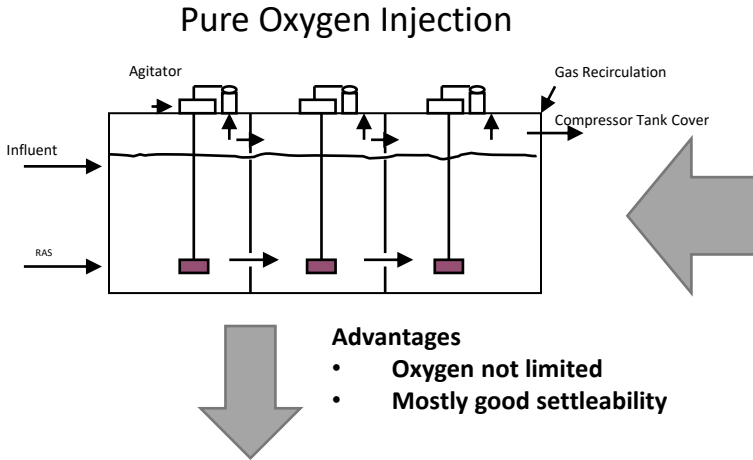


# Increasing Throughput & Capacity While Reducing Biosolids Production



Rob Whiteman Ph.D.  
ABS Inc. - Technical Director

# HARDWARE EVOLUTION OVER 100+ YEARS

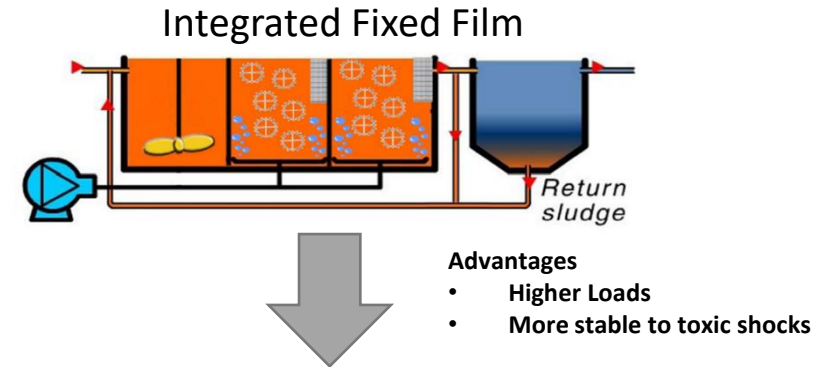


**Activated Sludge**  
Davyhulme, Manchester UK 1914

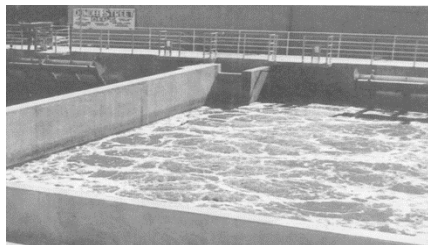


**Capacity Limitations**

- Oxygen Transfer Efficiency
- Settleability of Biomass



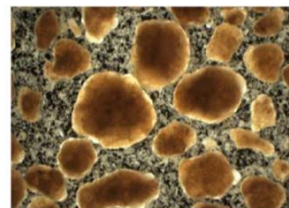
**Sequencing Batch Reactor**



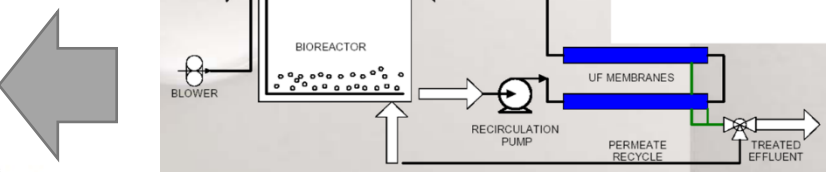
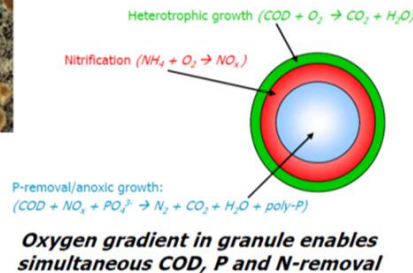
**Advantages:**

- No clarifiers
- Need 2+ SBRs
- Easy Operation

**Granular Activated Sludge**



**Selection mechanism:**  
settling pressure and/or short decant phase



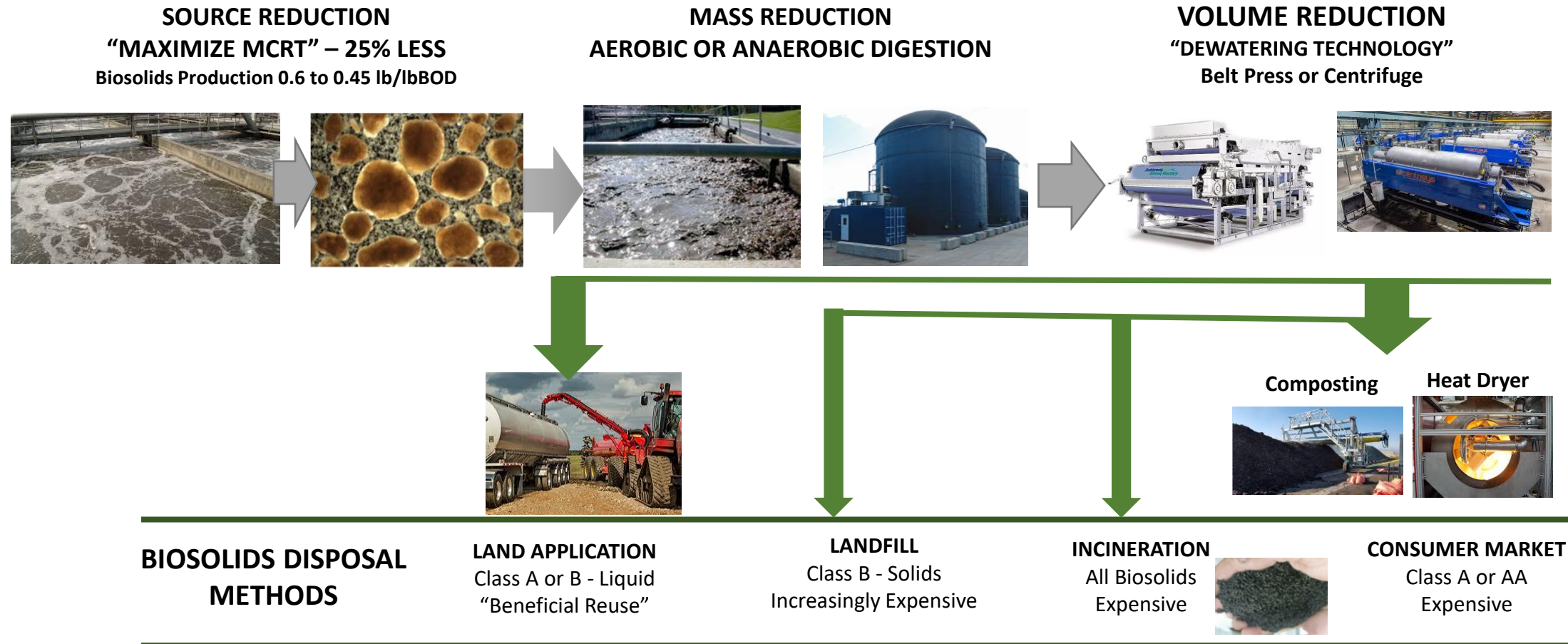
**Advantages**

- 25% less oxygen consumption
- 25% less biosolids production
- Simultaneous Nutrient removal (N&P)

**Advantages**

- No clarifiers
- Effluent TSS excellent

# EVOLUTION OF BIOSOLIDS HANDLING



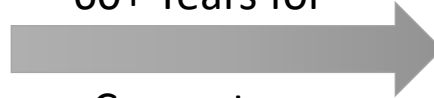
# What is The Future Challenge?

## Are there Parallels with Computer Technology?

1960 – 256K: Wow this computer is great!!



60+ Years for  
Computers



2020 – 16GB: I built the fastest, greatest hardware on the earth –what do they want from me!!



**UPGRADE MY SOFTWARE?**  
Apple/Dell/Intel.....upgraded hardware  
Apple/Microsoft upgraded software

Wow! I can do some much more with this new  
“software” ...with the same hardware!!

**THE FUTURE OF WWT:  
WHAT IF BIOLOGY WAS UPGRADABLE?**

**Can you UPGRADED the biology?**

# Evolution of Bioaugmentation Process Technology

Pre 1990  
Freeze Dried Bugs  
In-a-Bucket

1% ACTIVES  
NON-PERFORMING



INERT SPORES  
- PLANT SEEDS

1X

1990-1994  
Introduction of PAD

1% ACTIVES  
MODERATE  
PERFORMANCE



YEAST  
CONTAMINATION

100X

2000-to-date  
ABS Introduces  
On-Site Biofermentation

100% ACTIVES  
FULL PERFORMANCE  
CUSTOM BLENDS  
GROW ANY BUG



CONTROLLED  
FERMENTATION

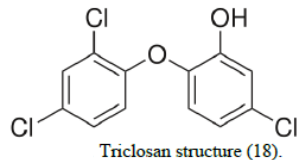
10,000X

# WHY DO WWTP'S NEED PROBIOTICS?

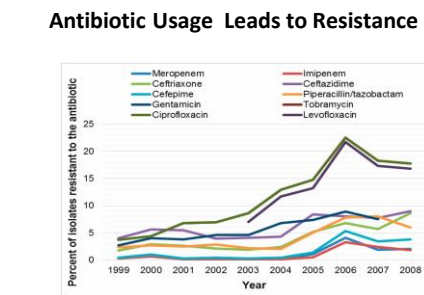
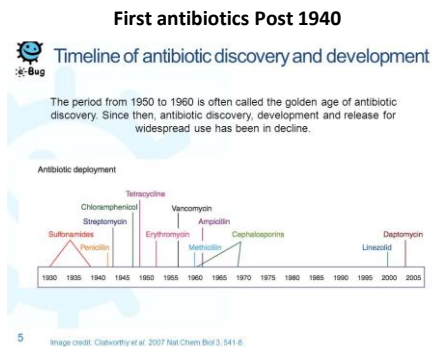
## Hand Sanitizers & Cleaners



## Widespread Nitrification Inhibitor - Triclosan

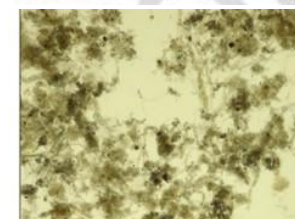


**Good microbes are inhibited, killed or replaced by undesirable microbiology.**



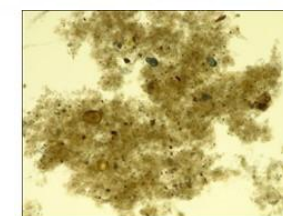
**Improving settleability & health provides WWTP's with more capacity**

### BEFORE PROBIOTICS



**Poor Settleability**  
Filament Rating 4-5

### RESULT OF PROBIOTICS



**Good Settleability**  
Filament Rating 1

# How Does BioFermentation<sup>®</sup> Work?

NO PROBIOTICS  
*Viable Bacteria = Red*



NO PROBIOTICS  
Weight: 49.5776 g



A PLUG & PLAY BIOTECHNOLOGY  
MODEL 1500



WITH PROBIOTICS  
*New Viable bacteria = Green*

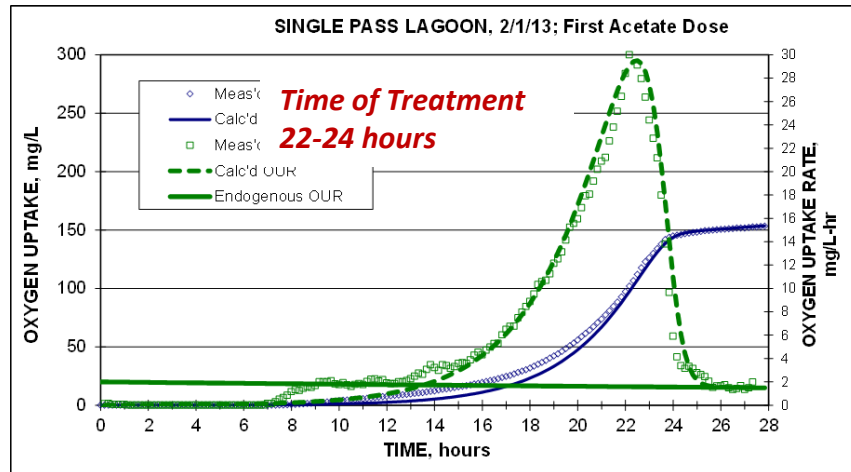


TREATED WITH PROBIOTICS  
Weight: 50.3648g  
Difference = 0.7872g = 1.5%

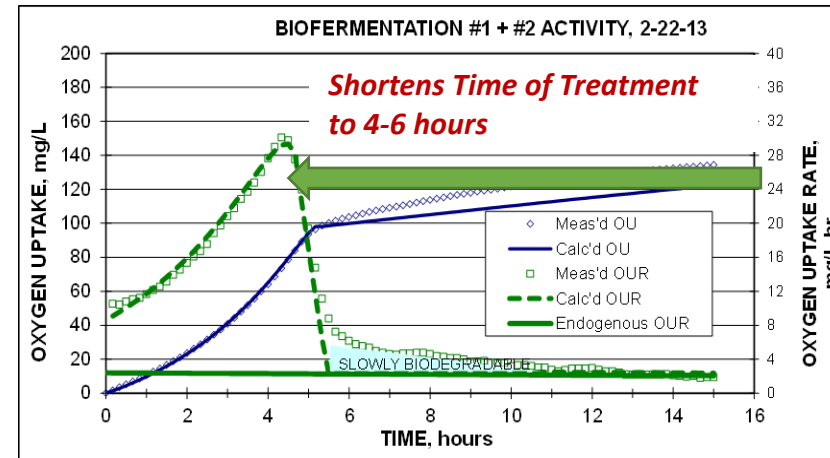
**10<sup>13</sup> bacteria weighs 1 gram**  
**Adding Viability NOT Mass**

# Does Ex-Situ Growth Really Increase Activity?

**Existing Biomass using Bugs  
Biomass – 1X Active**



**Biofermentation® Liquor  
Biomass – 1000X**

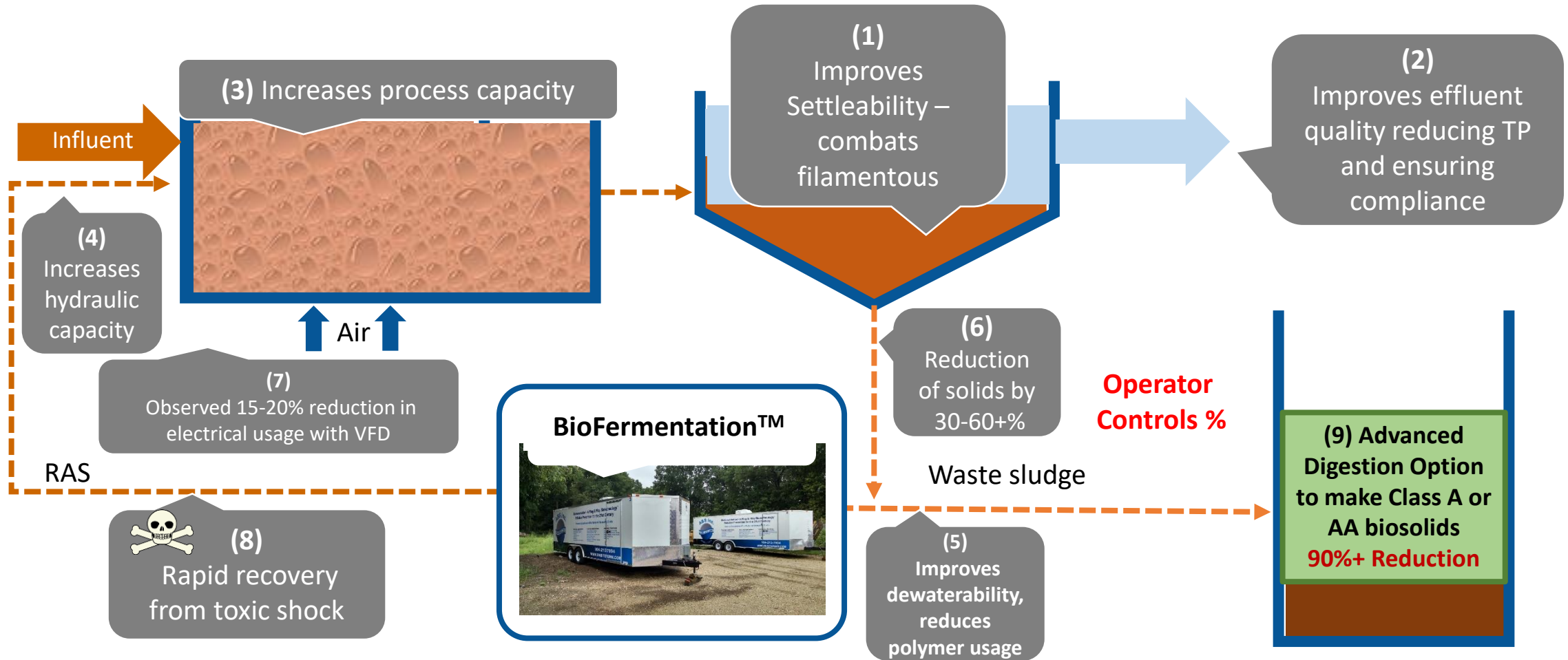


**NOTE LOWER OXYGEN DEMAND  
OBSERVED**



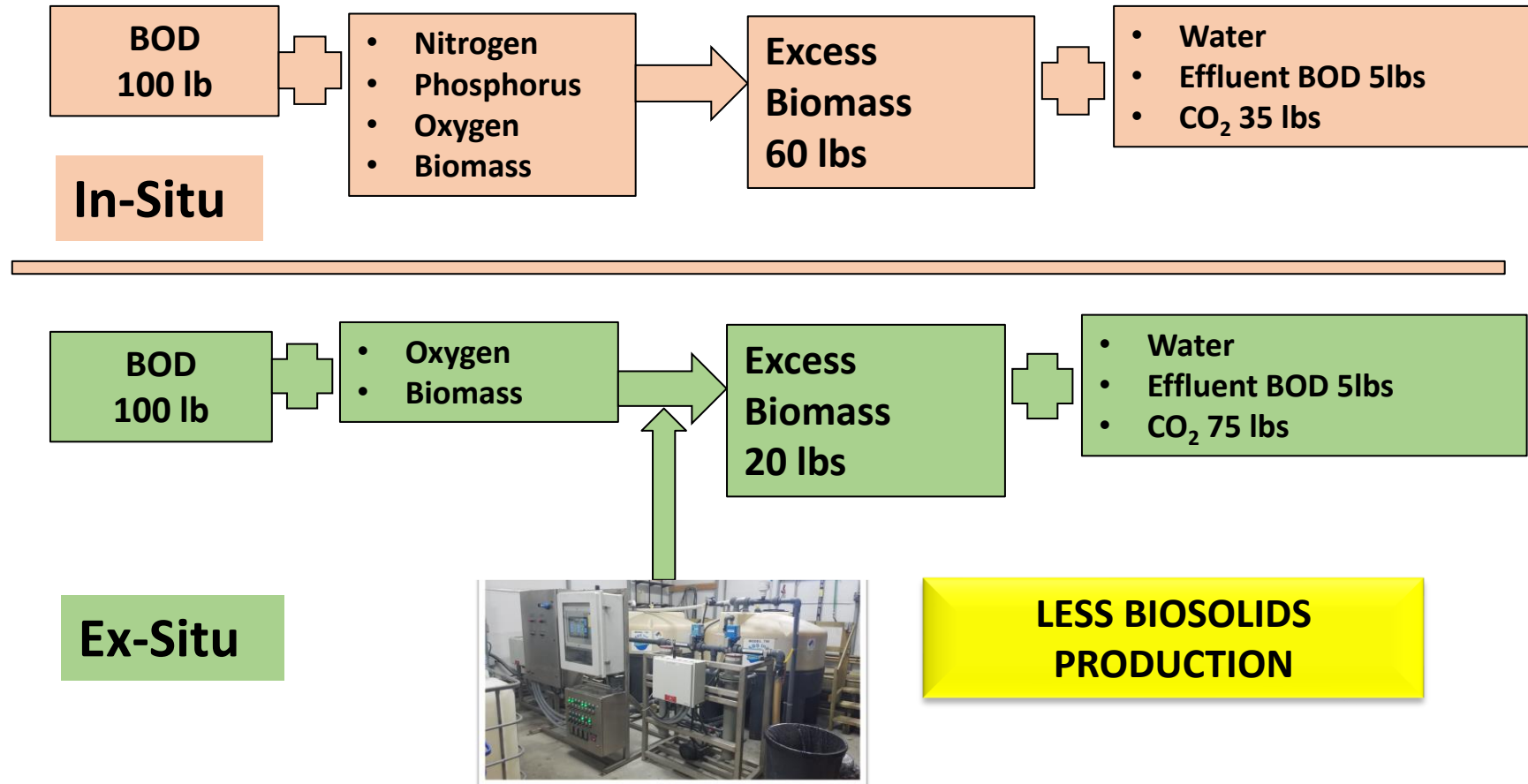


# What is the Impact of Biofermentation?



# What is Resultant Mass Balance with Ex-Situ Growth?

## THE BOD MASS BALANCE – 95% BOD Removal

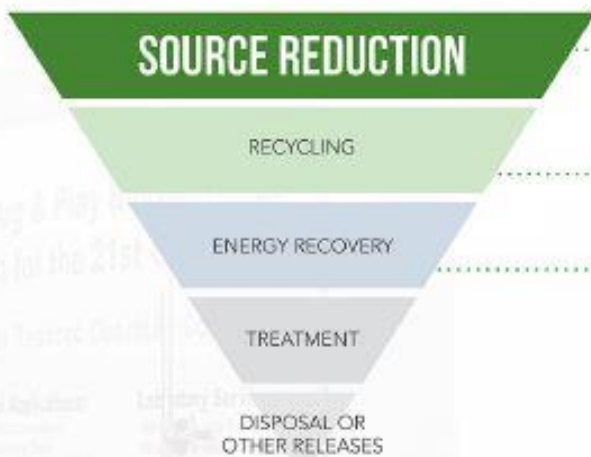


# APPROACH SUPPORTED BY EPA

## Biofermentation® - Point Source Reduction Technology



### EPA POLLUTION PREVENTION HIERARCHY



**BIOFERMENTATION®**  
A Point Source Reduction Technology

Beneficial Reuse/Pelletization

Anaerobic Digestion — Methane Production

STEP 1:  
Reduction  
in Aeration

### WHERE DOES IT HAPPEN?



STEP 2:  
“Advanced  
Digestion”

### AEROBIC OR ANAEROBIC DIGESTION



# Versatility of BioFermentation<sup>®</sup> - Any Biological Plant

1. Trickling Filter
2. Package Plant
3. Modified (SBR-E)
4. Oxidation Ditch
5. SBR (with P removal)
6. Extended Aeration
7. Industrial: Unox, ASB and Membrane
8. Scaling & Diversity 2020: 0.01-100+MGD
9. 2020 Diversification Projects:
  - Anaerobic Digester (Increased Gas Production)
  - Enhanced P removal
  - FOG – expand documented benefits – VFA production, lower BOD....
  - PFAS
  - Covid-19

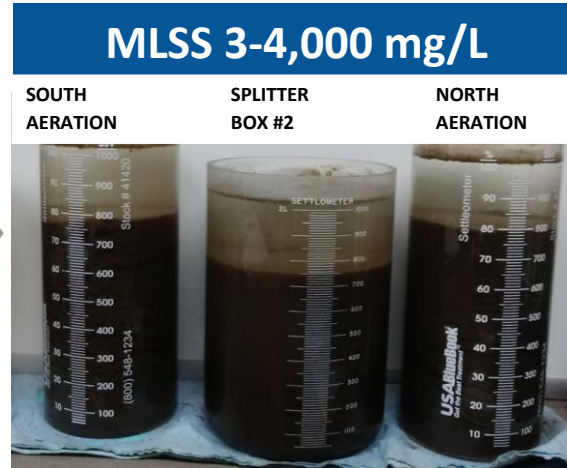
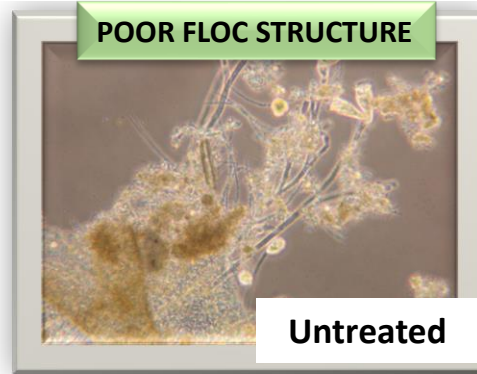


(E)



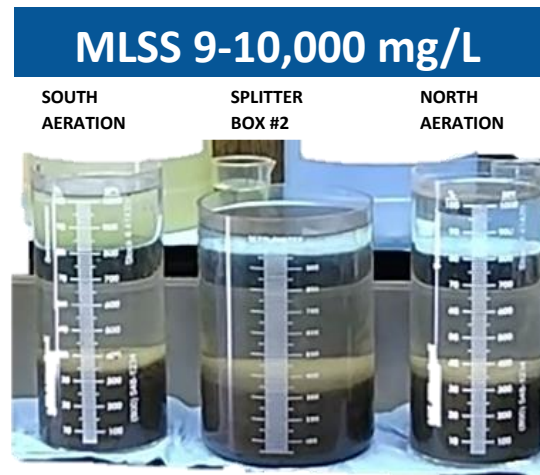
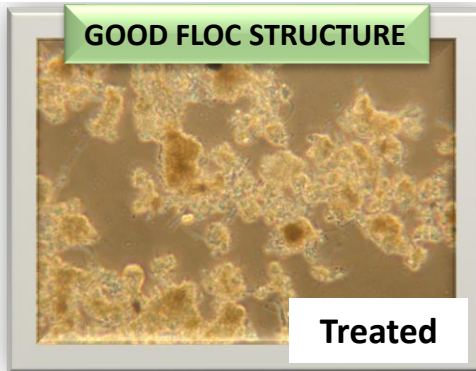
# The Evidence: Improved Settability Increases Hydraulic Throughput & Capacity

Filamentous rating 1-2. Open/Closed floc structure, weak-firm with irregular structure.



- PLANT NORM:**
- Poor settleability
  - No compaction
  - Highly turbid effluent

Filamentous rating 0-1. Closed floc structure, firm with irregular structure.



- BIOFERMENTATION RESULTS IN:**
- Excellent settleability
  - Good compaction
  - Great effluent clarity

# The Evidence: Improved Settleability: Increases Capacity & Throughput

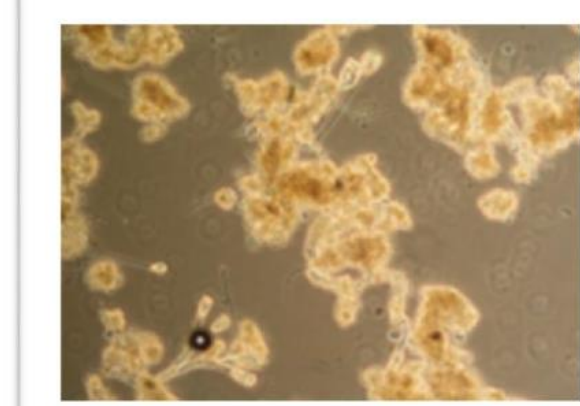
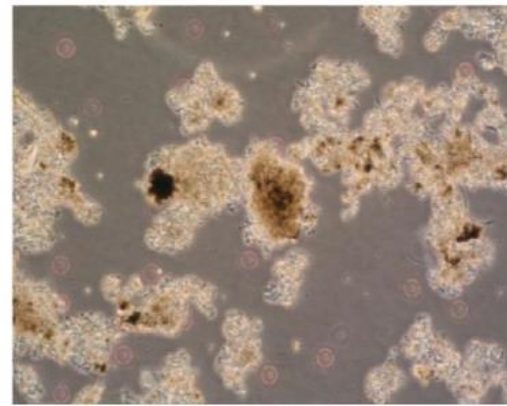
## UK Municipal Plant



**PLATE 1 – Pre-Biofermentation**

**PLATE 2 – Post-Biofermentation**

**PLATE 1: AQUA-ENVIRO ANALYSIS 8-25-17**   **PLATE 2: AQUA-ENVIRO ANALYSIS 12-8-17**



**PLATE 1: Bulk Liquid**

The bulk liquids for the two MLSS were slightly dirty, containing **single celled bacteria, floc fragments and broken filaments.**

**Filament Description**

Filamentous abundance for both samples was **3 (common)** on a 0-6 scale. The filaments identified were *Type 021N*, *Type 1851* and *N. limicola III*.

**PLATE 2: Bulk Liquid**

The bulk liquids for the two MLSS were clean containing **few single celled bacteria, floc was firm and tight**

**Filament Description**

Filamentous abundance for both samples was 0-1 (common) on a 0-6 scale. The filaments were not identified as these were insignificant to impact settleability ie <3.

# The Evidence: Increased Capacity & Throughput

## UK Municipal Plant

INFLUENT PARAMETERS	% CHANGE
Flow	1% Increase
BOD-5	8% Increase
TSS	6% Lower
NH3-Nitrogen	14% Lower
P-SRP	23% Lower
P-Total	22% Lower



FIGURE 5d: AMMONIA-NITROGEN EFFLUENT

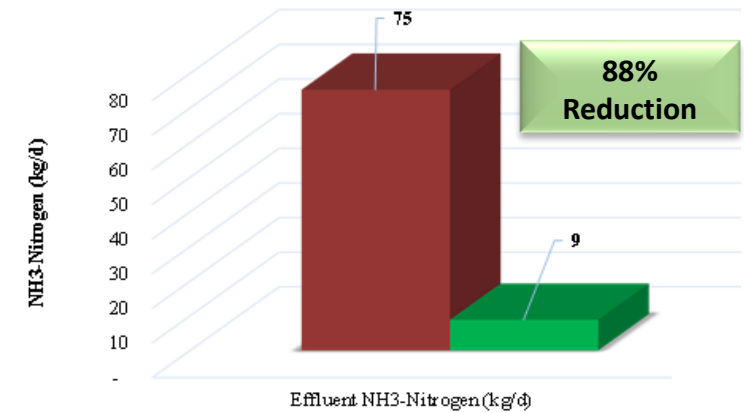


FIGURE 2b: BOD EFFLUENT

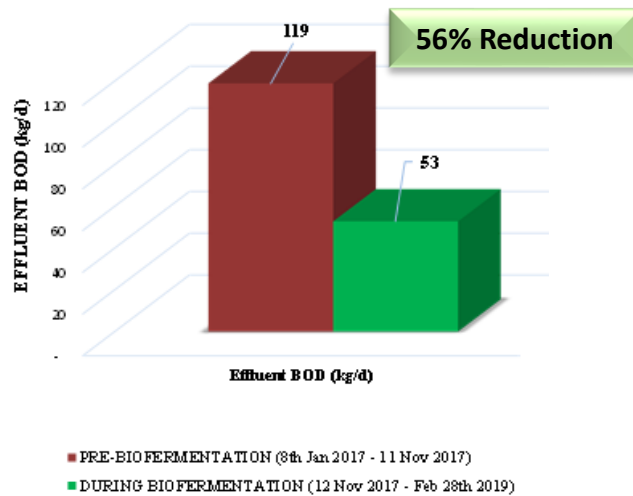


FIGURE 3b: MEAN EFFLUENT TSS

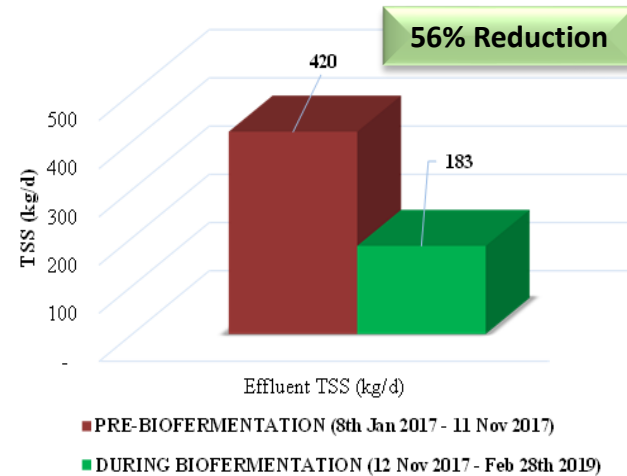
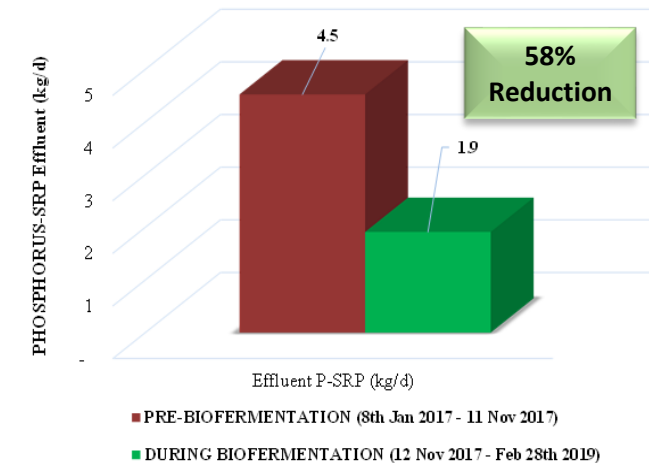
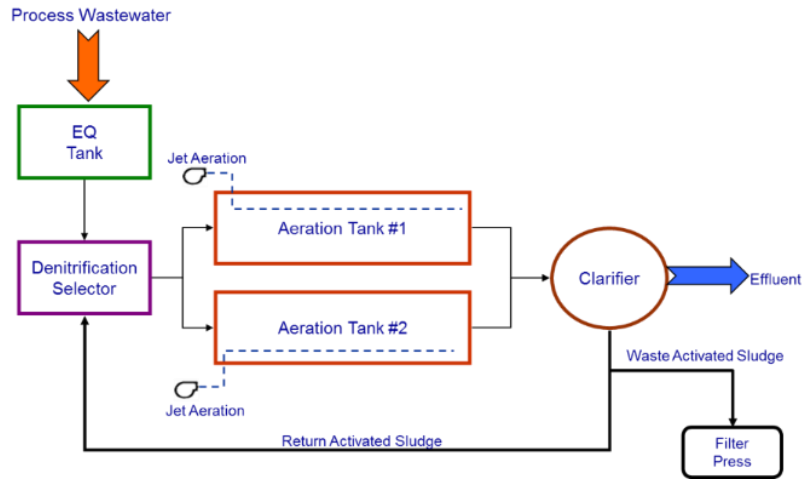


FIGURE 5b: PHOSPHORUS-SRP EFFLUENT



# The Evidence: Increased Capacity – Ability to Re-Rate



## BENEFITS OF TREATMENT:

- **Increased BOD Removal 8,061 lbs/Basin/d**
- **Increased BOD Removal Capacity 234%**
- **25% less biosolids produced**
- **No additional energy requirements**
- **Smaller footprint**

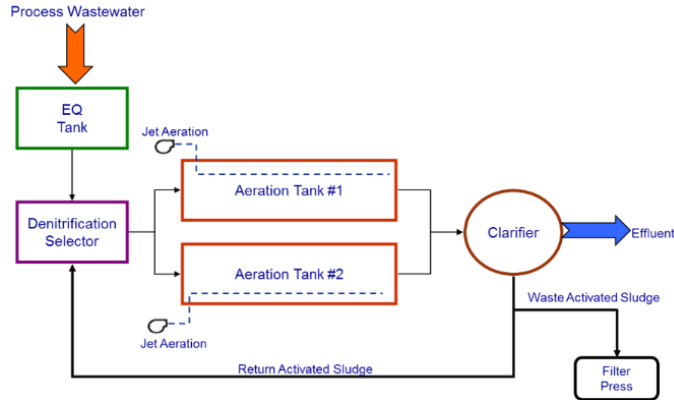
\* Data published in FWRJ 2016

PARAMETER	PRIOR UNTREATED	DURING TREATED
# of Basins	<b>2</b>	<b>1</b>
Flow (MGD)	3.70	3.67
Inf. BOD (lbs/d)	12,024	14,347
Inf. TSS (lbs/d)	13,686	17,011
Eff. BOD (lbs/d)	<b>47</b>	<b>63</b>
Eff. TSS (lbs/d)	<b>93</b>	<b>84</b>
BOD Removed (lbs/Basin/d)	<b>5,989</b>	<b>14,050</b>
Increased BOD Removed (lbs/basin/d)	<b>0</b>	<b>8061</b>
F:M (lb/lb/d)	0.21	0.24
MCRT (days)	14	85
MLSS (mg/L)	3,060	4,605
Biosolids Prod. (lb/lb)	<b>0.49</b>	<b>0.36</b>

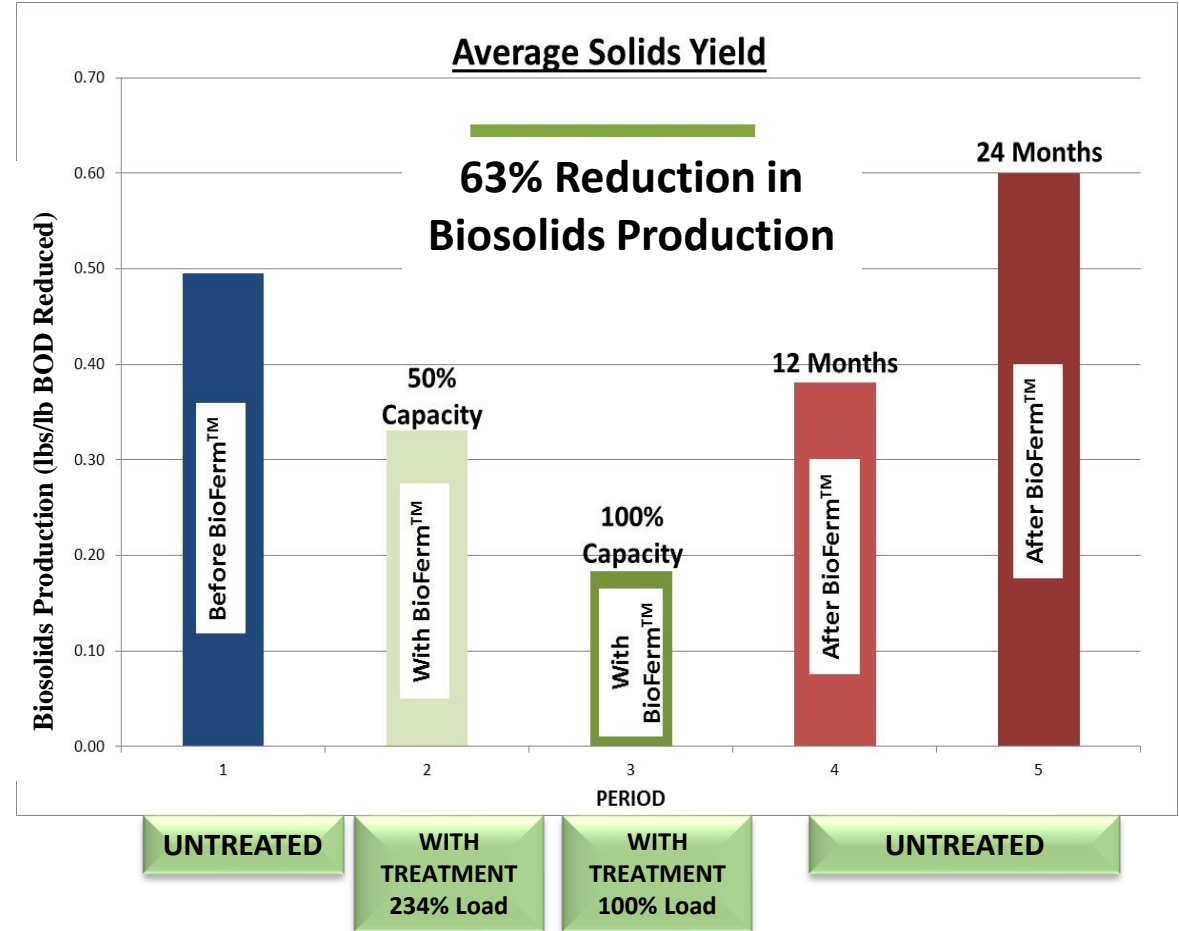


# The Evidence: Reduction in Biosolids Production

## Cause & Effect Study - 60+% Reduction in Biosolids



ABS has carried out multiple “Cause & Effect” studies over years.



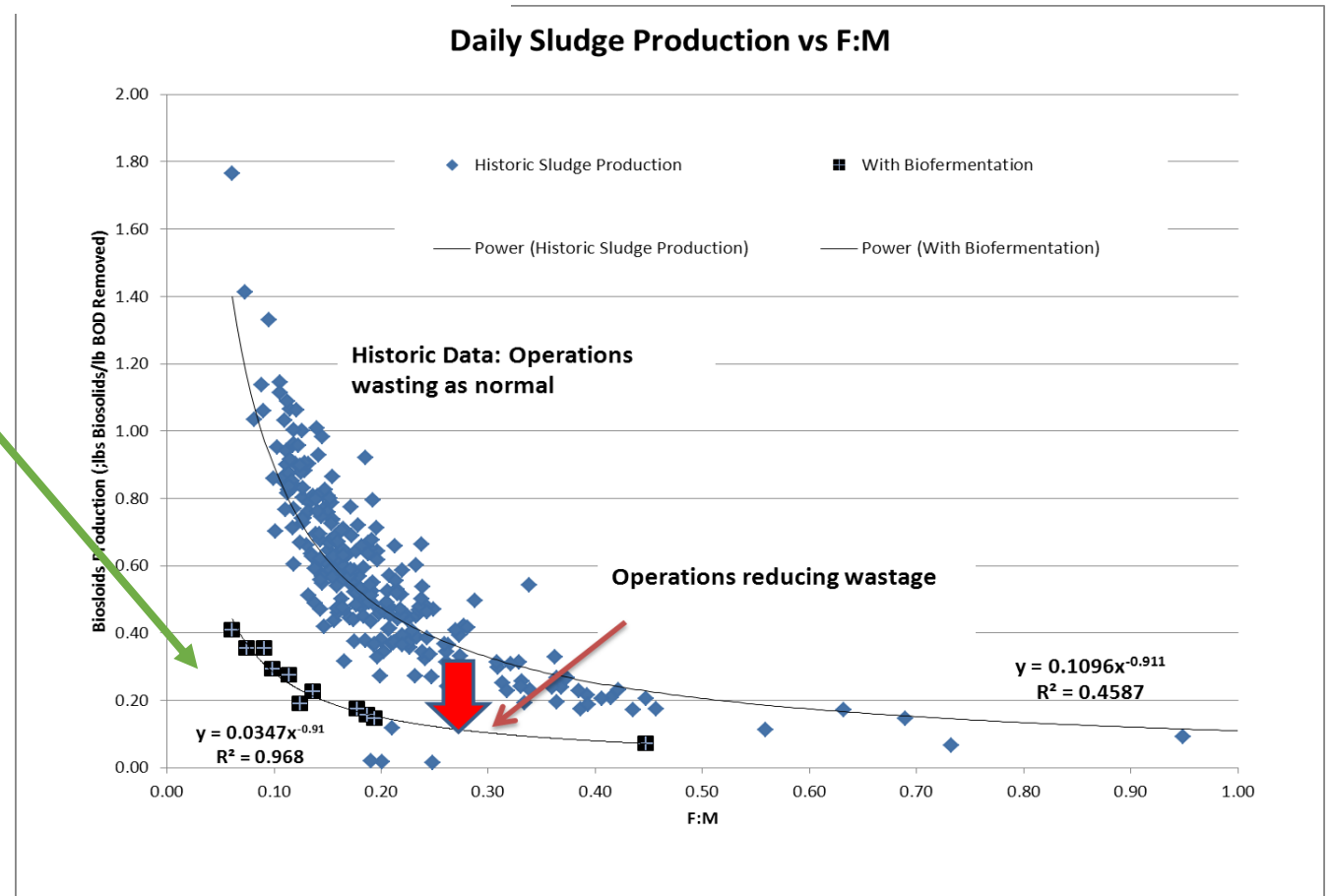
# The Evidence: Reduction in Biosolids Production – Cont.

Biosolids Reduction Irrespective of F:M

Improved  $R^2$  0.968 = Control of the Biology

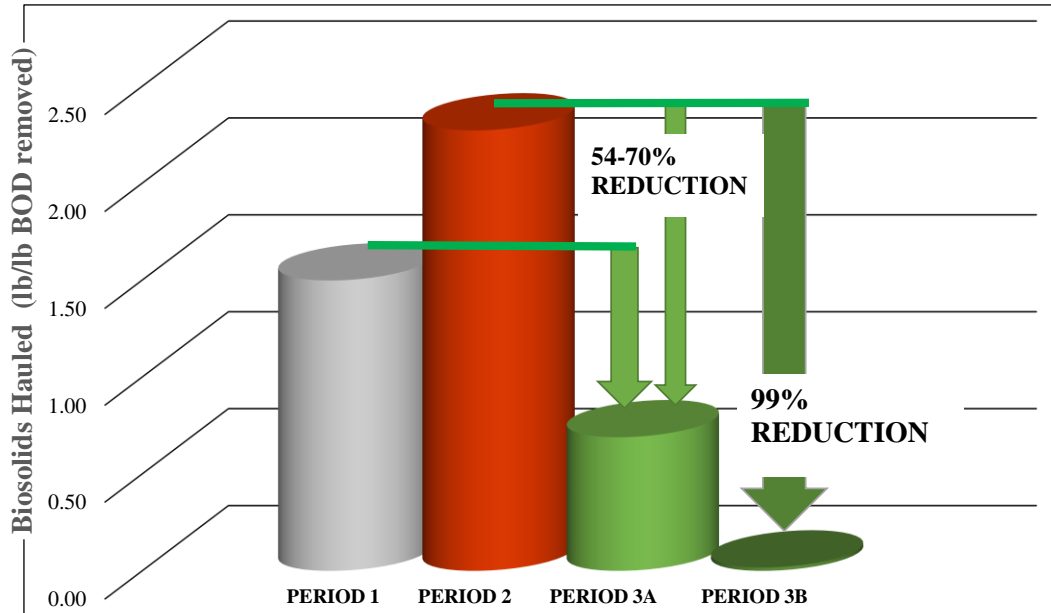
Biofermentation Always Improves  $R^2$

Part of 5 year study



# The Evidence: Advanced Digestion

Further Reduces Biosolids with Option to create Class A (City of Starke, FL)



- PERIOD 1: Liquid Hauling (Pre-2010)
- PERIOD 2: BCR 2010 to JUNE-2016 discontinued (Tons converted to gallons)
- PERIOD 3a: Biofermentation in Aeration JUNE-2016 (Inc. Emptying due to grit from sewer cleaning)
- PERIOD3b: Biofermentation APRIL-2017 to date

Since April 2017 no biosolids hauled

## Class A Biosolids

TEST #	Fecal	Salmonella	Enteric Viruses	Helminth Ova
	Per gram	Per 4 gram	Per 4 gram	Per 4 gram
1	123	<1.4	<0.5	<0.4
2	92.8	N/A	N/A	N/A
3	217	N/A	N/A	N/A
4	612	N/A	N/A	N/A
5	316	N/A	N/A	N/A
6	343	N/A	N/A	N/A
7	218	N/A	N/A	N/A
<b>Geometric Mean</b>	<b>232</b>	N/A	N/A	N/A

Class A = <1,000 cfu/g

- ✓ Starke-FL
- ✓ Crescent City-FL (14 months)
- ✓ DOC-Raiford-FL (12 months)
- ✓ Madison-FL (6 months)

NO ADDITIONAL EQUIPMENT OR ENERGY

# SUMMARY BENEFITS OF PROBIOTICS

**ONE TECHNOLOGY PROVIDES MULTIPLE BENEFITS WITH NO DOWNSIDE**

- **Improves plant performance, better settleability**
- Increases plant capacity (organic & hydraulic loading)
- No additional oxygen requirements
- Reduces biosolids production 60%+
- Advanced Digestion reduces biosolids 90%+
- Option to produce saleable Class A biosolids with Advanced Digestion
- Provides Operator more control
- Option to treat collection system
- **NO EQUIPMENT TO PURCHASE OR OPERATE**
- **REDUCES EXISTING OPERATING EXPENSES**
- **LOWERS ENERGY REQUIREMENTS**
- **SMALLER CARBON FOOTPRINT**

