BIOSCIENCE, INC.

Allentown, PA

www.bioscienceinc.com

Bioscience, Inc.

ISO 9001:2008 Registered Manufacturer

Bioscience, Inc.

- **Biotreatment Division**

  Microbial Products

- **Analytical Division**

  Respirometric Instruments (BOD)

  and COD Test Kits

Bioscience, Inc.

- In business for more than 30 years
- World-Wide Distribution Network in more than 35 countries
- Multitude of Domestic Distributors throughout the USA

MICROCAT
MICROBIAL PRODUCTS

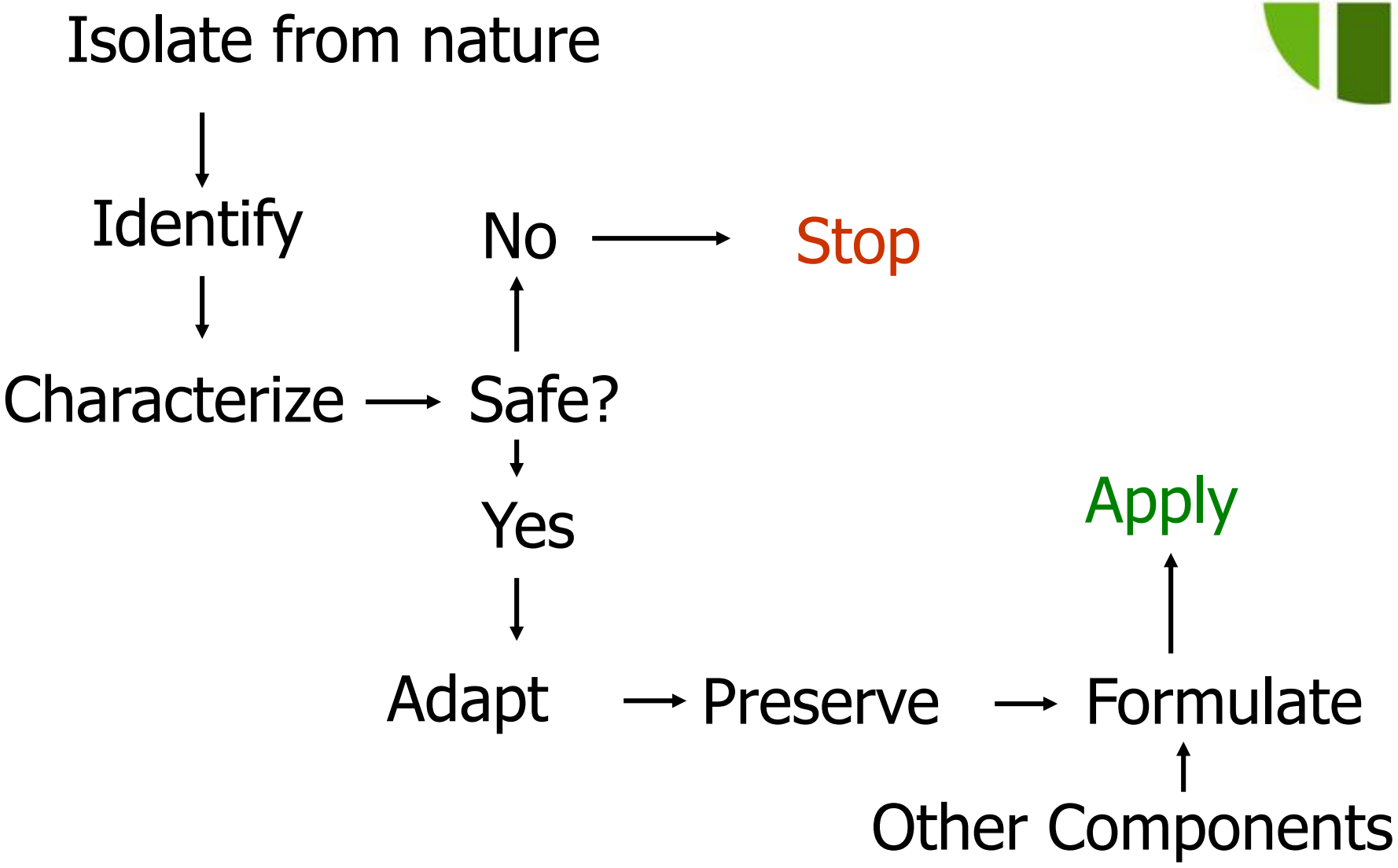
MICROCAT® Markets

- Aquaculture & Agriculture
- Municipal Wastewater Treatment
- Industrial Wastewater Treatment
- Sewer Lines and Lift Stations
- Grease Traps and Septic Systems
- Bioremediation & Spill Cleanup
- Odor Control

MICROCAT MICROBIAL PRODUCTS

- More than 50 off the shelf products
- Specialized products for specific applications
- Applicator systems
- Packaging Varieties
- Custom formulas for new applications
- “Green” or “Earth Friendly” Solutions

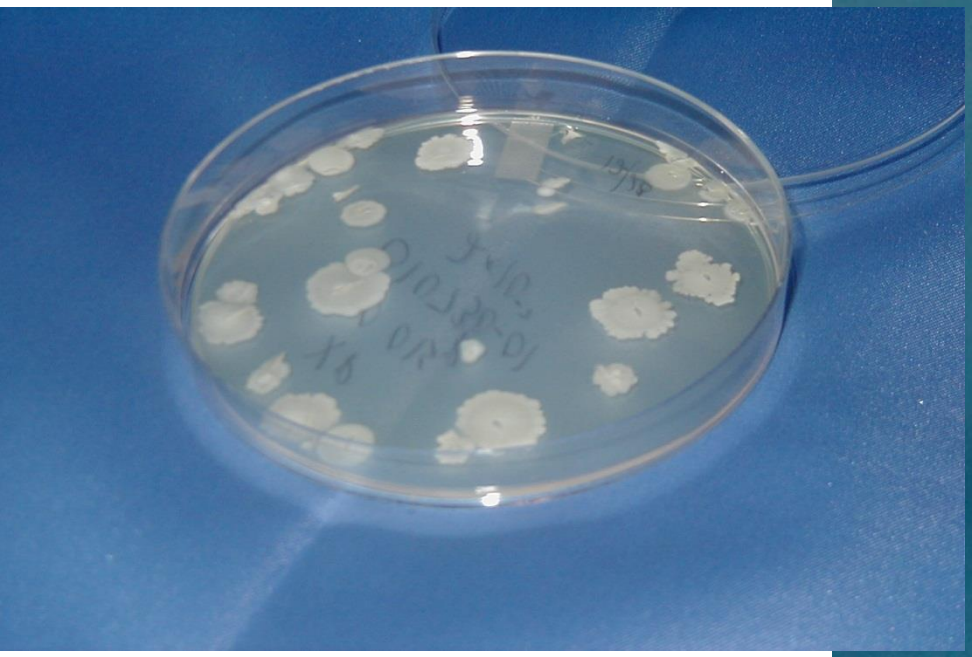
Where Do They Come From?



Product Forms

- Dry - granular powder, available in water soluble packets
- Liquid – water suspension
- Gel – refrigerated packets
- Bio-Pops – solid or semi solid “socks”
- Cartridges – Concentrated

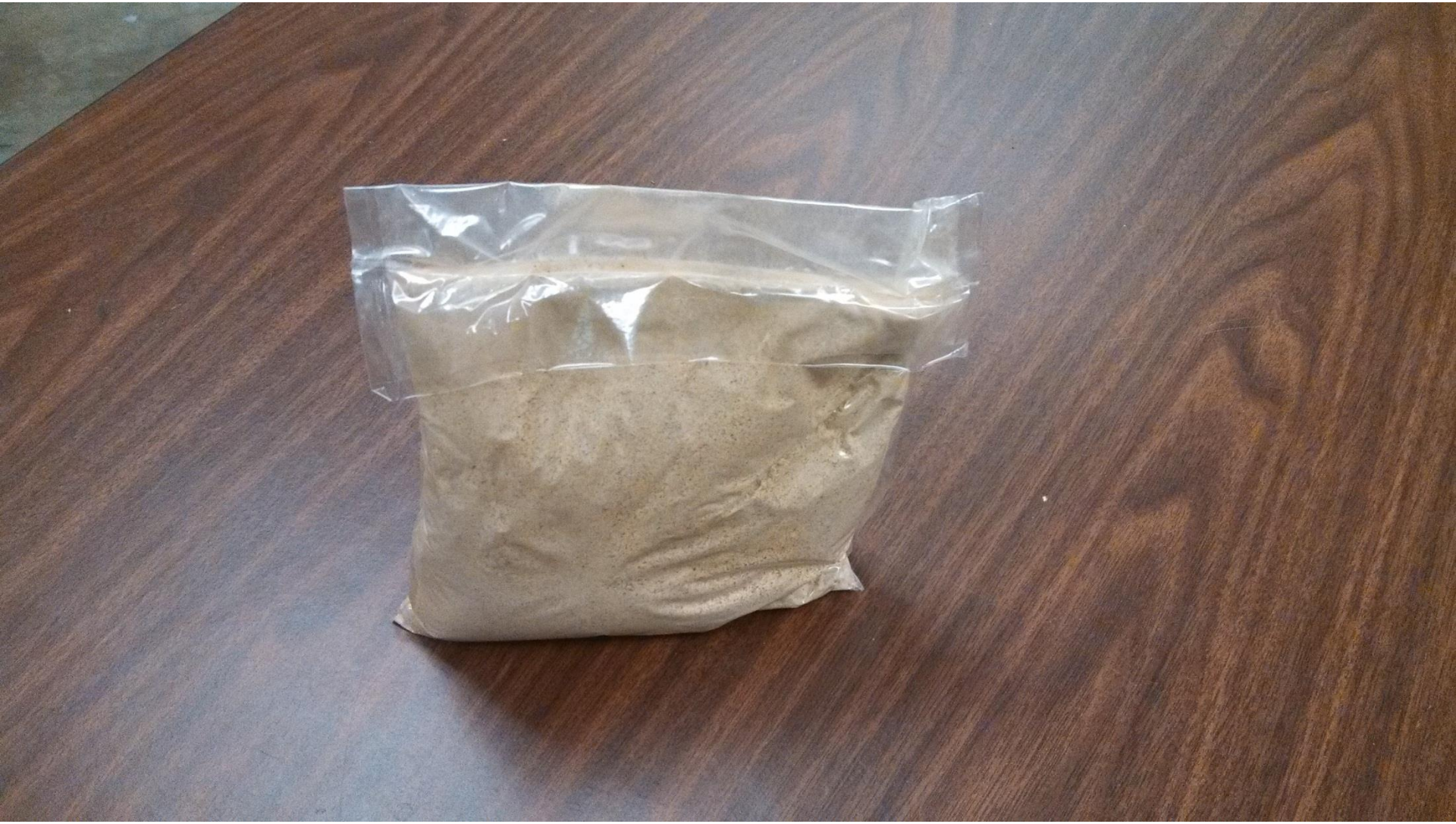

2.5 GAL./10L
MICROCAT®
Specialized Products
for Waste Treatment
type:
GEL
CONTENTS:
Preselected, adapted
microorganisms
Net Weight
2.5 Gal. (21 LBS)
Bioscience, Inc.
Environmental Products and Services




MICROCAT®
Specialized Products
for Waste Treatment
type:
HX
Net Weight
25 LBS (11.3 KG)
Bioscience, Inc.

Microcat BIOPOPS

Auto Release Cartridge System (ARCS)




EMERGENCY
2007 11 16

Aerobic Microbial Respiration

$$C_xH + O_2 \xrightarrow{*} CO_2\uparrow + H_2O + \text{protein}$$

* bacteria, N, P, pH, temperature

Requirements for Growth of Microbes

- Temperature
- pH
- Water activity
- Energy source
- Nutrients
  - Carbon
  - Nitrogen
  - Phosphorus
  - Minerals
  - Vitamins/growth factors

Operation Limits

- pH 6-9

<4: Most bacteria dead or inactive

<6: Bacteria activity drops, fungi may create settling problem

<6.5: Nitrification very poor

7.5: optimum for hydrocarbons, fog, nitrification, sulfide

>9: Bacteria activity drops

- Nutrients

BOD:N:P = 100:5:1

Effluent ammonium-N <2 mg/L may limit BOD removal or slow response to slug loading

Effluent ammonium-N <0.5 mg/L probably deficient unless nitrifying (nitrate provides N)

Effluent ortho-phosphate <1 mg/L may limit BOD removal or slow response to slug loading

Effluent ortho-phosphate <0.2 mg/L probably deficient

Operation Limits

- Temperature

<5°C Few bacteria are active

<15°C Nitrification and most bacteria growth very slow

20-35°C Optimum for most bacteria

39-45°C Bacteria activity drops, death rate increases

>45°C Only adapted or thermophilic processes occur

- Biomass

MLSS normally 1500-6000 mg/L

<1500 poor settling, dispersed

>6000 oxygen limited?; may overflow clarifier weir

MLSS/MLVSS 80-90%

<80% low viable percentage, possible accumulation of inert

<70% may occur in aerobically digested sludge

>90% light (poor settling) floc

Operation Limits

- Sludge Age/MCRT

<3 days Poor settling/COD removal/high sludge production

<8 days May have poor nitrification

>20 days May have filament problems or pin floc; good for exotic chemical degradation and sludge digestion

- SOUR

Complete mix system 3-15 mg O2/g MLSS per hour

<3 Inhibition or severe underload

>15 Slug load/ possible overloading

Staged aeration –1st Stage

30-100 mg O2/g MLSS per hour

<20 Inhibition

<30 Insoluble waste `

>100 Overloading

Operation Limits

- Dissolved Oxygen

2-7 mg/L normal range

<0.5 Anaerobic

<1 General BOD removal slows

<2 Nitrification slows

>7 Slow growth (inhibition) or underloaded

>9 Bacteria dead or inactive

- Sludge Blanket

Normal range 3-7 ft below surface

<3 feet(1 meter) poor settling or compaction; biomass may washout with flow increase

>7 feet (2 meters) Rapid settling may leave dispersed solids in effluent


Bioscience, Inc.
Lab Services


Microscopic Exams

Common Wastewater Treatment Problems

- Poor Settling
- Effluent Violation (TSS or BOD)
- Filamentous Forms
- Poor Nitrification
- Toxicity
- Odors

Causes of Wastewater Treatment Problems

- pH swings (or alkalinity)
- Increased (decreased) BOD Load
- Temperature Changes
- Increased Flow (combined sewer)
- Toxicity
- FOG
- Lack of Nutrients

Typical Treatment Plant Upsets

Heavy Organic Load

↓

Increased Growth/Respiration

→ Reduced Dissolved Oxygen

→ More Sludge to Clarifier

Reduced Growth/Respiration

→ Inadequate Removal

→ Deflocculation of the Biomass

Poor Settling

↓

Worse Effluent

Elevated BOD/COD

High Effluent Suspended Solids

Proactive Wastewater Treatment Troubleshooting

- BOD (oxygen uptake testing)
- COD (for “load” variation)
- BOD vs. COD
- MLSS Concentration
- DO
- Microscopic exam

Bioscience, Inc. Recommendations for Improved Wastewater Treatment Operation

- Physical Process Changes-adjust sludge age, divert flow or load, etc.
- Operation Process Changes: Adjust ph, DO, Alkalinity, etc.
- Chemical additions: Polymer, Nutrients
- Bioaugmentation

BIOAUGMENTATION

Bioaugmentation Defined

The addition of any beneficial microbe (either singly or more commonly in groups) in a process or system to achieve desirable effects such as – lower maintenance, improve performance, reduce odors, reduce FOG, etc…….

How Does Bioaugmentation Work?

Numbers – By adding cultures regularly the minor cultures (but important cultures) gain a survival advantage (against the dominant cultures) and remain in the system.

Natural Genetic Interchange – Recent work indicates the possibility of transfer to the biomass of desirable and needed characteristics (but not permanently), particularly capabilities controlled by the plasmids in the cells and demanded by the conditions in the system.

Bioaugmentation Benefits for Wastewater

Benefits for Collections Systems:

- Reduce FOG and Odors
- Reduce Maintenance and Labor
- Reduce Sewer Overflow
- Enhance Odor Complaints
- Reduce BOD load to downstream WWTP
- Improve downstream WWTP performance

Bioaugmentation in Collection Systems

Microbial vs. Enzymatic

Microbes are enzyme factories providing a continuous supply of complete enzyme systems.

Unlike enzyme-only systems, bacterial systems produce different enzymes based on the specific predominant compound.

Enzymes liquefy a waste; they will *not* digest it. All an enzyme product accomplishes is to change the form of waste.

There are enzyme products without microbes; however, without microbes, there is no Bio-Technology process.

Bioaugmentation in Collection Systems

Microbial vs. Degreasers

Degreasers are soap-based or petroleum-based and just re-deposit FOG from one surface to another.

Degreasers smear FOG and leave an “oily film” on floors, walls and equipment.

Degreasers emulsify the FOG, and it re-solidifies downstream creating problems in lift stations and WWTP’s.

However, Bioscience, Inc. products chemically break down FOG and consume it transforming it into carbon dioxide and water.

Microbial FOG Removal

Degradation of FOG begins with the breakdown of the complex molecule by enzymes produced by the microbes

Biosurfactants produced by the microbes, facilitate the growth of microbes by reducing the interfacial tension and making the subtrate (FOG) more bioavailable

Bioenzymes and biosurfactants reduce the FOG to fatty acids and glycerol, which are consumed by the microbes

Microcat Products

Contain a bacterial consortium of soil microbes but may contain other ingredients to assist with the microbial breakdown

Primarily facultative anaerobes, using nitrate as the final electron acceptor, but Also, can use oxygen as the final electron acceptor under aerobic conditions, so they have a competitive advantage over other microbes

MICROCAT - Benefits

Concentrated, microbe-powered product which digests fat, oil and grease (“FOG”).

Digests FOG and food waste converting them into carbon dioxide and water.

Unlike degreasers, which only re-deposit FOG, MICROCAT digests it completely.

Pump Station in Germany

It measures 6.5 feet (2 m) in diameter and rapidly accumulates significant FOG deposits on the water surface, walls and pumps of the station (see pre-product-application photo at left). The 2 submerged pumps deliver about 1,320 gallons (5 m^3) of wastewater per day. The wastewater is strictly municipal and contains high levels of FOG.

- **Application Procedure**
- In the fall, a BioPOP - 2 is installed in the pumping station. It is simply lowered into the pumping station well using a rope and tied off at the desired depth. The BioPOP should always be covered with water. Because of its biological makeup, no chemicals enter the station, sewer network or downstream wastewater treatment plant.
-
- The wastewater treatment plant staff‘s primary goals for this program in order of priority were:
- to reduce the rapid FOG accumulation in the pumping station, and
- to avoid pump malfunctioning caused by FOG depositing on and in the pumps and clogging them.

Pump Station in Germany

- In early winter after 2 months in the station, the first visual inspection of the BioPOP's performance is performed. See photo taken after 2 months at right. The staff observed:
-
- FOG deposits on the walls of the lift station are considerably reduced and what does deposit is easy removed.
- Grease balls floating in the sewage are much smaller in size than previously observed, and
- These small, soft balls no longer interfere with pump operation.
-
- While not a specific objective of this BioPOP program, an additional benefit observed in this station is significantly reduced odor. This BioPOP-2 continued to perform effectively for about 3 months. Since all of the goals of the BioPOP installation program were met and odor reduction was deemed to be a very special additional benefit, the BioPOP program has been continued.

Before

After


Before MICROCAT®


fter MICROCAT®

Before

After

May 12, 2011

Jay,

We continue to use the bio-pops in our kitchen lift station with very good results. Since we have started using them we have yet to have the lift station pumped. And we have had no complaints about odor. Our usage of the bio-pops is somewhat less than we had anticipated, one is lasting close to 3 months. On the whole we are very pleased and plan to continue our usage.

Thanks,

Dave Cordier
Panorama City

Jay,
I just wanted to let you know that we are waiting on our large lift station for the next cleaning to install the next batch of BIOPOPS but in our smaller station we are having great success. Normally there is a thick layer of grease on the wall of the wet well and large chunks of grease floating. Currently there is no grease build up on the walls and all grease in the wet well are golf ball size. I just wanted to say thank you.
Thank you,
John M. Carrillo
John M. Carrillo, C.W.P.
City of Fruita, Public Works Dept.
Wastewater Collections
Office: 970-858-9558 Ext. 6503
Fax: 970-858-4952
Jcarrillo@fruita.org

Maintenance of Drains and Traps

Before

After

Grease Trap Before

After

Common Wastewater Odors

- Hydrogen Sulfide (H2S)
- Methane
- Volatile Organics (VOC's)
- Mercaptans
- Amines – Indoles & Skatoles

Hydrogen Sulfide (H2S)

- Hydrogen sulfide (H_2S) is the most common cause of odor complaints – probably the source for more complaints than all other malodorous compounds combined. In addition to the rotten egg odor, H_2S causes serious corrosion problems costing many millions of dollars each year, serious health and safety concerns, and can diminish the effectiveness of any wastewater facility due to toxicity to the biomass that is necessary for biological treatment

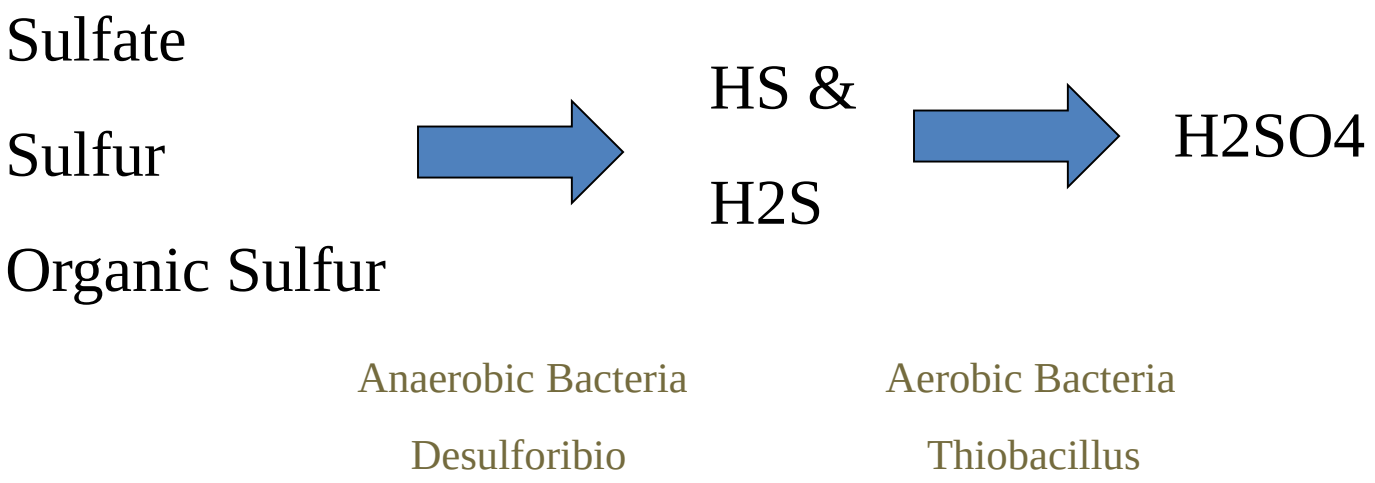
Hydrogen Sulfide

- Formed by reduction of sulfate to sulfide by sulfate-reducing bacteria under anaerobic conditions
- Corrosive
- Toxic

H2S

- **Production of Hydrogen Sulfide**
- The generation of hydrogen sulfide in wastewater results principally from the biochemical decomposition of the waste components. Bacteria remove electrons (oxidation) from the organic molecules, gaining energy. The electrons are then passed to an acceptor. This results in reduction of the acceptor. The electron acceptor can be an inorganic or organic substance. Under aerobic conditions, free molecular oxygen (O_2) is used by the microbes as the electron acceptor in a process that produces water.
- $C_6H_{12}O_6 + O_2$ $CO_2 + H_2O +$ biomass (aerobic heterotrophic bacteria)
- Under anaerobic conditions, various compounds or ions can be used by different groups of microbes as the electron acceptor. If neither oxygen nor nitrate (NO_3^-) is present, microbes that use sulfate (SO_4^{-2}) as an electron acceptor (sulfate reducing bacteria) predominate and these microbes generate sulfide.
- $C_6H_{12}O_6 + NO_3^- + H^+$ $CO_2 + H_2O + N_2 + N_2O +$biomass (denitrifying bacteria)
- $C_6H_{12}O_6 + SO_4^{-2} + H^+$ $CO_2 + H_2O + HS^- +$biomass (sulfate reducing bacteria)
- (Note: equations are illustrative and not meant to show stoichiometry; H^+ on the left side indicates acid is consumed in the reaction while H^+ on the right indicates acid generation.)
- Thus, as sulfate is normally present in wastewater, the sulfur cycle becomes a critical step in the breakdown of waste under anaerobic conditions. Sulfides are present in three forms: hydrogen sulfide (H_2S) at low pH, hydrosulfide ion (HS^-) at neutral pH and sulfide ion (S^{-2}) at high pH. The ionic forms stay dissolved in water while the neutral H_2S is easily volatilized. The oxidation of H_2S under highly aerobic conditions, e.g. in the biofilm above the waterline in sewers, generates corrosive sulfuric acid.
- $HS^- + O_2$ $SO_4^{-2} + H^+$

Sulfur Reduction



Note: Reduction of sulfur to sulfide occurs in the slime layer (FOG and bacterial) that adhere to pipe walls and lift stations in collection systems.

Odor Abatement Technologies

- Oxidants
- Reducing Agents
- Precipitation
- Absorption
- Scrubbers
- Biologicals

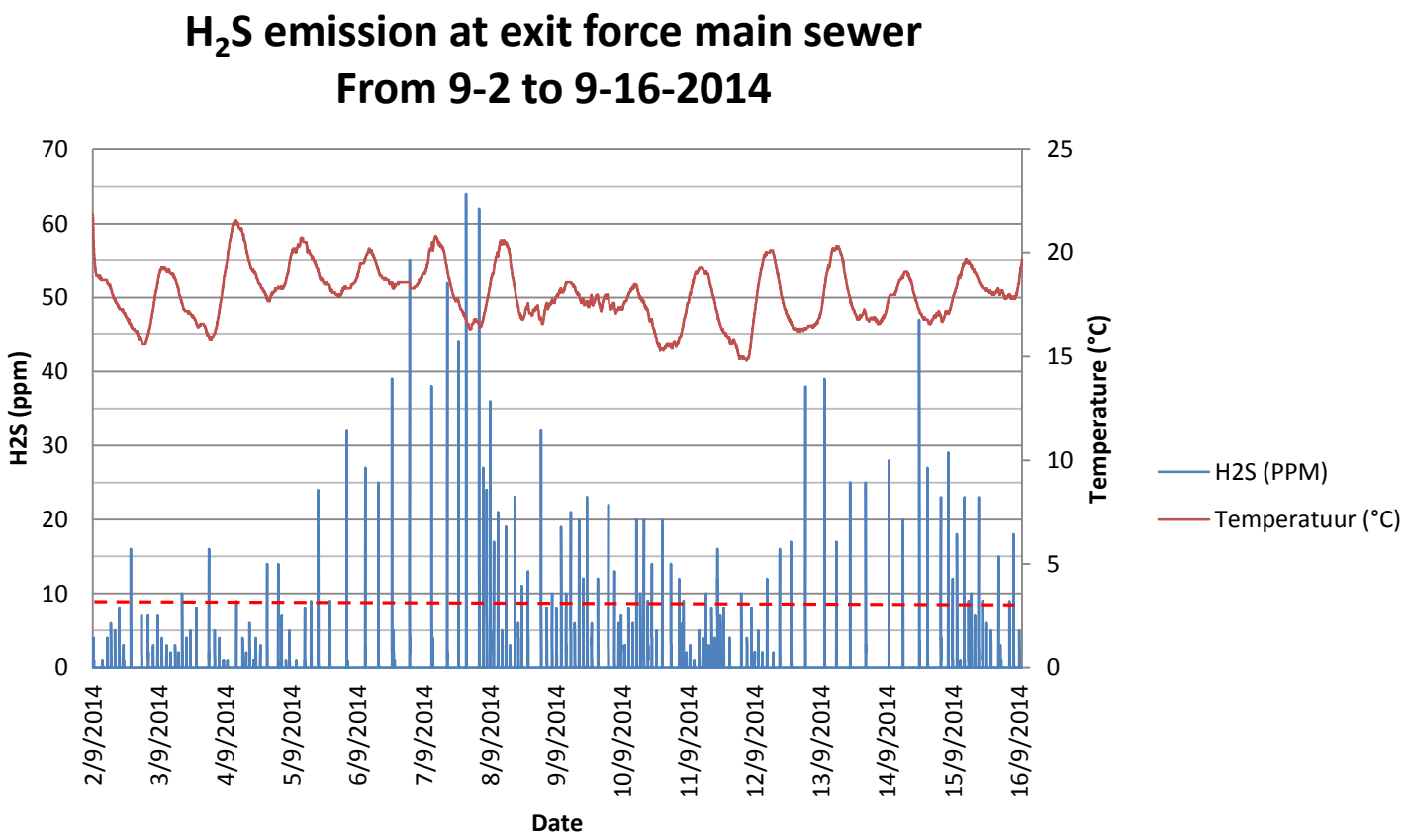
Bioaugmentation Case Study #3

A military base discharges its sewage through a 1.6 mile (2.5 km) force main sewer line into the municipal gravity sewer network in a nearby town. Local residents living in the surrounding area of the discharge point of the force main regularly complain about odor penetrating their houses. The odor has been identified as hydrogen sulfide (H_2S). This problem is more than a decade old and several attempts by the army to reduce the odor have failed. A report on the problem prepared by a renowned consultancy group was published in 2013. The report provided a list of potential solutions including low cost treatment of the force main with a bioaugmentation product.

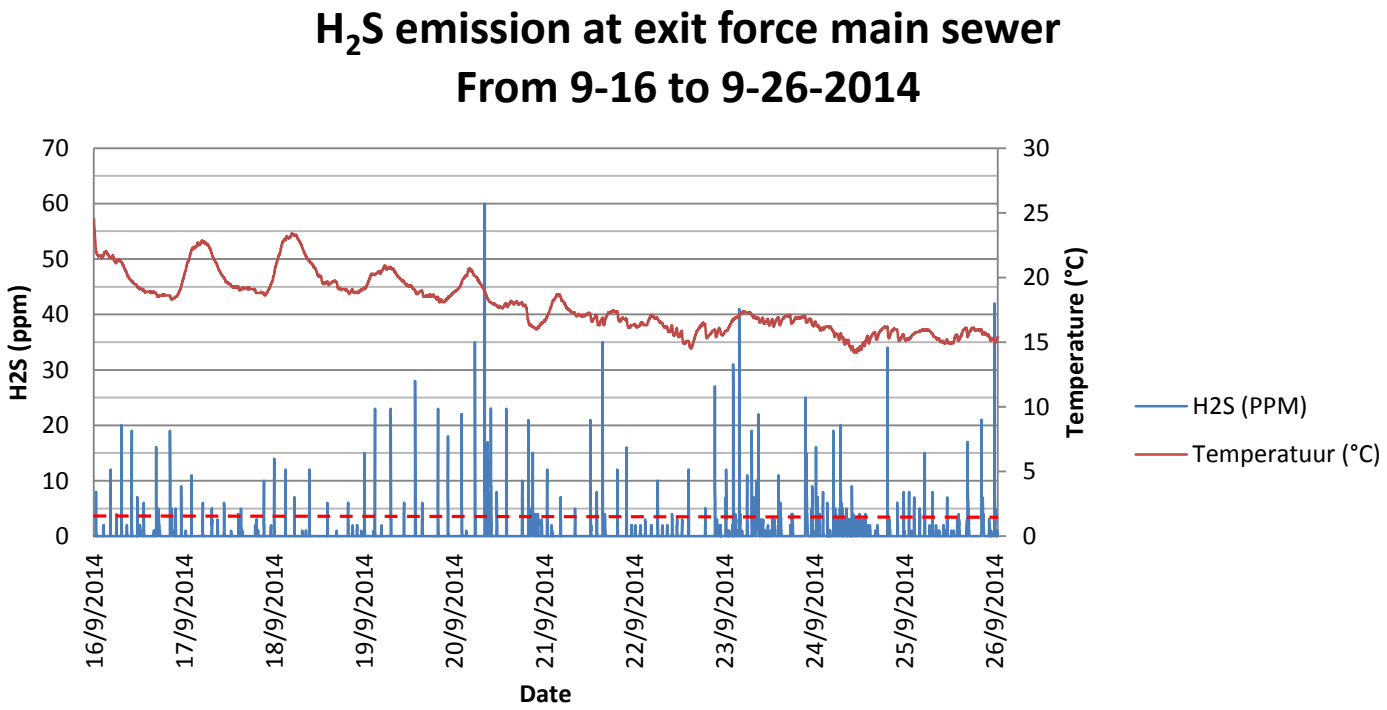
H2S Monitoring

Monitoring of the H_2S levels at the discharge point continued for a period of 2.5 months after the start of the program.

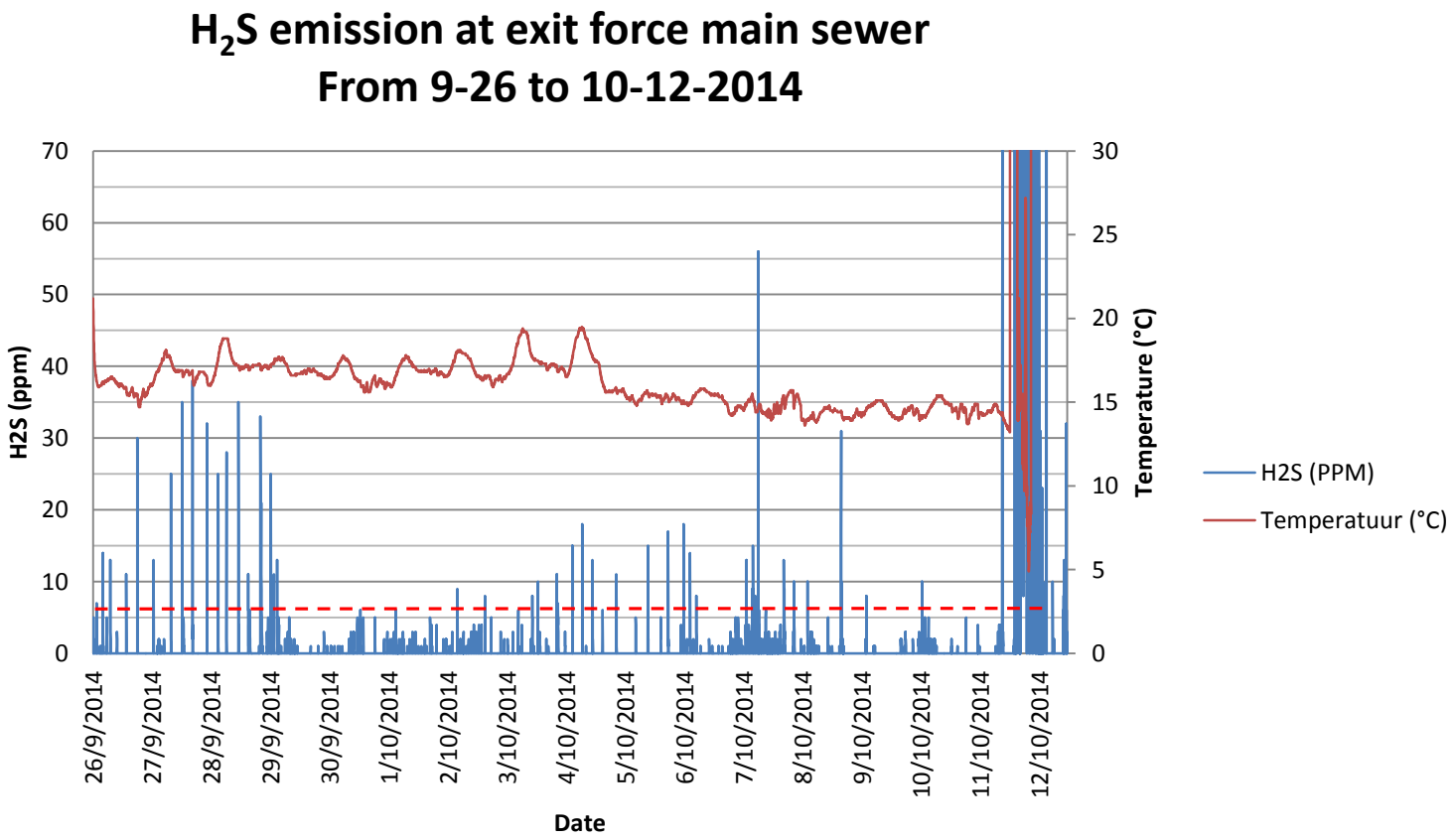
Before Treatment



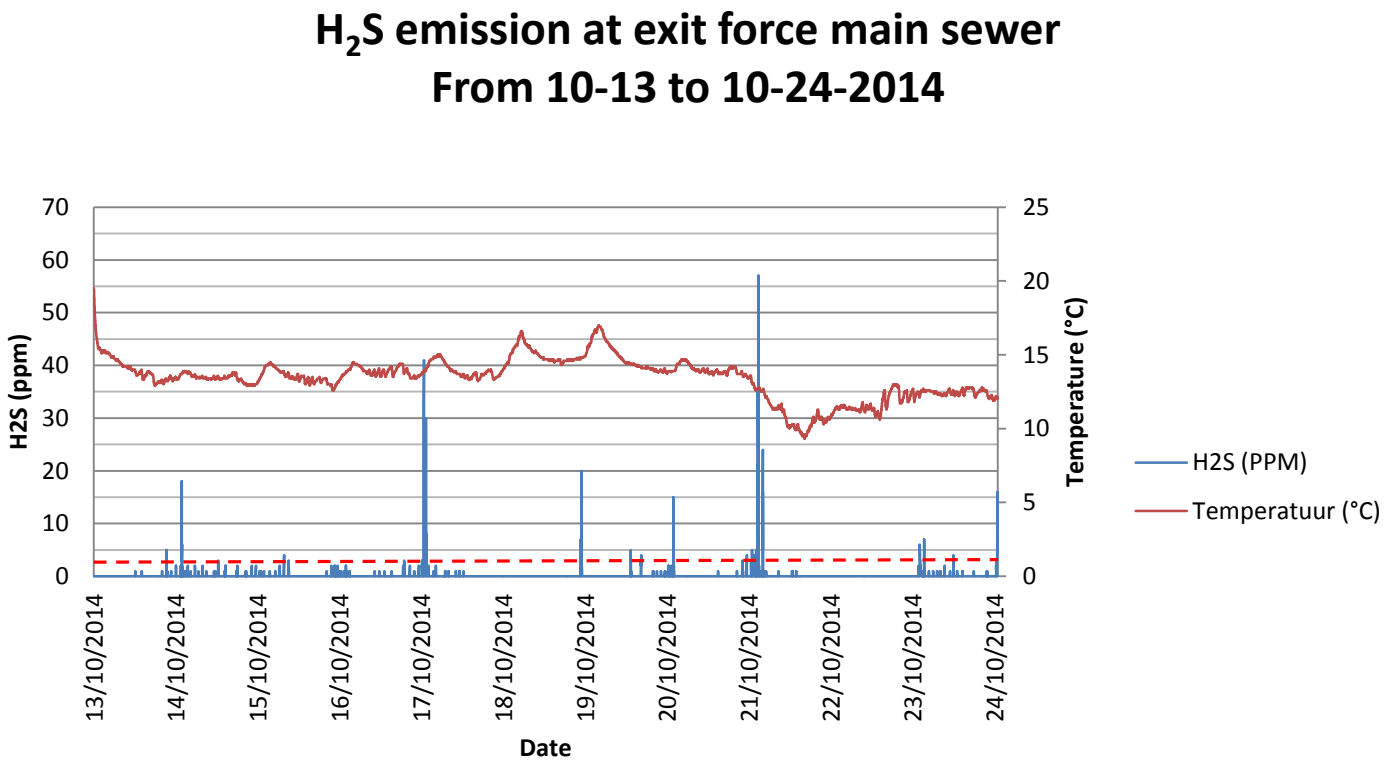
During Treatment – Week 1



During Treatment – Week 2



During Treatment – Week 3



Conclusions

- Consistently reduced H2S levels below 5ppm threshold
- Reduced corrosion and odor complaints
- Reduced the frequency of H2S spikes

Biological Advantages

- Inexpensive
- Easy to apply
- Non-hazardous
- No negative impact on the sewer system or treatment plant
- Positive effect on reduction of BOD loading and FOG buildup
- Improves treatment plant performance

Bioaugmentation Benefits for Wastewater Plants

Benefits for Wastewater Treatment Plants:

- Reduce Effluent Peaks (NPDES outages)
- Reduce Effects of Toxic Compounds
- Improve Settling Thru Filament Control
- Enhance Process Stability
- Reduce Sludge Production
- Reduce Maintenance and Labor

Bioaugmentation Case Studies

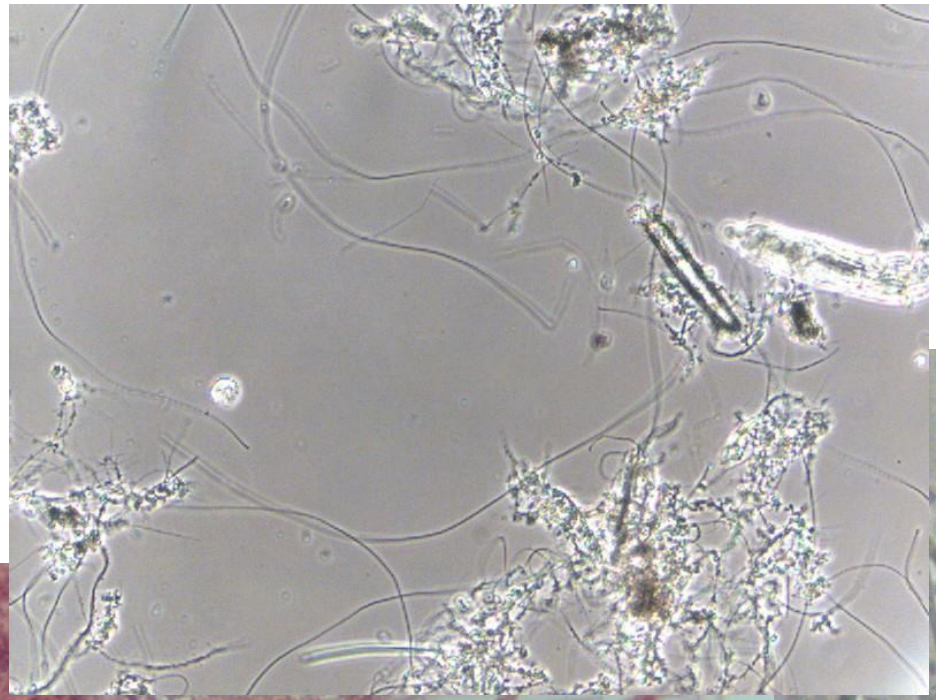
Benefits for Wastewater Treatment

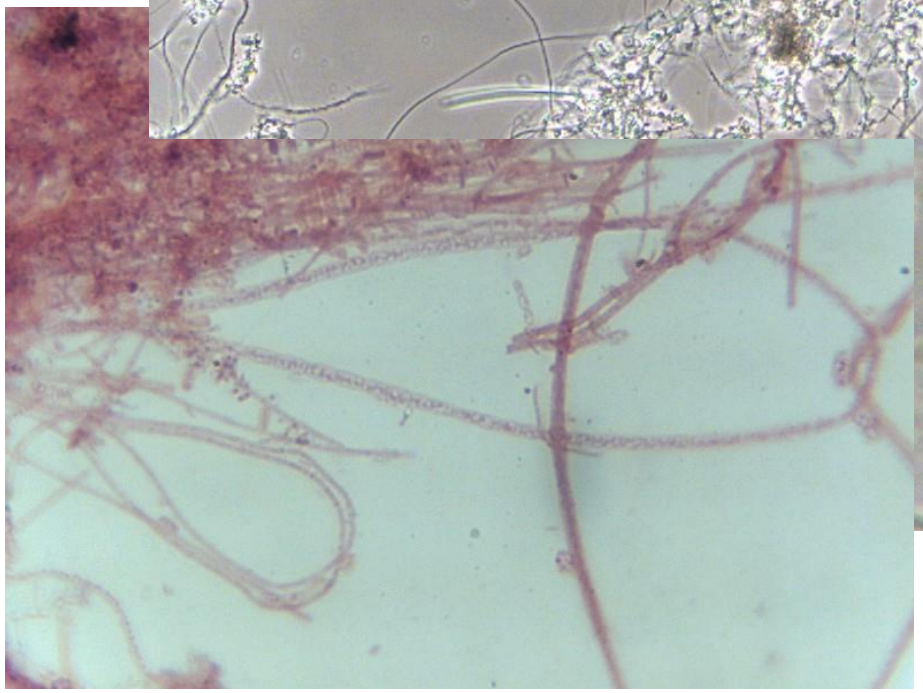
Bioaugmentation Case Study #1

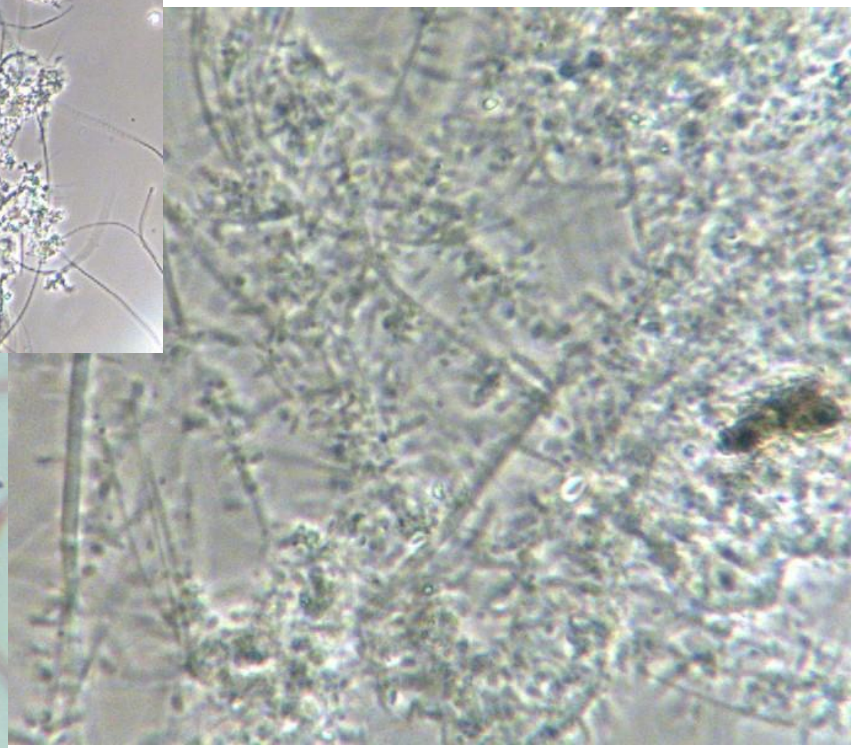
Benefits for Wastewater Treatment:

- Improve Settling with Filament Control

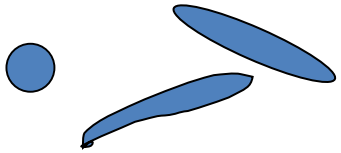
Filaments



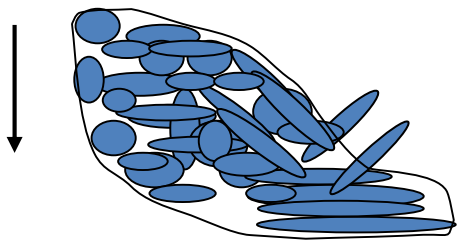




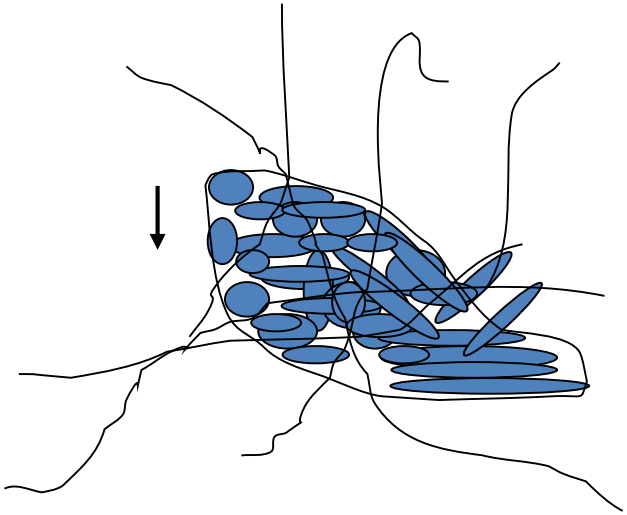
Filamentous Populations



Individual microbes do the work



Microbes flocculate and form particles that settle



But the filamentous forms inhibit settling

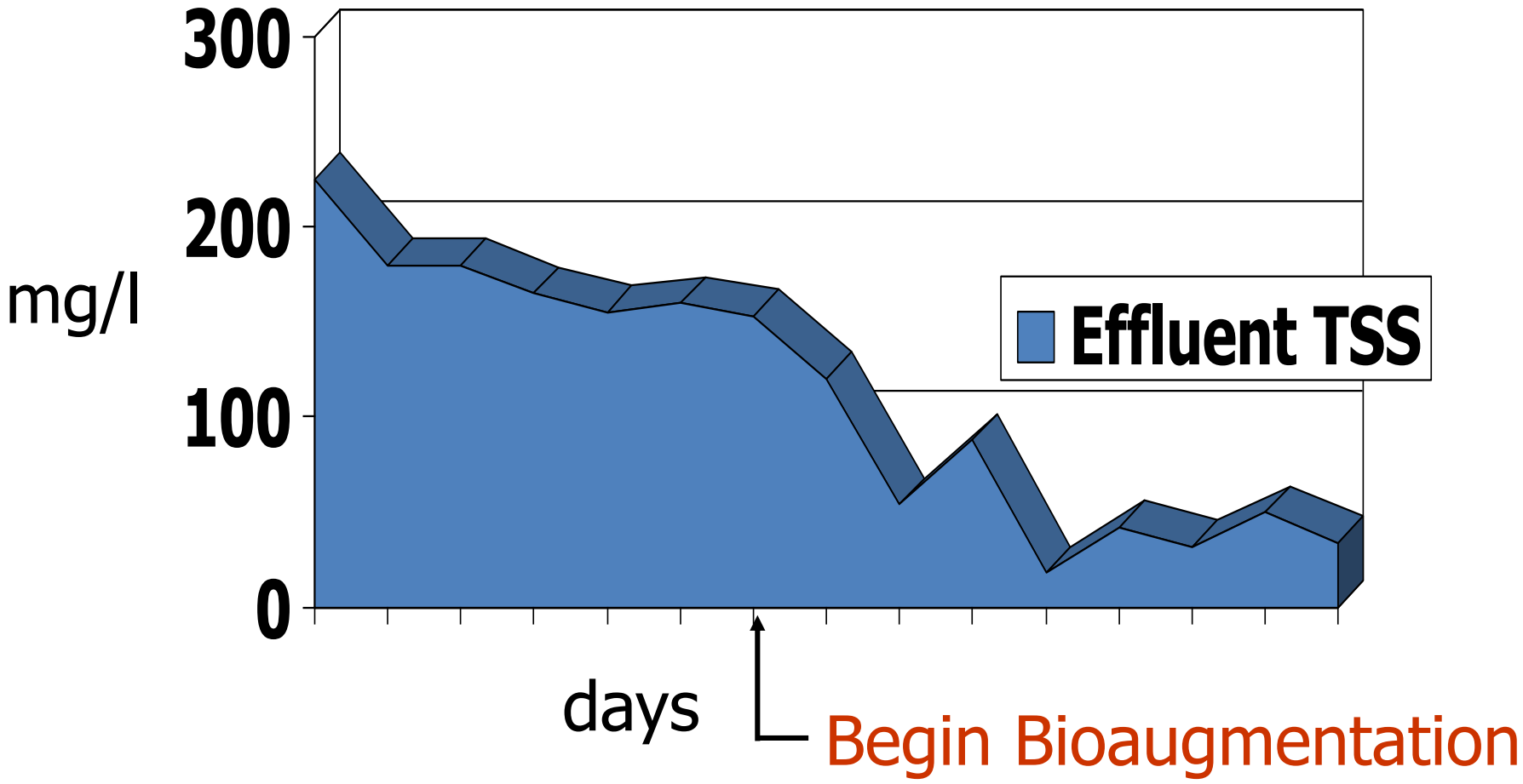
Filamentous WWTP Problems

- Dispersed growth-poor floc formation
- Slime formation-floc contains extra cellular slime, poor dewatering
- Pin Floc- small, compact weak floc settle slowly
- Bulking-filaments extend from floc into the bulk solution, poor settling and compaction
- Rising sludge blanket-denitrification in the secondary clarifier releases N2 gas causing floc to rise
- Scum/Foam formation-poor settling, high effluent TSS

Causes of Filamentous Bulking

- Low DO in aeration basin
- Low F/M in complete mix systems
- Septic wastes
- Nutrient deficiency
- Low pH
- Toxicity
- Specific wastewater types (High FOG)

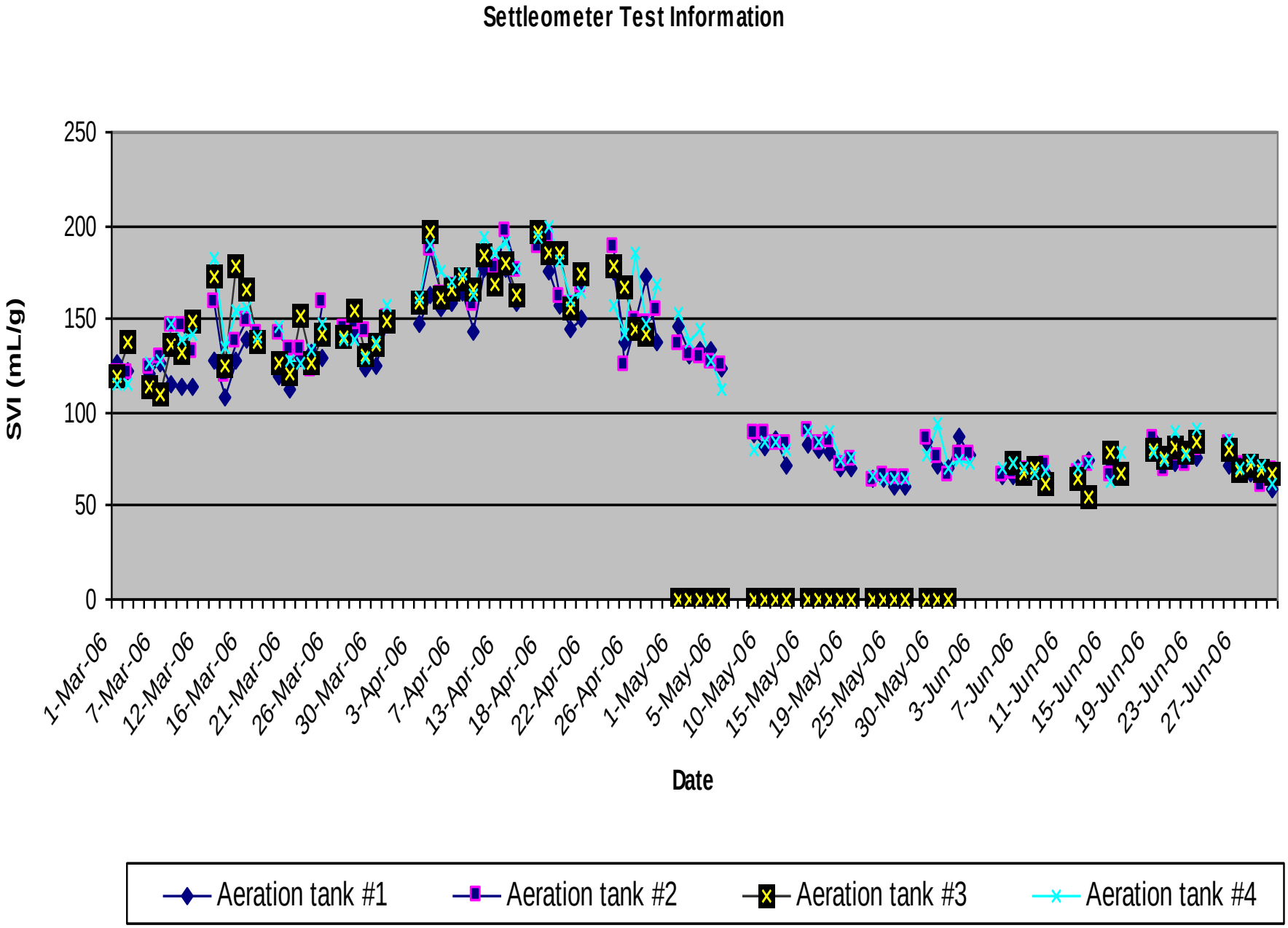
Reduction of TSS - Potato Processor



Bioaugmentation Case Study #2

Benefits for Wastewater Treatment:

- Enhance Process Stability


Settleometer Test Information
SVI (mL/g)
250
200
150
100
50
0
1-Mar-06
7-Mar-06
12-Mar-06
16-Mar-06
21-Mar-06
26-Mar-06
30-Mar-06
3-Apr-06
7-Apr-06
13-Apr-06
18-Apr-06
22-Apr-06
26-Apr-06
1-May-06
5-May-06
10-May-06
15-May-06
19-May-06
25-May-06
30-May-06
3-Jun-06
7-Jun-06
11-Jun-06
15-Jun-06
19-Jun-06
23-Jun-06
27-Jun-06
Date
Aeration tank #1
Aeration tank #2
Aeration tank #3
Aeration tank #4

Before bioaugmentation

After bioaugmentation (22 days)

Before bioaugmentation

After

Apopka, FL

Oxidation Ditch

Before bioaugmentation

After bioaugmentation

Bioaugmentation Benefits

- Reduce Maintenance, Improve Performance, Reduce Pumpouts, Reduce Sewer Clogs and Overflows, Reduce Permit Violations, Stabilize Operation

Bioscience, Inc.
Environmental Products and Services

ISO 9001:2008 Certified