Managing water to optimize performance

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Fact : Water is the most important nutrient !!
Compromise quality and quantity = increase risk for challenges which leads to poor performance

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Water Sanitation is An Insurance Policy

- Water supplies are like flies and rodents-can harbor almost EVERY pathogen challenge

Short list of pathogens isolated from poultry water supplies

- Cholera/Bordetella
- Pseudomonas
- E. coli
- Campylobacter
- Klebsiella pneumoniae
- Avian Influenza
- Salmonella (1700 species)
- Staph, Strep. …….

City water/Reverse Osmosis water

- No guarantee water is pathogen free-
  the nature of poultry operations invites recontamination
- No guarantee water will remain pathogen free

Dirty water systems means biofilm- a place for pathogens to thrive

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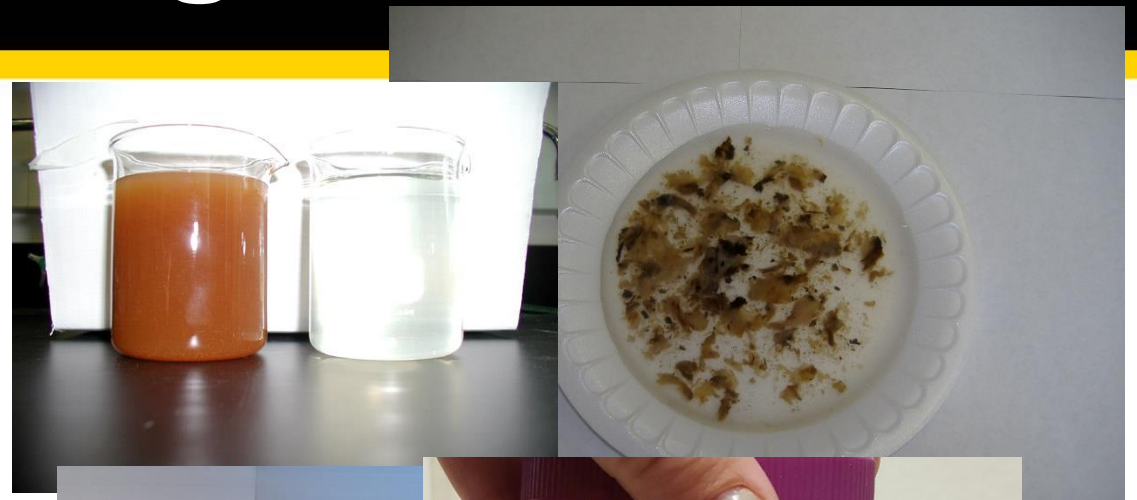
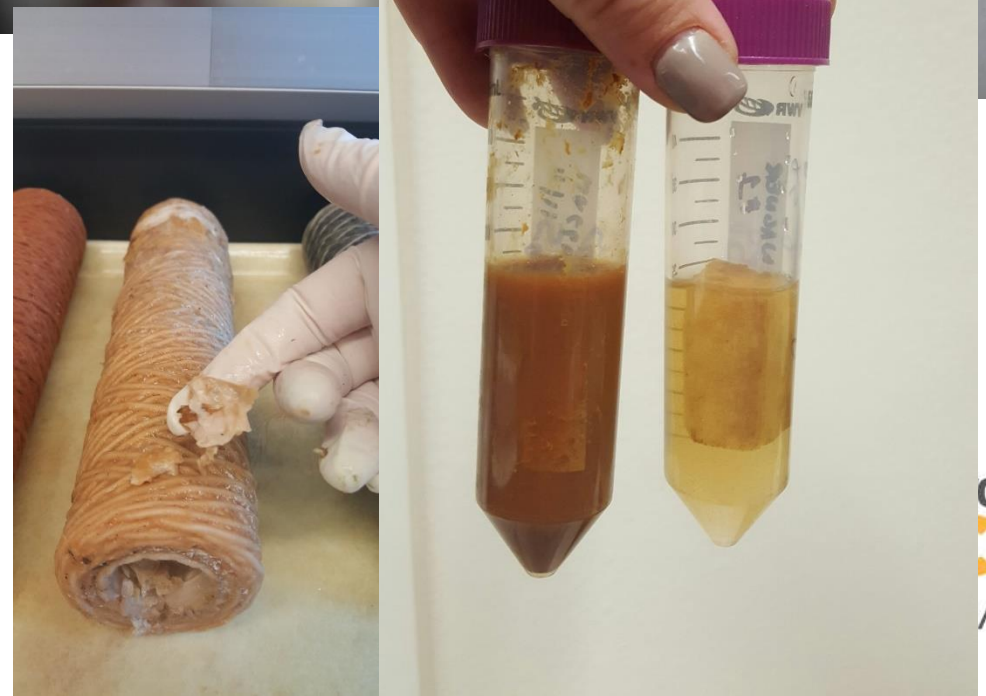
Water is Perfect Carrier of Health Challenges

Poultry drinking systems easily contaminated

- Water slow moving/warmed
- Water lines have many hiding places-pinch points
- Water often contains food the organisms need
- We add food-vitamins, organic acids





Proven Facts

Clean pipes can rebuild biofilm in 3-5 days if poor quality water is re-introduced

- Systems need line cleaning AND daily sanitation

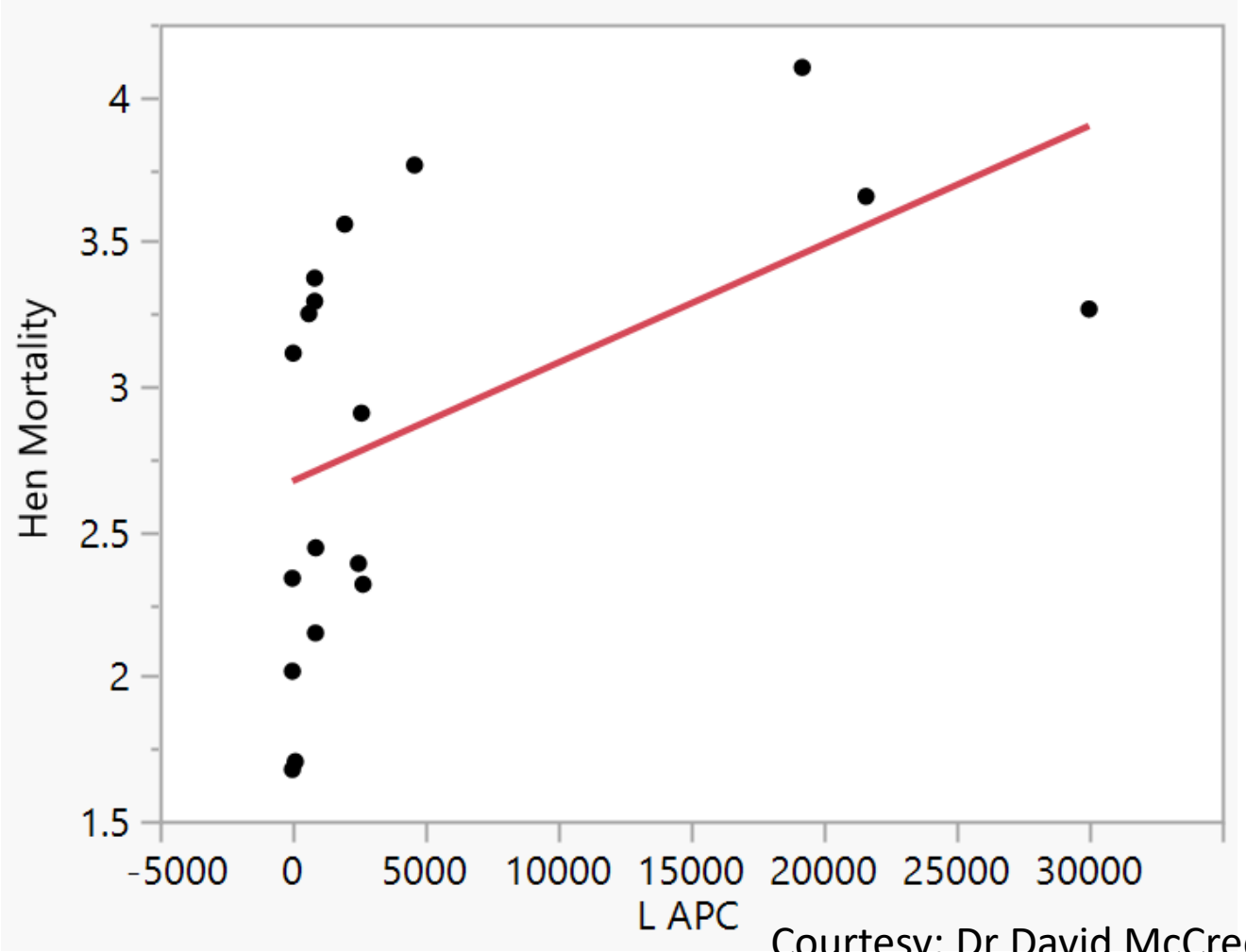
If E. coli is introduced into the water systems, can incorporate into the biofilm

- Problems can get introduced, water sanitation reduces the risks opportunistic pathogens create

Total Bacteria Inexpensive Quality Assurance Test > 10,000 cfu/ml-potential problem

Farm	Source	End of Line in Poultry Barn
	colony forming units of Bacteria/ml	
A	2,700	26,600
B	203,000	2,340,000
C	0	4,775,000
D	0	0

Correlation of Drinking Water Bacteria to Hen Mortality (Log10 Aerobic Bacteria)



Courtesy: Dr David McCreery, Pilgrim's Pride

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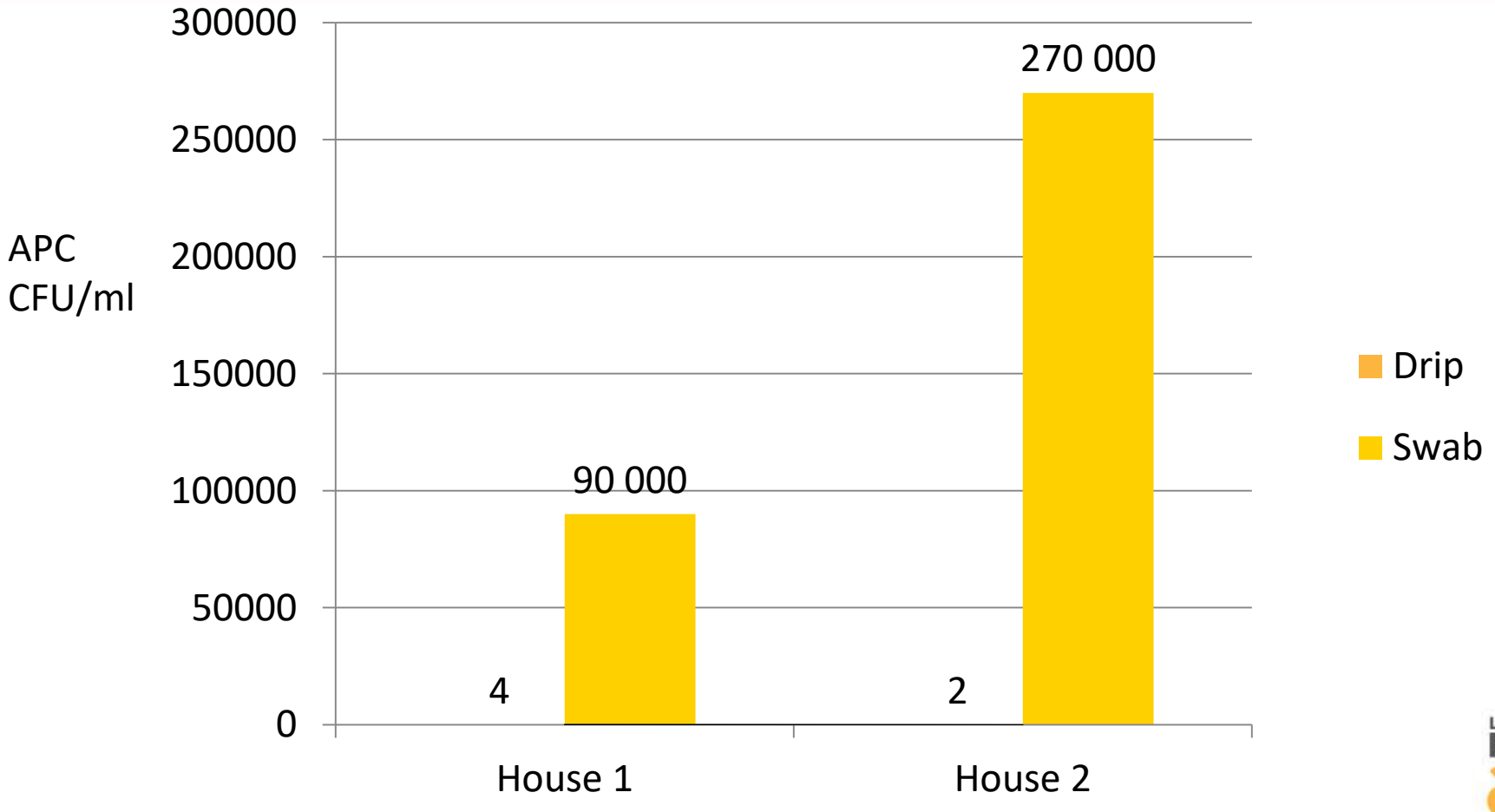
Even more Accurate for Problem Solving Line Swab Procedure

Drip sample may not always reflect what's present in the lines-swab inside of the line at end of line

Drip Versus Swab Sampling for Evaluating Water Lines



Farm using gas chlorine- drip samples were acceptable but swab showed lines full of biofilm

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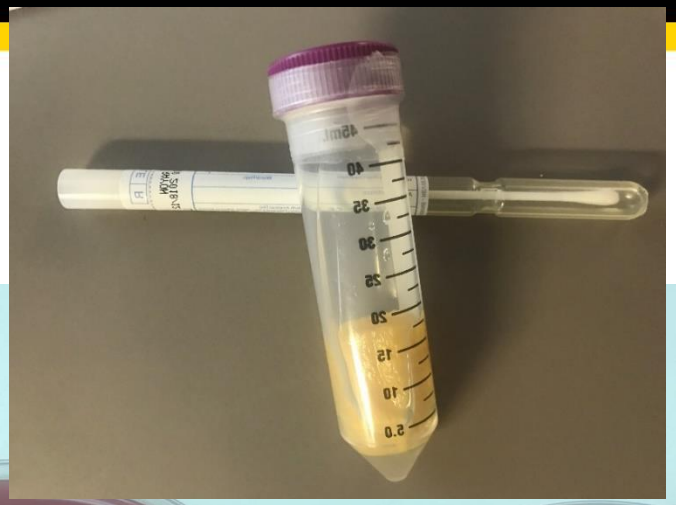
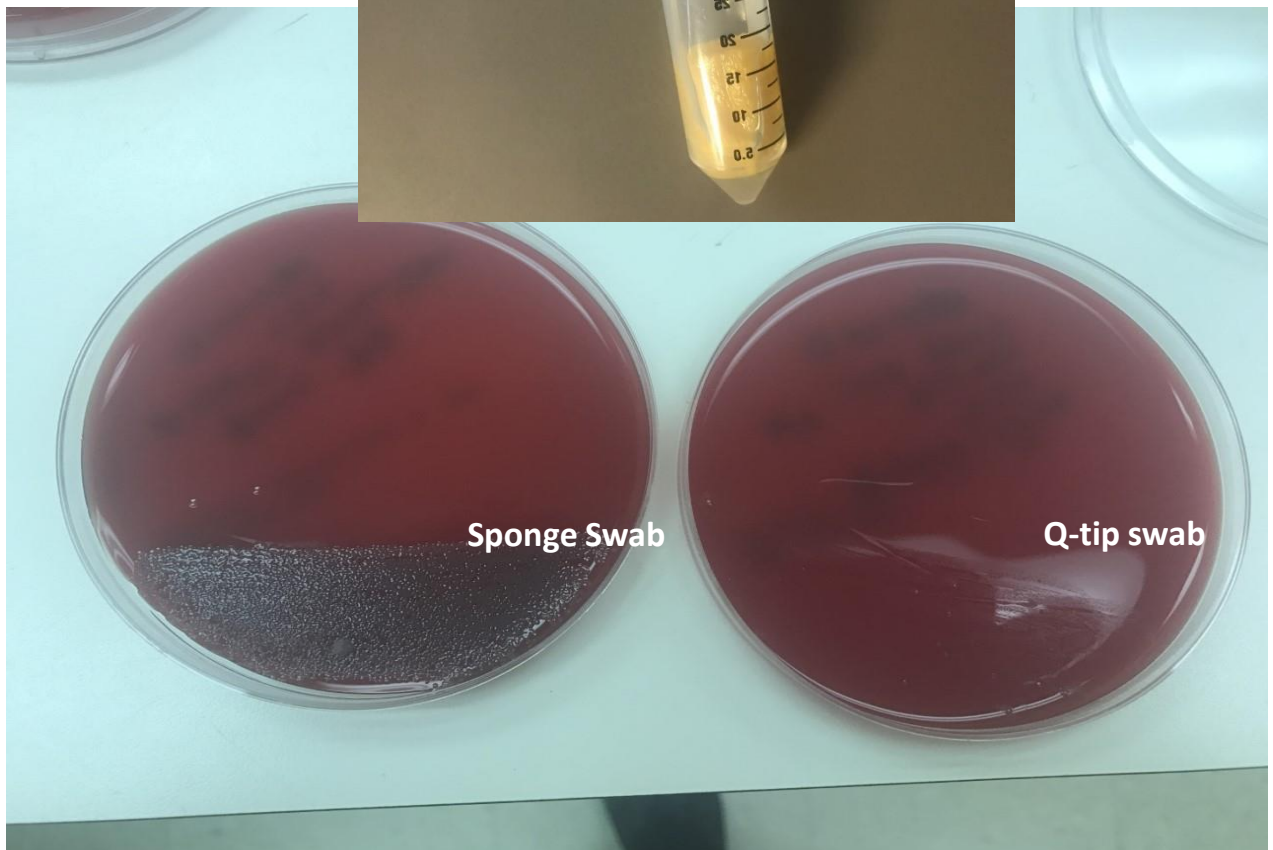
Use a swab that will thoroughly wipe the surface





Tested inside of line leaving the holding tank
Loaded with Bordetalla but not
detected by culture swab

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Monitoring Water System With Drip and Swabs Helps Identify Weaknesses

Source	Drip/Swab	APC (aerobic) (CFU/ml)	Yeast	Mold	E. Coli
House 1	Drip	20	0	0	0
House 1	Swab	154,000	0	11	0
House 2	Drip	1	0	0	0
House 2	Swab	9,100	0	7	0
House 3- Control Room	Drip	1	0	0	0
House 3- End of Line	Drip	72	3	1	0
House 3	Swab	291,000	310	290	0
House 4	Drip	1	0	0	0
House 4	Swab	1,130	675	65	0

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Add dye to water
line cleaning products to
assure it is in the system
or completely removed

Even good products have limits in tough situations

Product	Pre Bacteria cfu/ml	48 Hours Post Cleaning Cfu/ml
50% H2O2- 3% solution	155,000	530
	579,000	43,000
	603,000	10,200
	164,000	23,3000

Don’t let biofilm rebuild-Flush system with sanitizer at a level safe for birds

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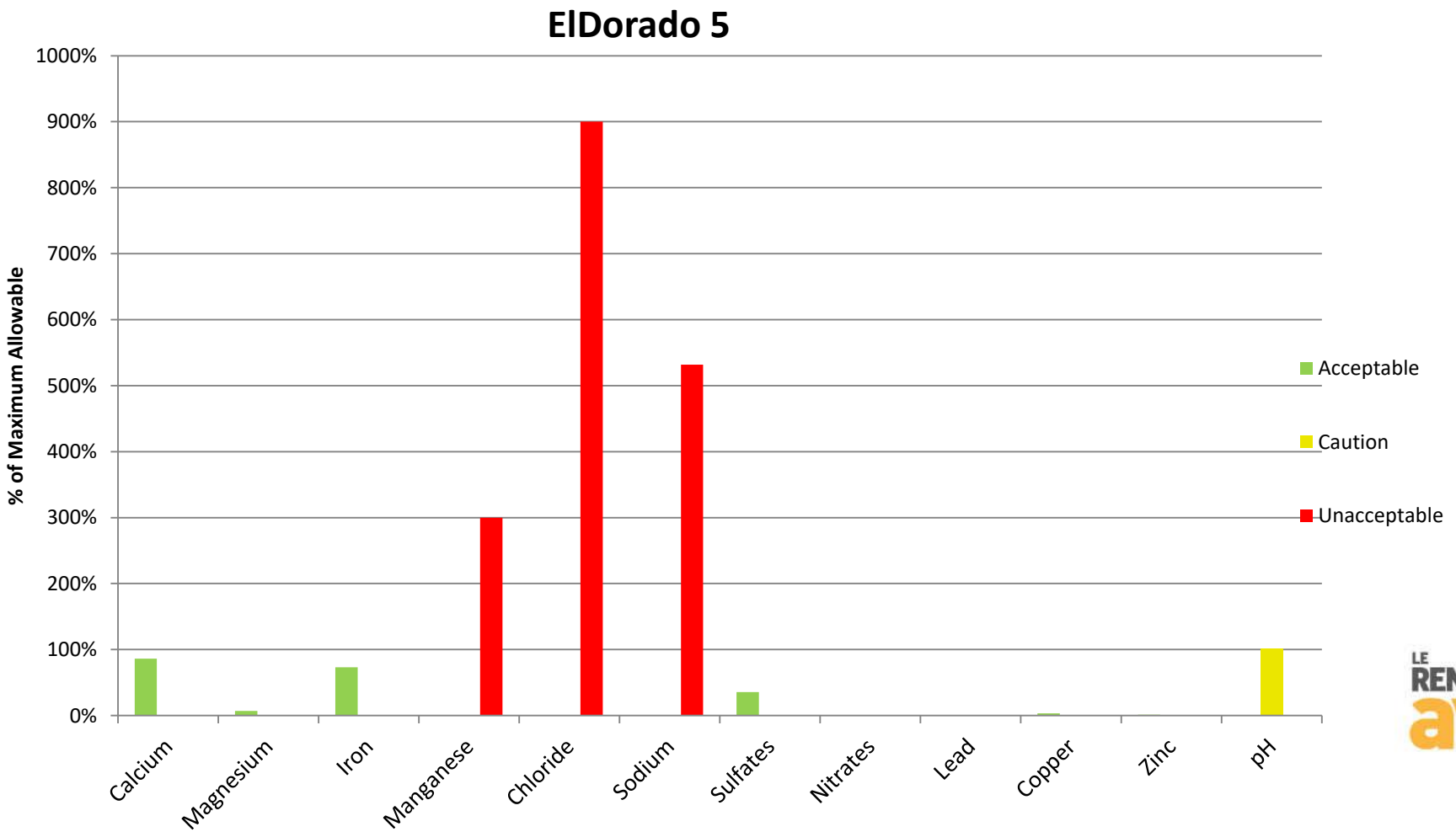
Flush Waterlines to Reduce Bacteria Load (cfu/ ml Aerobic Bacteria)

Treatment	Dosage	Pre	Post	Residual ppm
Control	City water flush	1,326,900	2	0.6
50% H2O2	8 oz/5 gal stock H2O2	1,674,300	207	40
Chlorine tablets	6.7 g tablet/gal stock Chlorine	326,419	<1	3.4
Anolyte System	highest setting Chlorine	92,170	0	40

Analyze water for mineral content Some issues must be fixed to prevent production challenges



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Checklist for Water Mineral Analysis

pH

Minerals

- Sodium
- Chloride
- Iron and manganese
- Calcium and magnesium-Hardness/alkalinity
  - Bicarbonate (HCO_3)
- Nitrates/nitrites
- Sulfur-sulfates
- Heavy metals-lead, arsenic, copper

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Minerals that are biggest challenges

Iron-red water
Manganese- black solids
Sulfur-black solids or rotten egg smell
Small quantity- bitter metallic taste for people

- .3 ppm Fe-Iron
- .05 ppm Mn-Manganese
- ~250 ppm Sulfate

Birds not sensitive to mineral tastes

- Pigs more sensitive??

Promote the growth of organisms

- Form heavy gelatinous stringy masses
- Reduces pipe volume
- Clogs drinkers

Promotes *Pseudomonas* and *E. coli*, other pathogens
Mineral deposits cause drinkers to stick
Hydrogen sulfide bacteria (rotten egg smell) can airlock water lines
Over time can create scale in pipe-water quantity issue
Chlorinate and then filter to remove



Hardness/Alkalinity

Hardness-Calcium and magnesium

- Birds very tolerant ~250 ppm
- Primary concern is mineral deposit on equipment and pipes

Alkalinity-Refers to the amount and types of chemicals that can shift pH > 7

Usually expressed as calcium carbonate ($CaCO_3$)

Also dependent on bicarbonate, (HCO_3), and sulfate (SO_4)

Poisons in nature usually alkaloid so high alkaline, content may back birds off water

Mineral control
Chlorination-Filtration-Acidification

Step 1-oxidize iron and sulfur

- Chlorine
- Chlorine dioxide
- Hydrogen peroxide/PAA

Correct pH and contact time help

- Iron 7-7.5 pH and 20 minutes
- Sulfur-2.7 x more oxidizer and contact time-20 min.

Step 2-Filtration-mineral removal

Step 3-acidification and/or other treatments

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Water Sanitation

Chlorine great sanitizer but not perfect

Affected by:

- pH, best pH is 4.0 to 7.0
  - Adding bleach to high pH water can cause calcium crystals a point of injection
- Low concentration bacteria will live
- Water temperature, <18.9 C loses effectiveness
- Turbidity (dirty water)
- Short exposure time, will not work
- Growth stage and type of bacteria present
- Age/ storage conditions of bleach

Abuse and misuse of chlorine results in water borne disease breakthrough

Chlorination

Goal- 2-4 ppm Free Chlorine

- Target- same reading beginning/end of line

May need more for disease control or problem farms

Cleaner the system- less required

Check- total and free chlorine

- Once these two numbers are the same reading, system is clean

Chlorine smell- chlorine-organic by-products

- Chlorine reacting with organic material present

High chloride levels – chlorine may not be best sanitizer choice

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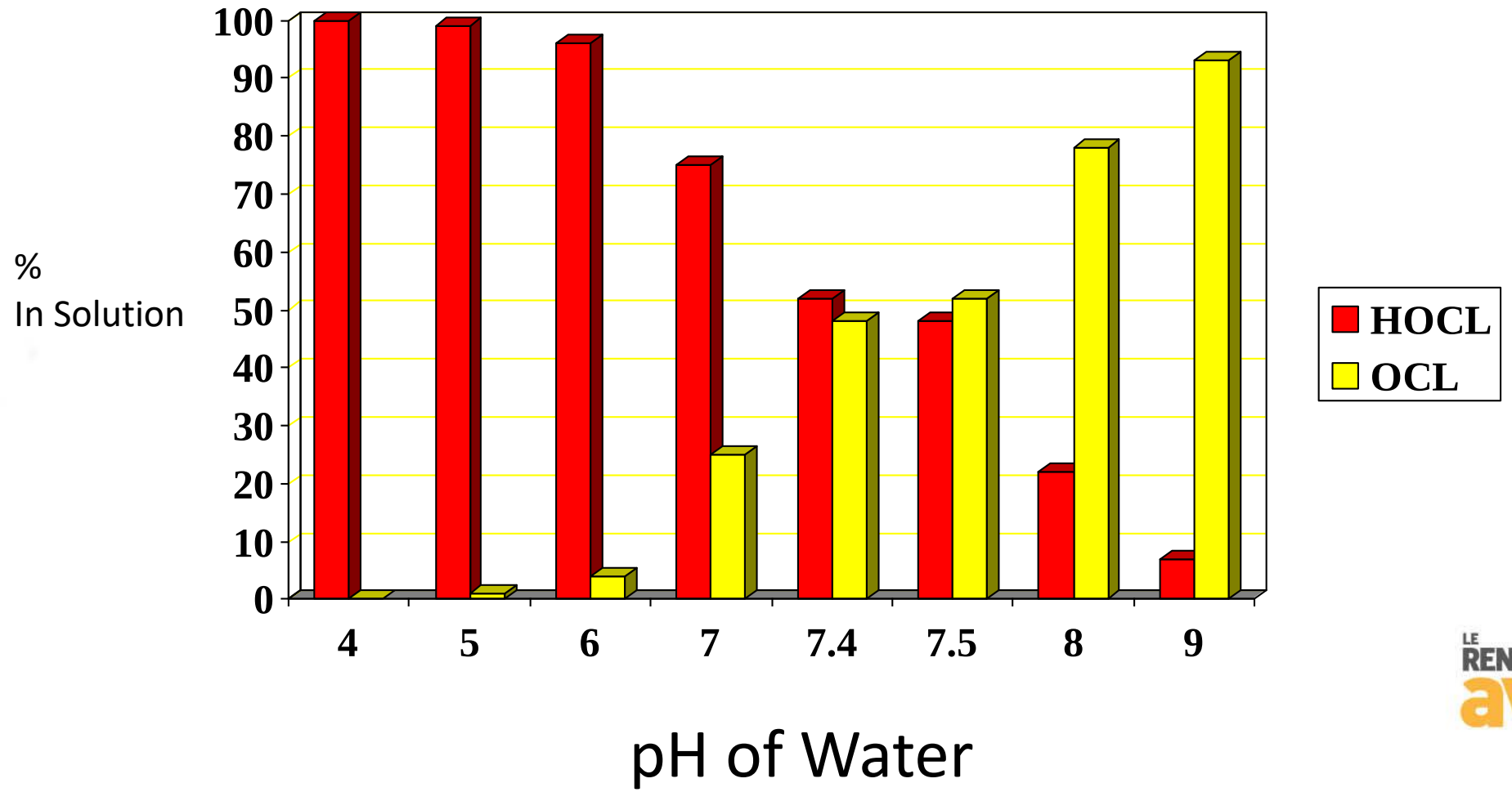
How pH Affects Chlorine
Ratio of Hypochlorous Acid to Chloric Ion



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What Form is Your Chlorine?

Hypochlorus acid is 80-300 times more effective as a sanitizer than chloric ion

Free chlorine not considered effective unless it is 85 % Hypochlorus acid

Recommended Chlorine Contact Time for Disinfection of Water (40 to 50 ° F/ 4.4-10° C)

Free Chlorine Residual (ppm)	Contact Time (min.)
0.2	40
0.4	20
1.0	8
2.0	4
4.0	2
8.0	1

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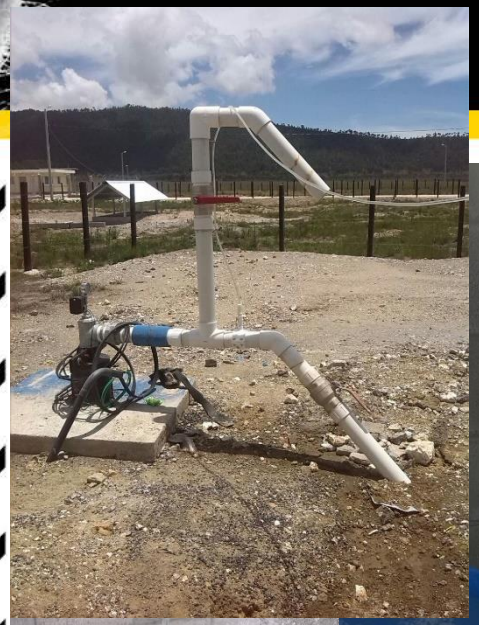
Manage Chlorine to Optimize Value



- Chlorine products have limited stability
- Keep chlorine container sealed
- Use chlorine concentrate within 4-6 weeks
- Consider smaller volumes to reduce loss of chlorine efficacy
- Do not expose chlorine to sunlight-use dark/black hoses

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Optimize value of injection technology

Peristalic pumps great tool

BUT they do not promote uniform mixing of products into water

Two injectors too close without mixing can cause chlorine loss/gas off

Separation of the injectors should be 30x the width of the pipe size

Create a mixing chamber after first injection

injector 1 injector 2

Mix Tank-promotes contact time

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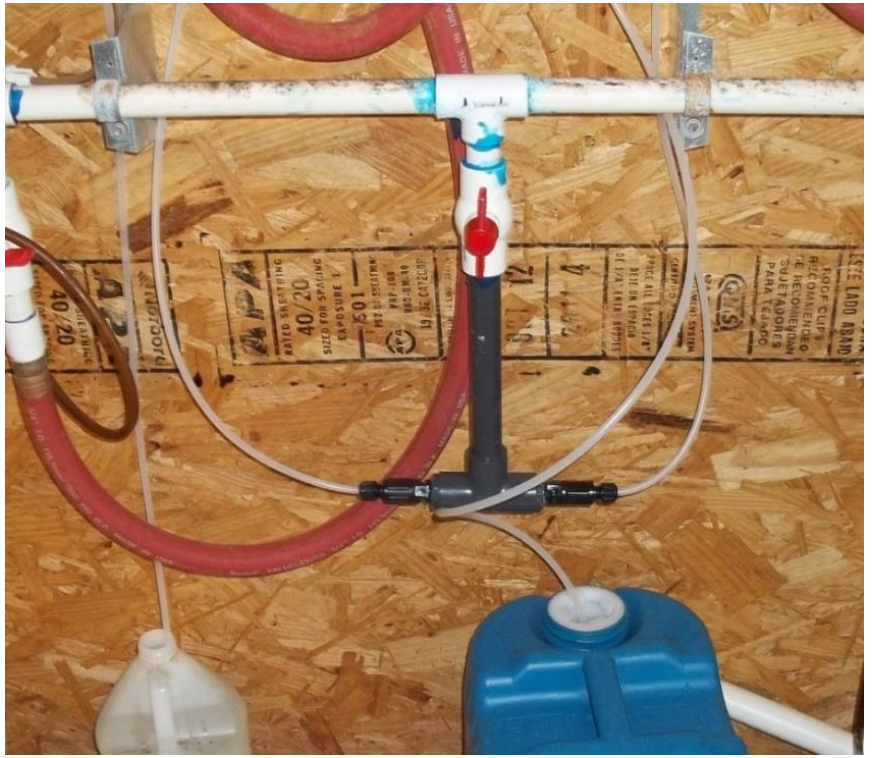
Chlorine Dioxide

Strong oxidizer
Effective: 6-10 pH range
Target residual

- Total ClO_2-up to 5 ppm
- Free residual ClO_2- 1 ppm
- Monitor free

Available as:

- Ready to use products-5-7% solutions of sodium chlorite
- Dry acid/Na-chlorite
- Sodium chlorite + acid = chlorine dioxide
  - Liquid acids best activator
  - Quality acid reduces risk of mineral contaminants



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Hydrogen Peroxide

- Target- 25-100 ppm residual in drinking water
- Good for sanitizing pond or river water- controls taste issues/no chlorine by-products
- Not as good at oxidizing iron and manganese
- Can be dangerous to store and handle, flammable
- Effectiveness deteriorates with storage
- Stabilized products last longer

5 Day Residual for Different H_2O_2 Products

(ppm or mg/l)

Products, stock concentration	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5
50% H2O2 stabilized, 16 ml/l	79.0	76.7	64.2^{gh}	58.6^{hijk}	55.5^{klm}	>50^{lmn}
20% PAA stabilized, 16 ml/l	44.4	37.1	32.9	27.0	26.3	>10
34 % H2O2 stabilized, 16 ml/l	53.5	49.6	41.2	36.5	32.6	>10
28% H2O2 non-stabilized, 16 ml/l	36.3	34.1	26.6	22.1	19.2	>10

Each product was mixed at the concentration shown then added at a rate of 1 ml to 128 ml of drinking water

Stabilized hydrogen peroxide can be a good sanitizer during low water flow

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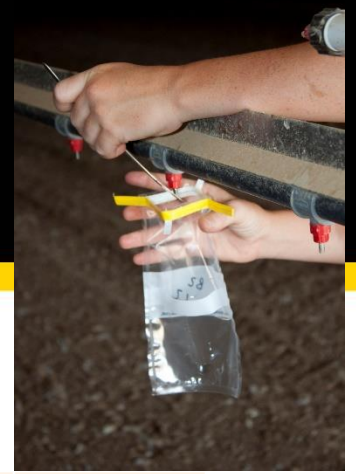
Monitor and Document

Injectors fail and a good monitoring program will limit the time water is unprotected

Water Sanitation Verification
Confirm what works



Farm Name	Source	Drip/Swab	APC (aerobic) (CFU/ml)	Yeast	Mold	E. Coli	Coliforms
Farm A	Waterline	Swab	2	0	0	0	0
Farm A	Waterline	Swab	3	0	0	0	0

Farm Name	Source	Drip/Swab	APC (aerobic) (CFU/ml)	E. Coli	Coliforms
Farm B	Well	Drip	109	0	0
Farm B	End of line	Drip	0	0	0

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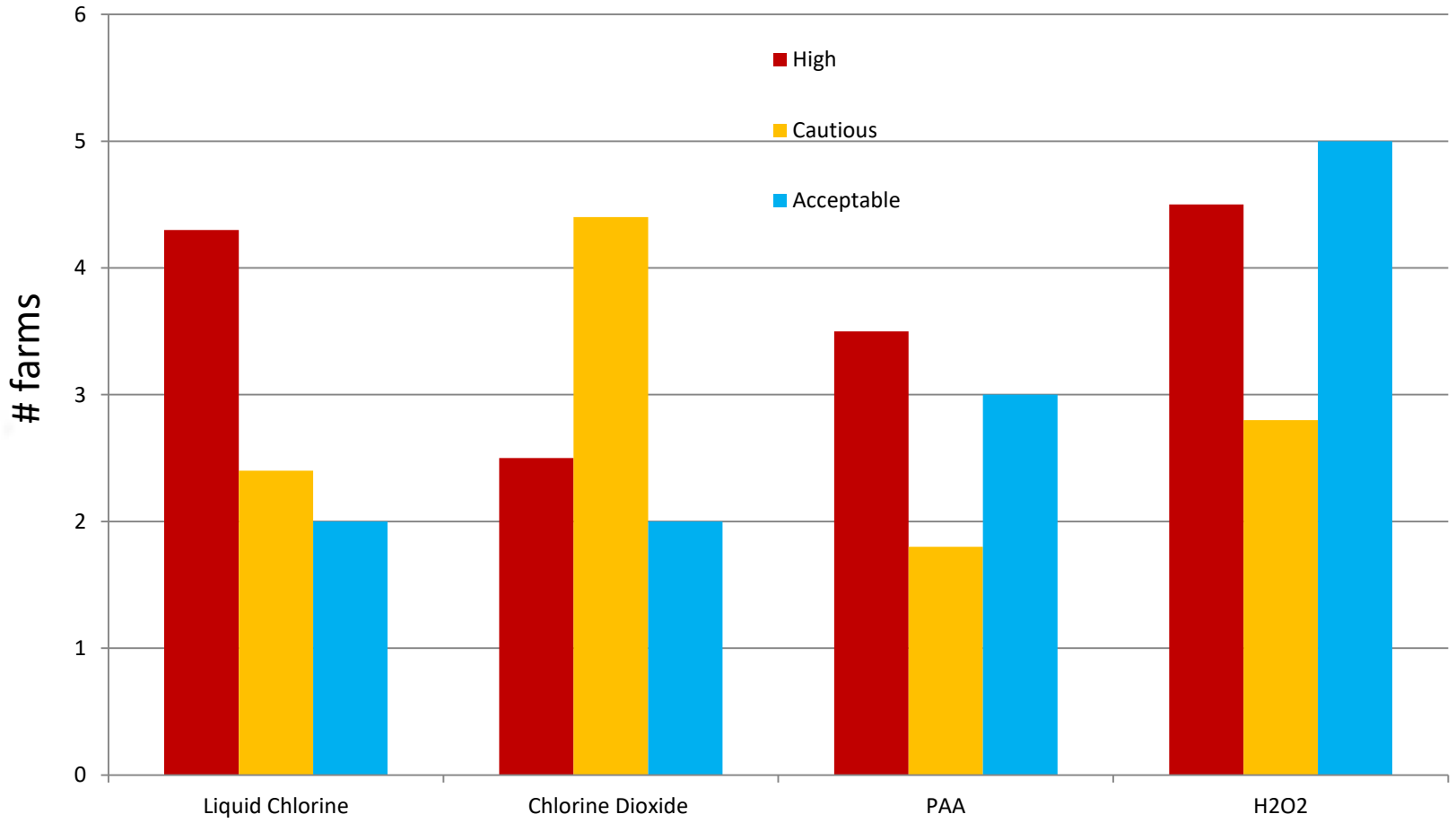
Any product can work or fail - Verify



Source: Dr. Brian Wooming-Cargill

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Inspection cameras great tools to check waterline cleanliness

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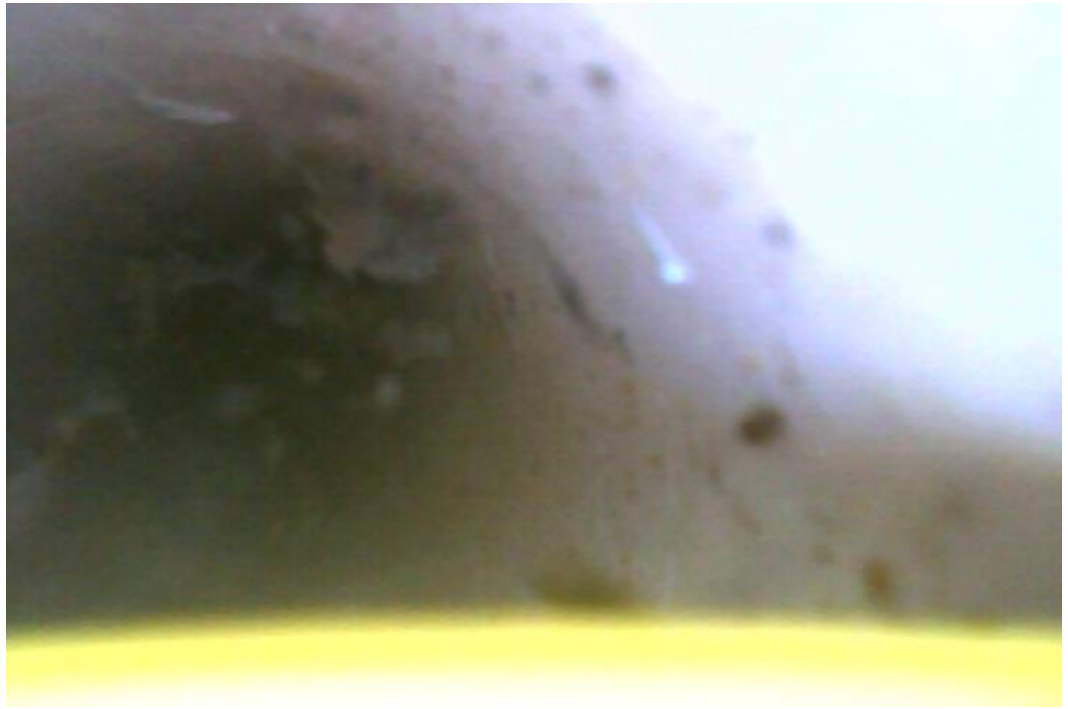

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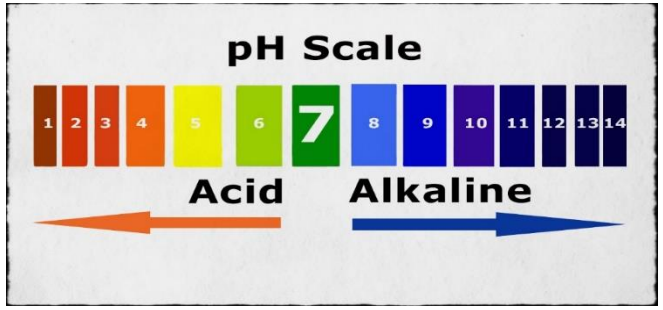
Understanding pH

pH is a measure of how acidic or basic water is



Factors which affect pH

- Alkalinity of water-bicarbonate, sulfates,
  - buffers against pH becoming more acidic even when acid added
- Type of acid
  - Inorganic or mineral acids-typically strong-phosphoric, sulfuric, hydrochloric, sodium bisulfate converts to sulfuric acid- tend to easily shift the pH
  - Organic acids-weak acids-acetic, citric, proprionic, formic

Organic Acid Benefits

Microbial control benefits of organic acids due to acid remaining intact at lower pH

- Weak acid does not want to give up its H^+
- In solution- “HA” NOT “$H^+ + A^-$” like inorganic acids

Intact acid more easily enters microbial cell where the higher pH of the cell causes the weak acid to then give up its H^+

When cell tries to pump out the H^+-

the work load kills the cell

pH Bottom Line

Focusing only on pH without understanding the alkalinity or buffering capacity of the water as well as what type of acid can lead to problems

- Adding acetic acid if water has high buffering capacity won't give much pH drop but the presence of the weak organic acid can still provide gut health benefits
- Dropping the pH of water with little or no alkalinity and naturally low pH can be detrimental to bird performance

Natural Low pH Water Needs Neutralizing Not More Acid

Sample ID	B	Mg	Ca	Mn	Fe	Ba	S	Na	Cl	pH
Farm A	0.09	1.54	4.74	N.D.	0.02	0.07	3.53	3.38	0.12	3.79
Farm A	0.23	1.49	4.32	0.01	0.01	0.07	8.97	7.65	N.D.	3.71
Farm A	0.08	1.54	4.36	0.02	0.02	0.07	2.94	2.74	N.D.	4.60

Acid water common in sandy soil areas

Symptom-Low weights, high feed conversion but good livability, poor water consumption

Diagnosis-water with low pH , no natural buffering

Solution: Neutralize with sodium bicarbonate/carbonate

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- Careful leaving organic acids in mixing tanks and water lines between flocks
- If using acids and slime blooms occur-turn off acids during last few hours of production to prevent issues
- Use products like bleach which raise pH

Slime challenges

Increased organic acid use for gut health and food safety- resulting in water system slime issues

Isolated following:

- Pseudomonas aeruginosa
- Brevundimonas vesicularis

Conducted disinfectant sensitivity test

Disinfectant sensitivity

50 % stabilized H2O2

- 2 ml/128 ml stock solution
- Add 1:128

10% sodium hypochlorite

- 4 ml/128 ml stock solution
- Add 1:128

56% acetic acid

- 1 ml/128 ml stock solution
- Add 1:128

Acetic acid/bleach

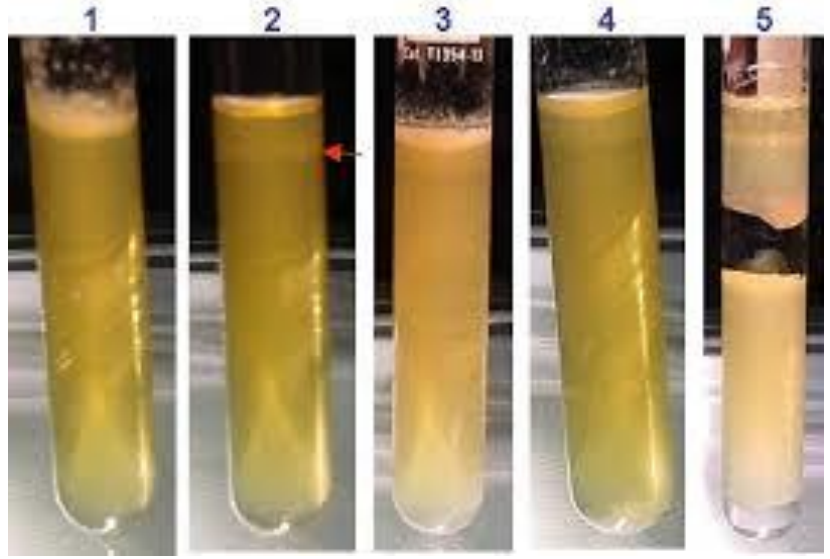
- Combined at above rates

Acetic acid/H2O2

- Combined at above rates

Control-no treatment

100 ul of each product/combo added to 3 BHI tubes per organism



Results-Organism response (24 hours)

Treatment	P. aeruginosa	B vesicularis
Acetic acid	1 in 3 tubes (24 hours)	3 in 3 tubes (48 hours)
H2O2	3 in3 tubes	No growth
Bleach	No growth	No growth
Acetic acid/H2O2	No growth	No growth
Acetic acid/bleach	No growth	No growth

Control-3 of 3 growth for both organisms (24 hours)

Conclusion

Organic acids without sanitation could lead to slime challenges that result in clogged drinkers

More evaluations needed to determine the conditions which promote this incidence but currently know that if water is susceptible to pseudomonas, there is a risk

Sanitizer sensitivity is a tool to determine what is best for your operations

The Watkin's Water Recipe

Accept water can create risks for flocks

Identify and quantify water contaminants

- Minerals, pH
- Bacteria, yeast, mold, other

Prepare a strategy to reduce/eliminate challenges

Use between flock line cleaning to reduce challenges

Utilize a daily water sanitizer best suited for the operation

- Compatible with water
- Easy to use
- Easy to monitor
- Cost effective-in the scheme of things

Monitor and verify program works