Water Softeners and Wastewater Treatment Systems

Mark Gross, PhD, P.E.
Training Manager, Orenco Systems®, Inc.

The Concern:

Does water softener backwash brine affect wastewater treatment system performance?

Research That Says "No"

- Corey and Tyler, 1998: Brine doesn't seem to hurt the soil absorption system
  - Note that this study focuses on the soil component

Research That Says "No"

- NSF Report on Aerobic Treatment Units: There is little impact of brine on ATUs
  - Note that this test and report address aerobic treatment units over a short period of testing

Research That Says "No"

- Canadian Field Study: No significant difference in septic tank performance with or without water softener backwash
  - Note that this study did not address watertightness of the tanks

Research That Says "Yes"

- Metcalf and Eddy, 4th Ed., 2003: Sodium concentrations over 3500 mg/L inhibit anaerobic treatment
- Metcalf and Eddy, 4th Ed, 2003 : Chloride inhibits autotrophic microorganisms at 180 mg/L and above
- Winneberger, 1984: Study shows stratification in a septic tank receiving water softener backwash brine that includes 2 lb salt/week

How Do Water Softeners Work?

- A media (resin) is saturated with sodium using a saturated sodium chloride (salt) solution
- As the hard water is passed over the media, the sodium is exchanged for the divalent metal cations (calcium, magnesium, ferrous iron)
- When the sodium is exhausted, the media is backwashed and regenerated with a saturated salt solution

So What Is The Problem?

- ***Softened water is not a problem***
- The strong concentration of salt in the backwash brine is the concern

How Much Salt Is Added To The Tank?

- Two kinds of water softeners
  - ~ Time Clock Softener
    - 12 pounds of salt in 112 gallons of backwash water
    - Regenerates about 15 times per month (every other night)
  - ~ Demand-Initiated Regeneration (DIR) Softener
    - 6 pounds of salt in 38 gallons of backwash water
    - Regenerates once or twice per week

Stratification in Septic Tank
From Water Softener Backwash Brine

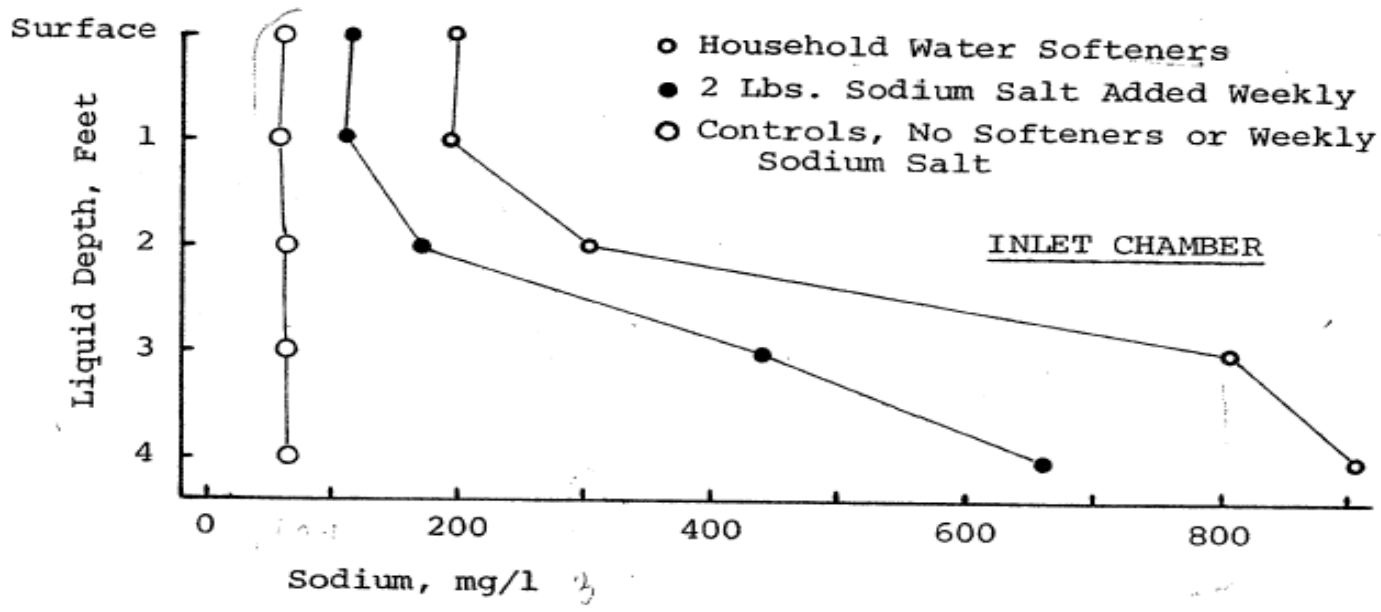


Figure 6. Sodium profile, mean of three septic tanks per treatment.

From: Winneberger, J.H.T., Septic Tank Systems, A Consultant's Toolkit, Butterworth Publishers, Boston, 1984

Results from Virginia Testing Program

- 18 systems in three soil types
  - ~ Clay to silt loam
- Quarterly samples for $cBOD_5$, TSS, turbidity, NH_3-N, TKN, NO_3-N, TN, Cl^-, alkalinity, E. coli
- Grab samples taken by commercial laboratories approved by Virginia Department of Natural Resources
- Samples taken from ...
  - ~ Processing (recirculation) tank
  - ~ AdvanTex® filter pod effluent
  - ~ Lysimeters

AdvanTex® Performance in VA (w/o softeners)

	Min.	Max.	Mean	Median	σ, All	σ, w/o Softeners
$cBOD_5$, *mg/L*	< 2	33	4.7	3	13.31	6.7
TSS, *mg/L*	< 2	46	6.9	5	10.04	7.4
Turbidity, *NTU*	0.05	20	1.6	1	3.8	2.9
TKN, *mg/L*	0.1	39	5.0	3	15.29	7.7
NH_3-N, *mg/L*	0.1	64.9	1.8	0	11.7	8.3
NO_3-N, *mg/L*	0.8	69.9	12.2	7	12.05	13.2
TN, *mg/L*	0.2	81.8	15.6	12	19.17	16.2
CL^-, *mg/L*	10.0	166	58.1	50	706.26	32.0
Alk, *mg/L as* $CaCO_3$	11.0	486.0	161.0	158	185.68	77.6
E. coli, *mpn/100mL*	< 1	> 24,000	5008	840	12,141.41	12,700

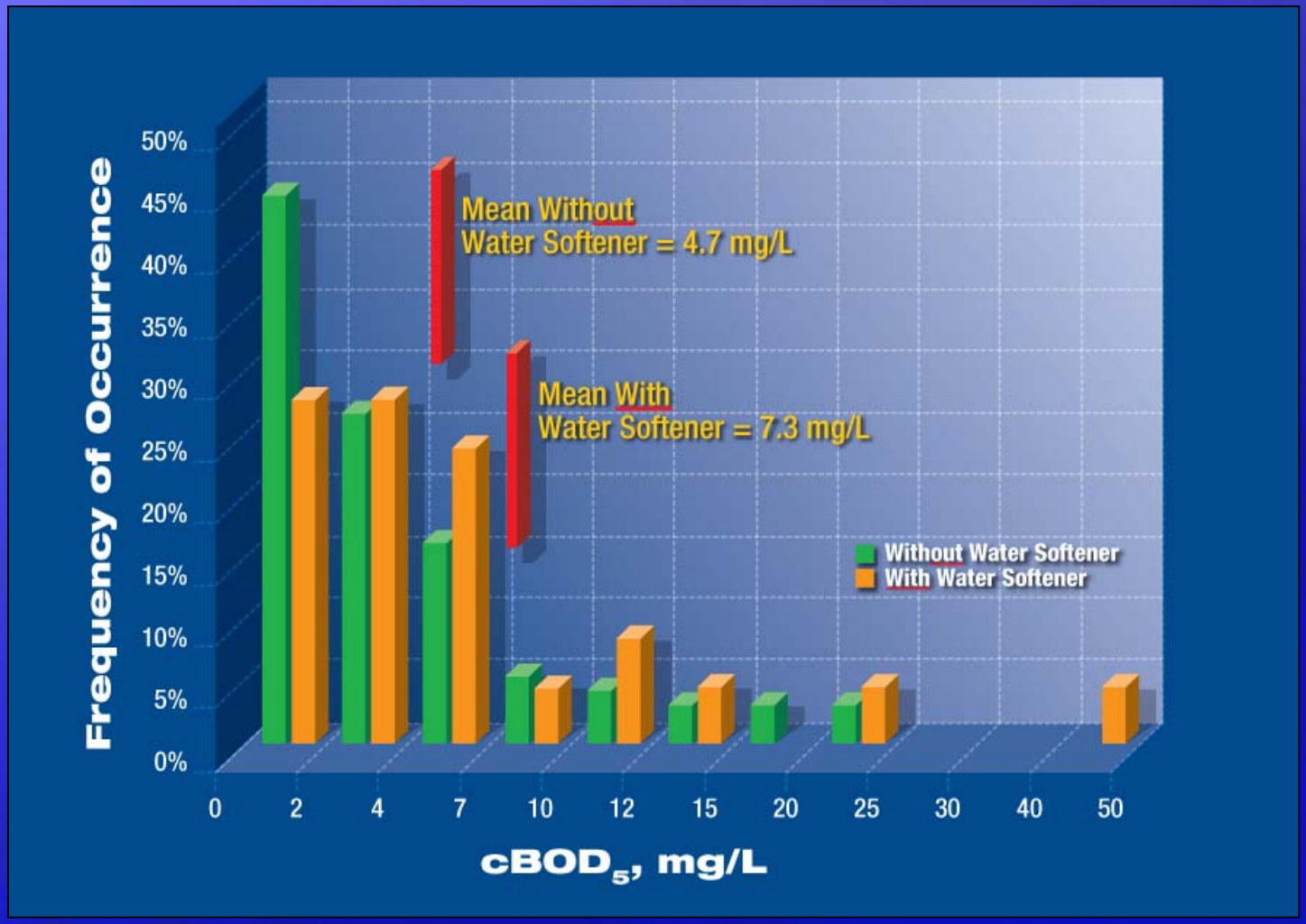
AdvanTex® Performance in VA (w/ softeners)

	Min.	Max.	Mean	Median	σ, All	σ, w/ Softeners
$cBOD_5$, *mg/L*	< 2	79	7.3	4	13.31	17.8
TSS, *mg/L*	1	60	9.8	8	10.04	9.3
Turbidity, *NTU*	0	26.5	2.1	1	3.8	3
TKN, *mg/L*	< 0.2	105	9.1	4	15.29	21.7
NH_3-N, *mg/L*	< 0.2	52.0	6.3	2	11.7	12.8
NO_3-N, *mg/L*	1.3	33.8	8.4	6	12.05	7.7
TN, *mg/L*	< 0.2	116	19.9	14	19.17	23.8
CL^-, *mg/L*	47	10,900	1207	1000	706.26	1014
Alk, *mg/L as* $CaCO_3$	57	2000	177	180	185.68	353
E. coli, *mpn/100mL*	< 1	> 24,000	7957	1600	12,141.41	10,250

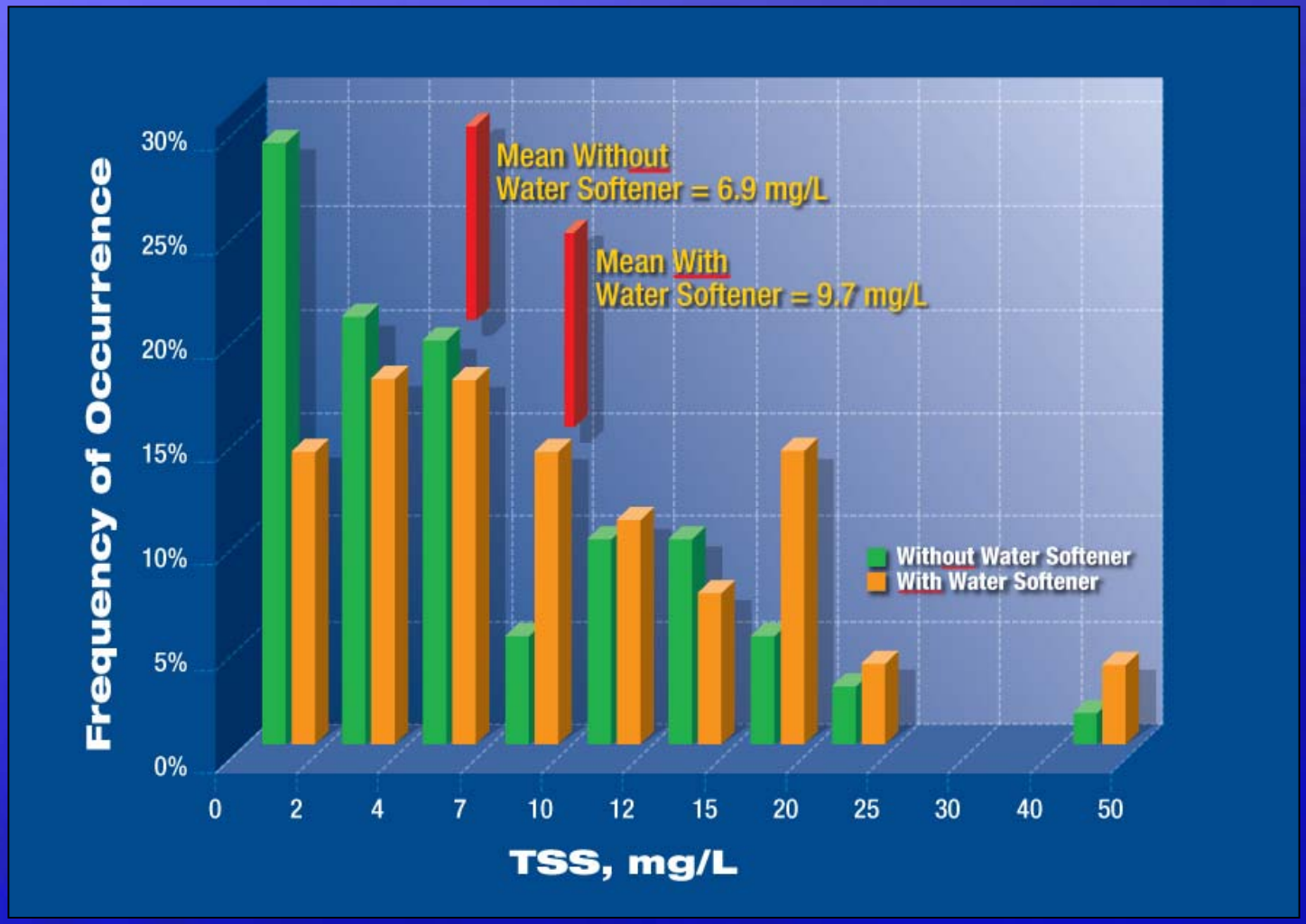
Statistical Comparison

	Systems w/o WS Brine		Systems w/ WS Brine	
	Mean	Std. Dev.	Mean	Std. Dev.
$cBOD_5$, *mg/L*	4.7	6.7	7.3	17.8
TSS, *mg/L*	6.9	7.4	9.8	9.3
Turbidity, *NTU*	1.6	2.9	2.1	3
TKN, *mg/L*	5.0	7.7	9.1	21.7
NH_3-N, *mg/L*	1.8	8.3	6.3	12.8
NO_3-N, *mg/L*	12.2	13.2	8.4	7.7
TN, *mg/L*	15.6	16.2	19.9	23.8
CL^-, *mg/L*	58.1	32.0	1207	1014
Alk, *mg/L as* $CaCO_3$	161.0	77.6	177	353
E. coli, *mpn/100mL*	5008	12,700	7957	10,250

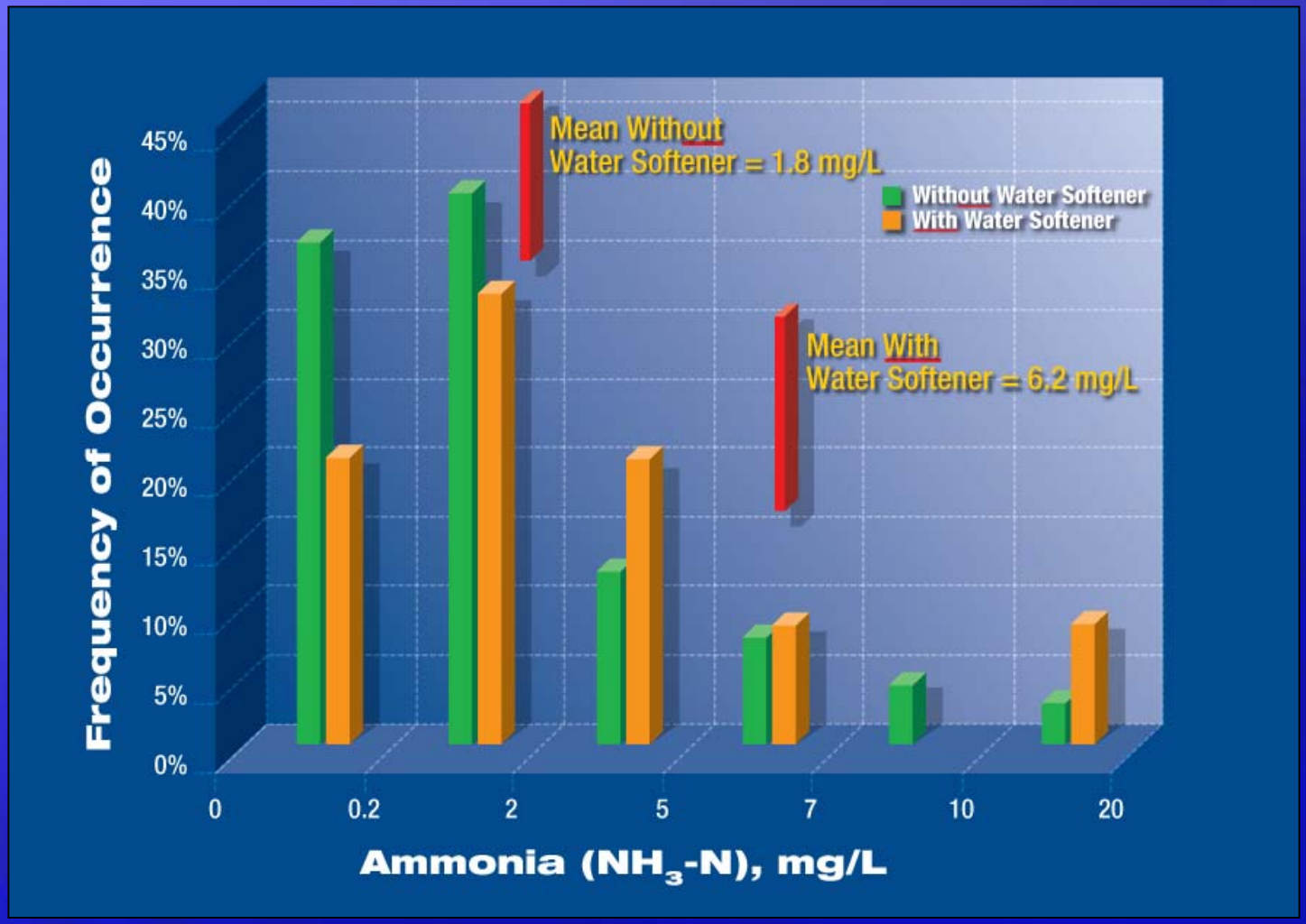
Effects of Water Softener Brine on cBOD



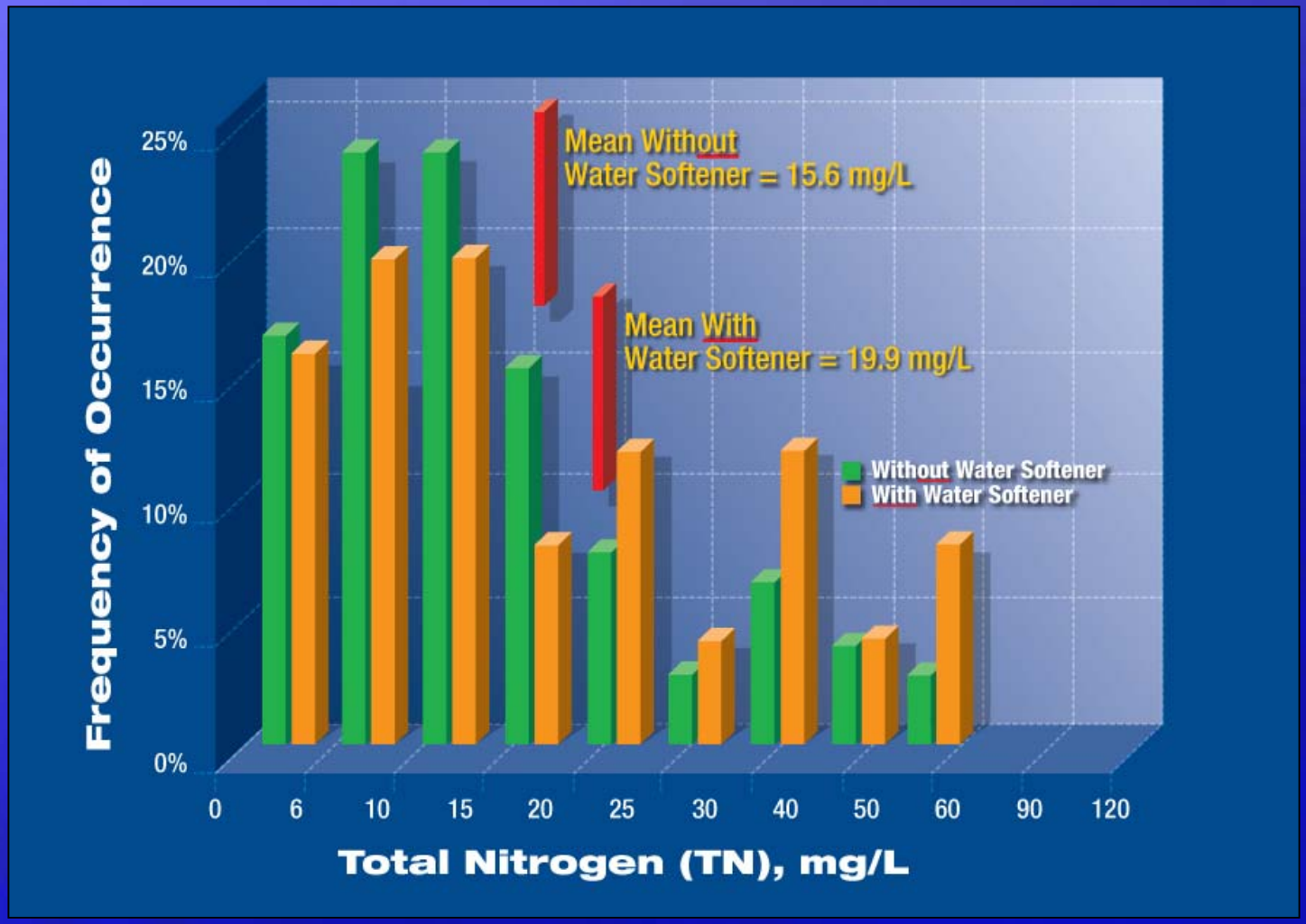
Effects of Water Softener Brine on TSS



Effects of Water Softener Brine on NH_3-N

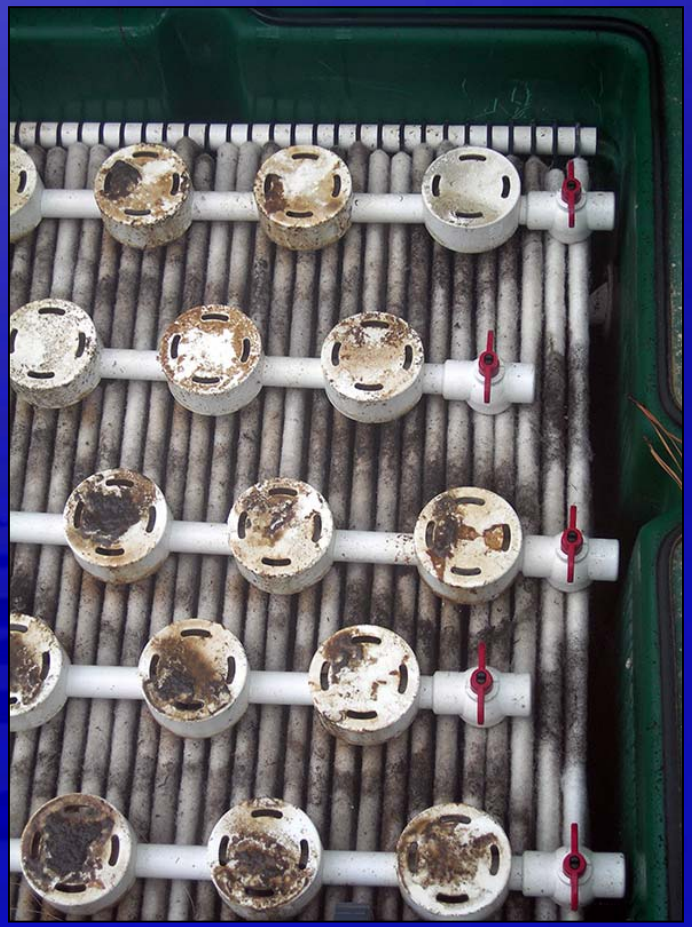


Effects of Water Softener Brine on TN



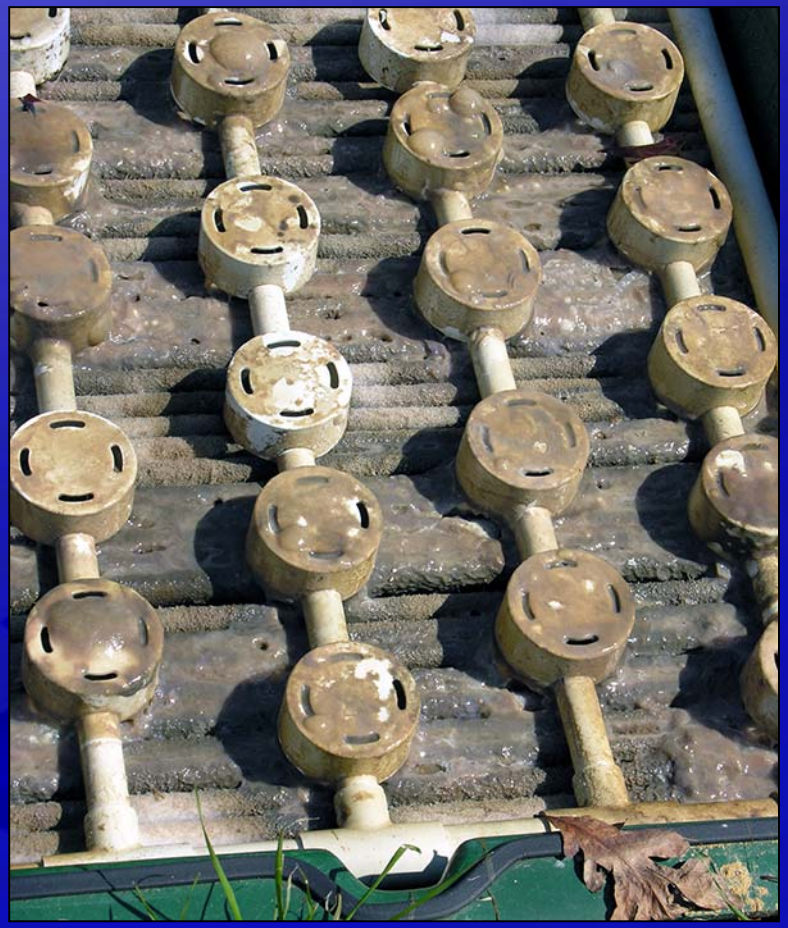
Biomat Development Without Backwash Brine

- Virginia Demonstration Project, 4581 Waterside Drive, Lanexa



Biomat Development With Backwash Brine

- Virginia Demonstration Project, 3815 Summit Crossing Rd



Filter Receiving Backwash Brine

- Shale from a gravel filter that expanded and cemented together in less than a year as a result of backwash from a water softener

Photo courtesy of Rich Piluk, Maryland Department of Health

Chamber System in a Montana Mound

Wiedebush/Lenty
Shared Sand Mound
April 2006

Constructed 2000

with water softener

without water softener

Gelatinous Material From Effluent

With a Water Softener On The System

Inside a Chamber Receiving STE
With Water Softener Backwash Brine

Trench Bottom Media From STE
with Water Softener Backwash Brine

Slime in Trench

Slimy Crust in Trench

Slimy Crust in Trench

Important Note ...

- For watertight tanks, there is no dilution from groundwater
- The discussion and calculations presented here begin with the assumption that the tanks are watertight

Ten of the Major Treatment Systems
Have Prohibitions Against Water Softener Backwash

- Ecological Tanks, Inc. – Aqua Aire
- Ecological Tanks, Inc. – Aqua Safe
- Bio-Microbics, Inc. – FAST
- Hoot Aerobic Systems, Inc. – Hoot Aerobic Treatment Systems
- Jet, Inc. – Jet Series 1500 BAT Media Plants
- Consolidated Treatment Systems, Inc. – Multi-Flo
- Consolidated Treatment Systems, Inc. – Nayadic
- Delta Environmental Products, Inc – Whitewater
- Orenco – AdvanTex

Video of Experiment

- Brine introduced to the tank
- Effluent introduced to the tank
- Second brine discharge. Second layer forms below the first
- More effluent enters the tank
- Sludge simulation with brine entering the tank
- Second brine discharge floats sludge layer

Solutions for Decentralized Wastewater Treatment

Orenco Systems®, Inc.

www.orenco.com