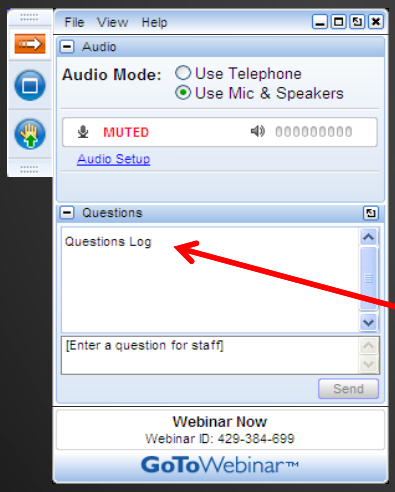
Cost-Effective Nutrient Removal Options for Small Systems

Thursday November 8, 2018
1:00 – 2:30 PM ET

How to Participate Today



- **Audio Modes**
  - Listen using Mic & Speakers
  - Or, select "Use Telephone" and dial the conference (please remember long distance phone charges apply).
- **Submit your questions using the Questions pane.**
- **A recording will be available for replay shortly after this webcast.**

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Today's Moderator

Uma Vempati
Associate Principal

ISG

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Today's Speakers

- Tom Grafft and Steve Jantz
  - Alternate Wastewater Processes for Small Systems – Kingsley, IA Case Study
- Rhine Perrin
  - Ammonia and BOD Reduction Using Recirculating PolyGeyser® Technology
- Martin Gross and Kuldip Kumar
  - Recovering Ammonia, Total Nitrogen, Total Phosphorus and Reducing BOD using Algae

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Our Next Speakers

Tom Grafft
Associate Principal +
Certified Operator, ISG

Steve Jantz
Operator-In-Charge,
City of Kingsley, IA

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Alternate Wastewater Processes for Small Systems

Kingsley, IA Case Study

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Kingsley, Iowa *Challenge*

- Original treatment system consisted of a conventional 2-cell aerated lagoon constructed in 1967
- NPDES Permit Limits Changed
  - Driven by changes in water quality regulations
  - New permit included a schedule to achieve compliance with NH3 + E.coli limits
  - Tighter limits required different approaches for cold-weather treatment
- The existing lagoon system could not consistently meet new ammonia nitrogen and E.coli limits
- City of Kingsley began evaluating options for alternative treatment technologies

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Kingsley, Iowa *Solution*

- To effectively treat ammonia nitrogen, you need:
  - Nitrifying bacteria
  - Good environment for bacteria to thrive
- Technologies evaluated to treat ammonia nitrogen:
  - SAGR™ - Submerged Attached Growth Reactor by Nexom
  - LemTec™ - Covered Aerated Lagoon + Polishing Reactor by Lemna Environmental Technologies (LET)
- Technology selected by Kingsley:
  - SAGR™ (Submerged Attached Growth Reactor) by Nexom
  - Cost to retrofit with SAGR™ was less than LemTec™

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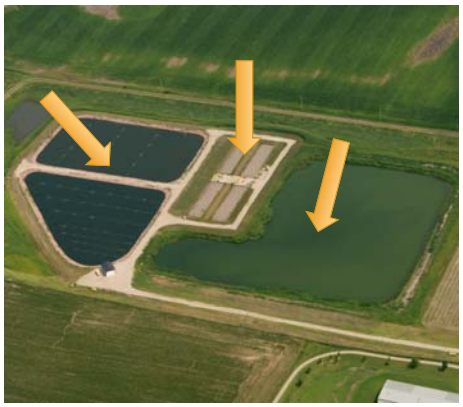
SAGR™ | Submerged Attached Growth Reactor

- Produced in Canada by Nexom
- Efficient for existing lagoon retrofits
- Treatment is driven by heat retention in SAGR™ cells
- Disinfection is provided by UV



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SAGR™ | Design Parameters

Design Population:
1,500

Design Flow:
0.300 MGD (AWW)

Detention Time:
25.8 Days

Total Footprint:
5.7 Acres

Construction Cost:
$1,765,100

Flow Type	Flow (MGD)
Ave. Dry Weather (ADW)	0.131
Ave. Wet Weather (AWW)	0.300
Max. Wet Weather (MWW)	0.439
Peak Hourly Wet Weather (PHWW)	0.820

Parameter	30-Day Ave. (lbs/day)	Daily Max. (lbs/day)
BOD	262	393
TSS	300	486
TKN	45	73

	Storage Capacity (gallons)	Detention Time (days)
Cell #1	2,618,263	11.8
Cell #2	2,670,794	12.0
SAGR™	500,000	2.0
Total	**5,789,057**	**25.8**

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SAGR™ | Design Parameters

- 2 Lagoon Cells
  - **Cell 1**: Aeration + Complete Mix
  - **Cell 2a**: Aeration + Partial Mix
  - **Cell 2b**: Quiescent, Settling Cell
- Enclosed Blowers

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SAGR™ | NH3 + Disinfection





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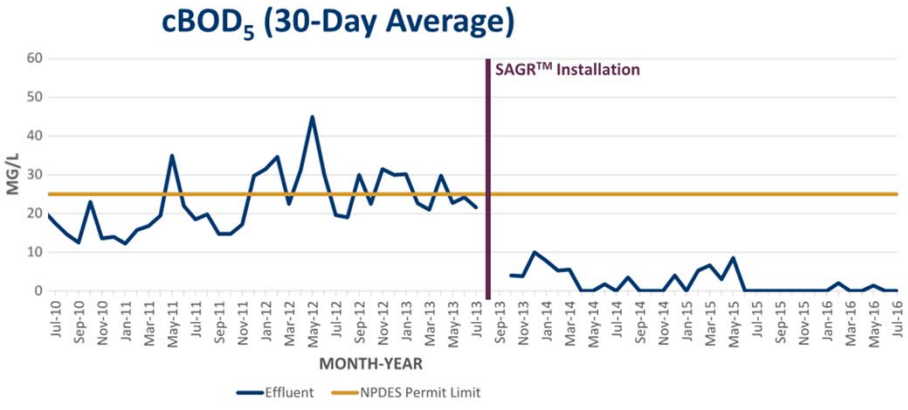
SAGR™ | $cBOD_5$ + TSS Efficiency



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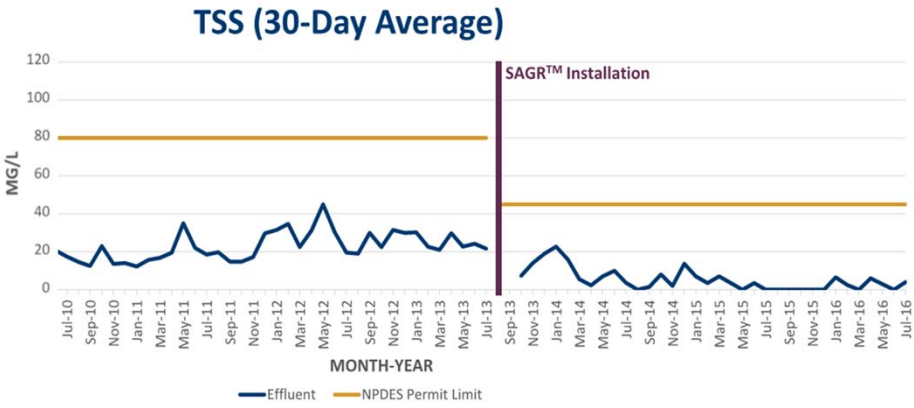
SAGR™ | $cBOD_5$ + TSS Efficiency



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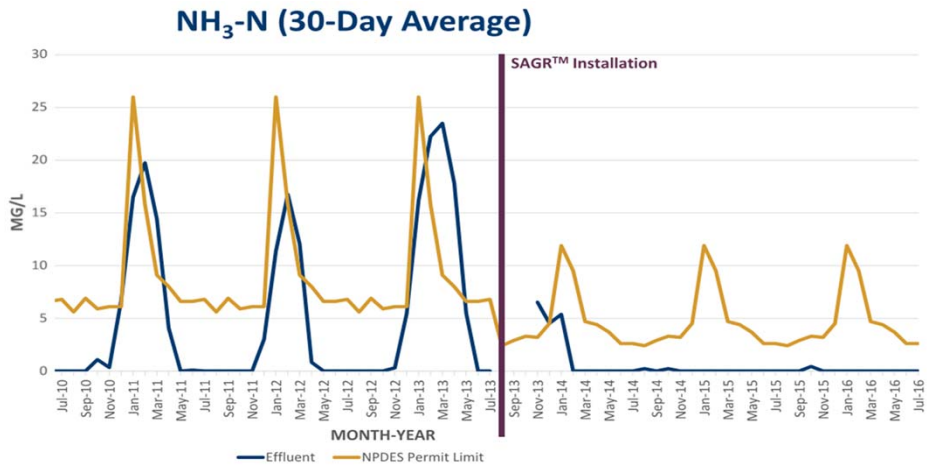
SAGR™ | NH_3 Efficiency



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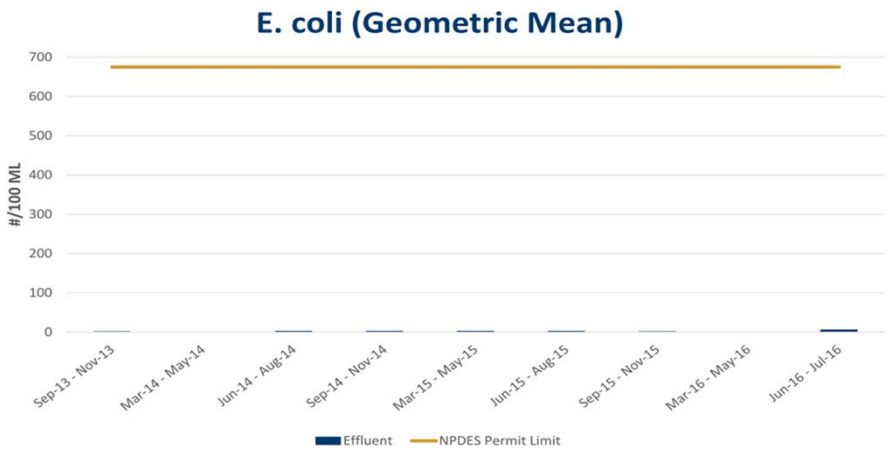
SAGR™ | E.coli Efficiency



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SAGR™ | Start-Up + O&M

- Add ammonia supplement to 'seed' the SAGR system
  - Nexum on-site assistance
  - Locally available ammonium nitrate
  - Process takes several weeks to establish biomass
- Operation & Maintenance
  - Scale build-up in SAGR air lines sometimes occurs with hard water
  - SAGR air lines – blow off condensation monthly
  - Blowers – change oil annually
  - Lagoon aeration diffusers – require occasional maintenance
  - UV system – clean and remove for winter
  - Replenish wood mulch – every 3-5 years

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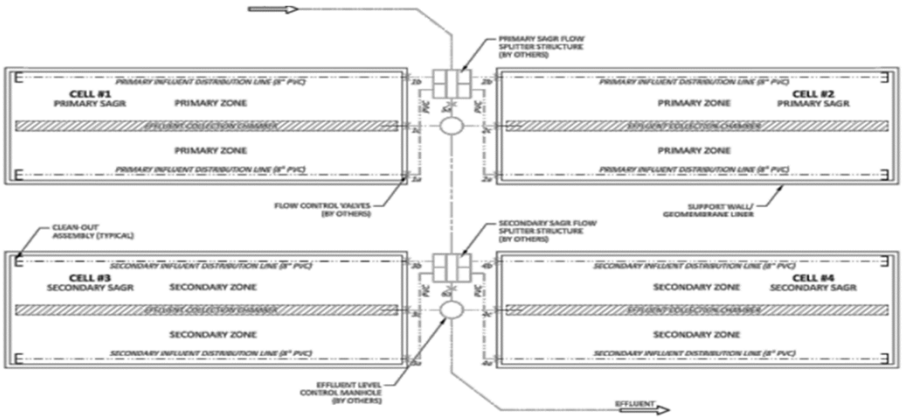
SAGR™ | Winter vs. Summer Operations



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Questions?

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kmaint@wiatel.com

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Our Next Speaker

Rhine Perrin, EI
Design Specialist

AST™
BEAD FILTER SOLUTIONS

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Ammonia and BOD Reduction Using Recirculating PolyGeyser® Technology

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Overview

- What is a Beadfilter?
- What is a PolyGeyser®
- How does a Recirculating PolyGeyser® Work ?
- Present Field Study Results of Facultative Lagoon Polishing

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Bead Filter Basics

- Uses Floating Media to form a Packed Bed to Capture Solids
- Acts as a Fixed Film Reactor to Biologically Filter Wastewaters
- Minimizes Water loss due to Backwashes
- Operates at Low Pressures and Head Losses Increasing Energy Efficiency

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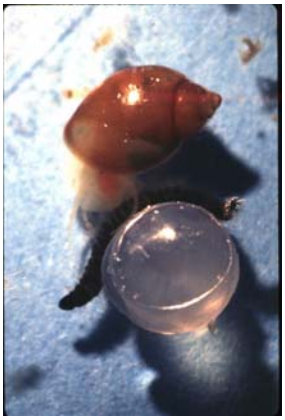
Types of Bead Media



Standard Media
35% Porosity
1/8th inch diameter
Solids only Application

- Food Grade LDPE Plastic
- 1100 m^2/m^3 of Surface area
- Never Needs Replacement
- Granular Attached Growth Media

Enhanced Nitrification (EN) Media
55% Porosity
Crushed Design for
Solids and Biological Filtration

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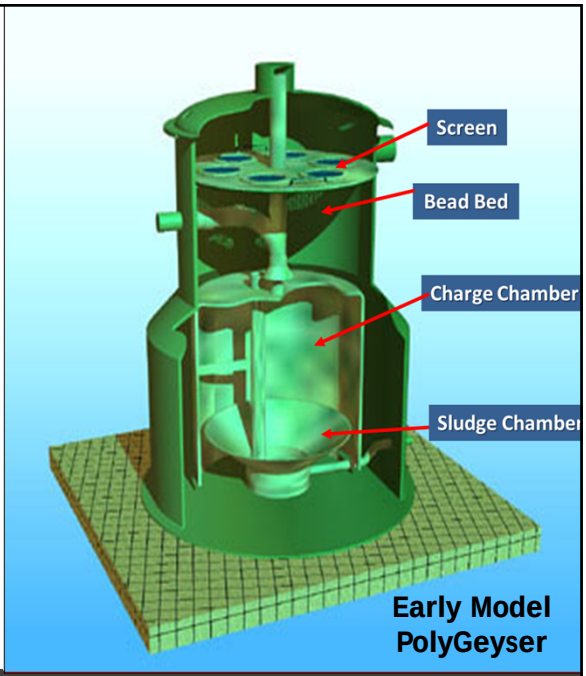
What Makes a PolyGeyser?

- **Screen**
  - Contains the floating media
- **Charge Chamber**
  - Holds the pneumatic charge in-between back washings
- **Trigger**
  - Non mechanical, Non electrical backwashing mechanism
- **Sludge Storage**
  - Internally settles sludge



Early Model PolyGeyser

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The Backwash

- **Trigger Fires Injecting the Air into the Bead Bed**
- **Bead Bed Expands, releasing solids**
- **Air Scrubs the Beads Harvesting Excess Bacteria**
- **Backwash Waters Refill Charge Chamber**

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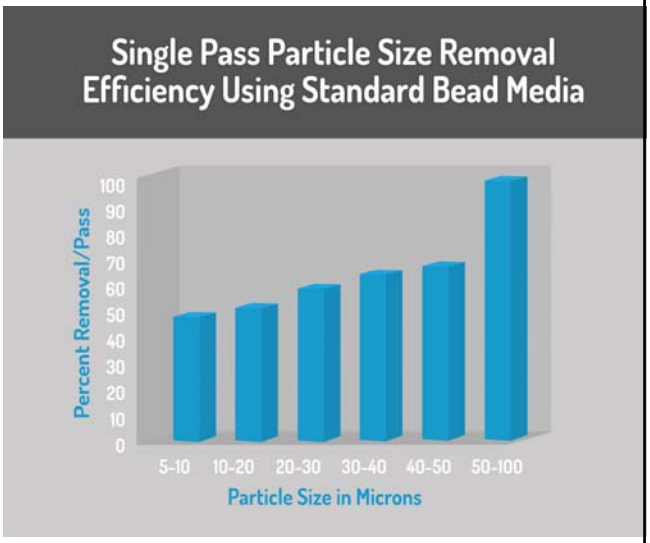
- Bead Filters have the Same Solids Capturing Efficiencies as Traditional Sandfilters of the Same Grain Size
- Unlike Sand Filters, Bead Filters are Immune to Bio Fouling and Channeling



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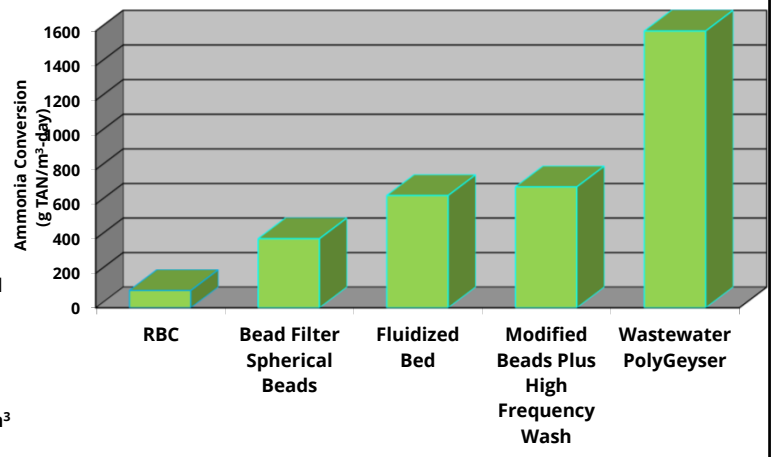
Biological Filtration Capacity

- BOD and COD Removal, Nitrification, Denitrification, BTEX Remediation, Hormone Degradation
- Acts as a Fixed Film Bioreactor whose biofilm can be Managed (MCRT) (Backwash Frequency)
- Active Surface Area: 1100 m^2/m^3 (335 ft^2/ft^3)



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Auto Pneumatic Backwashing

- Trigger Fires Injecting the Air into the Bead Bed
- Bead Bed Expands, releasing solids
- Air Scrubs the Beads Harvesting Excess Bacteria
- Backwash Waters Refill Charge Chamber

Early Model PolyGeyser Filter

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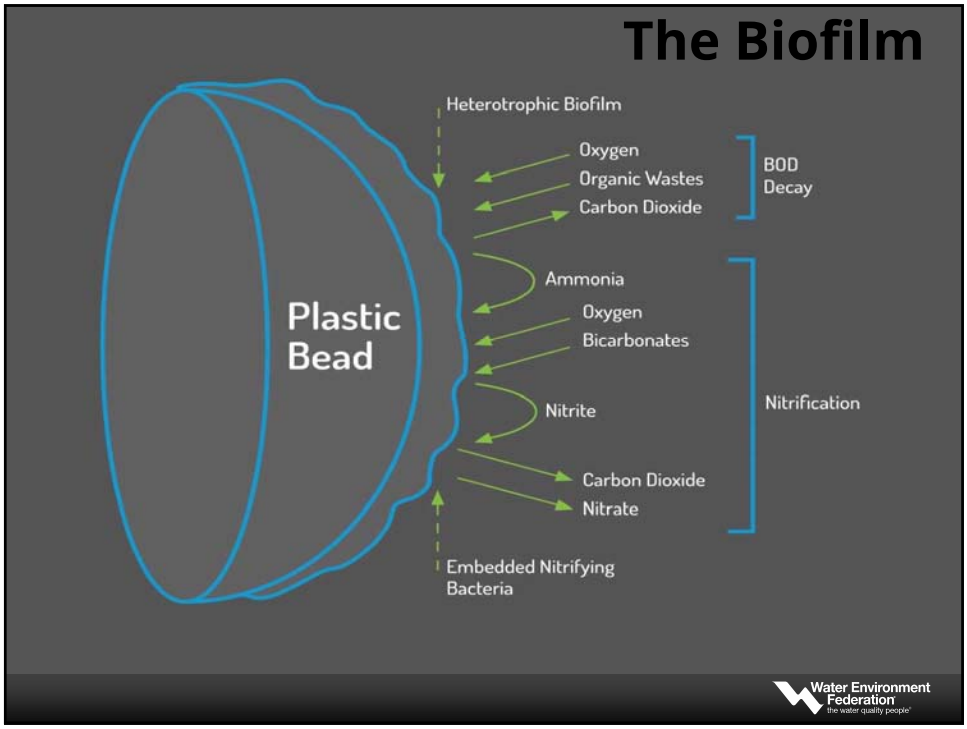
The Biofilm
Heterotrophic Biofilm
Oxygen
Organic Wastes
Carbon Dioxide
BOD
Decay
Ammonia
Oxygen
Bicarbonates
Nitrite
Nitrification
Carbon Dioxide
Nitrate
Plastic
Bead
Embedded Nitrifying
Bacteria
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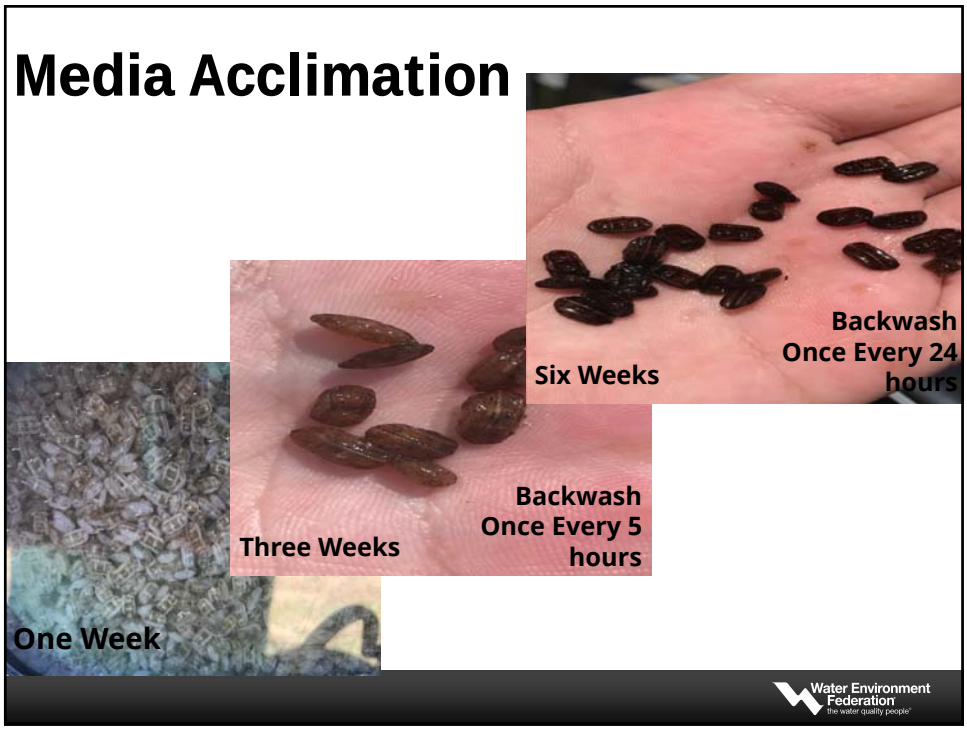
Federation


Media Acclimation
Backwash
Once Every 24
hours
Six Weeks
Backwash
Once Every 5
hours
Three Weeks
One Week
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Federation

What is a Recirculating PolyGeyser?

- Same Auto-Pneumatic Backwashing Technique as Traditional PolyGeysers
- Employs Direct Pneumatic Discharge (DPD) Sludge Handling
- Internally Recirculates Wastewater Multiple Times Before Discharging
- Uses Airlifts to Recirculate and Re-oxygenate Filtered Wastewater

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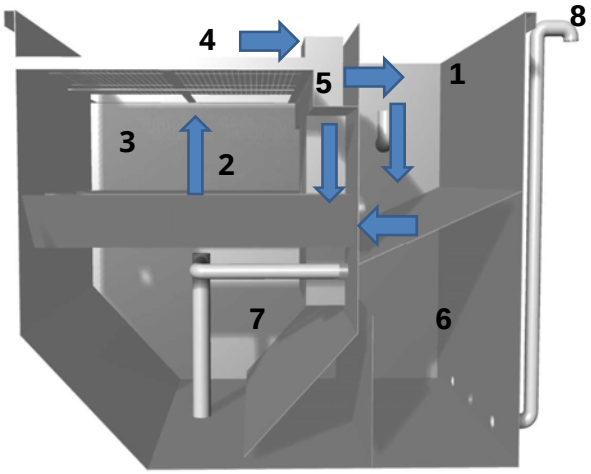
Anatomy of a Recirculating PolyGeyser

1. Recirculation Basin
2. Inlet Diffusers
3. Bead Bed
4. Bead Retention Screen
5. Recirculation Airlift
6. Internal Charge Chamber
7. Auto-Pneumatic Trigger
8. Sludge Discharge



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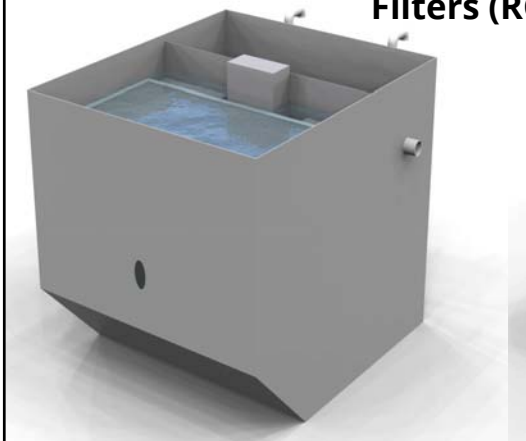
Recirculating PolyGeyser Filters (RCPG)



250 ft³ RCPG
2,500 GPM Recirculation Rate
Total Surface Area: 7,750 m²
(83,500 ft²)

100 ft³ RCPG
1,000 GPM Recirculation Rate
Total Surface Area: 3,100 m²
(33,400 ft²)

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Why Recirculate with Airlifts?

- Airlifts not only Physically Recirculates the Wastewaters Through the Filter but Also Re-oxygenates at the Same Time
- Provide High Flux Rates Through the Bead Bed Increasing Oxygen Transfer into the Biofilm

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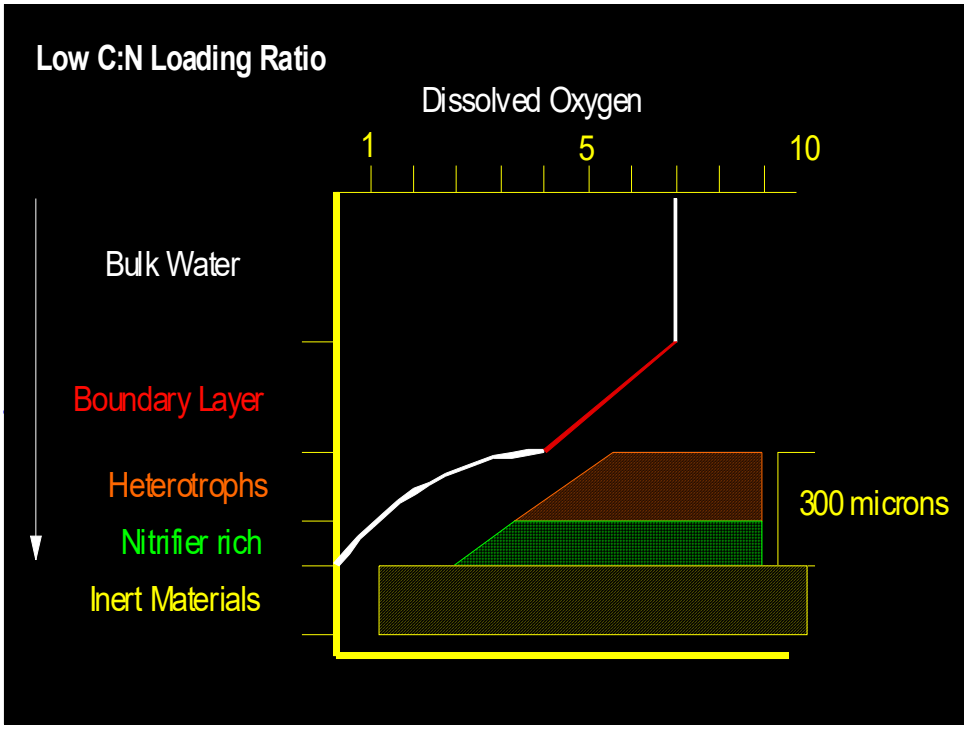


PolyGeyser
Direct Pneumatic Discharge

- Charge Chamber Slowly Fills with Air
- DPD Wall Creates Additional Pressure
- Sludge is Automatically Discharged

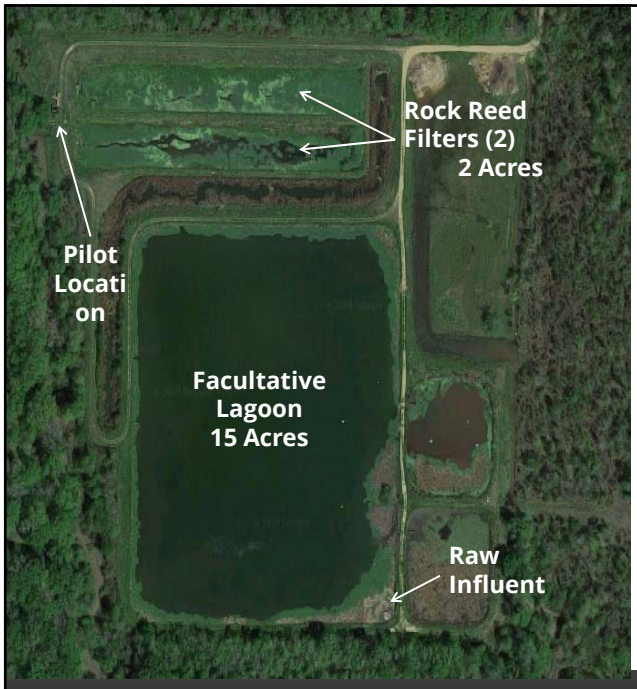
Early Prototype PolyGeyser

Case Study: Pelahatchie, MS

- Study Ran from 6/28/17-8/16/17
- Consistently Discharged:
  - BOD: <3
  - Ammonia: <1
  - TSS <30
- Unit ran untouched for 1.5 months
- BOD and Ammonia Conversion rates upwards: 2.5 kg/m^3-day and 2 kg/m^3-day Respectively

Pelahatchie, MS

- Facultative Lagoon followed by a Rock Reed Filter
- Trying to Meet a 3/30/2 Discharge Criteria
- Completed a 6 month Study using the RCPG 10 Demo unit.



Pelahatchie Site Layout

- 15 Acre Facultative Lagoon
- Dual 2 Acre Rock Reed Filters
- 0.84 MGD

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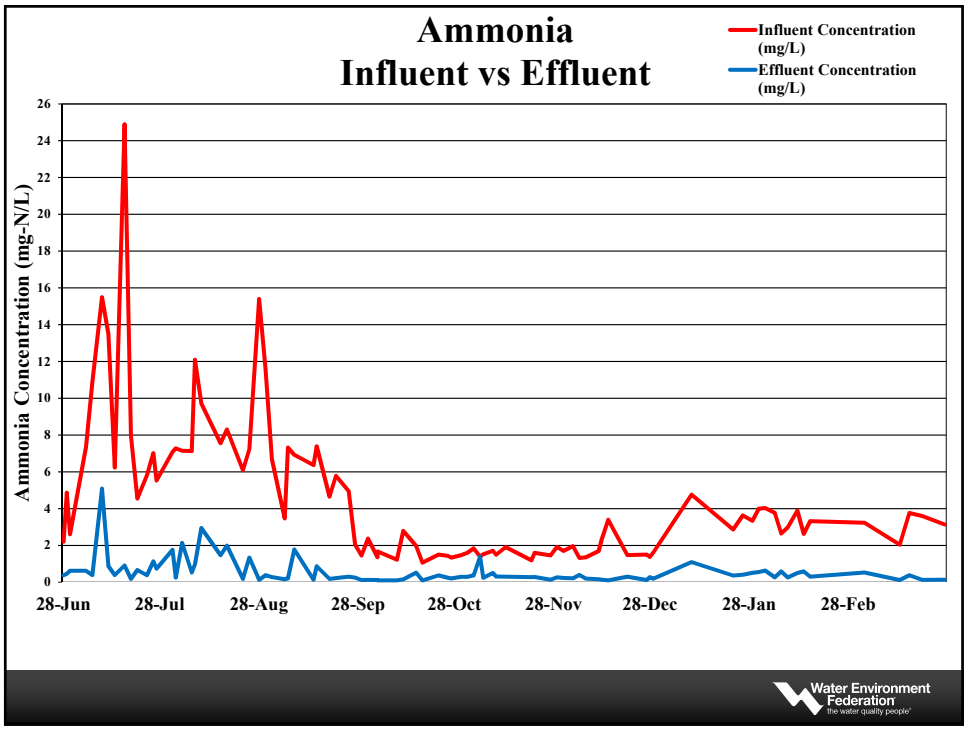

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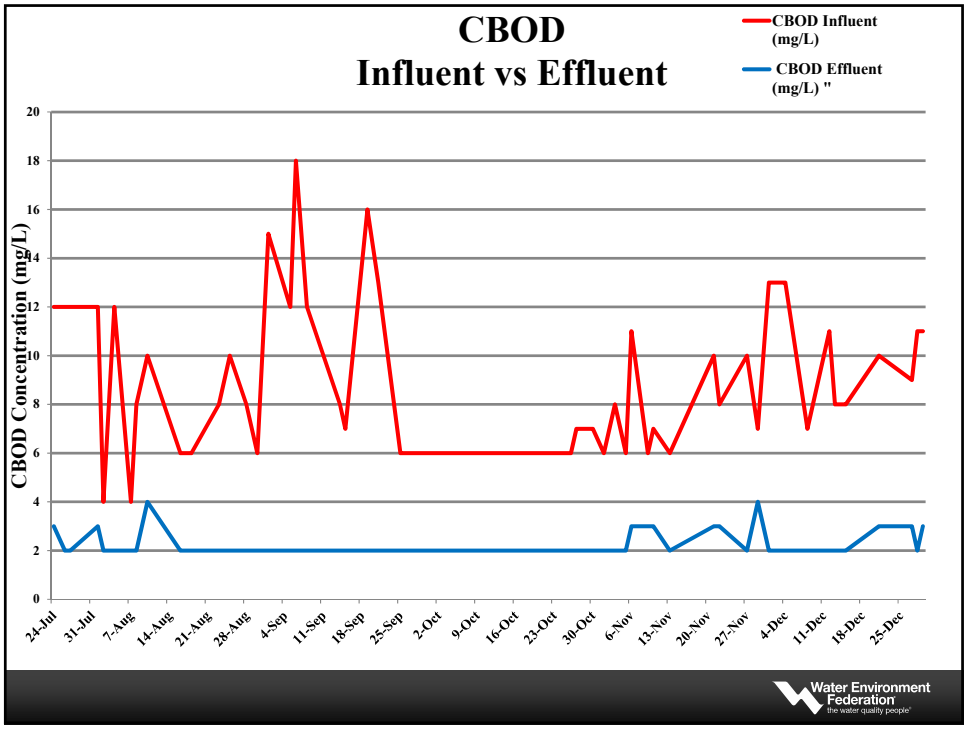

Summary of Pelahatchie Pilot Scale Study

Table 1. Summary of Pelahatchie Results

Constituent	Average Influent (mg/L)	Average Effluent (mg/L)
Ammonia	4.9±2.9; n=82	0.5±0.49
CBOD5	10.9±3; n=82	2.4±0.7
TSS	27.1±29.6; n=82	16.1±15.3

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Other Lagoon Polishing RCPG Applications

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Other Recirculating PolyGeyser Applications

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Questions?
Contact: Rhine.Perrin@ASTFilters.com

Special Thanks To:

Environmental Technical Sales (ETEC)

The City of Pelahatchie, MS

Our Next Speakers

Dr. Martin Gross
President

GWT
GROSS-WEN TECHNOLOGIES

Dr. Kuldip Kumar
Sr Environmental Soil Scientist

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Recovering Ammonia, Total Nitrogen, Total Phosphorus and Reducing BOD using Algae

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If you Google Nutrient Pollution You Find…

Dead in the Water
Florida Sportsman Magazine - Aug 22, 2018
Both **phosphorus** and **nitrogen** loads to Lake O have been increasing since 2010. very committed to addressing excess nutrients **pollution**.

What is causing Florida's algae crisis? 5 questions answered
The Conversation US - Aug 10, 2018
Very high levels of **nitrogen** and **phosphorus** are washing into the water .... We ca control the weather, but we can control nutrient **pollution**, ...
Florida's Blue-Green Algae Bloom 10 Times Too Toxic to Touch ...
The Weather Channel - Aug 10, 2018
View all

DCR holds second round of Agricultural Sector meetings to clean up ...
WHSV - Aug 21, 2018
"We know that Virginia is making tremendous progress; we have made in reducin **nitrogen** and **phosphorus pollution** to the Chesapeake Bay," ...

What's the difference between red tide and blue-green algae?
EcoWatch - Aug 13, 2018
Very high levels of **nitrogen** and **phosphorus** are washing into the water ... We car control the weather, but we can control nutrient **pollution**, ...

Official: Pennsylvania 'clearly behind' in **pollution** goals
Cecil Daily - Aug 7, 2018
Official: Pennsylvania 'clearly behind' in **pollution** goals ... are absolutely committe the reduction of **nitrogen, phosphorus**, sediment, in our ...
Pennsylvania officials admit their state is behind in curbing ...
In-Depth - Baltimore Sun - Aug 7, 2018

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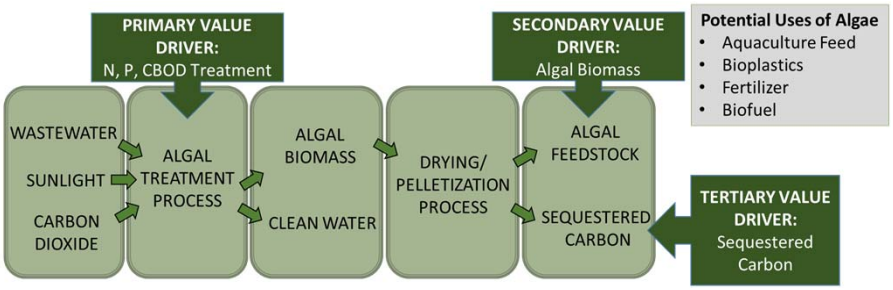
GWT's Algae Solution for Cleaning Wastewater



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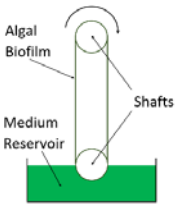
Revolving Algal Biofilm (RAB)



Invented at Iowa State University

US Patent: 9,932,549

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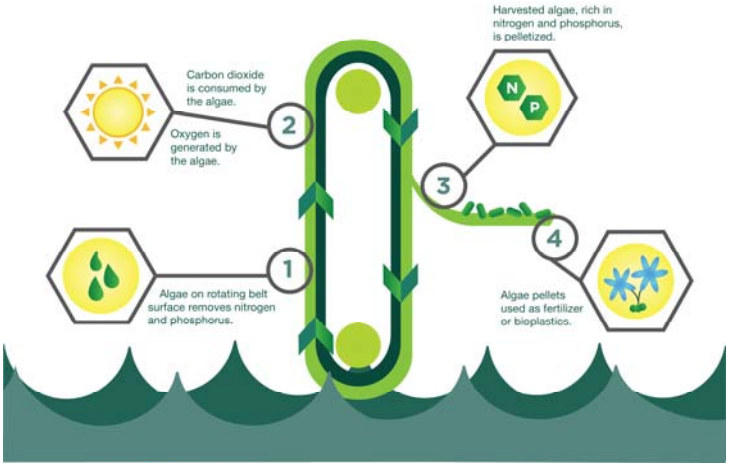
How the RAB System Works



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Results from Algal Fertilizer Trial

No Fertilizer	Algal Pellet	Algal Paste	Synthetic Fertilizer	Milorganite Fertilizer

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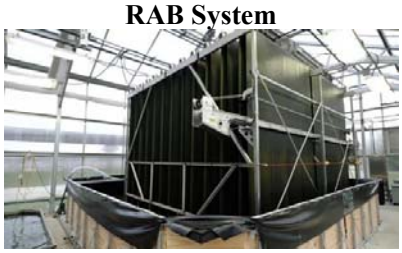
Advantages of RAB vs Conventional Algae Systems

Conventional Algal Culture

- Low productivity and treatment
- Limited light and CO_2 supply
- Land intensive
- High harvest & processing costs

RAB System



- Simple and inexpensive harvest
- Enhanced delivery of light & CO_2
- 10× higher productivity & treatment
- Efficient space utilization
- Natural separation of HRT & SRT

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Algae serves as a simple retrofit to existing treatment systems and can treat a variety of wastewater streams

- Tertiary treatment for TN, TP polishing
- Primary treatment for NH_3, TN, TP, BOD
- Concentrated side streams such as anaerobic digestion effluent
- Industrial pretreatment

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How the RAB System can Help Small Communities Using Lagoons Meet New Ammonia Permits

Case Study Example

Columbus Junction, IA

- **Population Served:** 2,600 people
- **Problem:** Cannot reach new ammonia discharge permit
- **Requires Treatment Plant Upgrade**

Limited solutions

- **Solution 1:** Convert mechanized system ($5.5M)
- **Solution 2:** Retrofit SAGR Process or Lemna Lagoon Cover ($4.5M)
  - Does nothing for phosphorus removal
  - Does nothing for total nitrogen removal (only converts ammonia to nitrate)
- **Solution 3:** GWT's RAB algal treatment system to recover ammonia, TN, TP, and BOD ($3.0M)

Iowa DNR approved RAB treatment system May 2018

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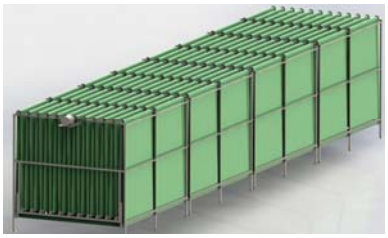
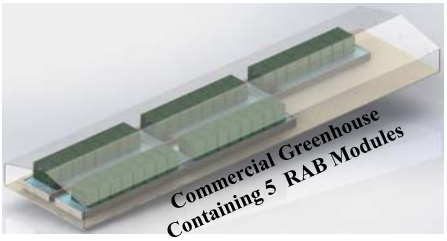
RAB System Sized for Columbus Junction, IA





Impact of the RAB treatment facility:

- Algal biomass (dry): 33 tons/year
- CO_2 fixation: 60 tons/year
- Nitrogen removal from wastewater: 12.7 ton/year
- Phosphorus removed from wastewater: 2.5 ton/year

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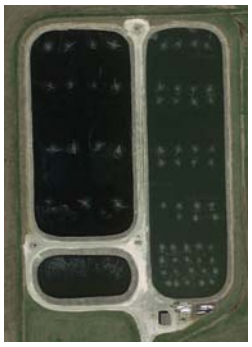
How the RAB System can Help Small Communities Meet TN, TP, and Ammonia permits

Case Study Example



Albia, IA

- **Population Served:** 3,700 people
- **Flow Rate (AWW):** 1.7 MGD
- **Problem**: Cities in Iowa that have a flow over 1 MGD are receiving TN, and TP permits. City also cannot meet new ammonia permit
- **Requires Treatment Plant Upgrade**

RAB Sizing to Meet Permits

- **Meeting TN permit (yearly average, 10 mg/L) :** 5 RAB Modules ($2.6 M)
- **Meeting TP permit (yearly average, 1 mg/L) :** 7 RAB Modules ($3.7 M)
- **Meeting NH_3 permit (daily limits) :** 9 RAB Modules ($4.7 M)

** $ values above are installed costs for RAB equipment, RAB reservoir, greenhouse*

RAB sized to meet ammonia permits also meets TN and TP permits

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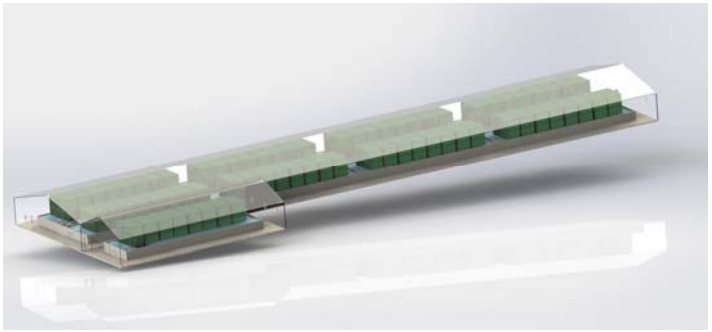
RAB System Sized for Albia, IA



Impact of the RAB treatment facility:

- Algal biomass (dry): 59 tons/year
- CO_2 fixation: 106 tons/year
- Nitrogen removal from wastewater: 24 ton/year
- Phosphorus removed from wastewater: 4.7 ton/year

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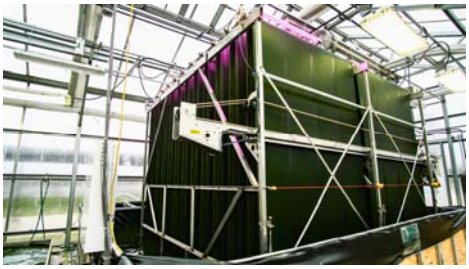
Our Business Model:

1. Provide and Install RAB System



I. **GWT provides RAB system and a design package for the "non-RAB" part of the system including headworks, greenhouse, reservoir etc.**

II. **GWT can provide a fixed price operating and maintenance contract upon request**

2. Provide Offtake Contract for Algae

I. **GWT collects, processes, markets, and sells algae**

II. **City receives revenue from algae sales revenue splitting is offer in 2 ways**

Option 1: 50:50 profit share

Option 2: Fixed price $250/dry ton algae

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Pilot & Demonstration Results

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MWRD Chicago Pilot Study 2015-2017

Primary Objective: Phosphorus Removal from Concentrated Side Streams

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MWRD Chicago Demonstration Study, 2017-Present

Primary Objective: Phosphorus Polishing from Plant Effluent

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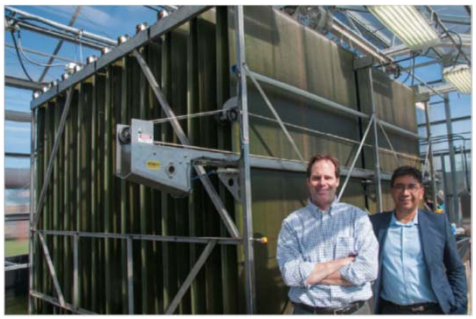
Feedback from MWRD Chicago Demonstration Project

MWRD Chicago Project Leads

Kuldip Kumar Ph D
Senior Environmental Scientist
MWRD Chicago

&

Tom Kunetz
Associate Director of Engineering
MWRD Chicago
President
Water Environment Federation



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Our Test Site in Dallas Center, IA

Small Community Needing Additional Ammonia Treatment

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Dallas Center, IA Pilot Study

Primary Objective Ammonia Removal (2.5 year pilot)

Ames, IA Pilot Study

Primary Objective TN, TP recovery from effluent and AD centrate

Cresco, IA Demonstration Study

Primary Objective TN, TP, BOD recovery from raw WW

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Algae is The Most Sustainable Treatment Option

Lower Carbon Footprint

- Algae consumes CO_2 from the atmosphere while it treats water

Capturing and REUSING Nitrogen and Phosphorus

- Traditional bacterial technologies do no capture and reuse N and P

Renewable Algae Biomass

- The algae grown on our system is used to make renewable bioplastics and biofertilizers

Lower Energy Use

- Our system uses motors to rotate belts, others pump air which is much more energy intensive.

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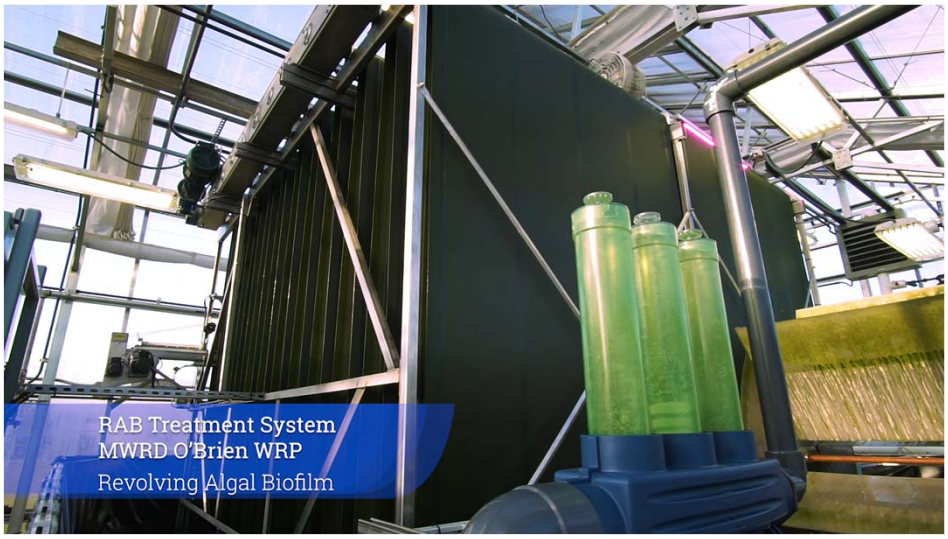
Questions?



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Contact: Martin@gross-wen.com
Check us out at Algae.com

Questions?

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