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June 1 2021

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THE Water Research FOUNDATION

MOLEAER®

ADVANCING NANOBUBBLE TECHNOLOGY

WRF Tech Scan

Presented by:

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MOLEAER®

ADVANCING NANOBUBBLE TECHNOLOGY

Moleaer™ manufacturers industrial-scale nanobubble systems that deliver extraordinary improvements in sustainable food production, chemical-free water treatment and the recovery of natural resources

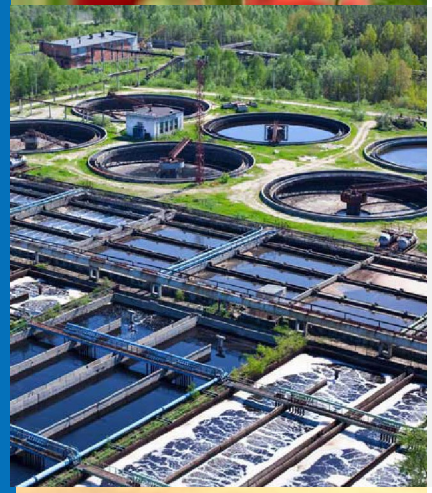
Typical payback when incorporating Moleaer technology into industrial process: 6-24 months

FOOD

Horticulture | Specialty Crops | Aquaculture | Food Safety

>400 Systems Installed

- Increasing crop yields by up to 50%
- Reducing oxygen costs in salmon farms by 70%
- Demonstrated that O_2 NBs can replace chlorine for food sanitization



WATER

Algae Control | Advance Oxidation | Biological Treatment | Floatation

>300 Systems Installed

- Eliminated use of harmful algicides and herbicides in >100 water bodies
- Reduced energy consumption >75% in industrial wastewater processes
- Potential to reduce energy consumption in municipal wastewater by 31% = 2.5M tons of CO_2

NATURAL RESOURCES

Produced Water Treatment | Heap Leaching | EOR | Floatation

>75 Systems Installed

- Reduced the cost of recycling produced water
- Increased oil production from aging wells by 50%-90%
- Demonstrated >14% increase in gold recovery

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Leadership Team

Experienced leadership team with backgrounds in water and building successful early-stage companies

NICHOLAS DYNER

Chief Executive Officer

20+ years commercial experience, with the last 13 years in the water treatment industry

WARREN RUSSELL

Co-Founder, Chief Commercial Officer

15+ years as a business owner in wastewater treatment and environmental services

BRUCE SCHOLTEN

Co-Founder, Chief Technical Officer

25+ years in water and wastewater treatment chemicals and equipment

JENNIFER LIM

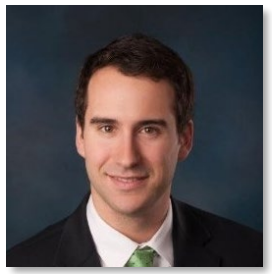
VP of Marketing & PR

20+ years in marketing and public relations leadership roles with early stage companies and established brand leaders in B2C and B2B

JOSH BACHNER

VP of Strategy & Corp Dev

7+ years in corporate strategy and commercial leadership roles in food & nutrition and consulting



BRAD HICE

Director, N.A. Sales

14+ years in sales leadership and engineering roles in water and wastewater treatment

ANDREA WHITE

Application Engineering Leader

15+ years of experience in water & wastewater with Tier 1 Engineering Consulting firm specializing in biological and chemical oxidation processes and gas transfer

POOYA MAHMOUDIAN

Director, Engineering

13-years of experience in new product development and designing strategic products for the aerospace, energy and compression industries

Nano H_2O

LG

EVADINE TECHNOLOGIES

EROGFIT USA

SoCal Water SERVICES

PELICAN

HYUNDAI

soylent

BAIN & COMPANY

EOSi

GHD

CDM Smith listen. think. deliver.

IR Ingersoll Rand

MOLEAER ADVANCING NANOBUBBLE TECHNOLOGY

Leader in Nanobubble Technology and Science

- ✓ Founded in August 2016 in Los Angeles, CA
- ✓ Officially launched first nanobubble generator in June 2017
- ✓ Globally recognized as market and technology leader
- ✓ Patented technology
- ✓ Independently validated by global experts in the fields of aeration, oxidation, food safety and nanobubble detection

DISTINCTION GLOBAL WATER AWARDS 2018
16 April, Pavillon d'Armenonville, Paris, France
www.globalwaterawards.com
EVOQUA

FAST COMPANY WORLD CHANGING IDEAS 2020

WAGENINGEN UNIVERSITY & RESEARCH

UCLA

VIRGINIA TECH

ASU Arizona State University

Malvern Panalytical
a spectris company

CLEMSON UNIVERSITY SOUTH CAROLINA 1889

- ✓ Commercially proven with ~900 installations, in >40 different countries
- ✓ 40 employees in U.S., Canada, Spain, Mexico & Netherlands

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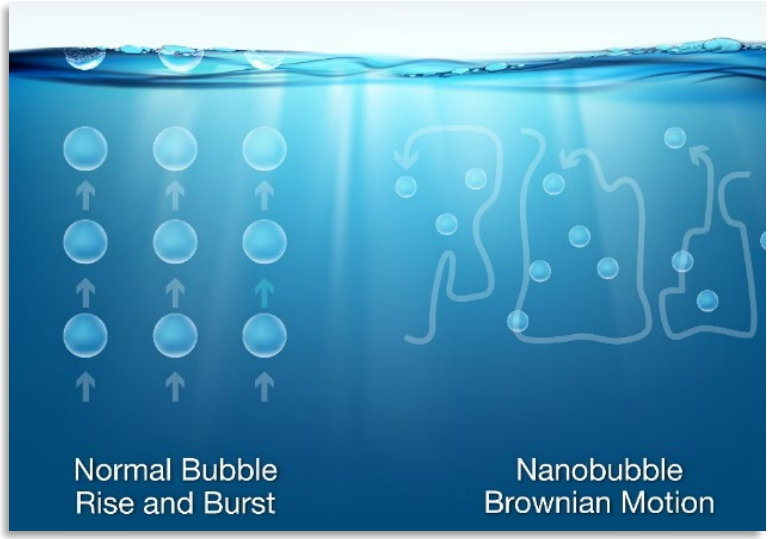
What Are Nanobubbles?

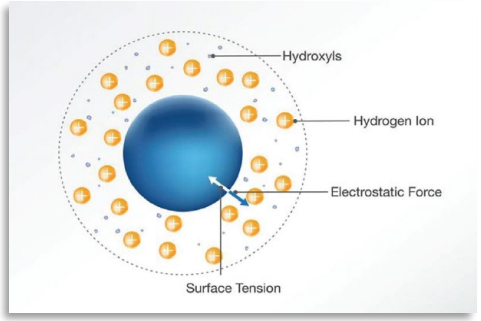
Nanobubbles are nano-size bubbles, 2000x smaller than a grain of salt, that improve water quality and industrial processes through oxygenation, flotation and oxidation

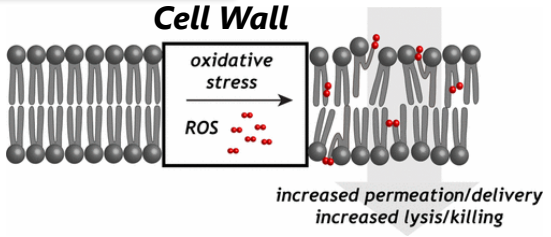
Even O_2 Distribution



- ✓ Don't rise to the surface and burst
- ✓ 30x better gas transfer efficiency then conventional methods
- ✓ Enables cost effective use of air, oxygen or ozone
- ✓ Remain suspended in water for months

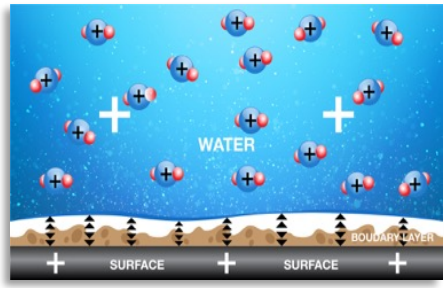
Chemical Free Oxidation

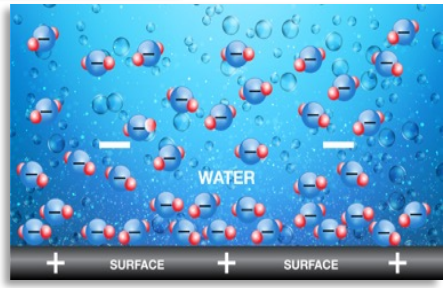




- ✓ On collapse, nanobubbles generate an oxidant
- ✓ Oxidants (ROS) react with cell membranes and cell walls to break apart cells. This is called oxidative stress.
- ✓ NB Oxidants exchange electrons to change molecular state (Ex: Fe2 to Fe3)

Scouring & Adhesion





- ✓ Nanobubbles have been suggested to act like hard particles in flowing liquids that break apart biofilm
- ✓ Negative charge enables bubbles to bond to particles with opposite charge changing their density

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Moleaer Nanobubble Generators vs. Alternatives

Moleaer:

Compressed gas is diffused into flowing water from 25-to-1000 gpm in our "Nanobubble Generator (NBG)" forming >200M nano-sized bubbles / ml

Nanobubble Generator

Advantages:

- Introduces **two forms of gas** into the water: dissolved and nanobubbles
- >85% oxygen transfer efficiency (OTE) regardless of water depth
- Evenly oxygenates the entire water column
- Highest oxygen utilization when compared to all alternatives
- Stable, uniform dissolved oxygen levels
- Minimal off-gassing

Alternatives:

Diffusers

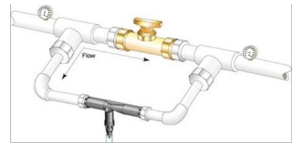
- 1-3% oxygen transfer efficiency per ft of water
- Susceptible to fouling
- High replacement rate
- Inefficient in shallow water

Cone

- High oxygen transfer efficiency
- High energy requirement
- Poor ramp up / down capability
- Frequent maintenance issues

Venturi

- 20-40% oxygen transfer Micro & Macro bubbles
- Inefficient and not economical when combined with pure oxygen



Moleaer: Robust, scalable, plug & play technology with best-in-class 86%+ oxygen transfer efficiency

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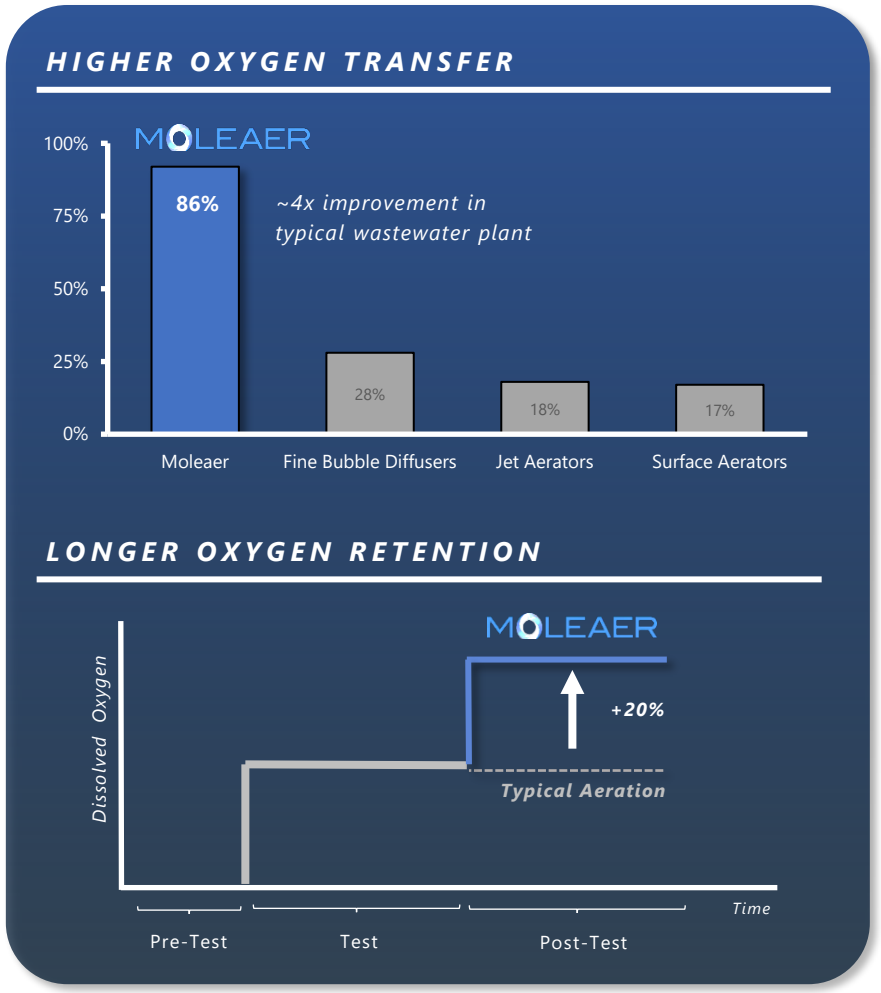
Independent Validation



Test Overview – April – June 2017

- Independently tested by Michael Stenstrom, distinguished UCLA engineering professor, world-renowned for research in aeration technologies

Key Findings

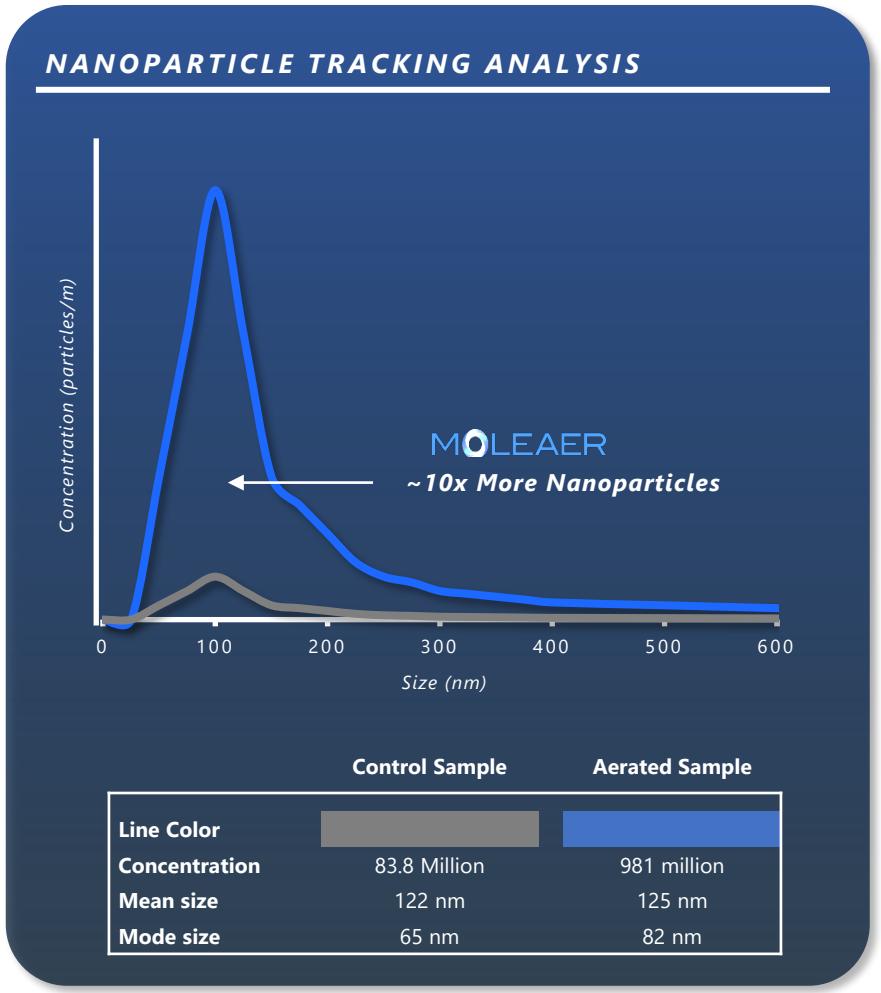
- **Moleaer bubbles achieve 86% oxygen transfer efficiency in any depth**
  - Vs. best-in-class of 2-3% per foot of water
- **Moleaer delivers 17.5 lbs. of O_2 / HP-Hr**
  - Vs. best-in-class of 8 lbs of O_2 / HP-Hr
- **Moleaer nanobubbles exhibit an Alpha factor > 1**
  - Typical Alpha factor for fine bubble aeration: 0.4-0.6
- **Moleaer achieves 20% increase in dissolved oxygen 24 hours after aeration**
  - Indicates nanobubbles increase gas holding capacity of water

Conclusions

- ***"Moleaer's nanobubble generators provide the highest oxygen transfer efficiency of any aeration technology I have tested so far"*** *- Dr. Michael Stenstrom, UCLA*

Independent Validation

NANOSIGHT



	Control Sample	Aerated Sample
Line Color		
Concentration	83.8 Million	981 million
Mean size	122 nm	125 nm
Mode size	65 nm	82 nm

Test Overview

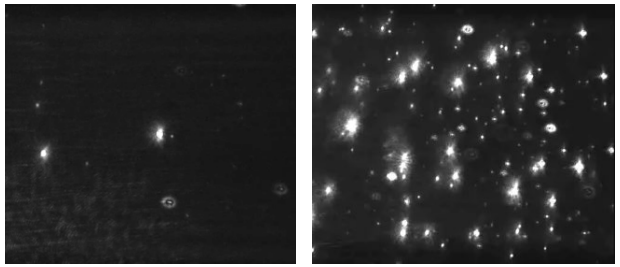
- NanoSight (Malvern) is regarded as the gold standard to detect the presence of nanobubbles
- Utilized independent lab "Particle Characterization Labs (PCL)" to conduct test
- Sent control and aerated samples to lab in September 2017

Key Findings

- Detected ~1B stable nanobubbles
- Nanobubbles detected 8-days after time of aeration, at which point the test was concluded

Conclusions

- *Moleaer's systems produce high concentrations of stable nanobubbles that remain suspended in saturated water indefinitely*



Images of Control vs. NB concentrated sample

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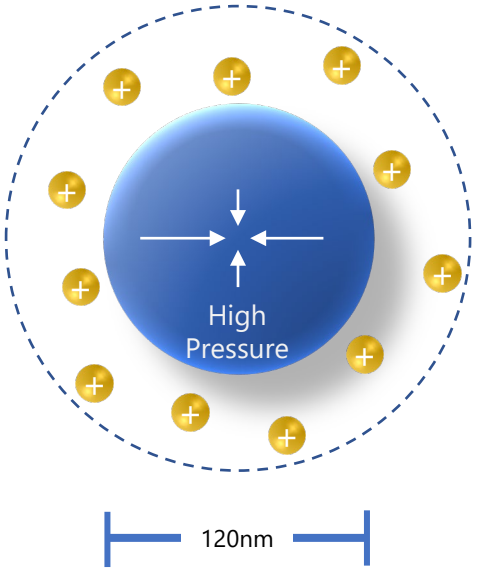
Report: Nanobubble Oxidation

Arizona State University

- Confirmed the generation of hydroxyl radicals, a reactive oxygen species (ROS), with Moleaer nanobubbles.
- Hydroxyl radicals create the nanobubble chemical-free oxidation.
- **Differentiates Moleaer nanobubbles from conventional gas injection and aeration.**

Nanobubble



+ Stimulus

- UV (Sunlight)
- Aeration
- Mixing

A stimulus can be any external force that causes the nanobubble to collapse.

Hydroxyl Radicals

- **Degrade algae and pathogens** by weakening the integrity of the cell.
- **Break down organics** such as algae toxins, taste and odor compounds, and emerging contaminants.

$$\cdot O-H$$

SOURCE: *Westerhoff, Paul. "Reactive Oxygen Species Testing of the Moleaer XTB 50 Nanobubble Generator", University of Arizona. 2020.*

Product Overview

Irrigation Water for Small-to-Medium Sized Greenhouses	Algae Treatment & Prevention for Source Water: Lakes, Ponds and Storage Tanks	Large-scale Greenhouses, Aquaculture Facilities and Food Safety Disinfection
Bloom™	**Clear™**	**Neo™**
		

Industrial Wastewater & Municipal-scale Aquatic Management	Industrial and Oil & Gas Processes	Off-shore Aquaculture, On-demand Treatment, Oil & Gas Produced Water	Nanobubbles for any Existing Pumping Process
Optimus™	**XTB™**	**Mobile NBG**	**Nexus™ (inline NBG)**
			

Industry Value Proposition for Developed Markets

Wastewater: Increase treatment capacity, improve discharge water quality
Customer ROI typically 6-24-months, depending on application and energy costs

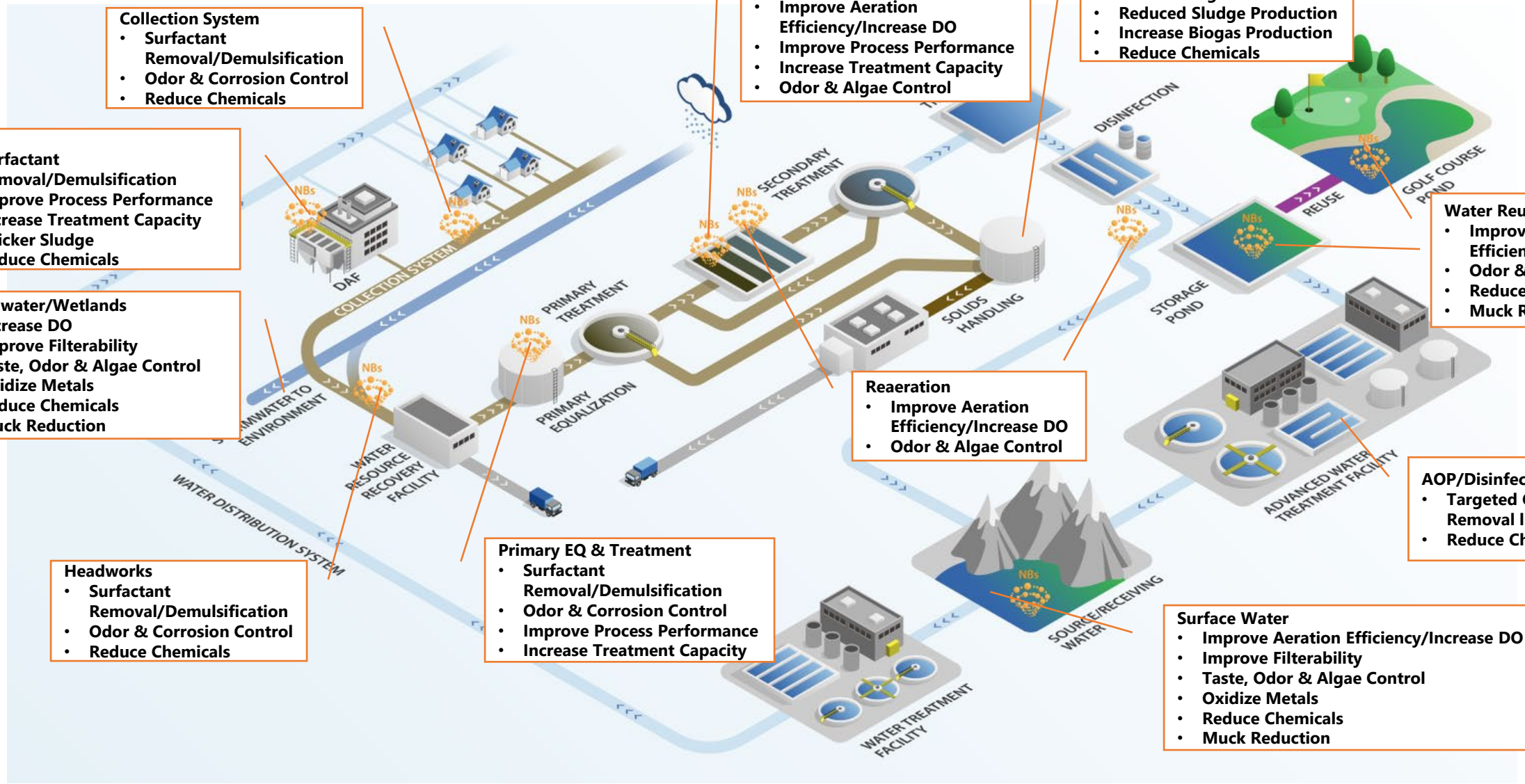
Surface Water: Chemical-free treatment to eliminate algae and other harmful contaminants.
Customer ROIs driven by cost of, or inability of, alternative solutions to treat water

Oil & Gas: Lower costs of produced water recycling; increase oil recoveries through EOR
Customer ROIs driven by well production and recovery rates

Irrigation: Improved water quality for healthier crops, less losses, higher yields.
Customer ROI typically 12-18-months, depending crop variety.

Aquaculture: Higher oxygen utilization, higher stocking densities, less disease.
Customer ROI typically 12-24-months, depending on Oxygen costs and additional NB benefits

Water/Wastewater Treatment: Where do Nanobubbles Add Value?



Collection System
- Surfactant Removal/Demulsification
- Odor & Corrosion Control
- Reduce Chemicals

DAF
- Surfactant Removal/Demulsification
- Improve Process Performance
- Increase Treatment Capacity
- Thicker Sludge
- Reduce Chemicals

Stormwater/Wetlands
- Increase DO
- Improve Filterability
- Taste, Odor & Algae Control
- Oxidize Metals
- Reduce Chemicals
- Muck Reduction

Headworks
- Surfactant Removal/Demulsification
- Odor & Corrosion Control
- Reduce Chemicals

Secondary Treatment
- Improve Aeration Efficiency/Increase DO
- Improve Process Performance
- Increase Treatment Capacity
- Odor & Algae Control

Primary EQ & Treatment
- Surfactant Removal/Demulsification
- Odor & Corrosion Control
- Improve Process Performance
- Increase Treatment Capacity

Solids Handling
- Reduced Sludge Production
- Increase Biogas Production
- Reduce Chemicals

Reaeration
- Improve Aeration Efficiency/Increase DO
- Odor & Algae Control

Water Reuse
- Improve Aeration Efficiency/Increase DO
- Odor & Algae Control
- Reduce Chemicals
- Muck Reduction

AOP/Disinfection
- Targeted Contaminant Removal like CECs
- Reduce Chemicals

Surface Water
- Improve Aeration Efficiency/Increase DO
- Improve Filterability
- Taste, Odor & Algae Control
- Oxidize Metals
- Reduce Chemicals
- Muck Reduction

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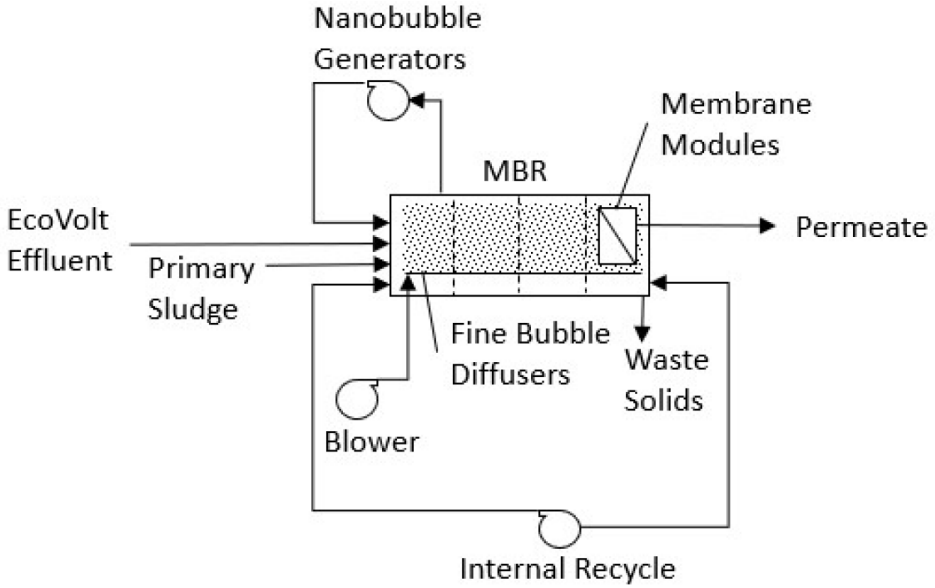
Case Study 1: Bear Republic Brewery MBR
Fine Bubble Aeration Supplemented with Nanoububbles

Operating with oxygen nanobubbles since October 2018



- ✓ Reduced Oxygen Requirements by 33%
- ✓ Increased Treatment Capacity by > 60%
  - ✓ Now also Treating Primary Sludge in MBR
- ✓ Increased Average MLSS by 70% to 12,000 mg/L
- ✓ Increased Treatment Capacity and Still Reduced OPEX by 11%
- ✓ Payback Period < 4 Years
- ✓ Eliminated Filamentous Bacteria Foaming Issues
- ✓ Eliminated Use of Chemical Defoamer
- ✓ Reduced Dewatering Polymer by 33% due to Improved Dewaterability
- ✓ Improved MBR Process Stability and Reliability

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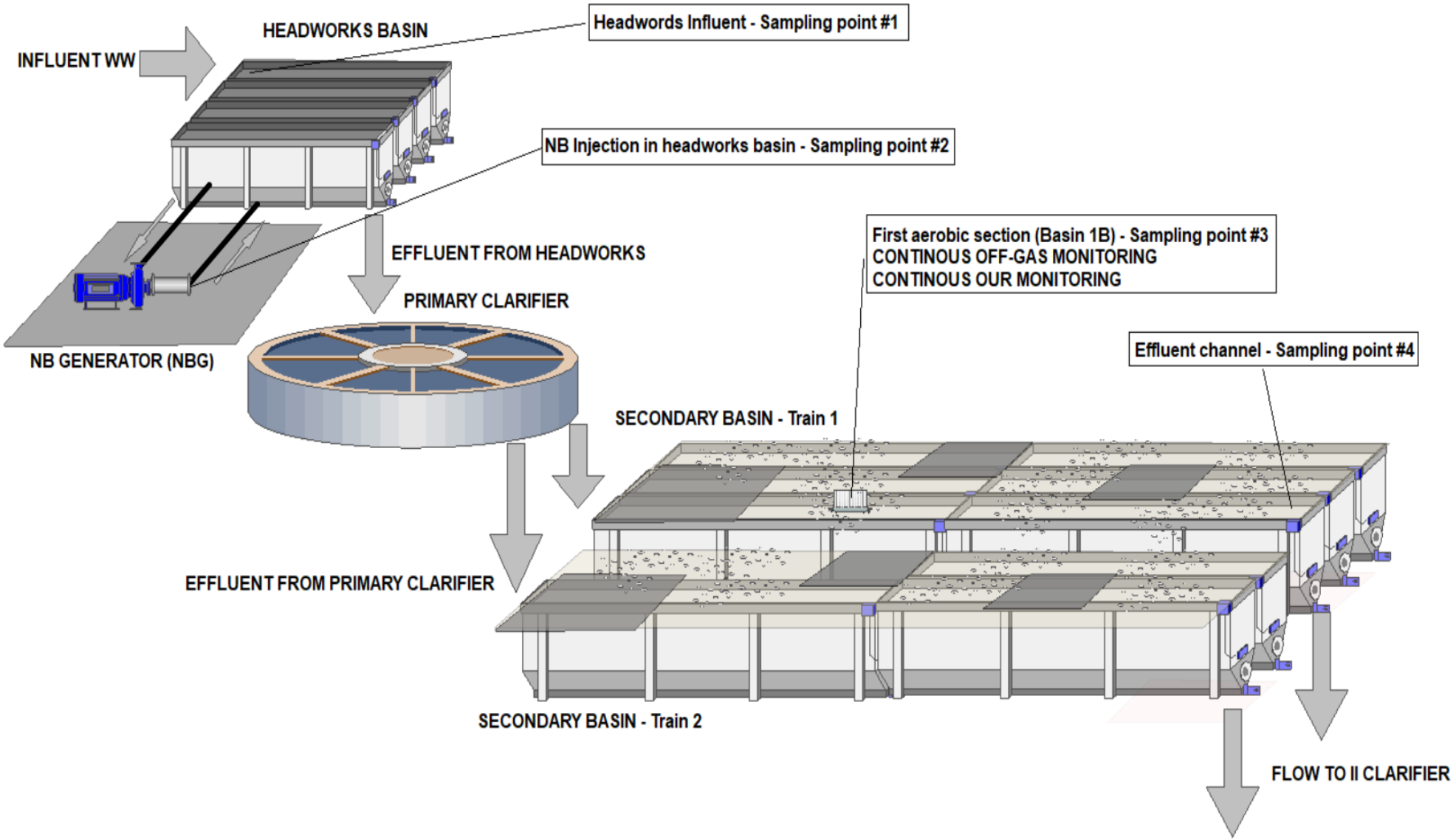
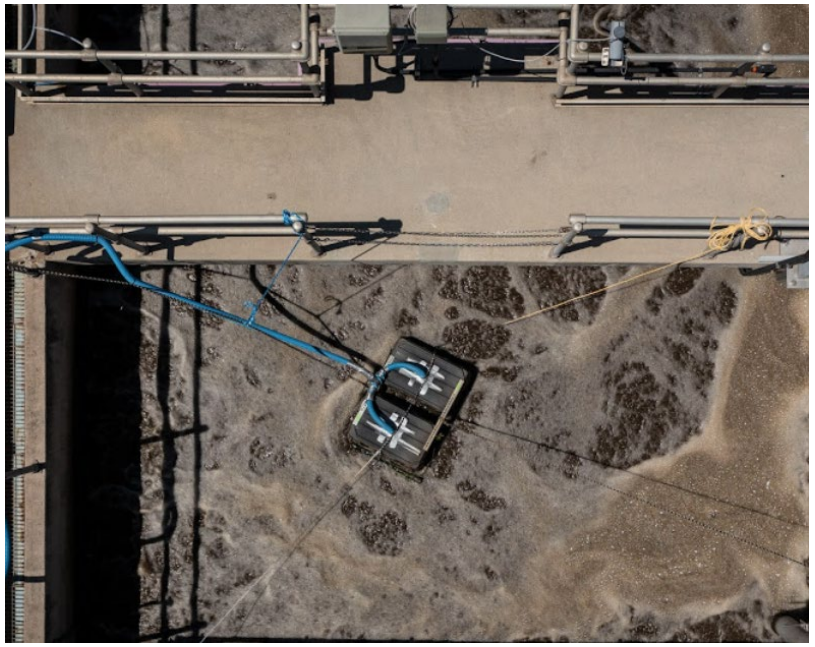
Case Study 2: Fallbrook WRRF#1
Nanobubble-enabled Surfactant Removal



Case Study 2: Fallbrook WRRF#1
Nanobubble-enabled Surfactant Removal (cont'd)



30-day Pilot Operated with Air Nanobubbles

- ✓ **Reduced Organic Load to Secondary Process**
- ✓ **Reduced Quaternary Ammonia Compounds by >20%**
- ✓ **Increased Secondary Process Aeration Efficiency by 45%**
- ✓ **Increased Oxygen Transfer Rate by 61%**
- ✓ **Improved Biomass Kinetics by 25%**
- ✓ **Increased Nitrification Rate by 22%**
- ✓ **Increased Treatment Capacity by 25%**
- ✓ **Payback Period 6 to 18 Months Depending on Permanent Install Location**

How Can WRF Help?

Nanobubbles:

- Are hydrophobic,
- Have a strong negative surface charge,
- Exhibit prolonged stability in 'dirty' water,
- Can behave like a solid nanoparticle,
- Exhibit selective contaminant removal,
- May cause phase change, and
- May enable precision separations

The fundamental behavior of nanobubbles needs to be further researched to determine which contaminants nanobubbles effectively remove and which water treatment processes they improve.

Specifically, Moleaer needs to better understand:

1. The phenomenon occurring at the interface of nanobubbles with surfaces and contaminants in water environments, and
2. Whether the properties of contaminants and surfaces relative to those of nanobubbles govern their interactions. Properties may include:
    - Water solubility
    - Water surface tension
    - Polar/ionic character
    - Octanol/water partition coefficient
    - Acid/base chemistry
    - Oxidation/reduction chemistry
    - Electrochemistry

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February 2021

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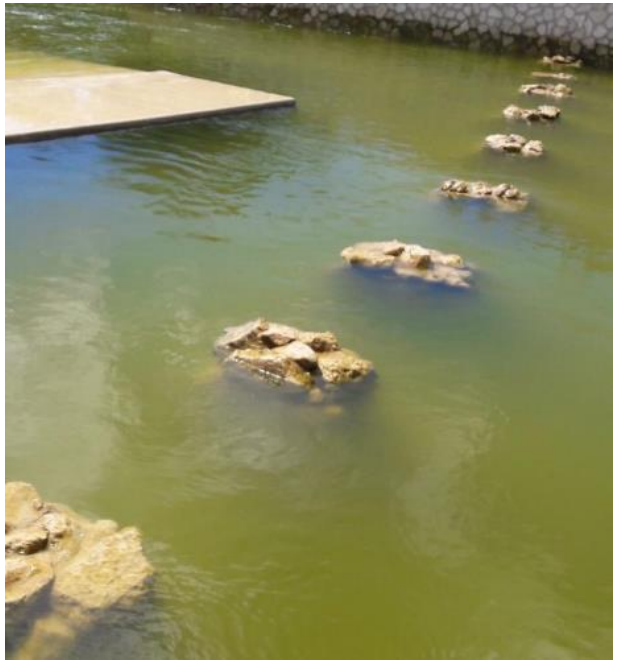
Thank You

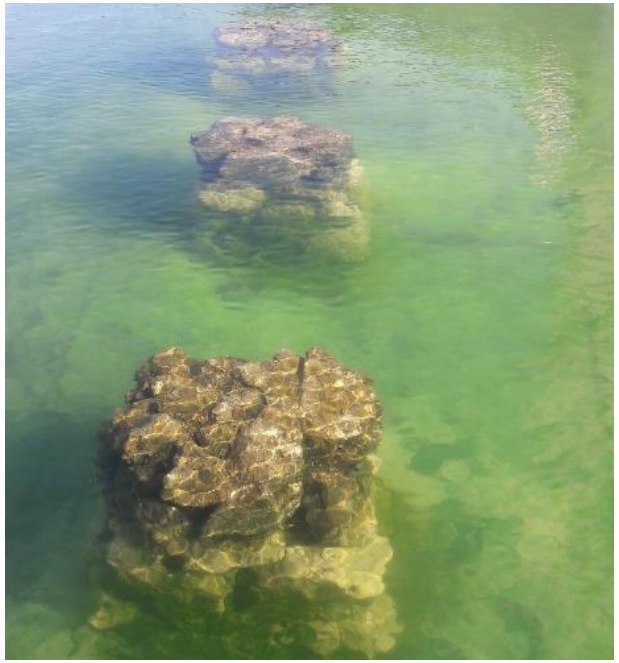
Case Study: Waterpark Aquatic Treatment

Xoximilco, Cancun, Mexico - 27 acre-ft, 8.7M gallons

Nanobubbles reduced suspended algae and biofilms



Prior to Installation



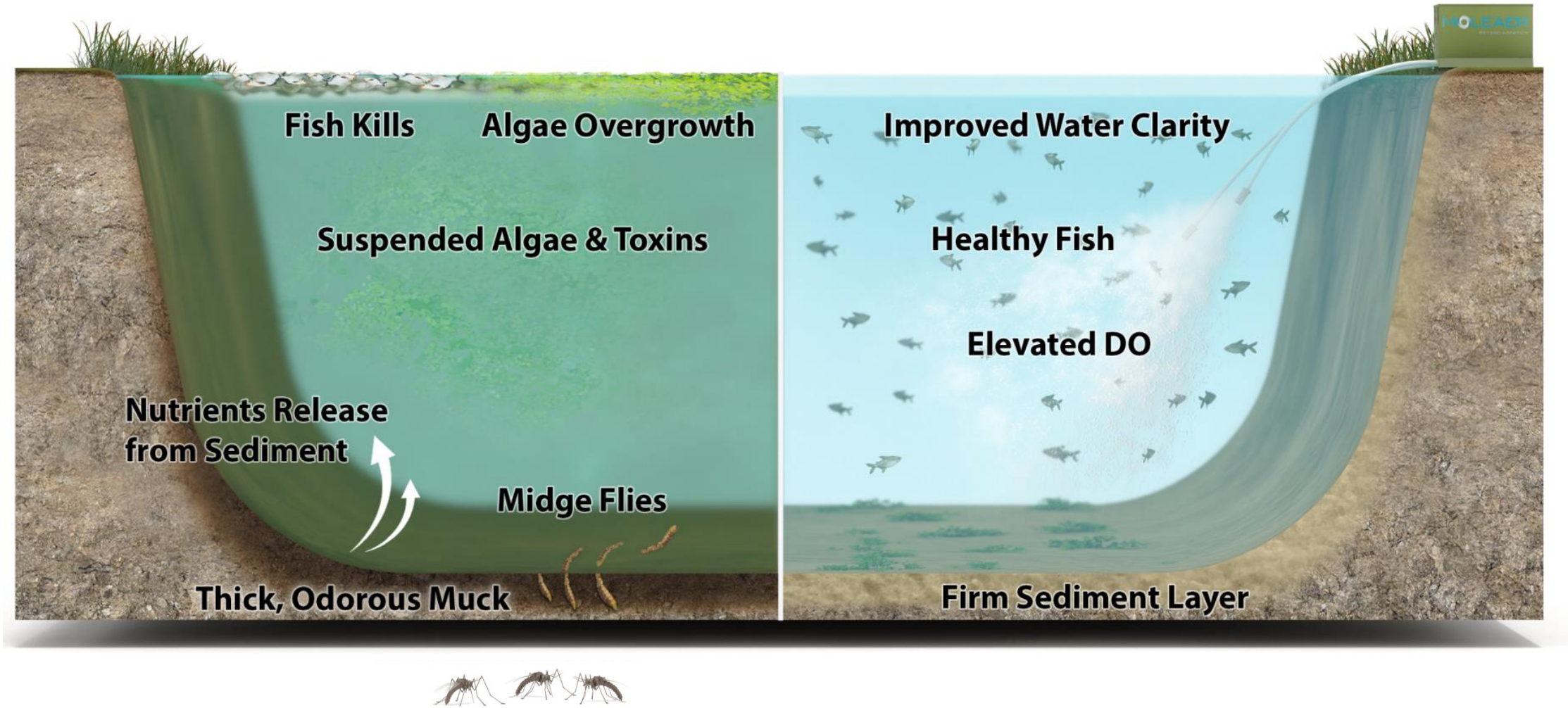
5 weeks after install

8 weeks after install

Nanobubbles Address Algae and Overall Waterbody Health

Untreated

Nanobubble Injection



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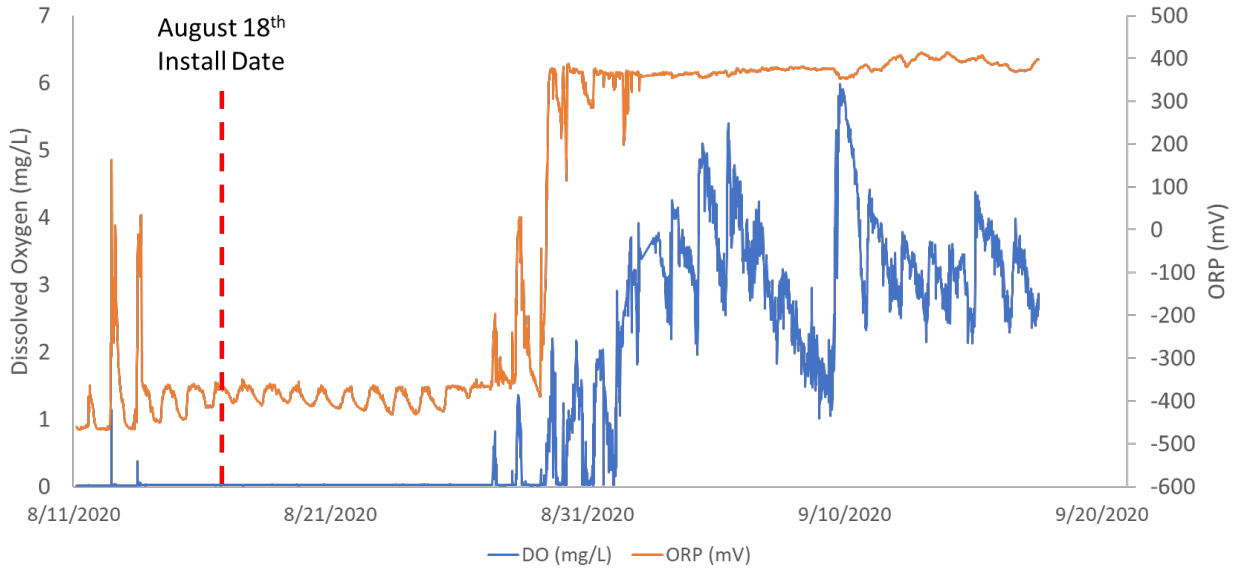
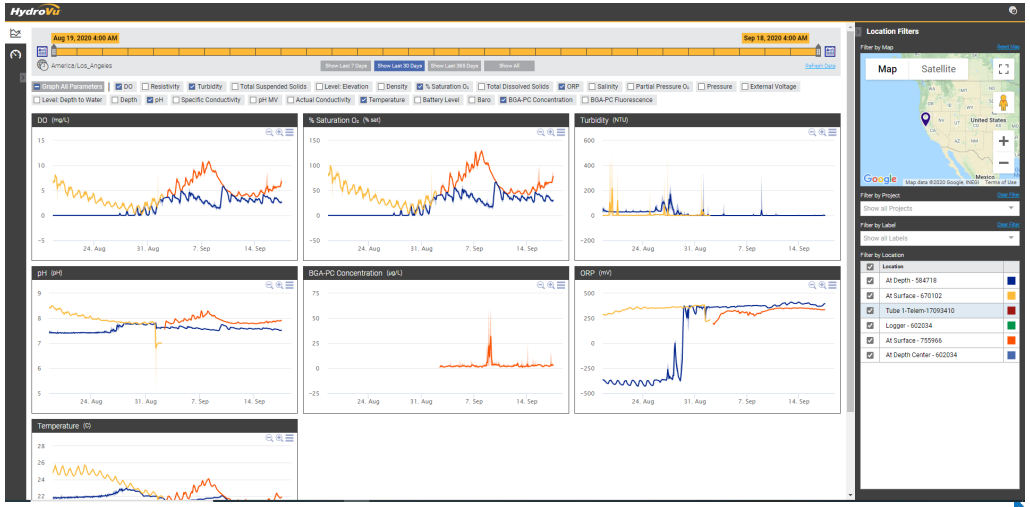
Aquatic Management: How Nanobubbles Add Value in Surface Waters

	Pain Point(s)	Moleaer Nanobubble Solution
Algae Control	**Persistent Algae Blooms**	• A demonstrated control and mitigation strategy for blue-green, green, and other algae species.
	Excessive Chemical Usage	• Moleaer nanobubbles are a chemical-free algae control solution utilizing only air and/or oxygen.
Ecosystem Health	**Low Hypolimnetic (Deep Water) Oxygen Levels**	• Efficiently increase oxygen levels at depth without breaking thermoclines.
	High Nutrient & Metal Levels	• Provide oxygen to the sediment to sequester nutrients (nitrogen & phosphorus) and metals.
	Odor Complaints	• Address the root cause of odor by reducing algae and odor causing bacteria.
	Fish Kills	• Improve fish habitat and avoid low oxygen during summer and algae bloom periods. • Oxygenate without disrupting stratification.
	Poor Sediment "Muck" Quality	• Promote beneficial bacteria that breakdown muck layer.

Mobile + Monitoring Solutions

East Bay Parks, California lake with known Cyanobacteria (toxic) algae blooms. Installed two mobile systems & sensors to treat and monitor lake

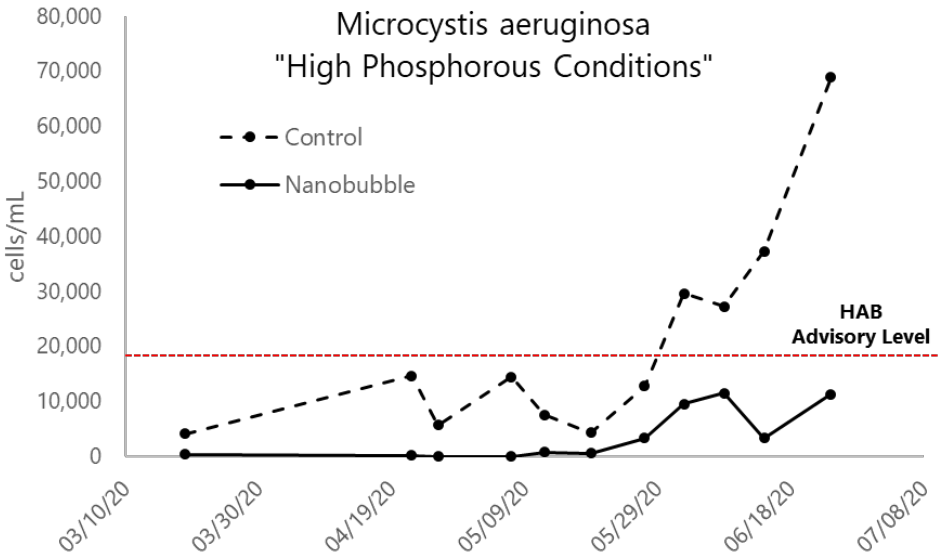




University Study & Case Study : Algae Control

UNIVERSITY OF GEORGIA

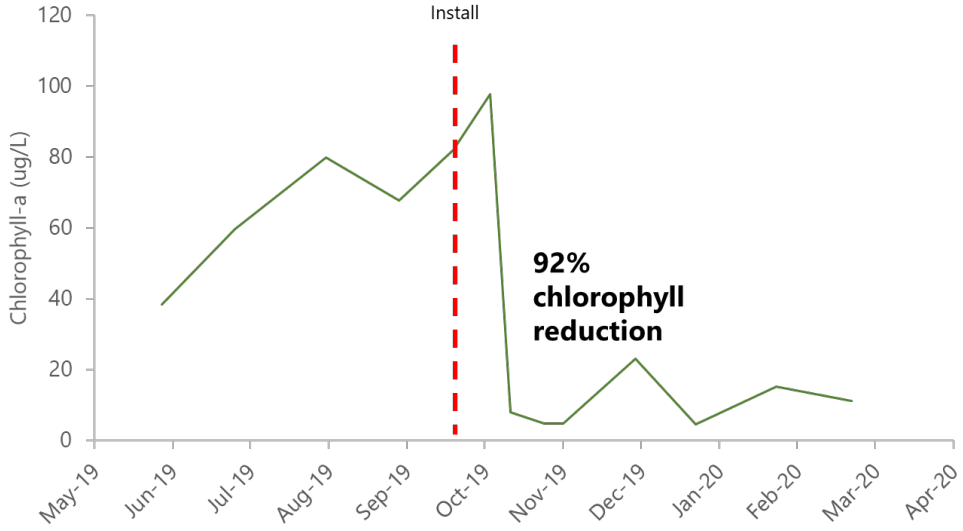
Nanobubbles were compared to control ponds to study reduction in Microcystis (HAB)



** No impact on zooplankton was observed.*

SOURCE: *Burtle, Gary "Oxygen and Phytoplankton in Earthen Ponds Treated with Nanobubbles: Preliminary Report 8/12/2020", University of Georgia. 2020.*

26-Acre Community Lake in Fort Myers, FL



*Chlorophyll indicates algae concentration
*Data collected by Florida Pond Watch Citizen Monitoring Program

Before

1-Month After Install

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