



Probiotic[®] SOLUTIONS

Wastewater Treatment: Thinking Outside the BOX

By

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- Lagoons
 - 100s of years
 - Effective at containing waste and reducing BOD
 - Not as effective on nutrient removal
- Activated Sludge
 - Just over 100 yrs.
 - Effective BOD & nutrient removal
 - Some advances in technology

BACKGROUND: *Wastewater Treatment Options*

- Screens and Filters
- Primary Sedimentation
- Lagoons (facultative/aerated)
- Aerated Stabilization Basins
- Sequencing Batch Reactors
- Oxidation Ditches
- Extended Aeration
- Membrane Technologies
- Secondary Clarification
- Disinfection (Chlorine/UV)
- Presses and Belt Filters
- Digesters (Anaerobic/Aerobic)



BACKGROUND: *Wastewater Terminology*

Typical Standards of Wastewater Measurements	
BOD - biological oxygen demand	SV30 - sludge settleability
COD - chemical oxygen demand	Ammonia - NH ₃ -N
TSS - total suspended solids	Total Nitrogen
MLSS - mixed liquor suspended solids	Total Phosphorus

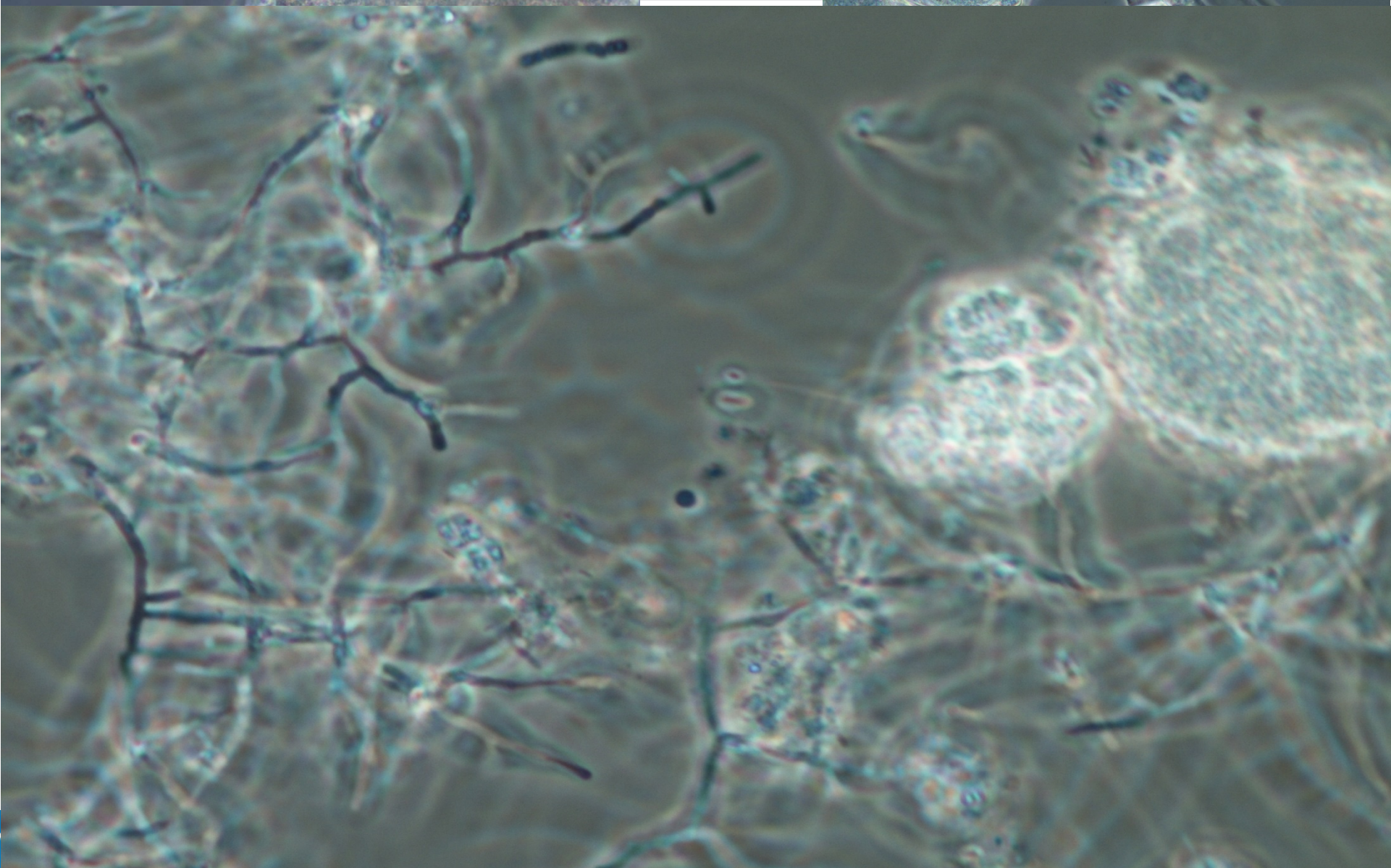
F/M - Food to Mass ratio.

Wastewater Treatment: Who Does The Work?

Do we focus our attention on the work horse of a wastewater treatment plant?

- Operators?
- Pumps?
- Blowers?
- Odor Control measures?

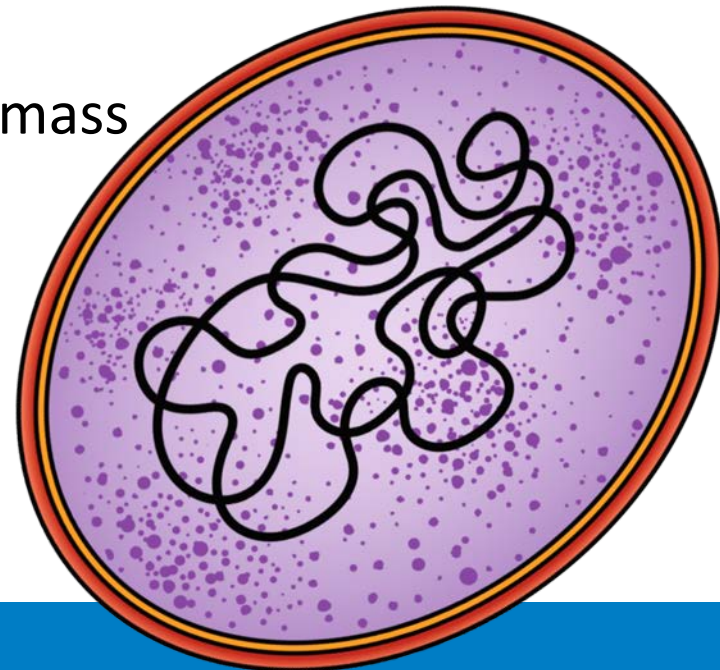
Microorganisms



Microbial Work Effort

- Microorganisms break down the organic load.
- Diverse microorganism community is efficient.
 - bacteria, protozoa
- Healthy biomass meets permit levels.
- System stability depends on a healthy biomass

Simple Bacterial Cell



Microbial Nutrition Needs:

Principal Nutrients

- ▶ **Carbon**
- ▶ **Nitrogen**
- ▶ **Phosphorus**
- Sulfur
- Potassium
- Magnesium
- Calcium
- Iron
- Sodium
- Chlorine

Micronutrients

- Zinc
- Manganese
- Molybdenum
- Selenium
- Cobalt
- Copper
- Nickel
- Valadium
- Tungsten

Addtl. growth factors: amino acids, purines and pyrimidines, vitamins

Microbial Needs

Major elements, their sources and functions in bacterial cells.

Element	% of dry Weight	Source	Function
Carbon	50	organic compounds or CO ₂	Main constituent of cellular material
Oxygen	20	H ₂ O, organic compounds, CO ₂ , and O ₂	Constituent of cell material and cell water; O ₂ is electron acceptor in aerobic respiration
Nitrogen	14	NH ₃ , NO ₃ , organic compounds, N ₂	Constituent of amino acids, nucleic acids nucleotides, and coenzymes
Hydrogen	8	H ₂ O, organic compounds, H ₂	Main constituent of organic compounds and cell water
Phosphorus	3	inorganic phosphates (PO ₄)	Constituent of nucleic acids, nucleotides, phospholipids, LPS, teichoic acids
Sulfur	1	SO ₄ , H ₂ S, S ₀ , organic sulfur compounds	Constituent of cysteine, methionine, glutathione, several coenzymes
Potassium	1	Potassium salts	Main cellular inorganic cation and cofactor for certain enzymes
Magnesium	0.5	Magnesium salts	Inorganic cellular cation, cofactor for certain enzymatic reactions
Calcium	0.5	Calcium salts	Inorganic cellular cation, cofactor for certain enzymes and a component of endospores
Iron	0.2	Iron salts	Component of cytochromes and certain nonheme iron-proteins and a cofactor for some enzymatic reactions

Microbial Needs

- Nutrient availability allows for system stability which leads to higher microbial life forms
 - amoebas, free and stalked ciliates, rotifers
- Lack of higher life forms is an indicator of toxicity and/or lack of nutrients and can lead to filamentous bacteria, sludge build up and potentially system upset.
- Instability in F/M ratio due to variable BOD loading creates more operational issues



Lack of Nutritional Balance



Lack of Nutritional Balance



Lack of Nutritional Balance



Lack of Nutritional Balance



If we can **REMOVE**
a limiting nutrient,
we can **IMPROVE** the
PROCESS!

Problem:

*WE NEED A MORE EFFICIENT
NUTRIENT CARRIER!*

- Must work with all types of nutrients
- Must limit precipitation
- Must limit undesired bonding/tying up with ions



Selection Process

CARBON is a MACRONUTRIENT

- Stable
- Low cost
- Abundant

RAW MATERIAL

- Soft humic material
- Rich in carbon
- Never compressed/heated
- More oxygenated



MCT Technology is Key to Success

Nano-sized particles that are sub-fractions of longer carbon chains

- Greater specific surface area
- Low molecular weight
- Higher cation exchange capacity
- More chemically active
- Additional sites available from functional groups



DEVELOPED VIA PROPRIETARY PROCESS

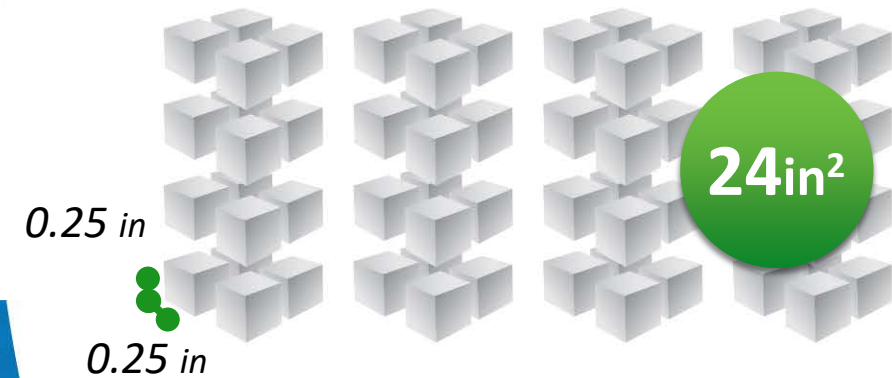
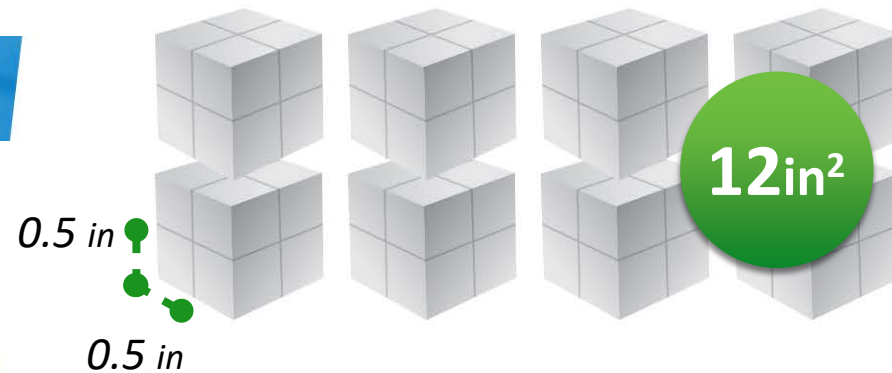
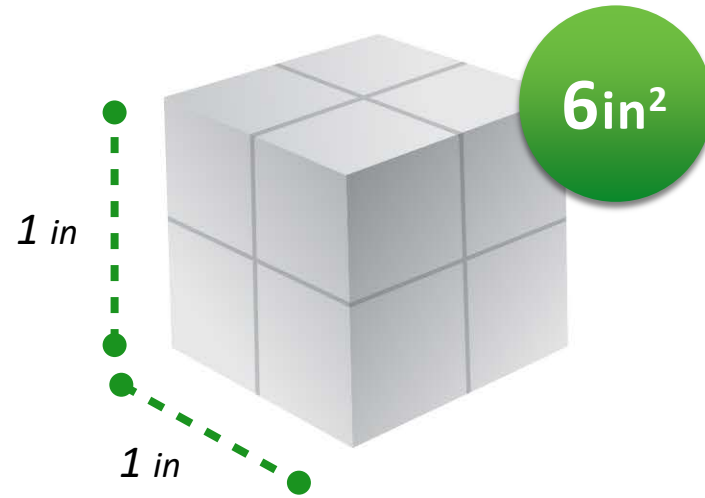
INCREASED SURFACE AREA

OF THE COMPLEXED NUTRIENTS IMPROVES:

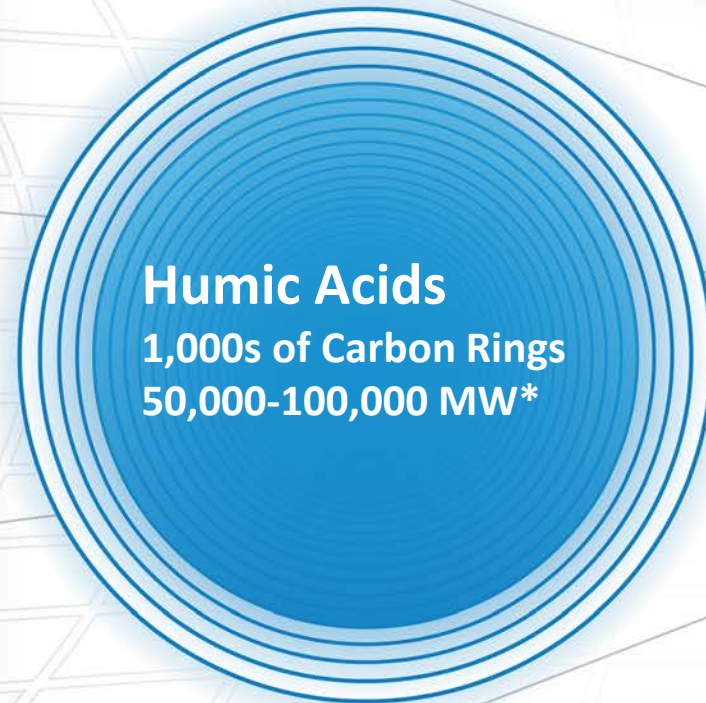
1 *The bioactivity of the limiting nutrients*

2 *The efficiency of nutrient uptake of the existing microbes*

3 *Biodegradation capacity of the microbes*



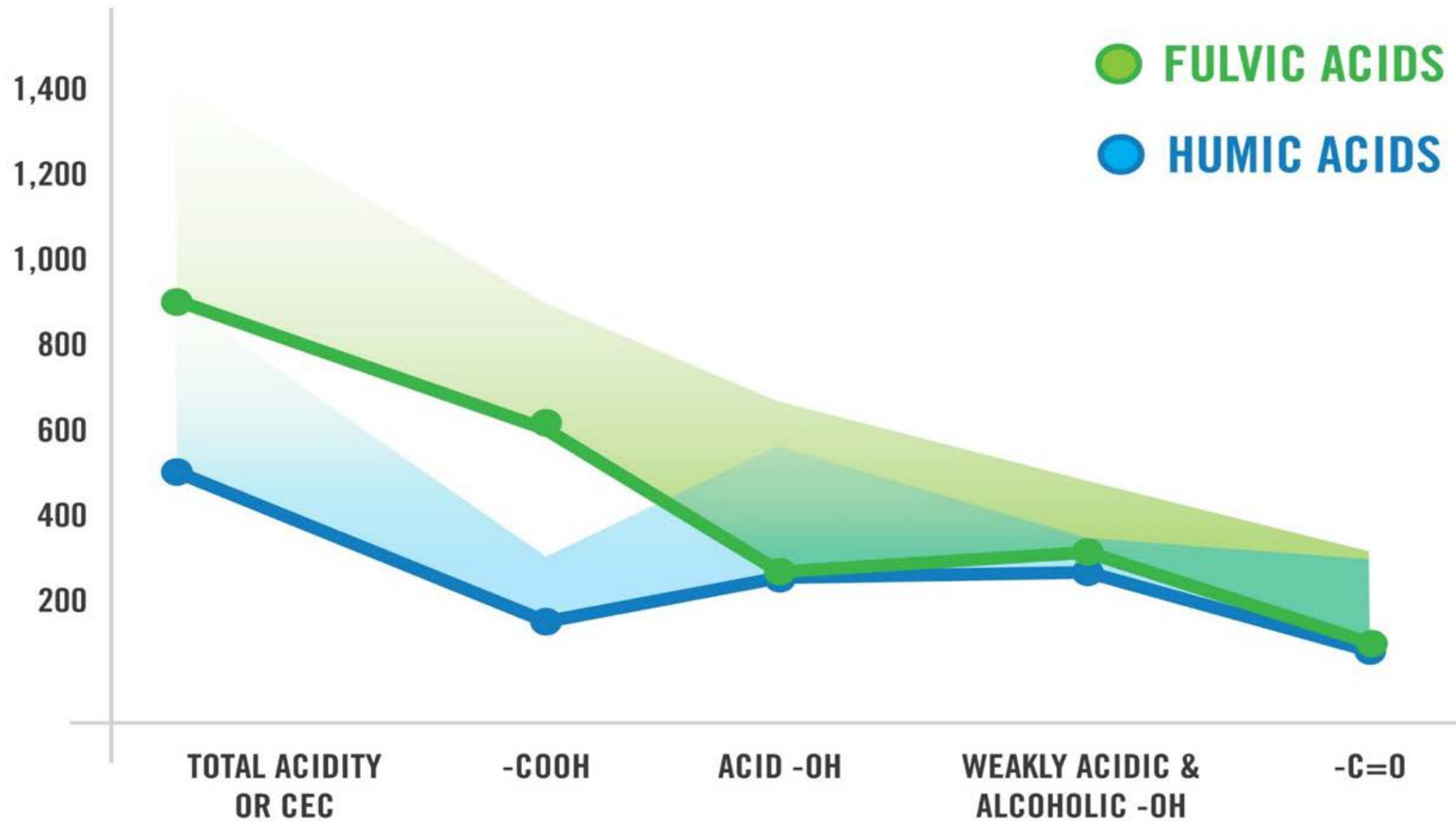
Carbon Molecular Size Makes the Difference



Our Technology
< 10 Carbon Rings
< 500 Daltons

A small black circular diagram with a white center, representing the size of the technology. It is the smallest of the three diagrams.

More Chemically Active



Functional groups of Humic and Fulvic Acids that contain Oxygen⁶

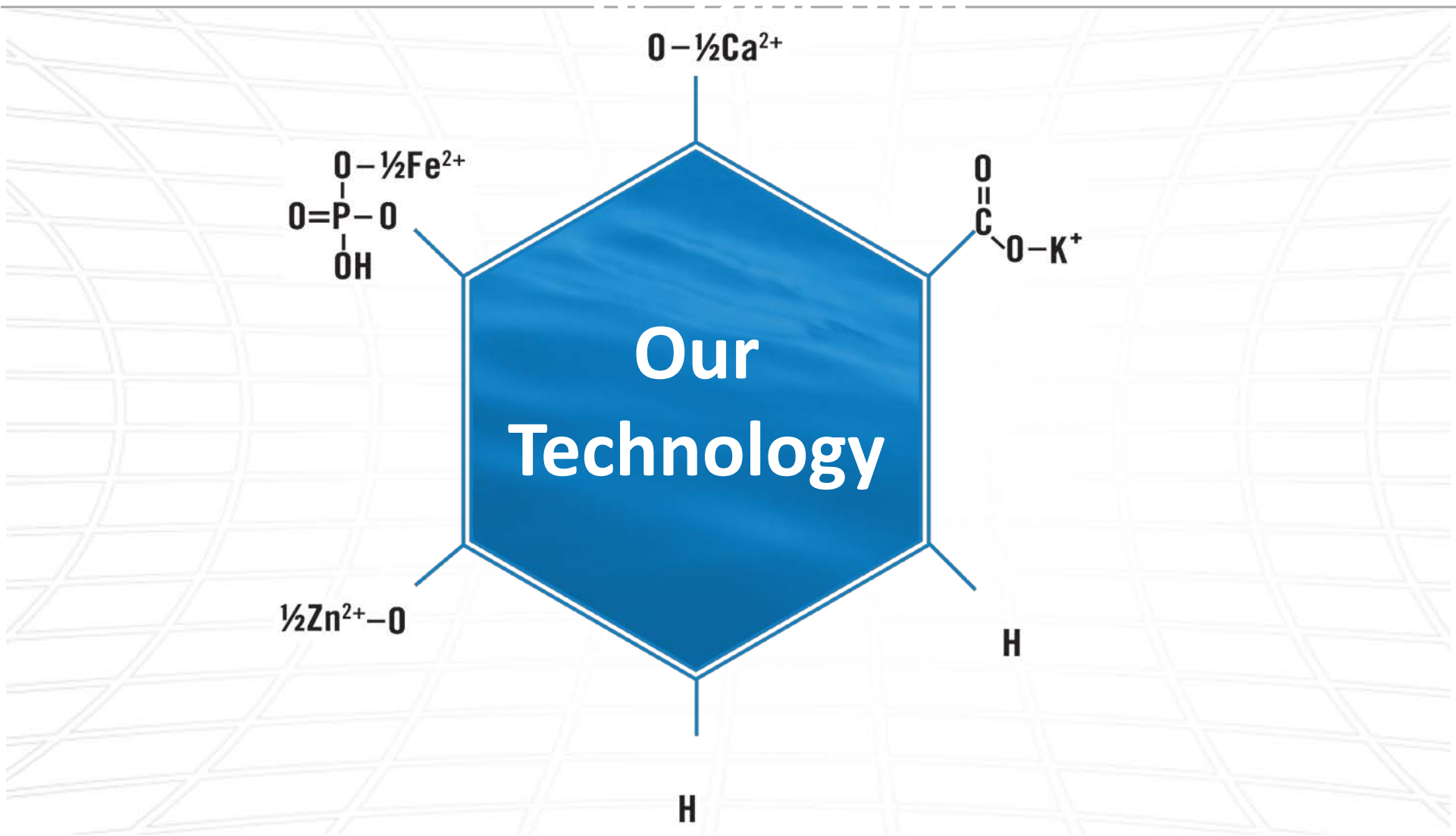
Proven Technology to Deliver Microbial Stimulants and Buffers



**MICRO CARBON
TECHNOLOGY®**

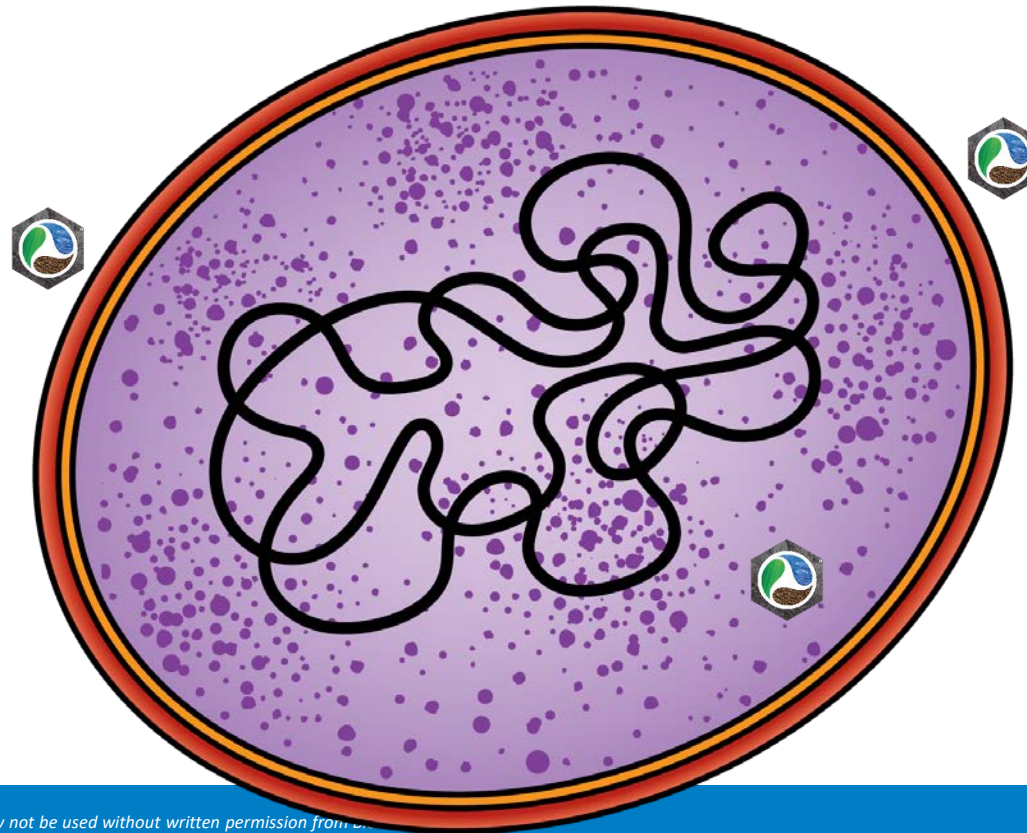
Delivering Nature's Science™

Complexing Diagram



Microbial Support

- MCT increases bioavailability of macro- and micronutrients.
- Stimulates a broader mix of microbial life forms.
- Increases system stability.



Bio Energizer[®] and Bio Genesis[®]

TRUE BIOSTIMULANTS

Complex Formulation of:

- ▶ *Nutrients*
- ▶ *Stimulants*
- ▶ *Vitamins*
- ▶ *Growth Factors*
- ▶ *Enzymes*
- ▶ *Bio Catalysts*

Optimizes Microbial Growth for Improved:

- ▶ *Settleability*
- ▶ *Foam reduction*
- ▶ *Filamentous bacteria control*
- ▶ *Solids digestion*
- ▶ *Odor Control*
- ▶ *BOD/COD reduction*
- ▶ *FOG elimination*
- ▶ *Pathogen control*



Activated Sludge Plant- Bio Genesis®

Arizona – WWTP intended to do the following:

- Reduce sludge wasting
- Reduce Foaming
- Improve SVI

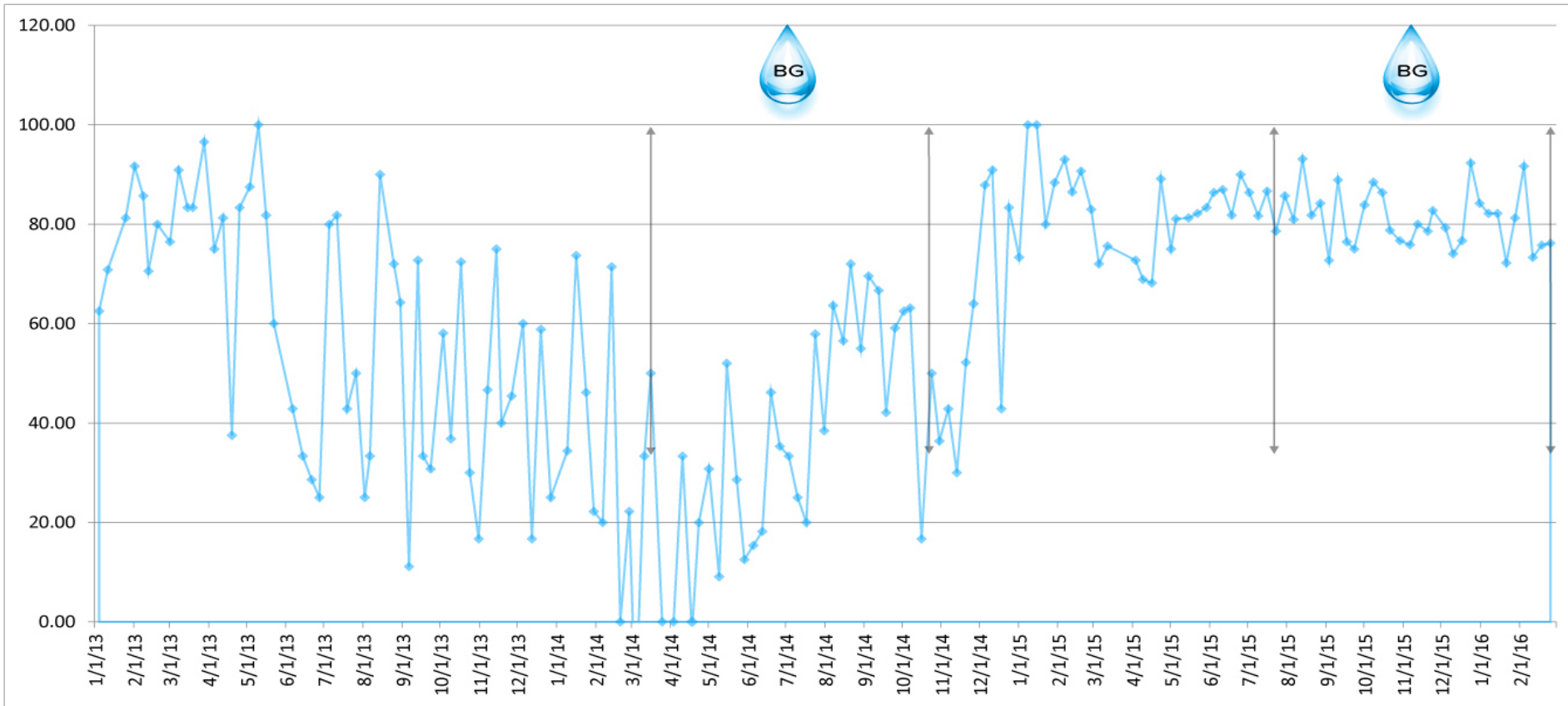
Facility Flow – 8 MGD (30,300 m³)

Current Results:

- **Eliminated foam**
- **Lowered disinfection chemical usage**
- **Improved SVI**
- **Improved Food to Mass Ratio**
- **Concentrated treatment (3 units)**
- **Lowered BOD and Nitrogen Discharge**



Effluent Nitrates/Nitrates % Removal



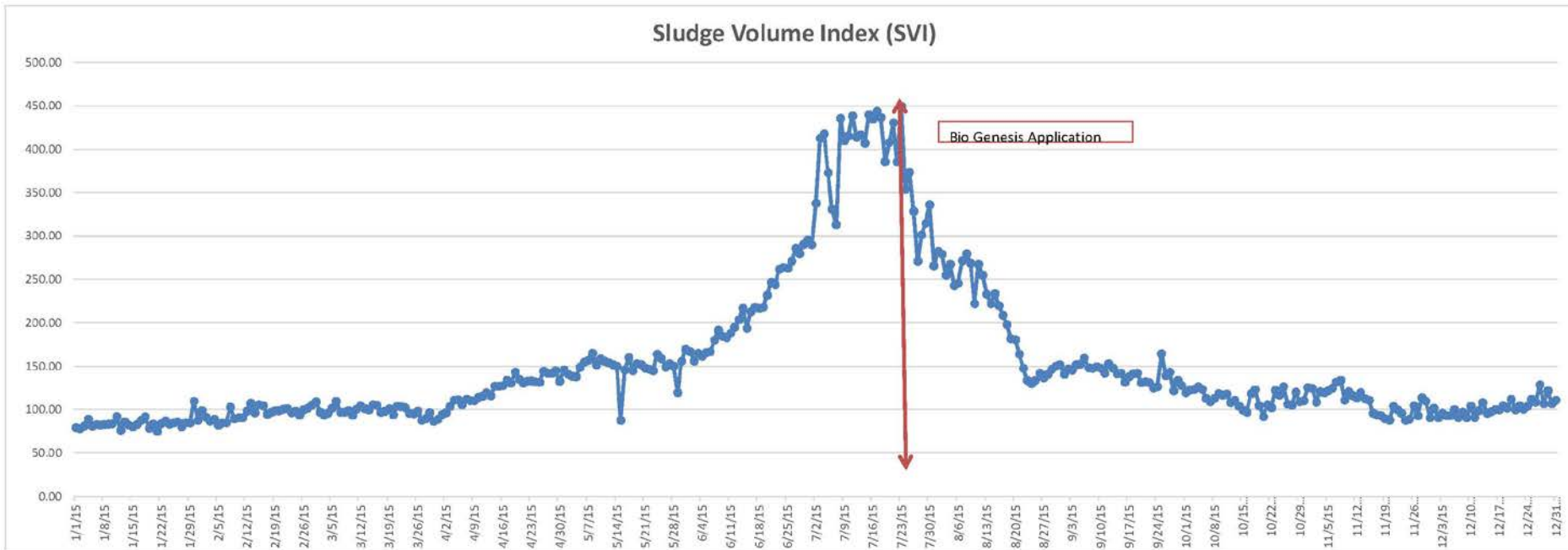
WAS Reduction

Totaled Influent and WAS for Three Years

- Percent WAS represents what portion of the Influent became WAS
- 2015 Total Influent when compared to 2014 saw a rise of 12.0%, WAS increased only 2.3%

	Total Influent MGY	Total WAS MGY	%WAS
2013	3,132	168	5.37
2014	3,076	166	5.40
2015	3,446	170	4.93

SVI Improvement



Activated Sludge - Bio Genesis[®]

IDAHO– WWTP intended to do the following:

Reduce wasting

Reduce scum

Reduce FOG

Facility Flow – 35,000 gpd

Current Results:

Eliminated foam and scum

Reduced Polymer usage

Reduced Coagulant usage

Eliminated Freezing issues



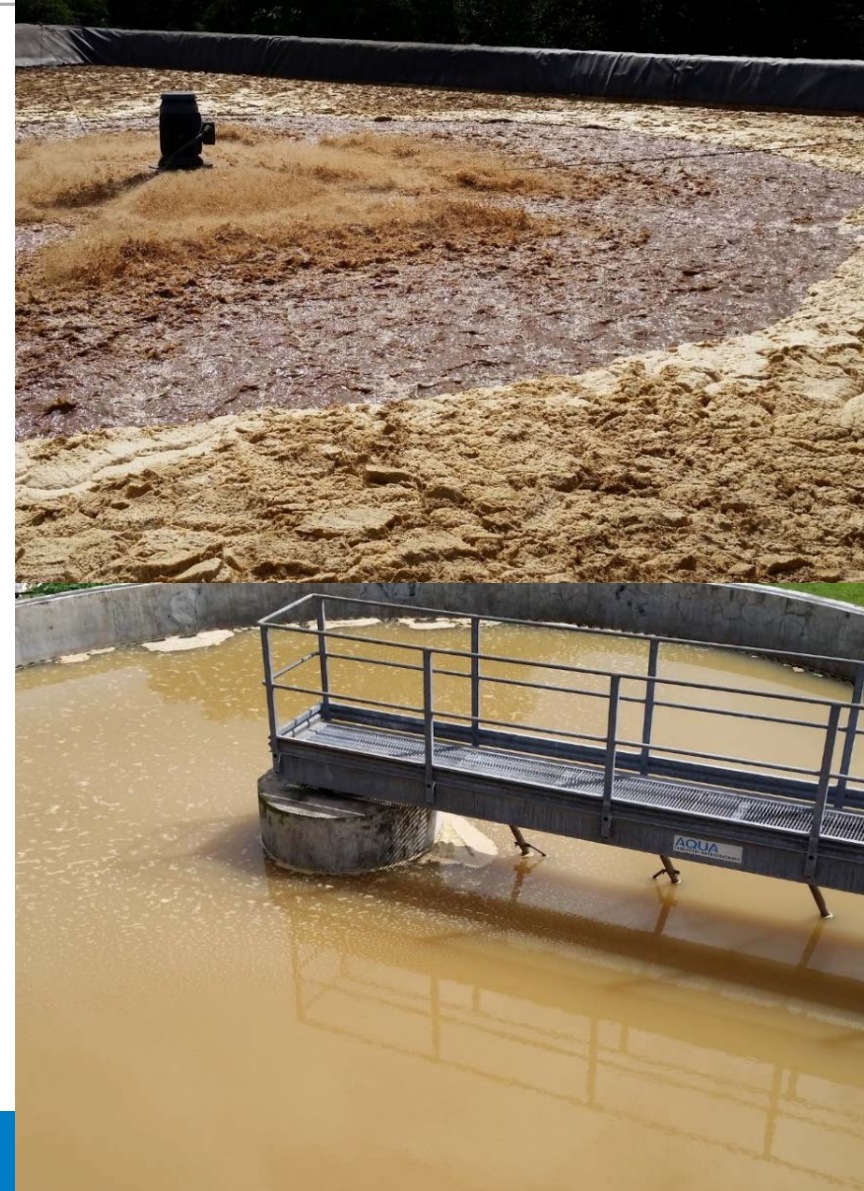
Panama

Within 2 weeks of application these are the following results (during high loading):

- **Elimination of offensive odors**
- **Microbial activity greatly increased**
- **95% foam reduction in clarifier**
- **35% foam reduction in aerated stabilization basin (ASB)**
- **Improved BOD reduction**

Current Status:

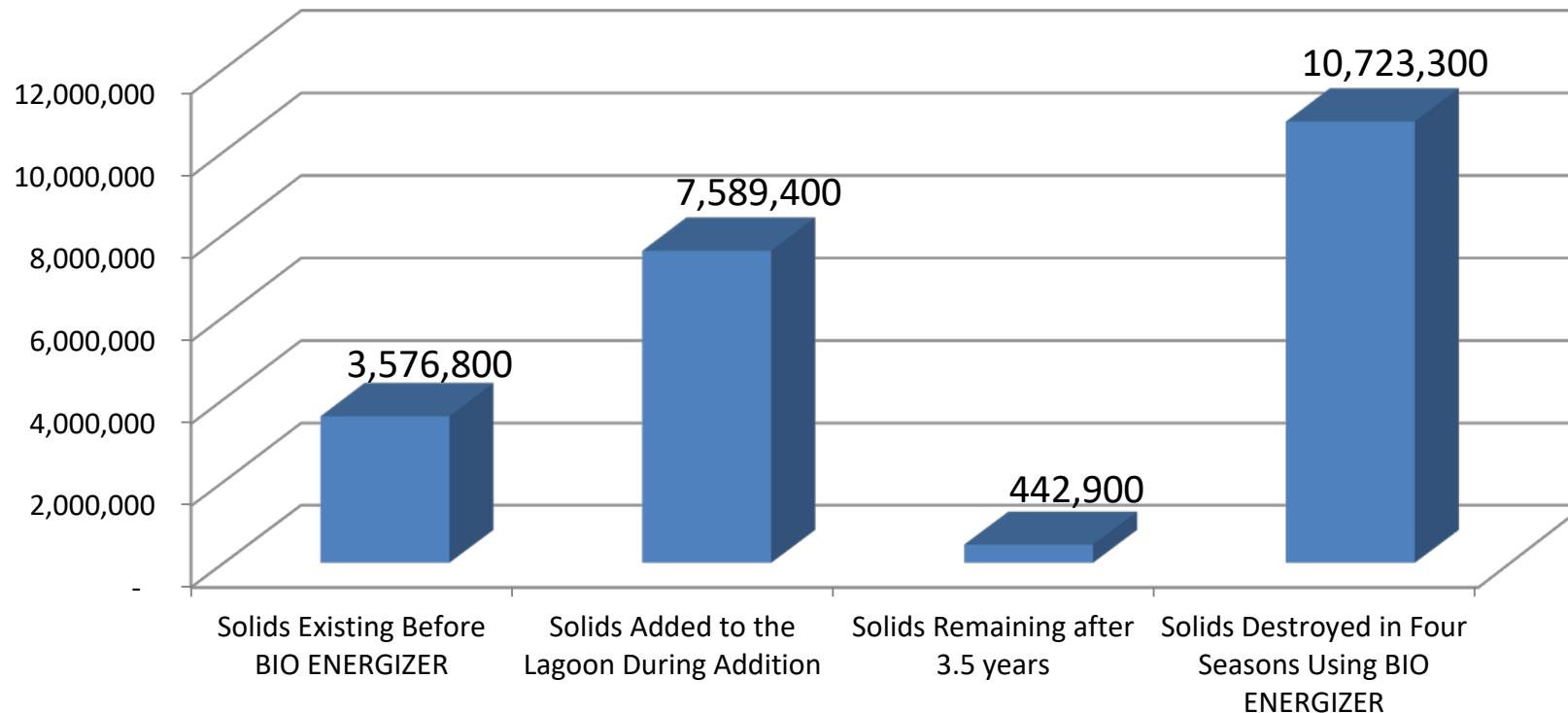
- **Foam in ASB reduced 95%**
- **Microbiology is very active**



Vegetable Processing Lagoon - Bio Energizer®

Illinois- Four Seasons

- 9 Million cases of peas, corn, carrots and lima beans per season
- Average 130 packing days
- 750,000 gpd of wastewater, Average BOD 6,500 mg/L
- 10 Million pounds of vegetable sludge removed



California-Municipal wastewater that receives dairy/cheese processing wastewater.

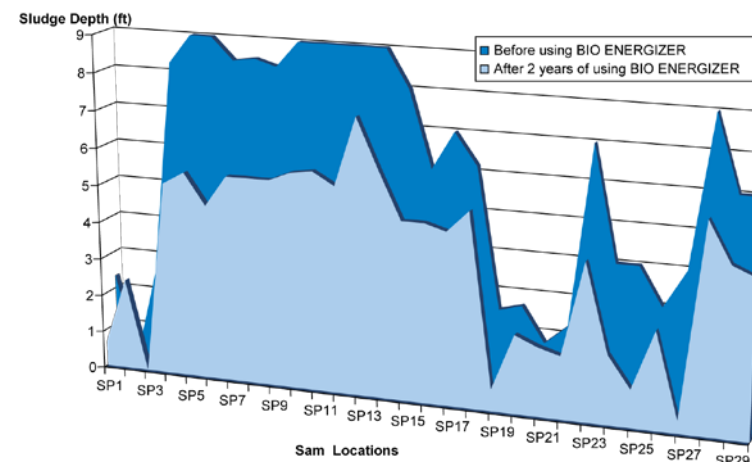
- Surface sludge average depth 6 ft. (1.8 m).
- Lost Capacity
- Dredging cost
 - \$341 per dry ton
 - Estimated 3,502 dry tons
 - Removal cost = \$1,194,000

BIO ENERGIZER® for 2 years

- **Removed 1,268 dry tons, as well as treated incoming solids**
- **Average depth of 3.82 ft. (1.2 m)**



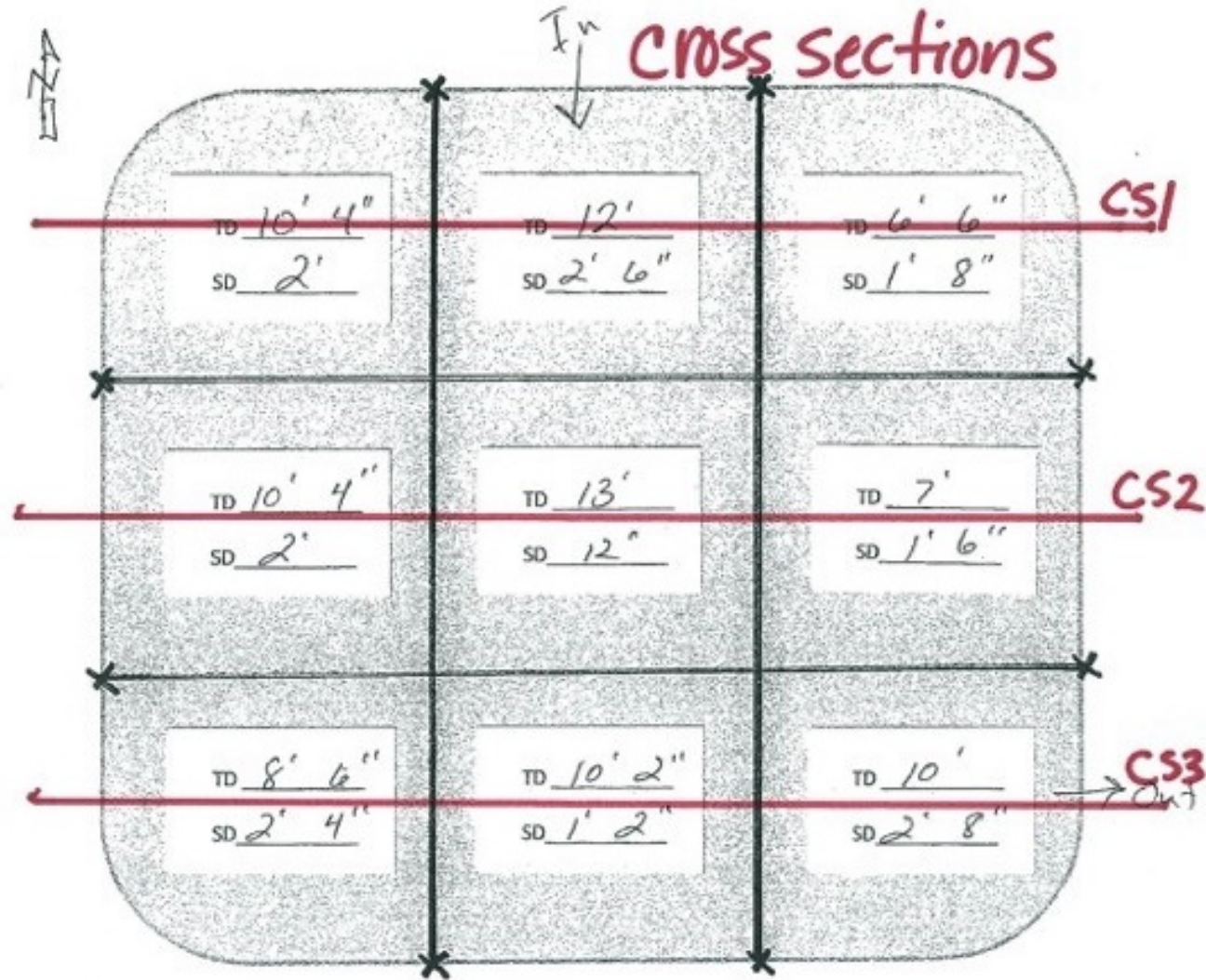
Pond #2 Sludge Blanket Profile
Over a 2 Year Period Using BIO ENERGIZER®



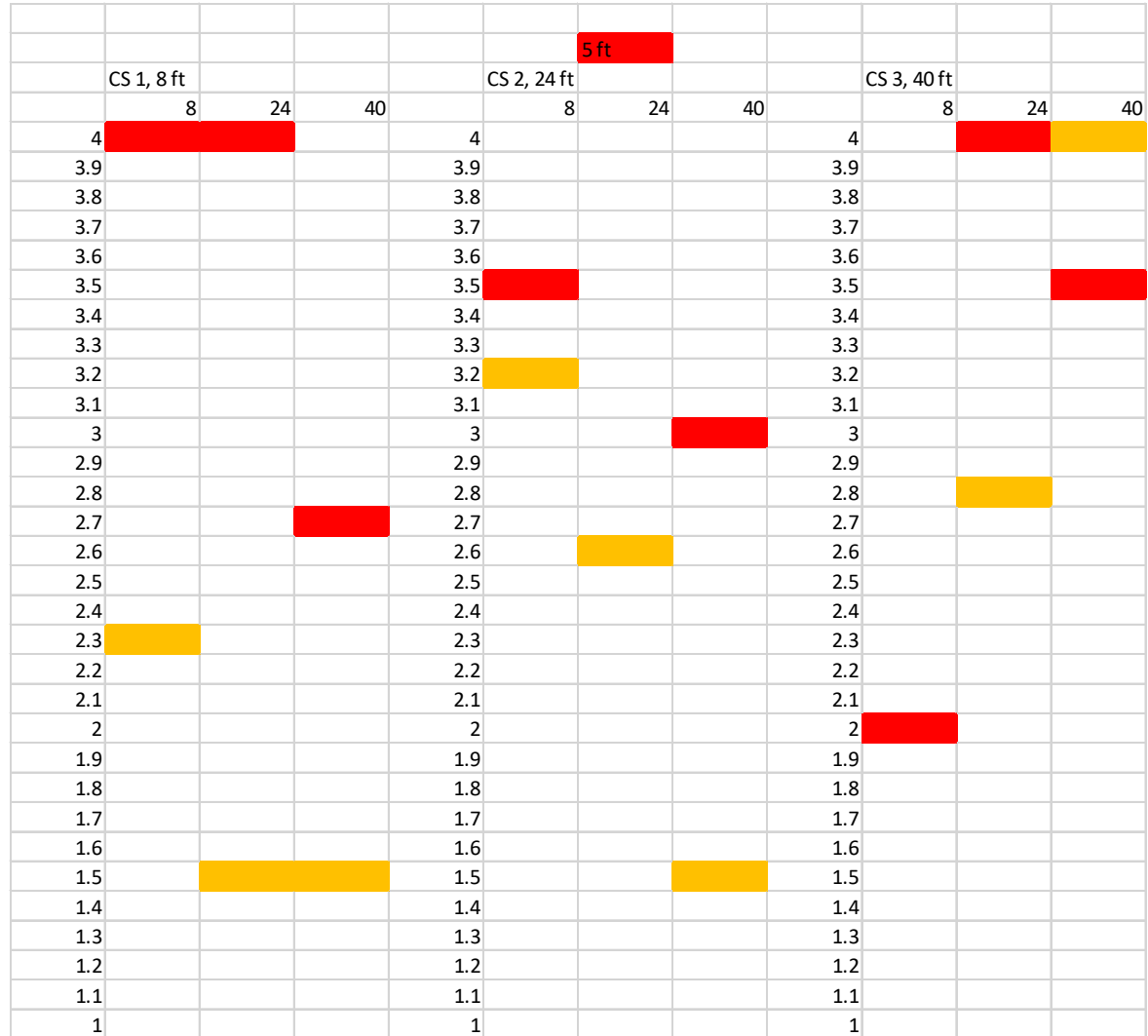
- Municipal Lagoon
 - Sloping bottom from 10-13'
 - Basic Aeration
 - Pond 2 is the focus as it had the most sludge



Municipal Lagoon - Bio Energizer[®]



- Measuring sludge from the bottom of the lagoon
- 90 day test, Baseline (Red) 1/6/16, Finished (Orange) 5/27/16



Municipal Lagoon - Bio Energizer®

Utah – Bioremediation of lagoon sludge. 80% Full

- **Under State Mandate to remove Sludge**
- **Variable sludge profile from 2' to 6' sludge – Surfacing sludge!**

Current Status:

- **≈45% reduction of solids in 6 months**
- **Regaining treatment capacity**
- **Improved water clarity / quality**



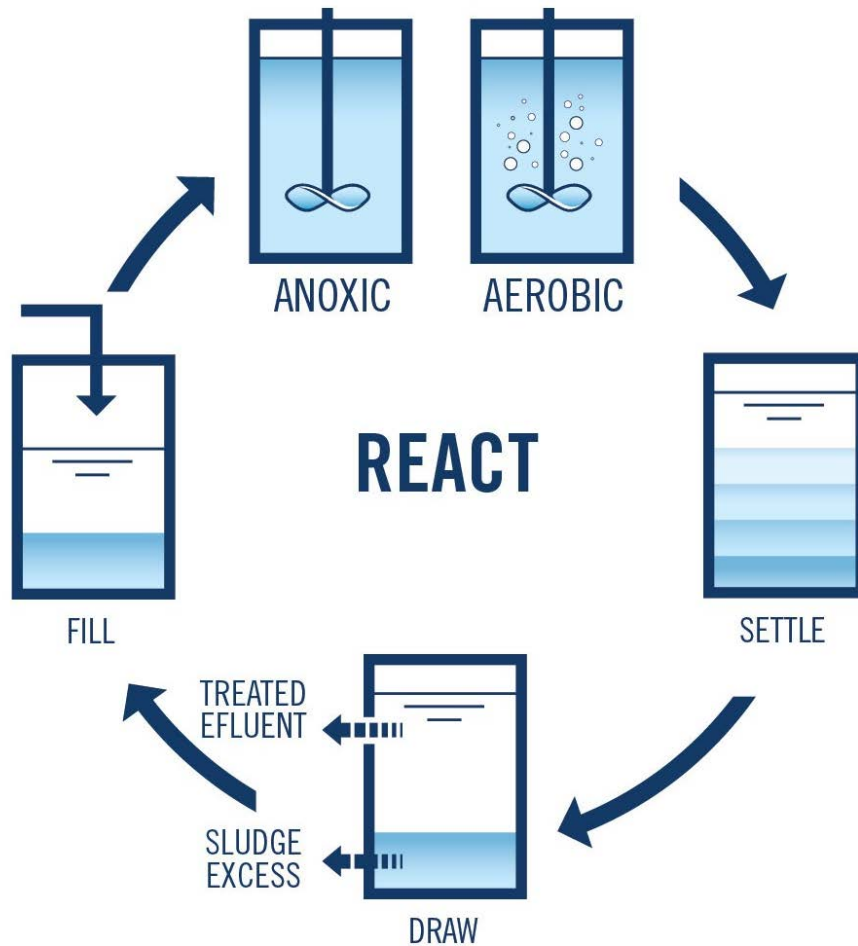
Abattoir Lagoon- Bio Energizer®

Australia – Bioremediation of lagoon sludge. 95% Full

- **Treatment Lagoon lost to sludge accumulation – offline in 2013**
- **Approximately 4.5 ft. (1.3 m) of sludge removed from extent of lagoon.**
- **Regained treatment capacity**
- **Improved irrigation water quality**



Pulp and Paper- Super Phos™



A preliminary pilot study was performed at Mill 2.

FACILITY TYPE:

- Aerobic sequencing batch reactor (SBR) wastewater system
- Treats 50,000 m³/day
- Uses one tank for the entire treatment process

Pulp and Paper- Super Phos™

- Over a period of seven days, Phosphorus Acid was incrementally replaced at a rate of 25% and optimized
- **Phosphorus Acid usage was reduced by 75%** while maintaining greater than 80% reduction of COD - final results below

Index	#3 SBR Tank	#4 SBR Tank
COD Removal Rate	84%	81%
Avg. MLSS	1941 mg/L	1949 mg/L
Avg. SV30	72	73

- Industries we service, activated sludge and lagoons
 - Municipal
 - Industrial/Pulp and Paper/Petrochemical
 - Food Processing
 - Aquaculture
 - Livestock Waste Management

- Bio Stimulants
 - Bio Energizer[®], Bio Genesis[®], Micatrol[®], Bio Genesis[®] II, Liquidator[®]
- Nutrients
 - Super Phos[™], Super Nitro[®], Max-Pak[®], Nutriplex[®]
- Carbon Source
 - Fulvi Pro[™], Huma Pro[™],
- Bio Augmentation (10 in all)
 - Ex. Microplex[™]-N, Microplex[™]-HS, Microplex[™]-FL

Product Applications

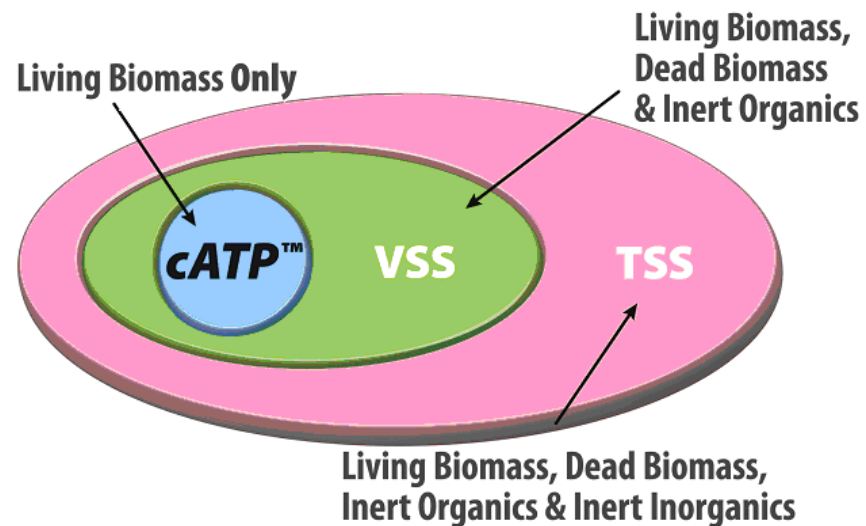
- Municipal
 - Lagoons: Bio Energizer[®]
 - Activated Sludge: Bio Genesis[®], Bio Genesis[®] II
Bio Energizer[®], Micatrol[®]
- Industrial
 - Activated Sludge: Bio Genesis[®], Bio Energizer[®],
Micatrol[®], Super Phos[®], Super Nitro[®]

- Biomass Evaluations

- Living Biomass – via cellular ATP

Adenosine Triphosphate

- Not just TSS or VSS but actual living biomass





Probiotic[®] SOLUTIONS

Thank You

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