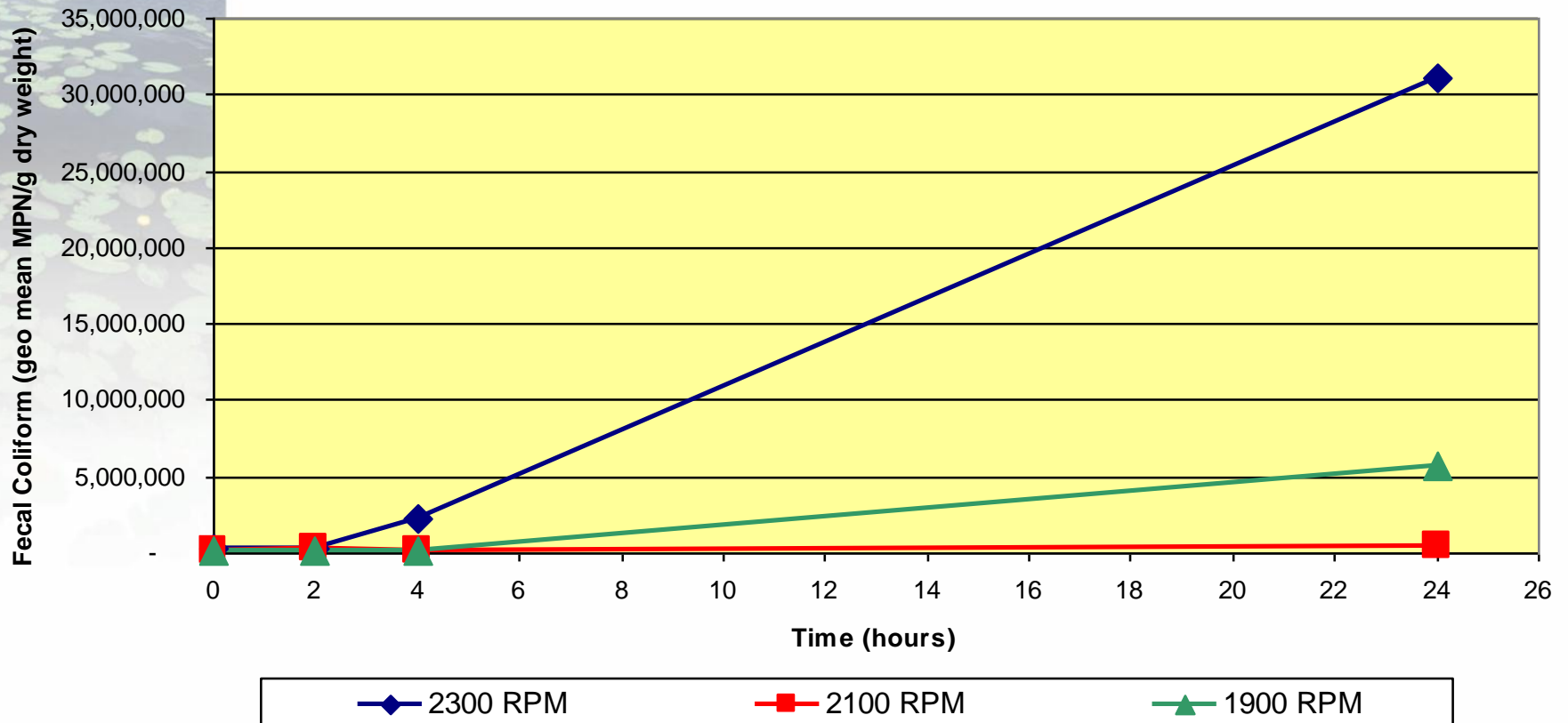


# BFP vs Centrifuge Trial Results

## FC Comparison Centrifuge and BFP Geometric Mean of 7 Samples

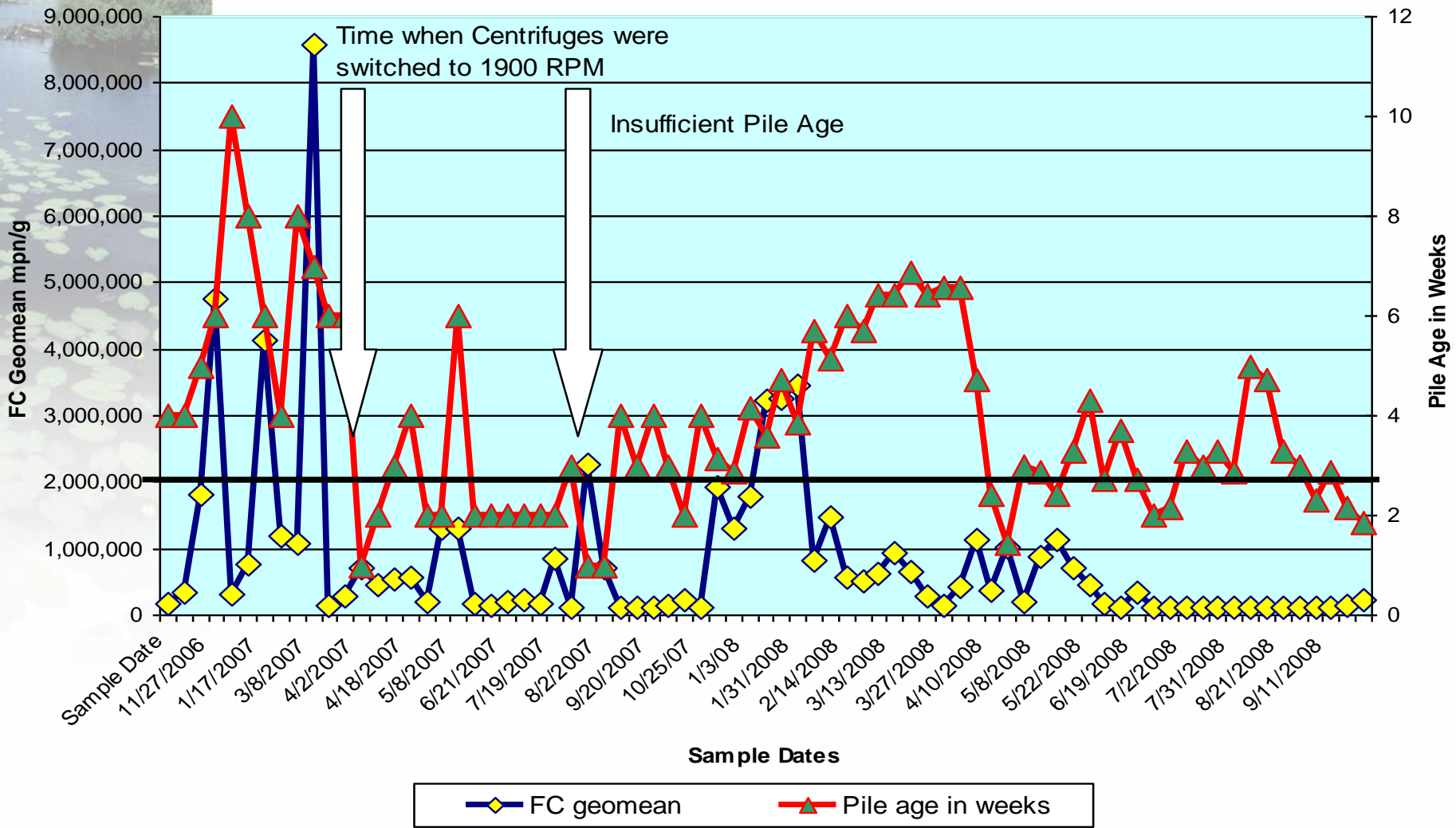


# Fecal Coliform Levels by Centrifuge RPM (geometric mean)

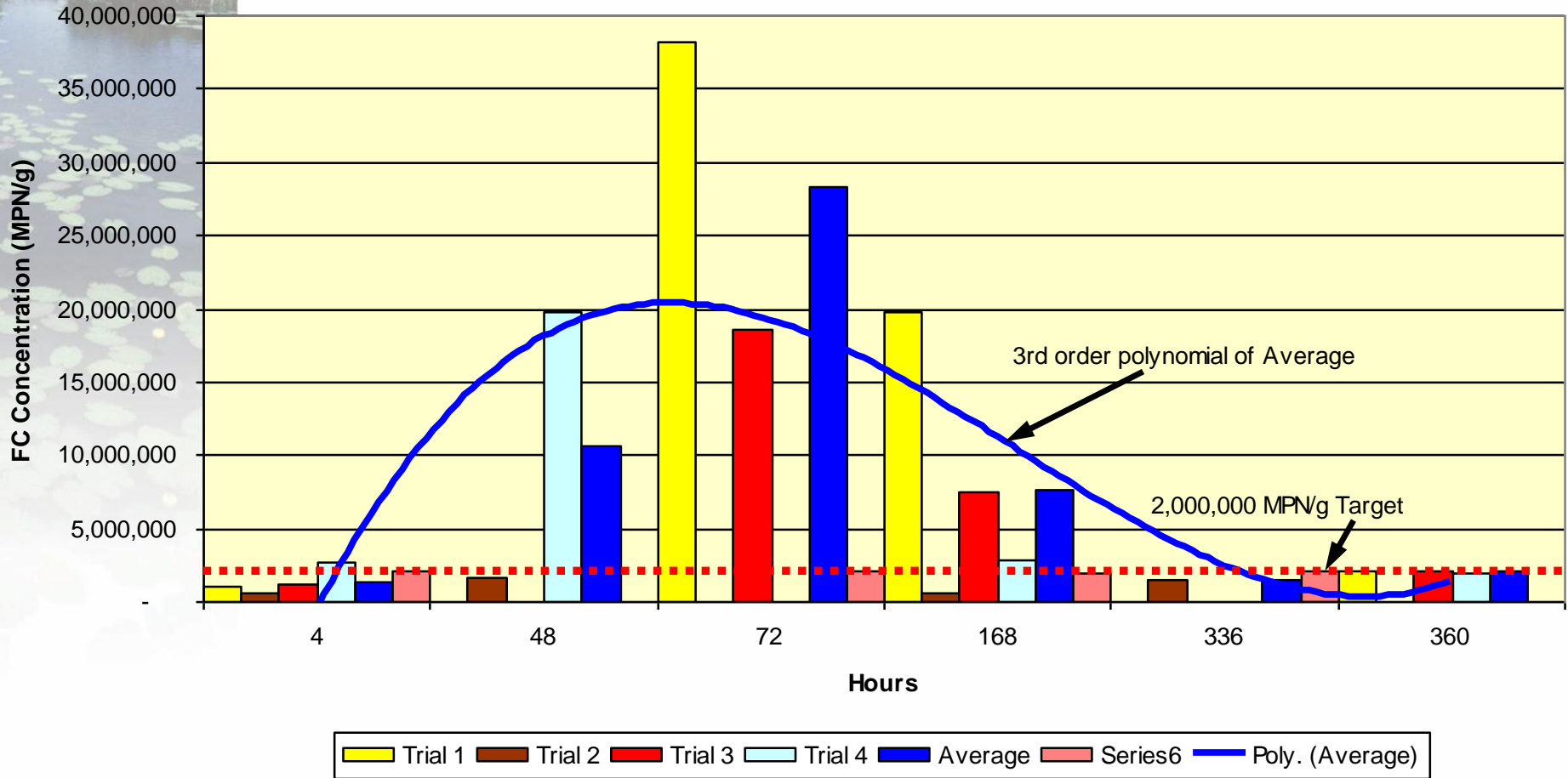


# Historical Results Since Operating at Lower RPM

Storage Pile Testing  
Fecal Coliform vs. Pile Age

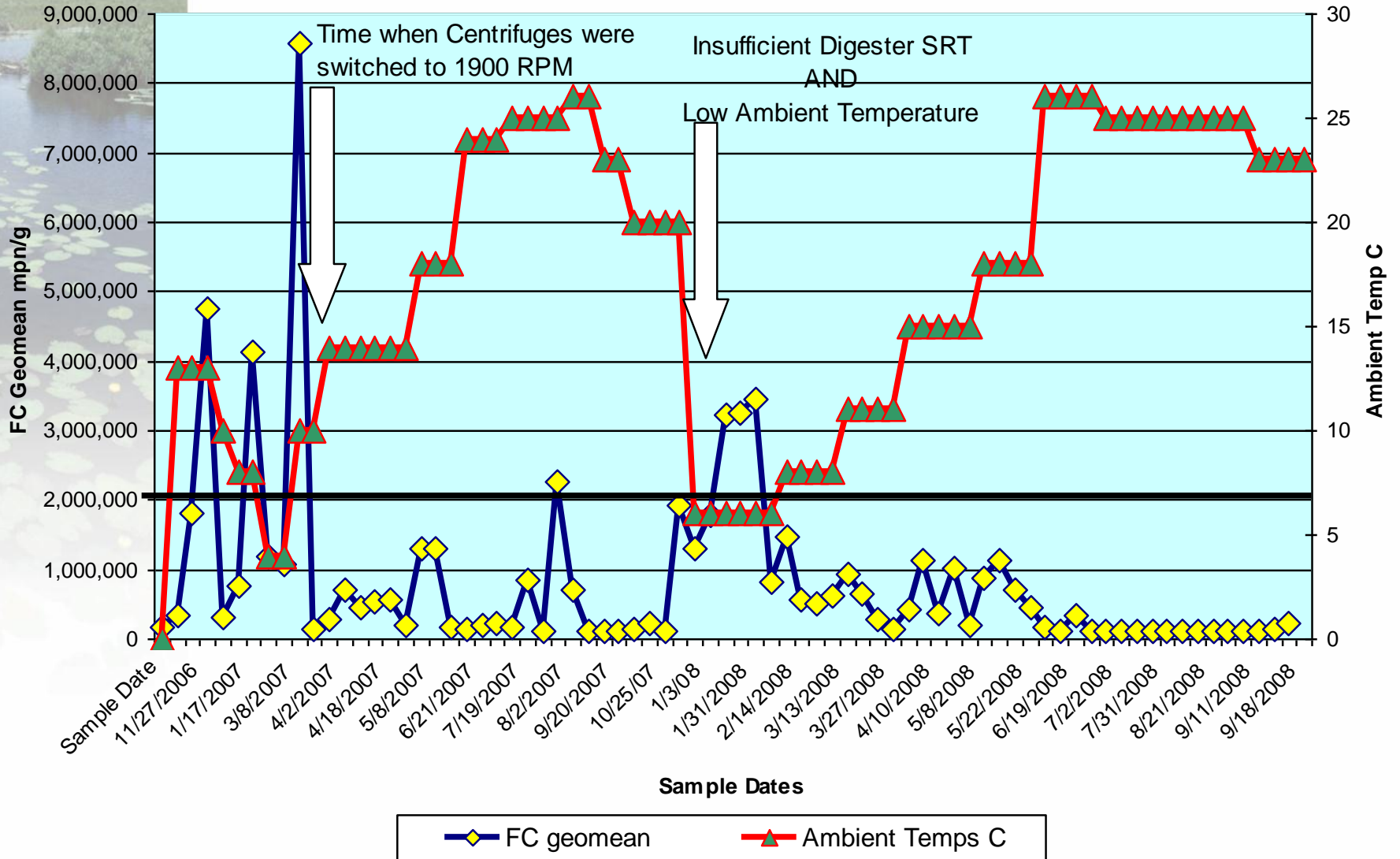


# Results of FC Testing in Jan-Feb 2008 Full Scale



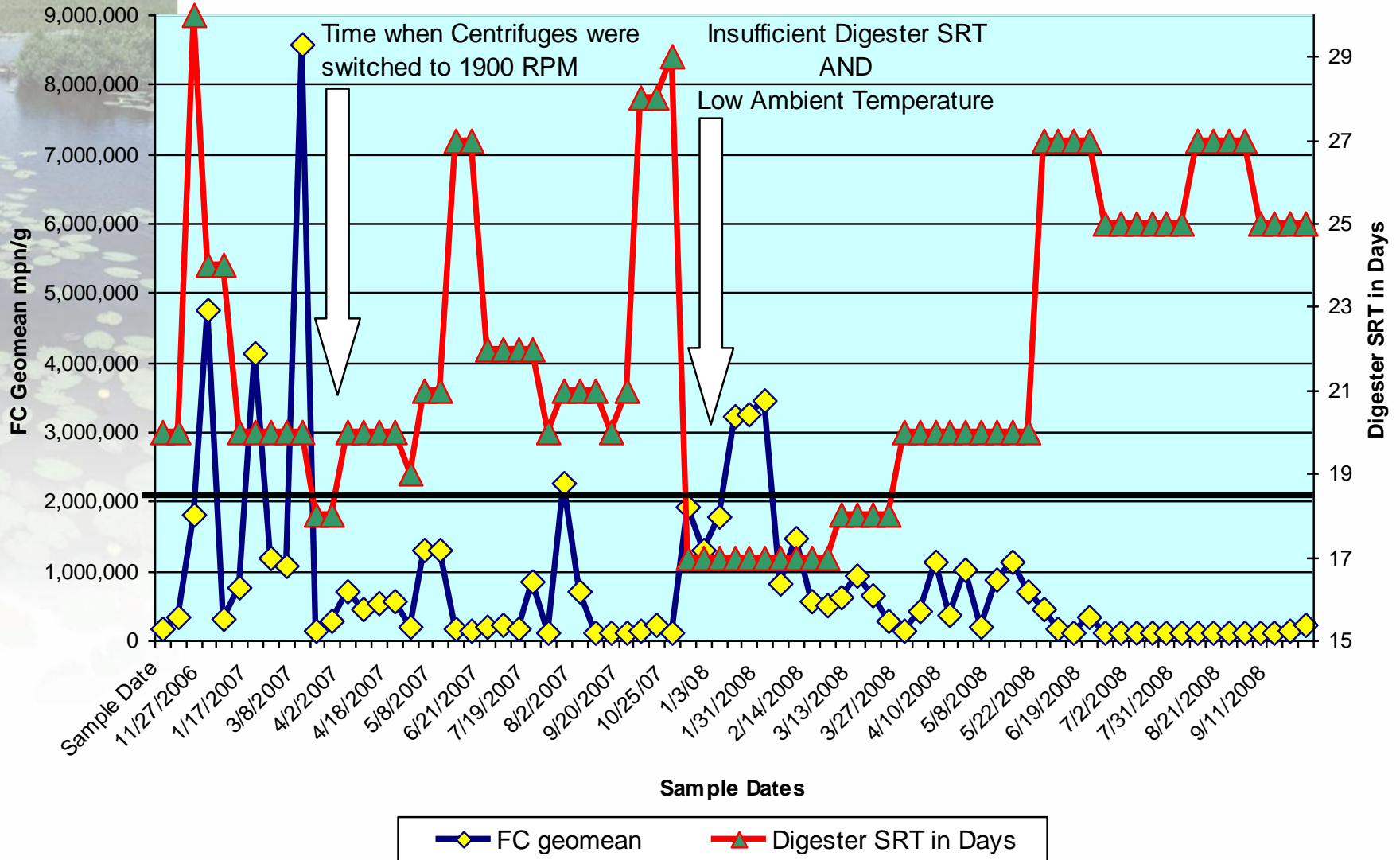
# Historical Results Since Operating at Lower RPM

## Storage Pile Testing Fecal Coliform vs. Ambient Temperature



# Historical Results Since Operating at Lower RPM

Storage Pile Testing  
Fecal Coliform vs. Digester SRT





# Conclusions for the Atlantic Plant Solids

- Centrifuge cake fecal coliform reactivation occurs immediately after dewatering with regrowth within hours
- Storage > 50 days required for FC reduction below 2 million MPN/gm TS during winter months, 30 days or less during summer months
- Low lime dosing at 9% CaCO provides effective reduction of FC for stored biosolids
- Low lime dosing at 3% CaCO is effective only if added within 2 hours after dewatering
- However, low lime dosing significantly increases odors, costs and handling



# Conclusions (continued)

- Belt filter cake did not experience reactivation
- Operating digesters in series decreased fecal coliform levels but regrowth still occurred above levels desired
- Operating digesters at higher temperatures (104°F) increases FC regrowth concentrations
- Decreasing centrifuge speed from 2300 rpm to 1900 rpm reduced storage time to 2 weeks to achieve target FC concentrations
- Higher storage pile temperatures results in higher FC concentrations in the first week, but the trend reverses between one and two weeks
- Cold ambient temperatures (< 8°C) results in FC concentrations above target level of 2 million even with long storage times.
- Reduced digester SRT (<20 days) in combination with cold ambient temperatures results in FC concentrations above target level of 2 million.

# Current HRSD Mode of Operation



- Continue tracking time and temperature for Class B compliance in digestion
- Added second storage building to provide > 90 days storage
- Weekly batch storage for better tracking
- Test stored biosolids bi-weekly for FC
- If FC below 2 million MPN/gm TS, batch is approved for land application
- Clean digesters in the summer or fall months only
- Converting to thermal hydrolysis in the future to achieve Class A, eliminate regrowth and reduce cake odors



# Acknowledgements

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- CH2M HILL
  - Technologists and Others
    - Bob Forbes, Tim Shea, Chris Easter, Thomas Hahn



# Pathogen Indicator Regrowth in Biosolids Cake Update

## QUESTIONS?

Todd O. Williams, BCEE, P.E.

[todd.williams@ch2m.com](mailto:todd.williams@ch2m.com)

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