Flue gas CO_2 recycling at Upper Blackstone Water District

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CLEARAS WATER RECOVERY

Objectives

Background

Setup &
Process

Results

Conclusions

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Acknowledgements

Massachusetts Clean Energy Center: Wastewater Treatment Plants - Innovative Technology Pilots (2017)

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Upper Blackstone Water District

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Independent

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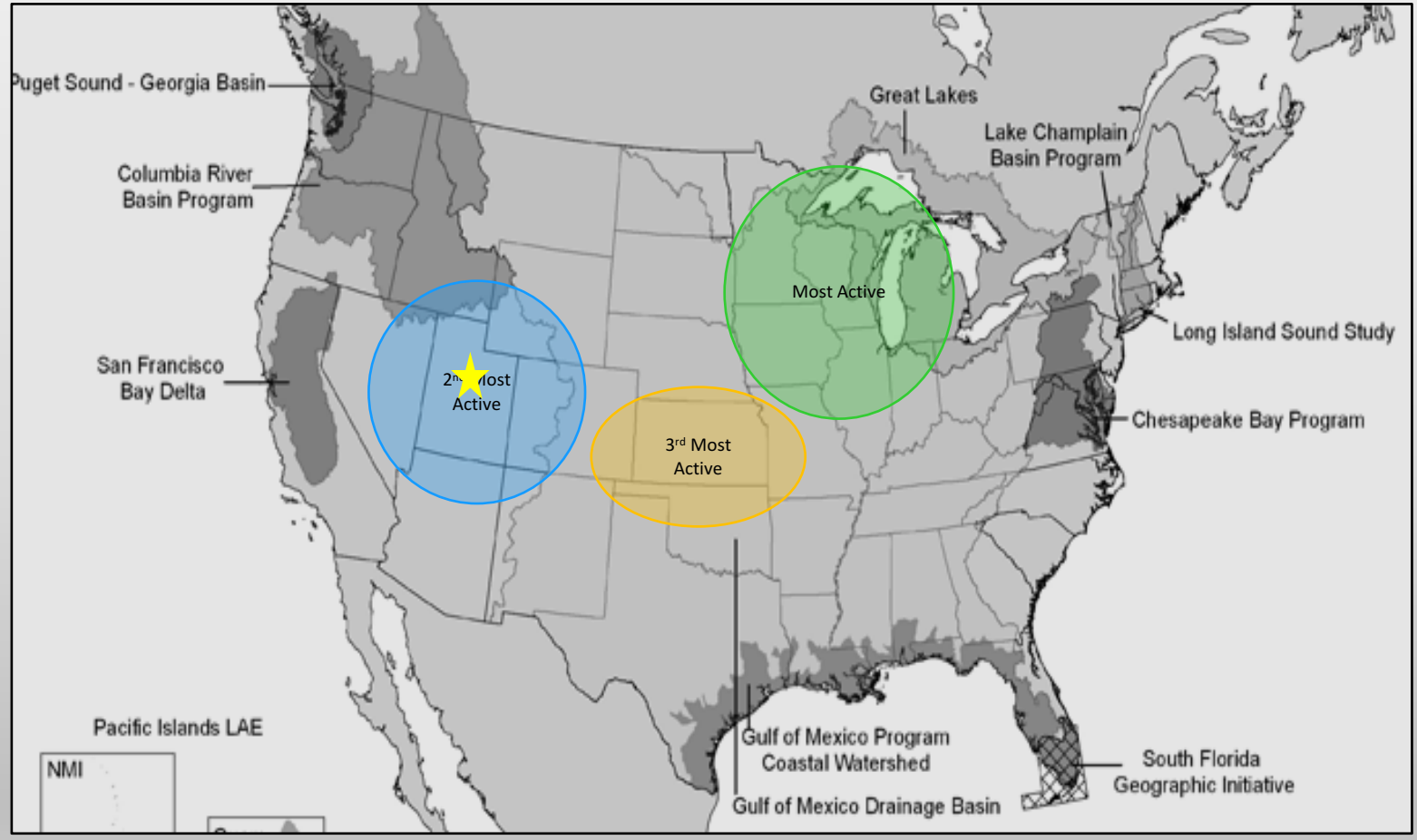
Background

Growing interest in the use of algal technology to achieve phosphorus recovery

CO_2 consumption represents the highest consumable product

Full scale commercial installations in progress



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Objective

To demonstrate if CO_2 produced on-site (sludge incineration, anaerobic digester off-gas, etc…) can be used to support the use of algal based technologies as a component to resource recovery and nutrient management:

- The impact on ***growth*** performance
- The impact on ***biomass quality***

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Test Site

Upper Blackstone (Milbury, MA)

- *Serves greater Worcester, MA area*
- *Designed for 45MGD, Peak flow 160MGD*
- *Currently incinerates sludge*

Site of extended pilot to demonstrate algal based performance for TP reduction

9 month demonstration

Feed: 0.254mg/L (Avg)

Permeate: 0.015mg/L (Avg)

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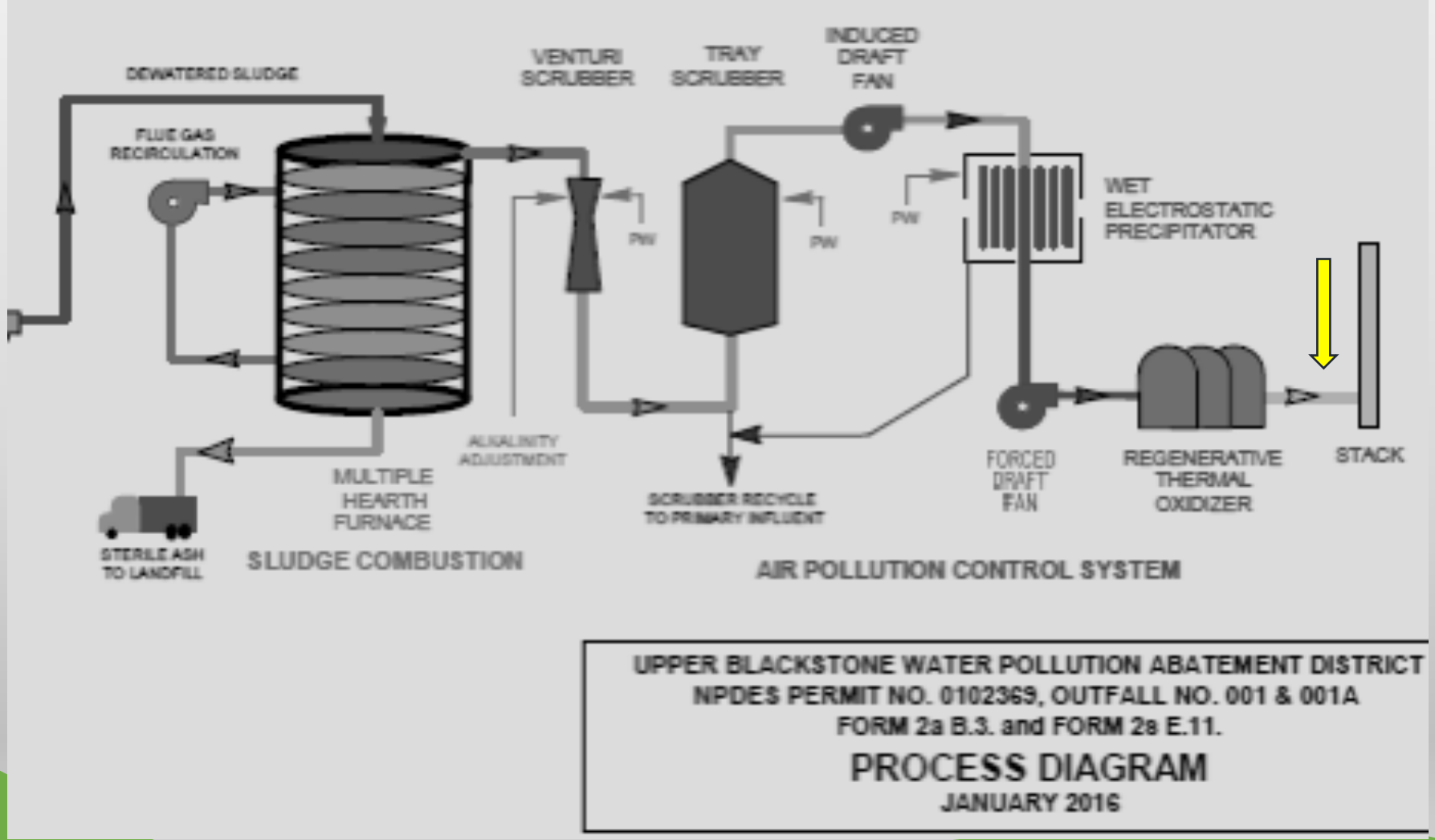
CO_2 Source

Source gas

- *~75F*
- *~10% CO_2 by volume*
- *NH_3*



Advanced Biological Nutrient Recovery®

Blackstone testing summarized at annual NEWEA conferences 2015 and 2016

Feed

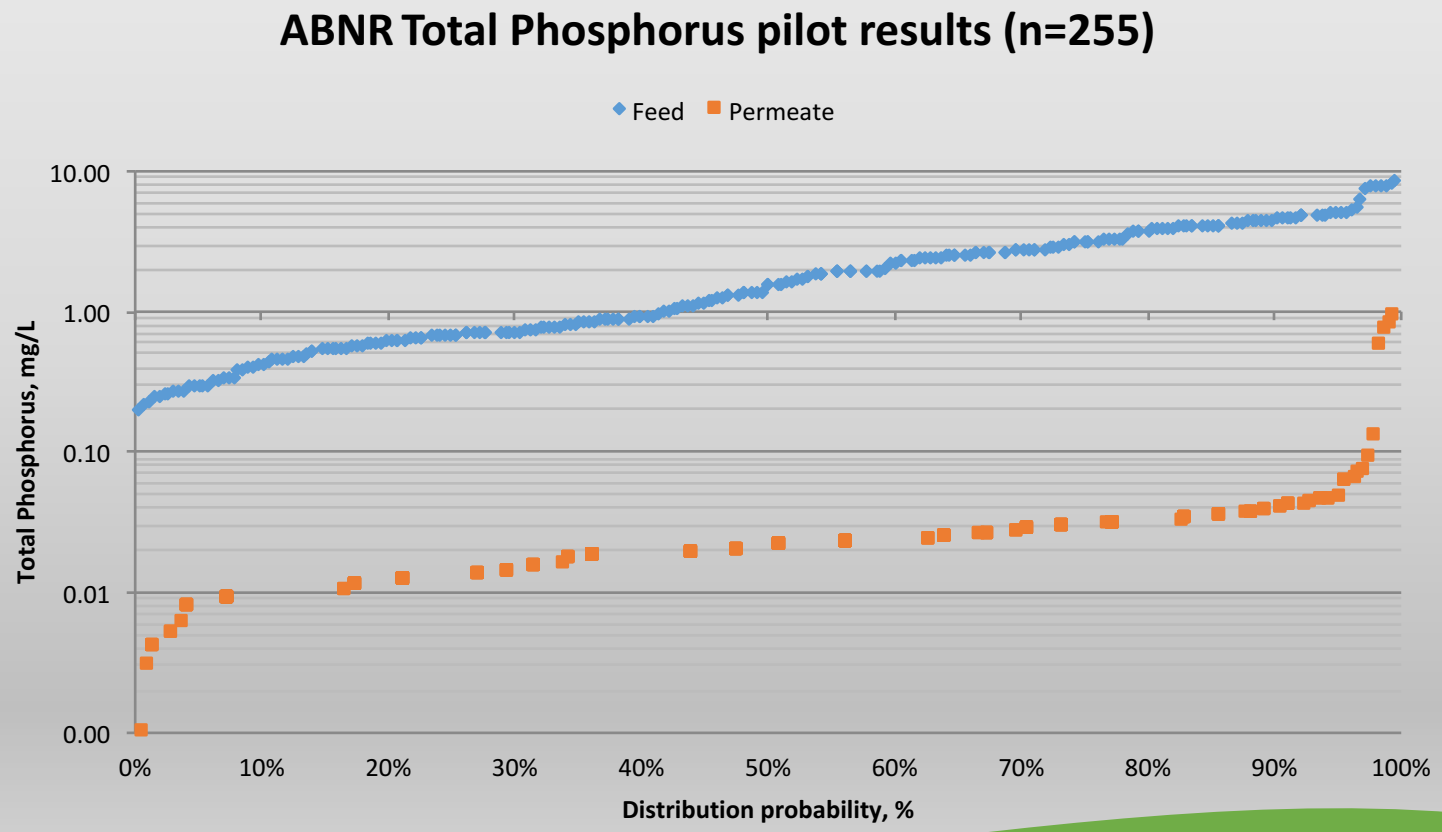
Median: 1.54mg/L

97.7%: 7.71mg/L

Permeate

Median: 0.02mg/L

97.7%: 0.10mg/L



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Projected CO_2 costs

	Units	38MGD
Algal growth demand	Tons/day	31.5
Net from flue gas	Tons/day	28.4
Purchased cost – Low ($0.04/lb)	$/ton	80
Purchased cost – High ($0.12/lb)	$/ton	240
Cost - low	$/year	$829,280
Cost - high	$/year	$2,487,840
Cost - low – 20 year PW	$ total	$10,334,662
Cost - high – 20 year PW	$ total	$31,003,985

Based on reducing TP from 1.0mg/L to <0.1mg/L

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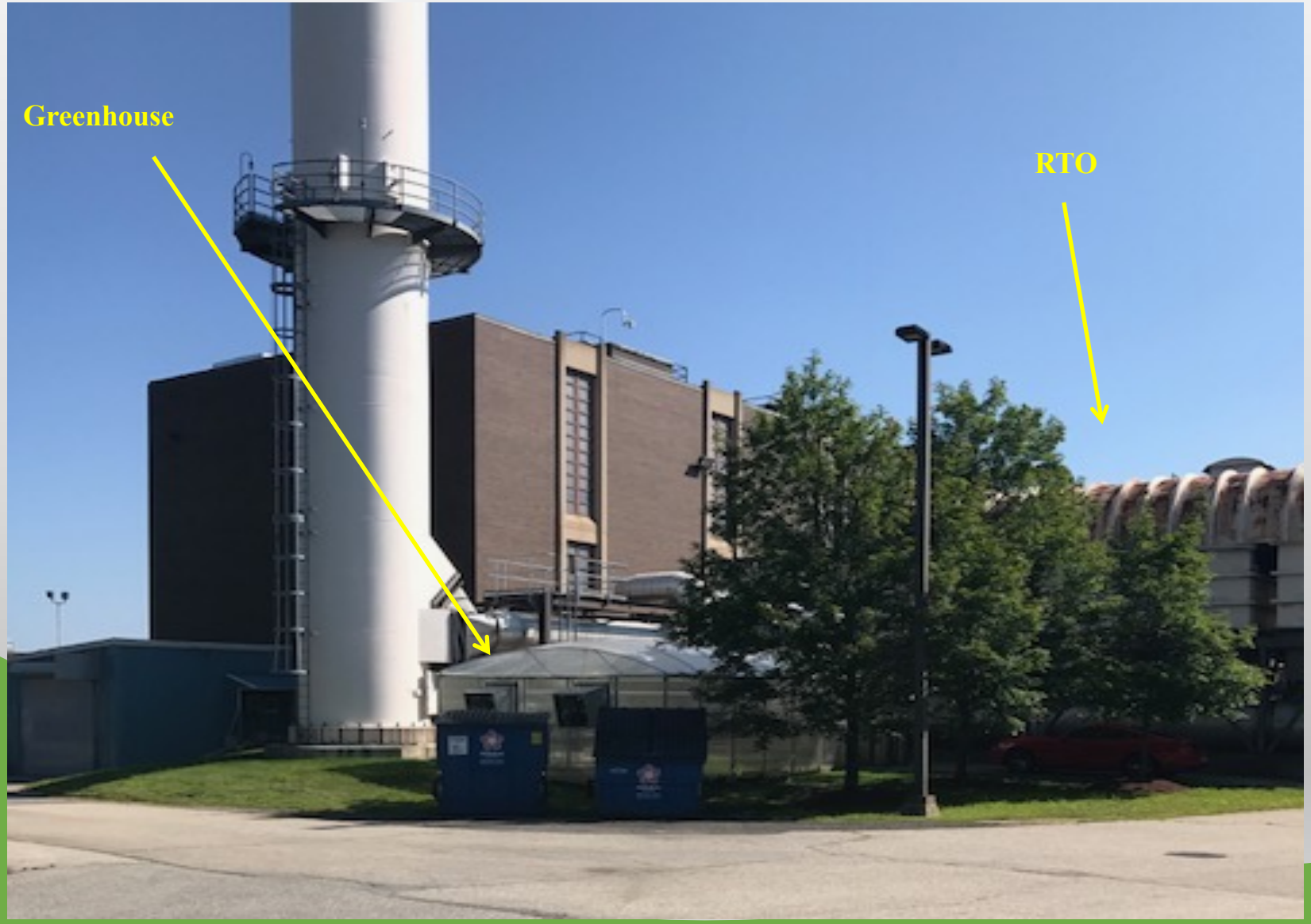

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Control Reactor

Test Reactor

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RTO Source

Gas compression

Gas bubbling stones

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Test Protocol

Parameter	Control Reactor	Test Reactor
Baseline -Duration -CO_2 source -Orthophosphate load - Density (TSS)	21 days Bottled 4.0mg/L 750mg/L	
After baseline established		
CO_2 source	Bottled	Flue gas
Target Orthophosphate	4.0+/- 0.2mg/L	
Target Density (TSS)	750 mg/L	
Duration	75 days	
Harvest	Daily to maintain density	
Nutrient source	Girard f/2 media (Part A and B)	
Makeup water	Plant process water	

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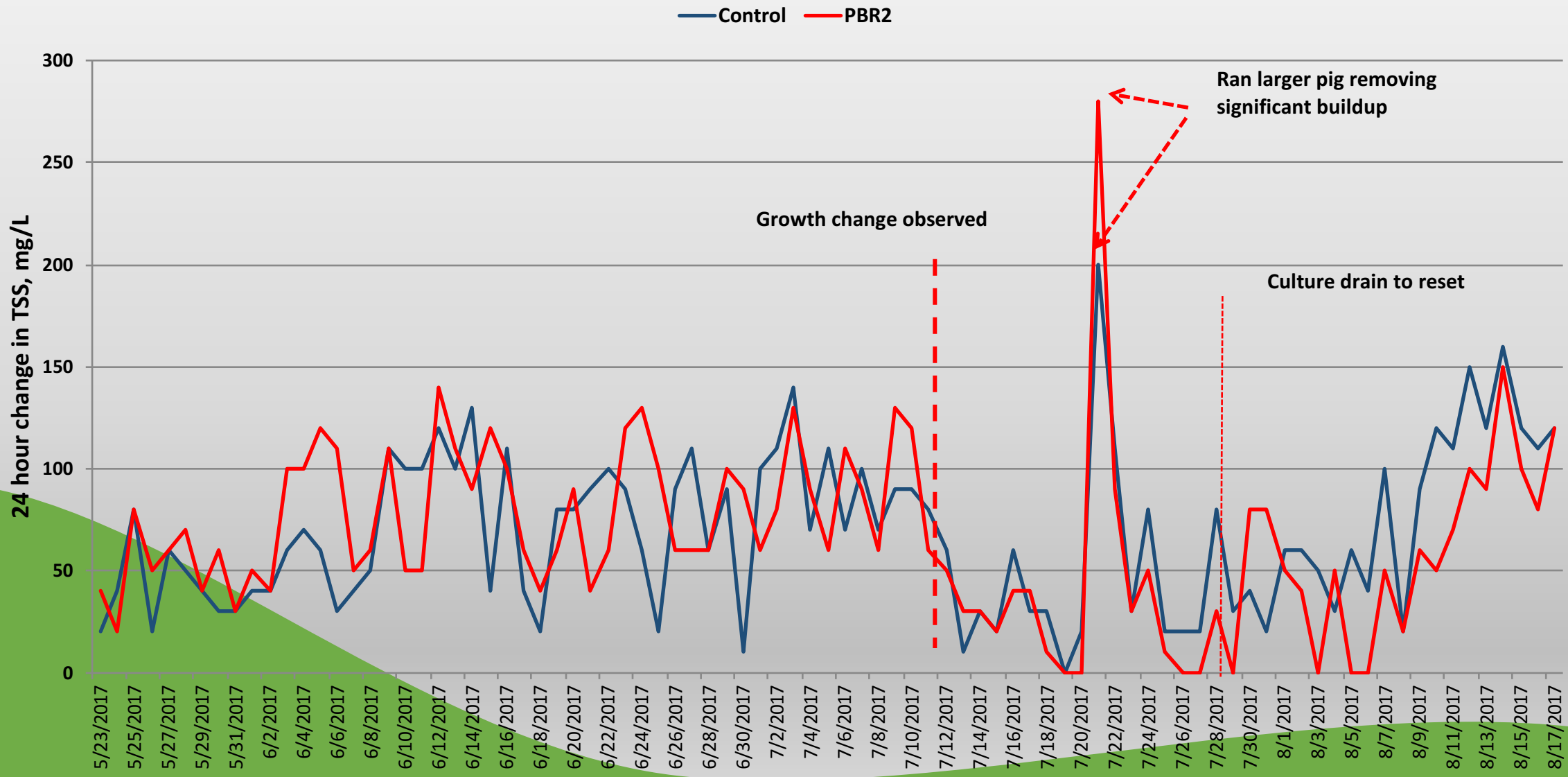

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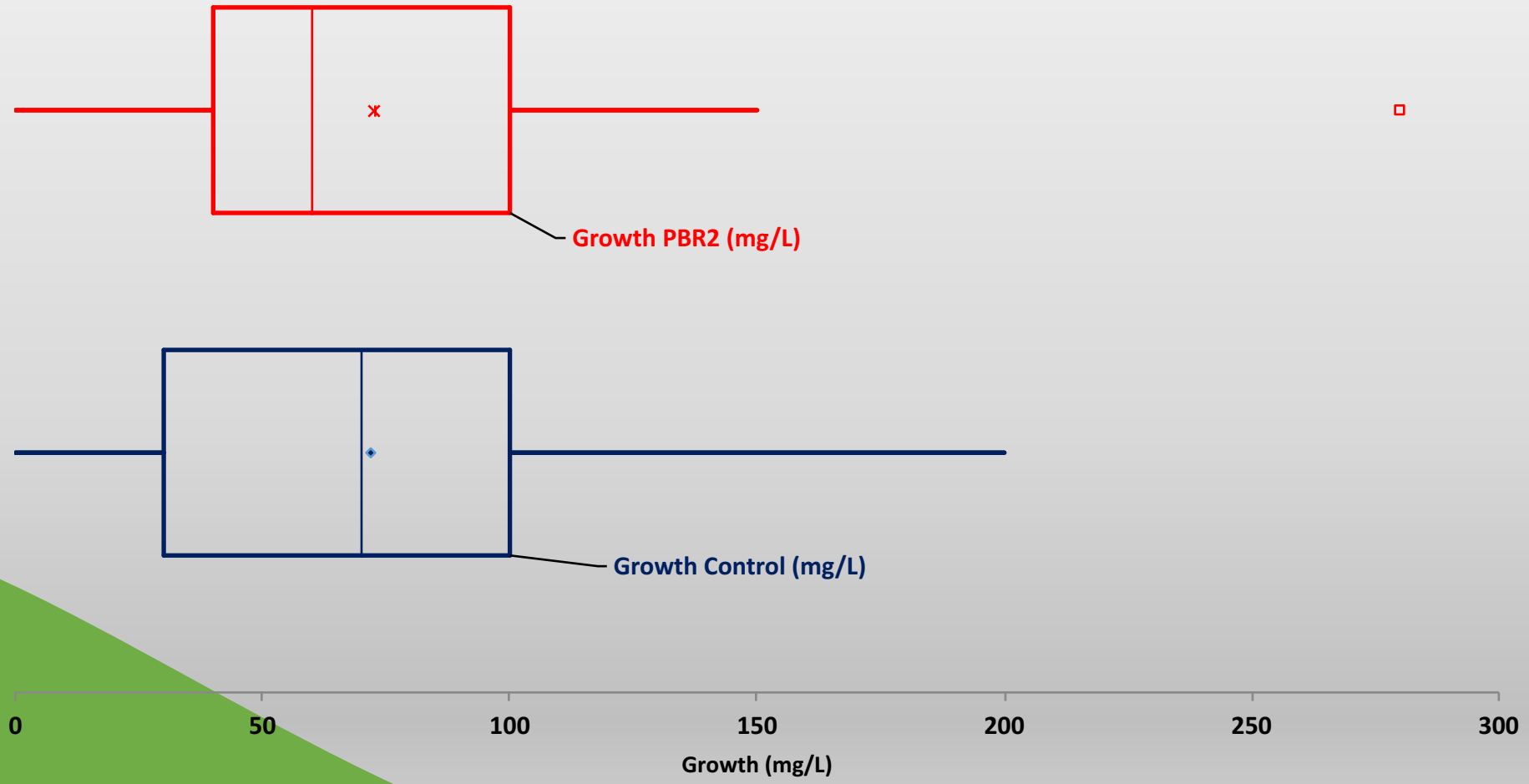
Box-Whisker Plot Comparison



No statistically significant difference

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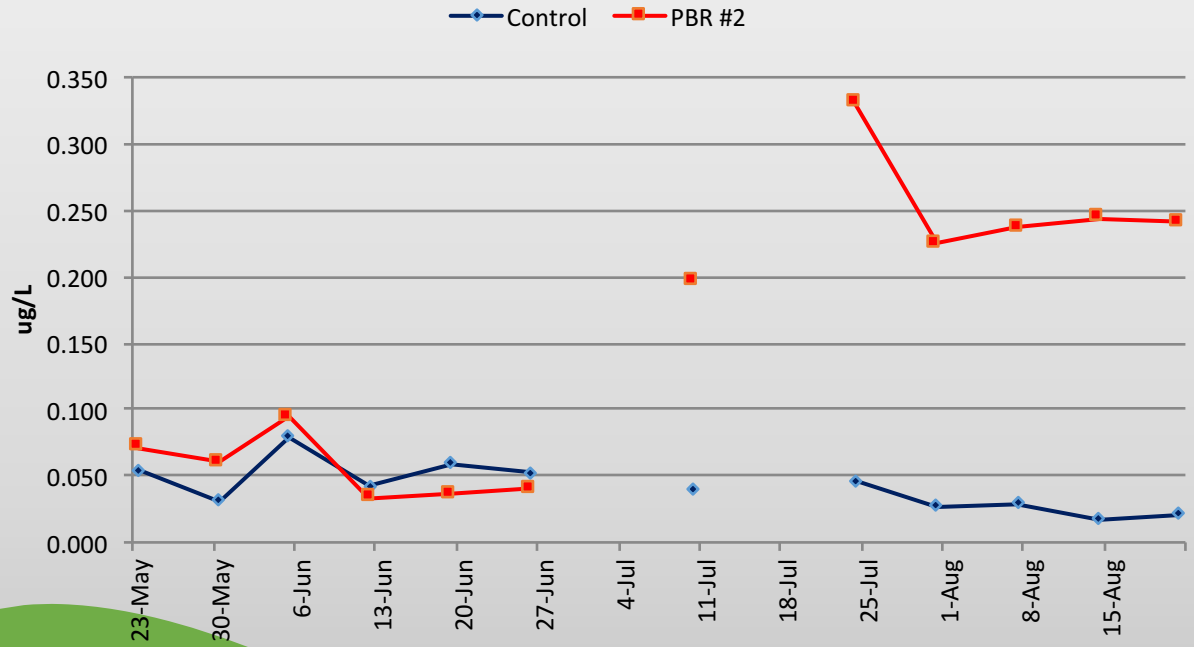
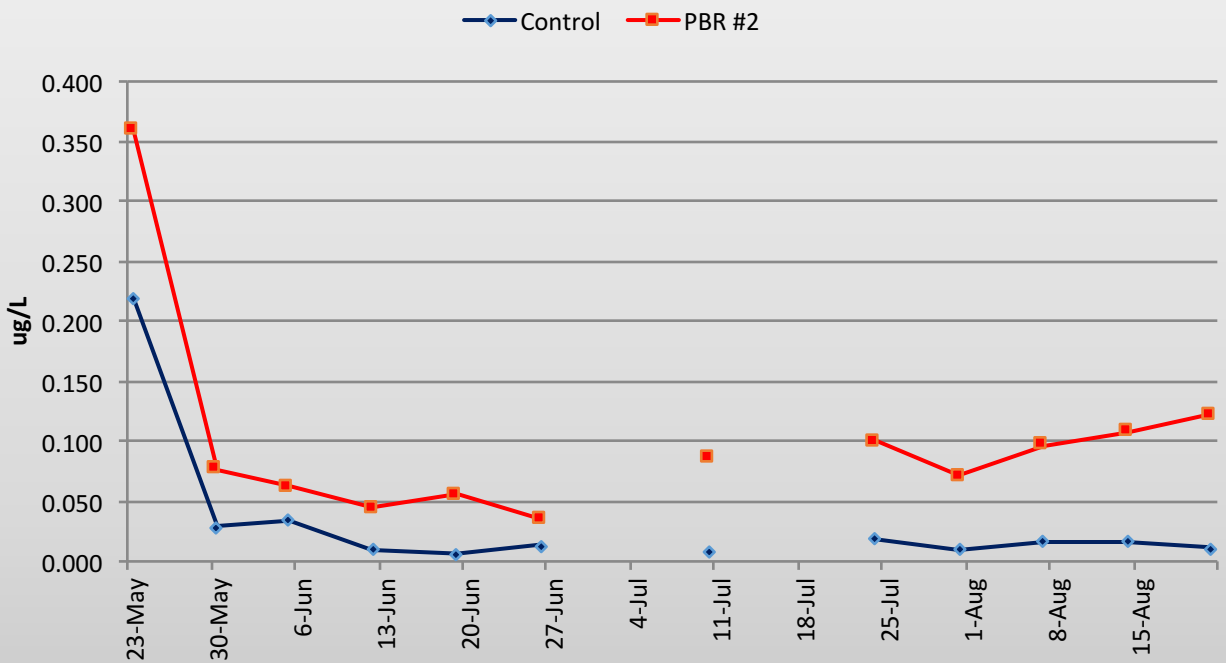
Arsenic



Ammonia



Note: No media samples for Pb or Hg available until late July

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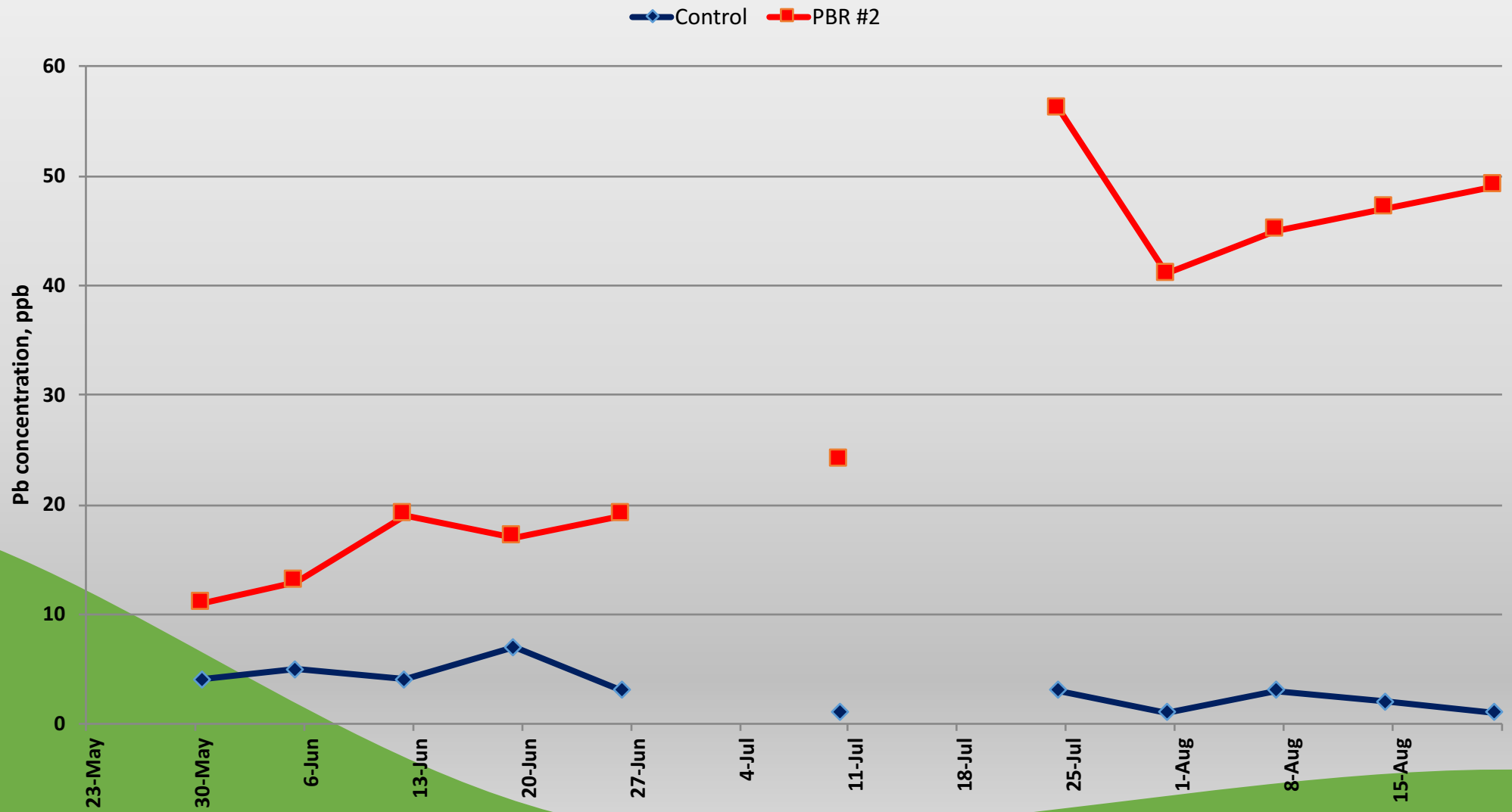
Biomass Pb concentration



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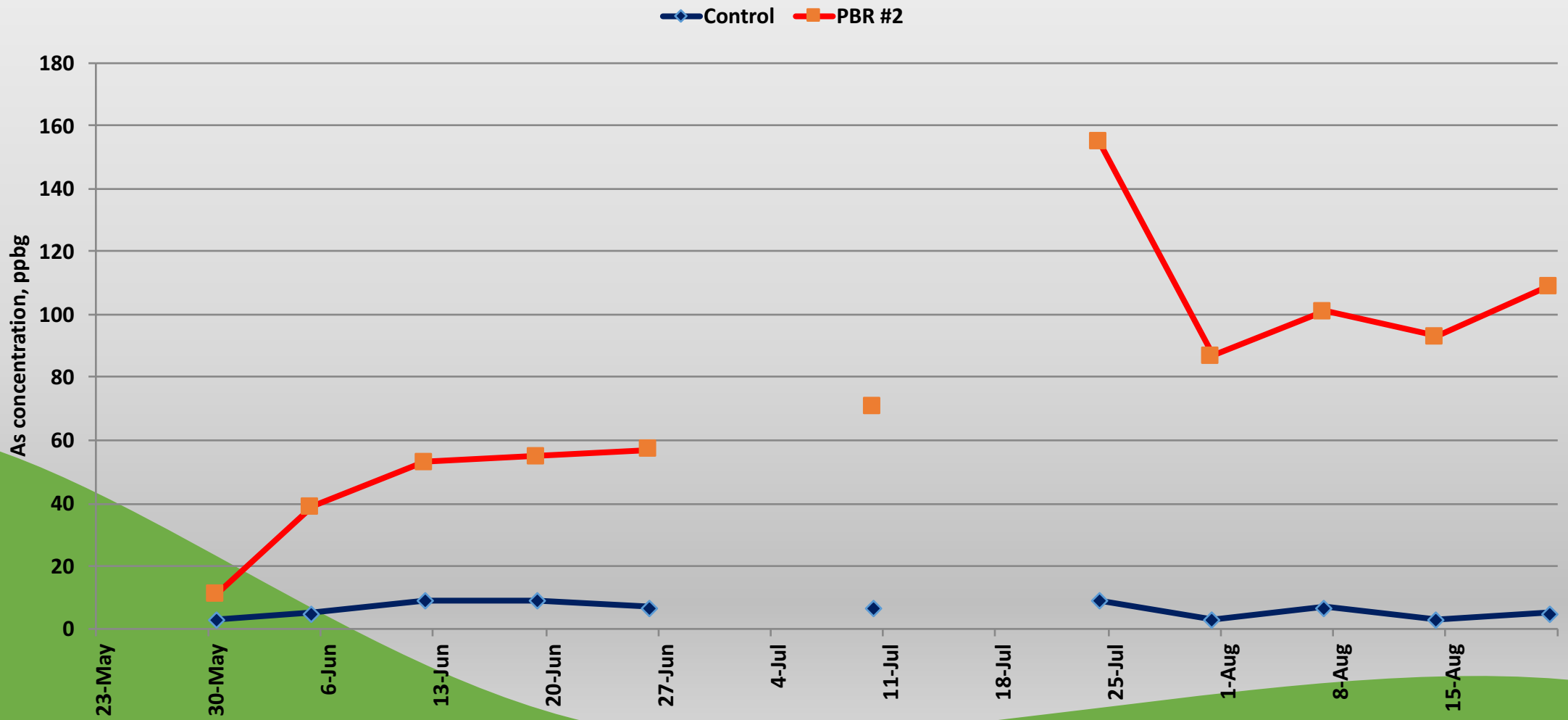
Biomass Arsenic concentration



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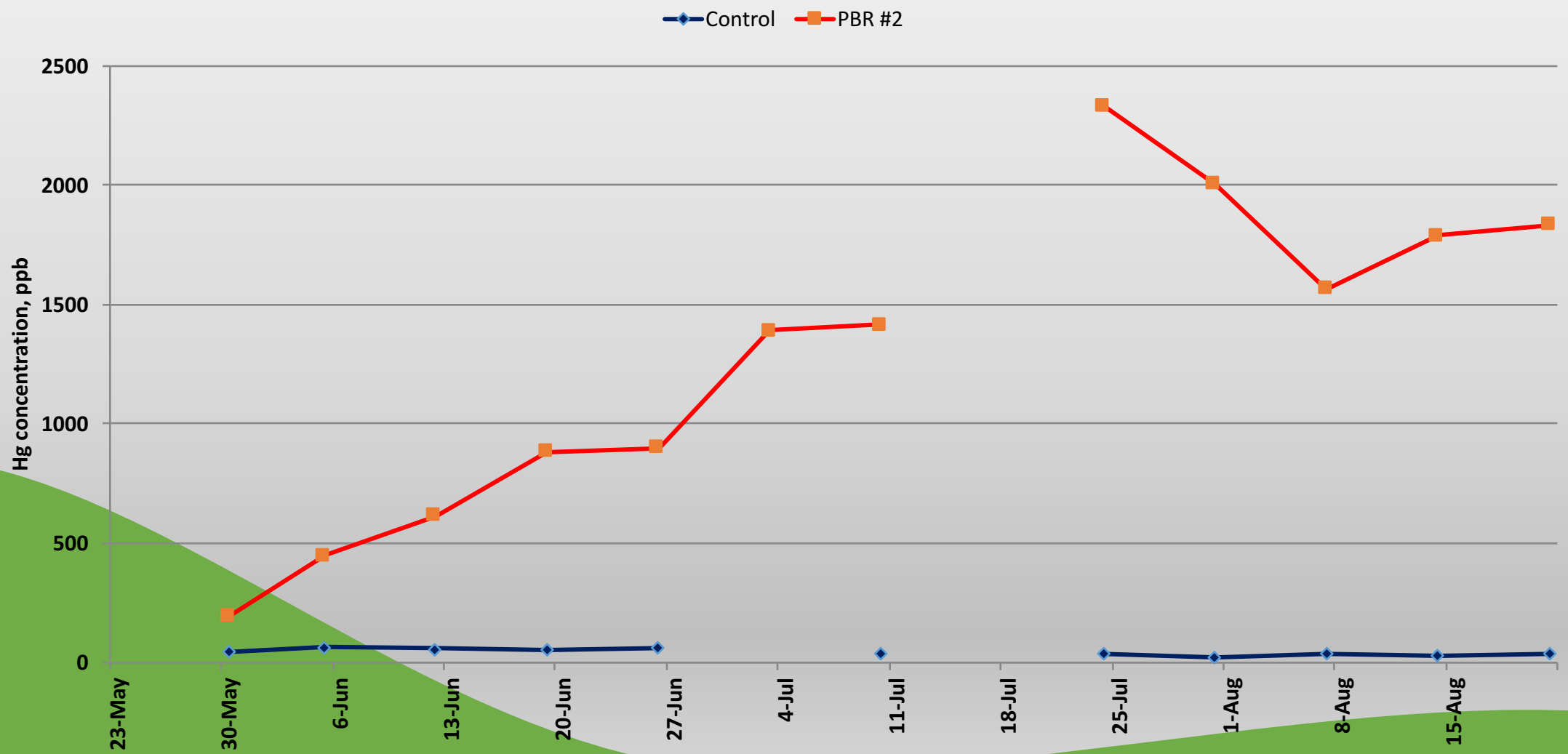
Biomass Mercury concentration



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Control

Flue Gas

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Conclusions

The use of flue gas, similar in quality to that at Blackstone, as a source of CO_2 to support algal production has no negative impact on growth density or recovery (in case of biological upset)

The impact on biomass composition (and components) must be considered

- All levels measured are below US EPA 503 guidelines

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Recommendations

1. Additional longer-term testing to study impact on growth, components and biomass composition should be undertaken before fully adopted

2. Of particular potential is the use of gas produced through anaerobic digestion co-generation as it would be expected to be a “cleaner” gas

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Questions

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