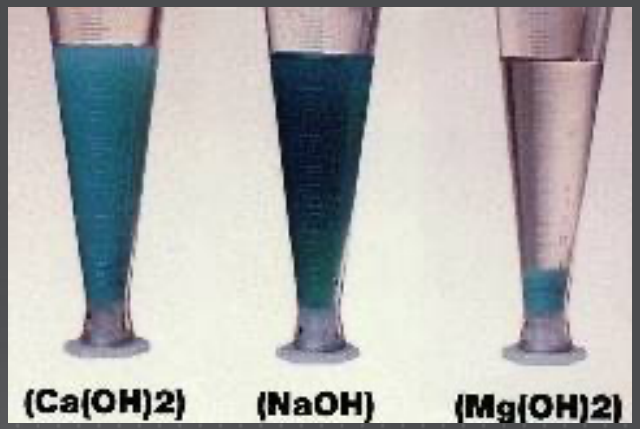



# CHEMISTRY AND APPLICATIONS

Milk of Magnesia, Magnesium Hydroxide,
For Total System Treatment

# GOALS

1. Hydroxide chemistry overview
2. pH and alkalinity chemistry overview
3. Applications
4. General chemical mechanisms

# Common Hydroxides

This section will discuss the three common sources of hydroxide chemistry encountered in the wastewater industry, their relative strength, handling/safety, quality and application

- Lime – Calcium Hydroxide – $Ca(OH)_2$
- Caustic – Sodium Hydroxide – NaOH
- Milk of Magnesia – Magnesium Hydroxide –$Mg(OH)_2$

# Lime –Calcium Hydroxide

Lime can be obtained in the powder or slurry form. If sludge sludge disposal and scaling are not a concern, it can be cheap chemical for controlling pH (alkalinity). Within a few feet of the addition point, it can raise the pH anywhere up to 12.5 standard units (s.u.).

- Slurry concentrations up to 40%.
- EPA states that lime addition in some cases can add as much a 50% more sludge for disposal.
- Certain dosages can kill treatment plant bacteria and form sludge through water softening.

# Caustic Soda –Sodium Hydroxide

Caustic soda is general supplied in the liquid form with a freezing point of 50 ° F at 50% concentration by weight. If storage can be maintained above freezing and scaling is not a concern, it can be an alternative for controlling pH (alkalinity). Within a few feet of the addition point, it can raise the pH anywhere up to 13 standard units (s.u.) and the concentrated liquid can cause sever burns.

- Increased single charged ions, like sodium, can cause problems with pin floc, dispersion, and settling.
- Accidental overdose will almost certainly kill treatment plant bacteria.

# Milk of Magnesia–Magnesium Hydroxide

Magnesium Hydroxide can provide alkalinity as a slurried hydroxide ranging 58-59% by dry solids weight or as a Magnesium Oxide powder. The slurry has a freezing point at or just below that of water. Overdosing of the slurry will have little impact on the biology or effluent discharge limits.

- Magnesium is a big part of the energy production in biology.
- For batch systems visited once or twice a week, a couple days worth of chemical can be added all at once.
- No reportable spill amounts or fish kills.

# Quality Pitfalls

- Caustic – hard water used to dilute to lower percentages
- Lime – Sea Shell lime
- Milk of Magnesia – Brucite (Magnesium Hydroxide Marble).

# Greatest Advantage/Caution

**Caution**

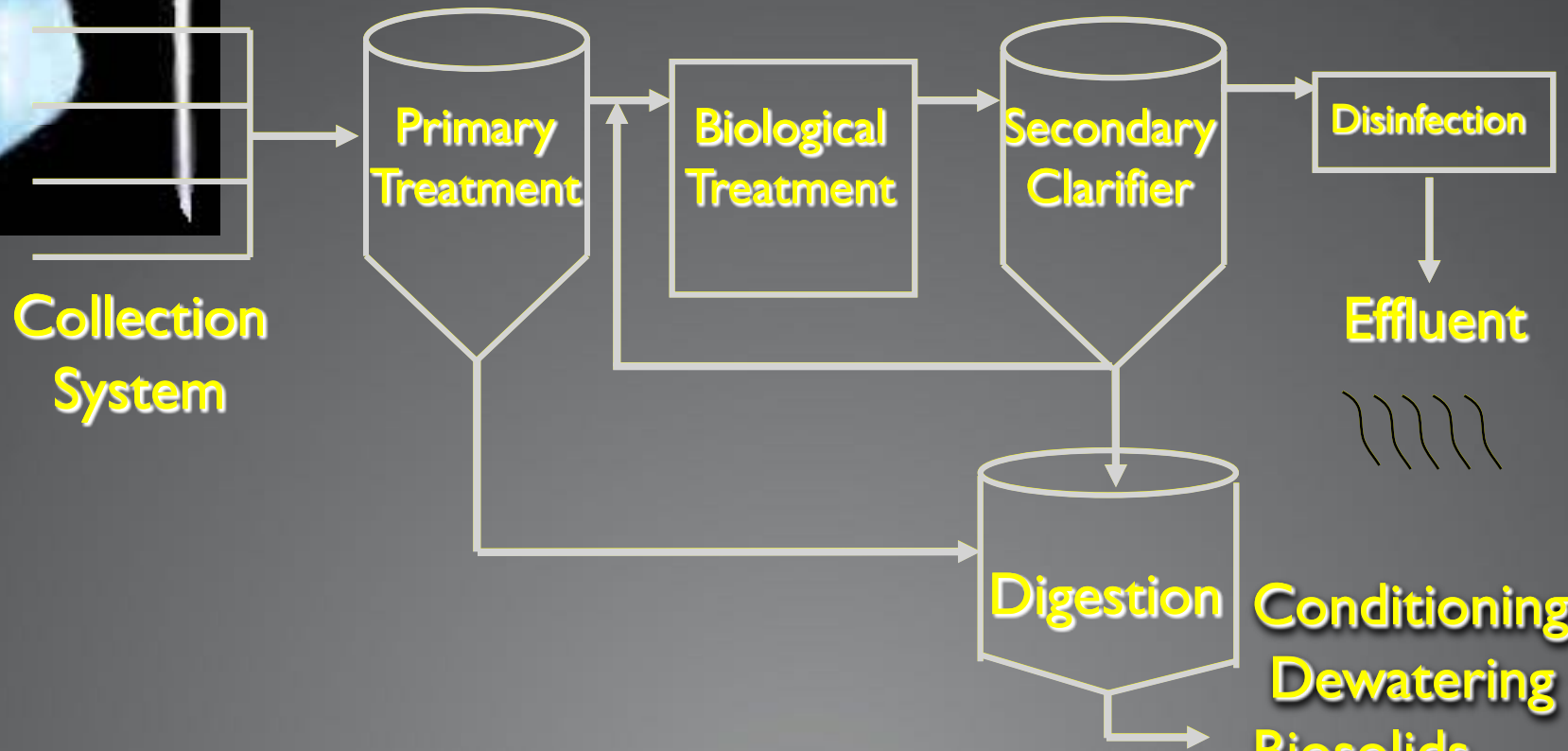
- Caustic – chemical burn risk
- Lime – softening/scaling/sludge costs
- Milk of Magnesia – turbidity

**Advantage**

- Caustic - completely soluble
- Lime - get it anywhere
- Milk of Magnesia - doesn’t drive pH above 9 su

# MOM In Your Sewer?

## Milk of Magnesia, Magnesium Hydroxide, for Total System Treatment



**Magnesium Hydroxide is a safe, cost saving and environmentally responsible chemical strategy which prolongs infrastructure life, manages wastewater odor, prevents plant upsets, improves treatment and enhances biosolids quality.**

# Applications for Odor Control

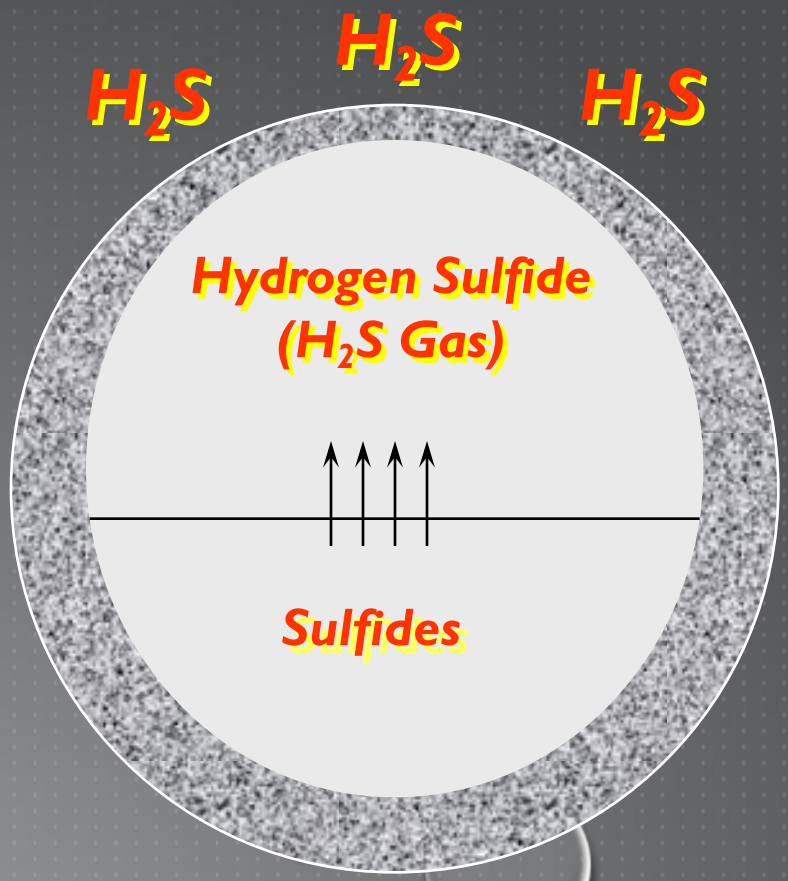
This section will discuss why there is a need for odor and corrosion control, what is causing the issue, and how to not miss hot spots .

- **Odor** – Bacteria and chemicals, detection technology
- **Corrosion**– Acid attack and life of concrete; surface pH
- **Common Chemistries**– Hypochlorite, magnesium hydroxide, nitrates
- **Magnesium hydroxide dosage -** equipment and calculations

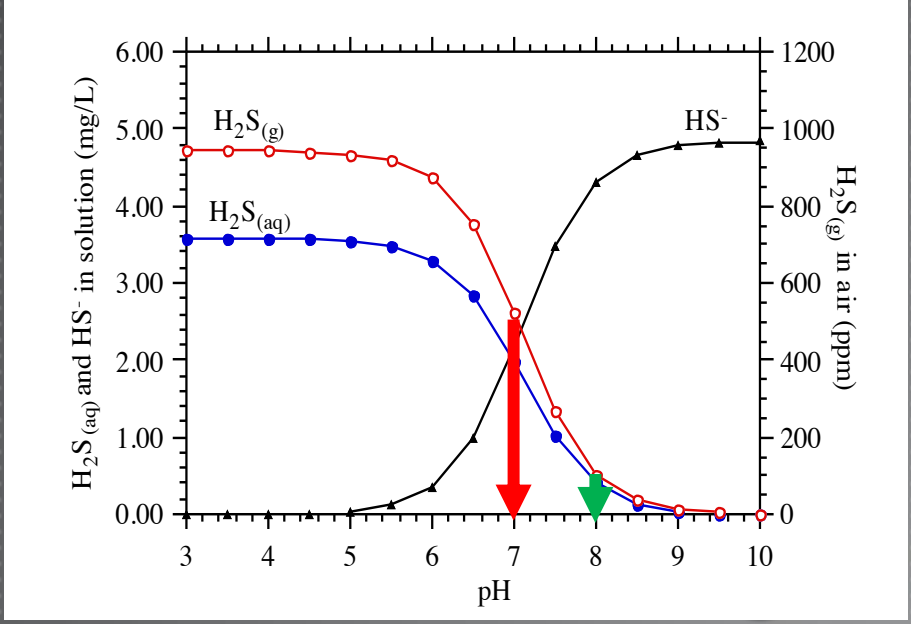
# ODOR

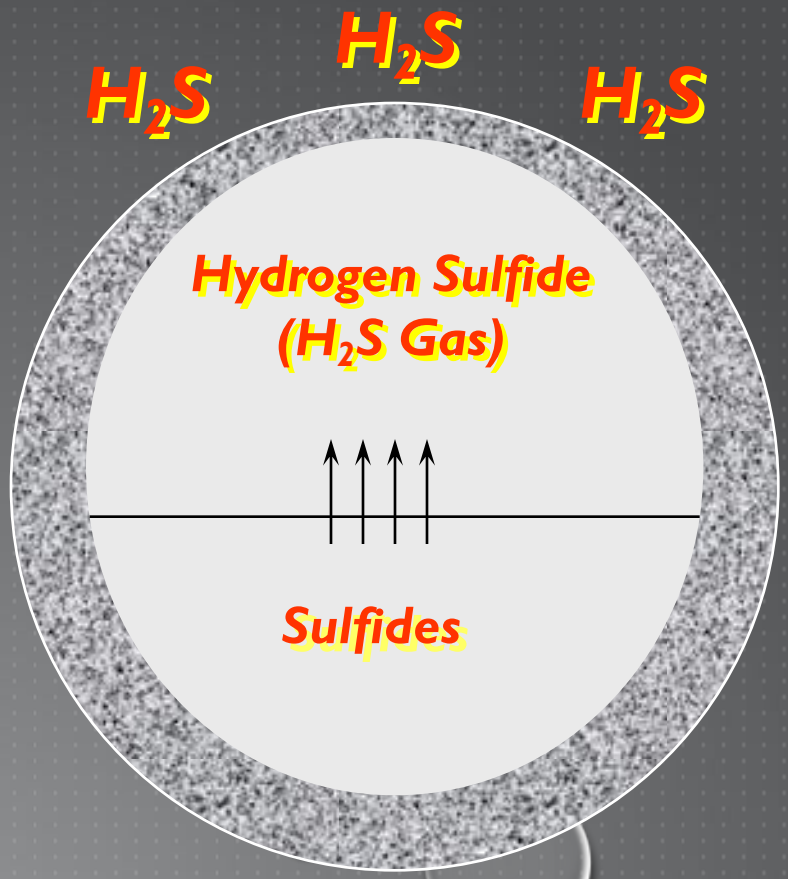
Raising wastewater pH from 7 to 8 eliminates hydrogen sulfide gas and extends the useful life of infrastructure subject to corrosion by over 80%.

Hydrogen sulfide (H2S) is a colorless, poisonous, flammable gas that produces foul odors like rotten eggs and contributes to acid corrosion to sewer pipes and equipment in collection systems.

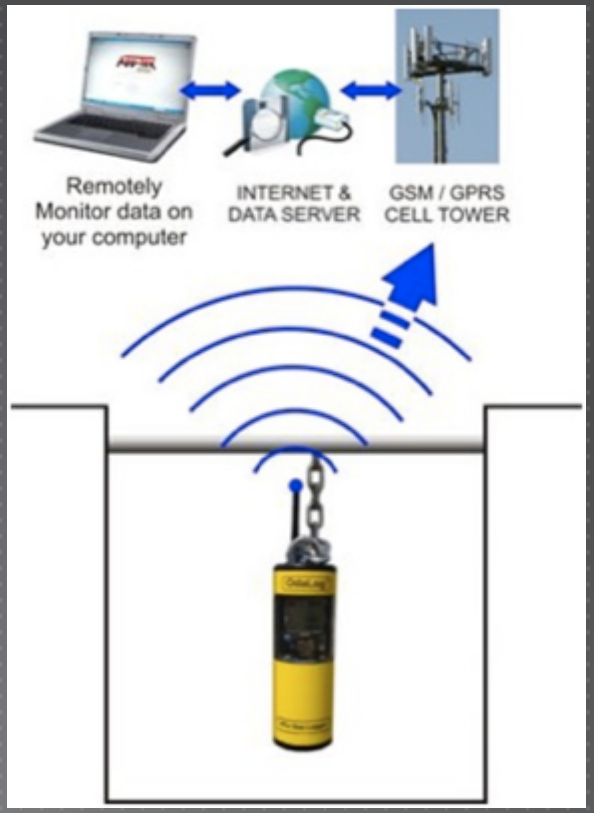


# In water at pH 7, about 50% of the dissolved sulfide converts to H2S gas.



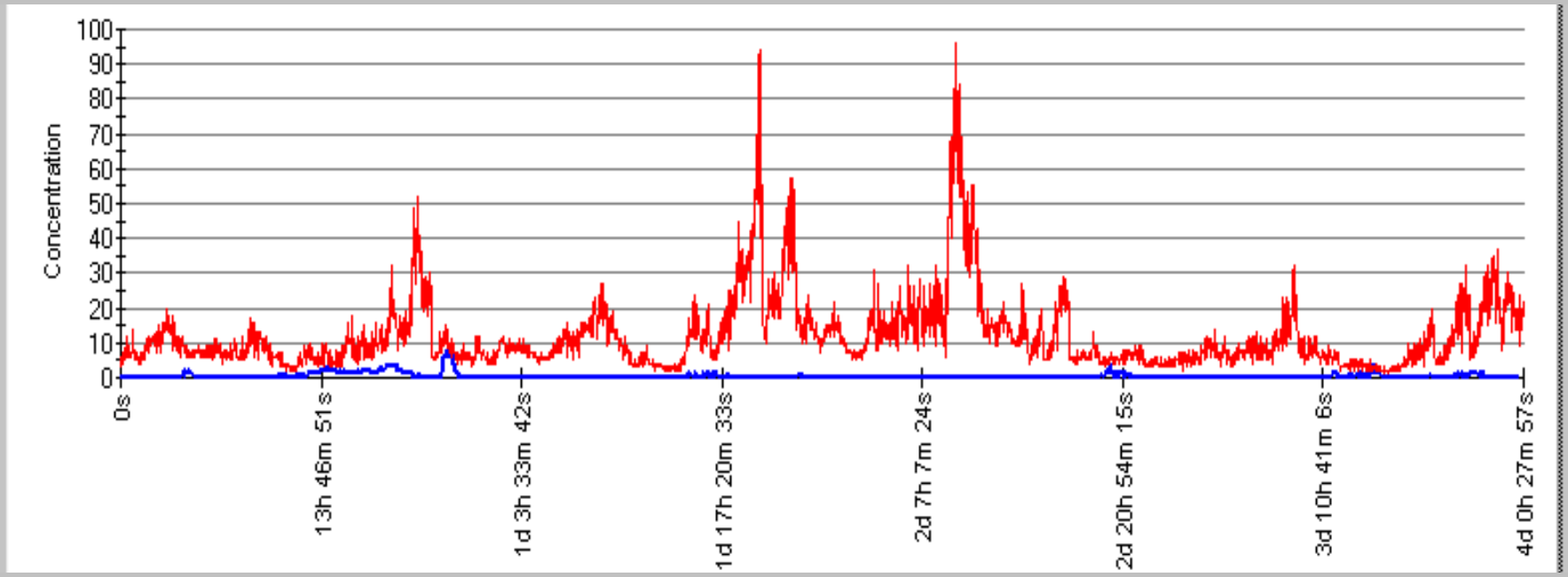
# GAS MEASUREMENT EQUIPMENT



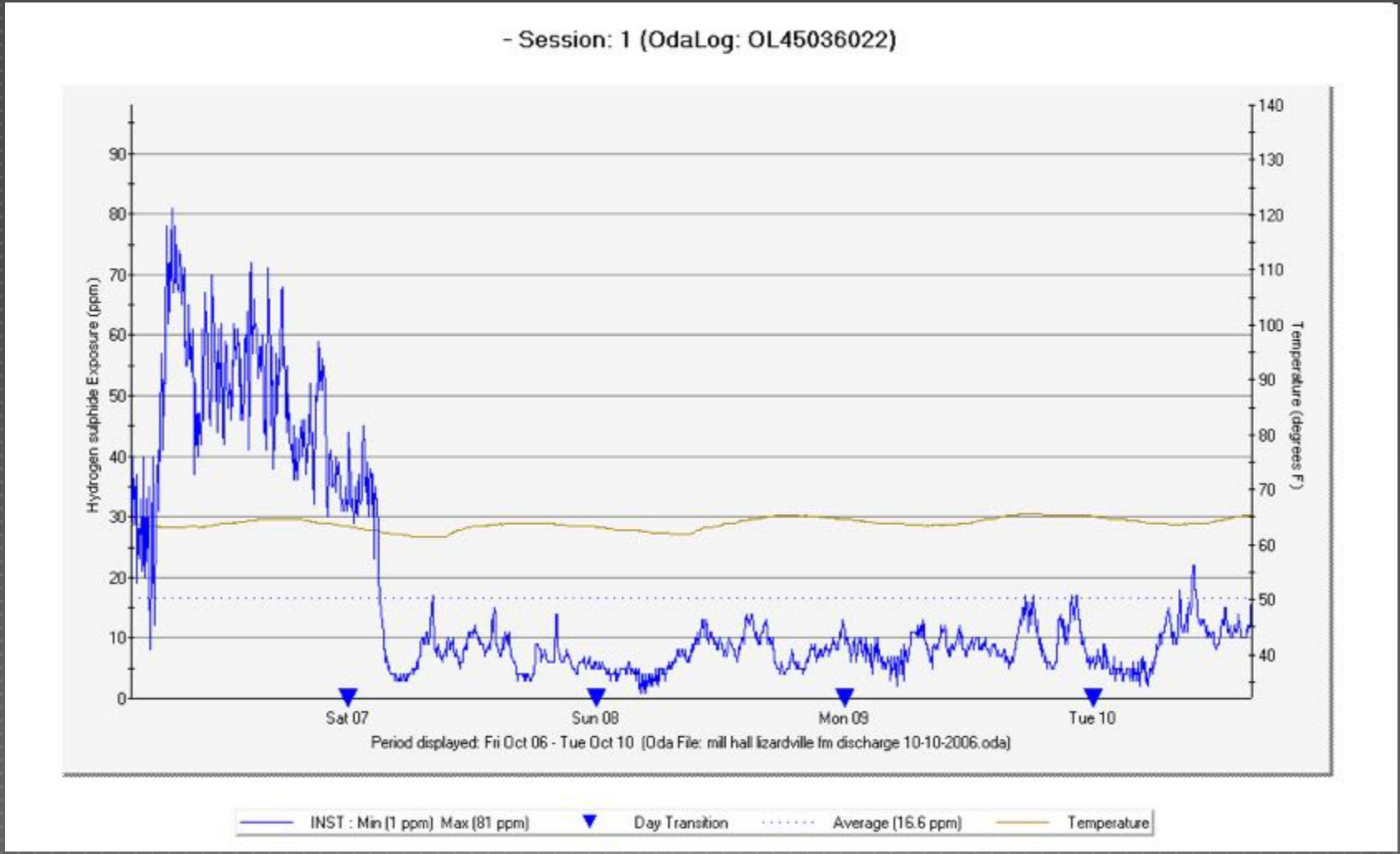
# Headspace Hydrogen Sulfide Gas

## Before and After

## Magnesium Hydroxide (<30 ppm dosage)



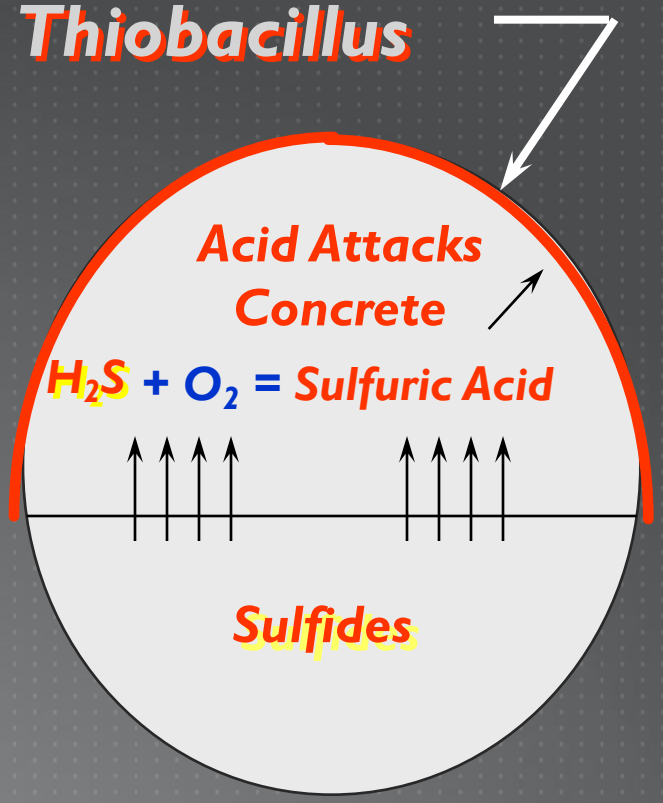
# TYPICAL GRAPH OF GAS LEVELS



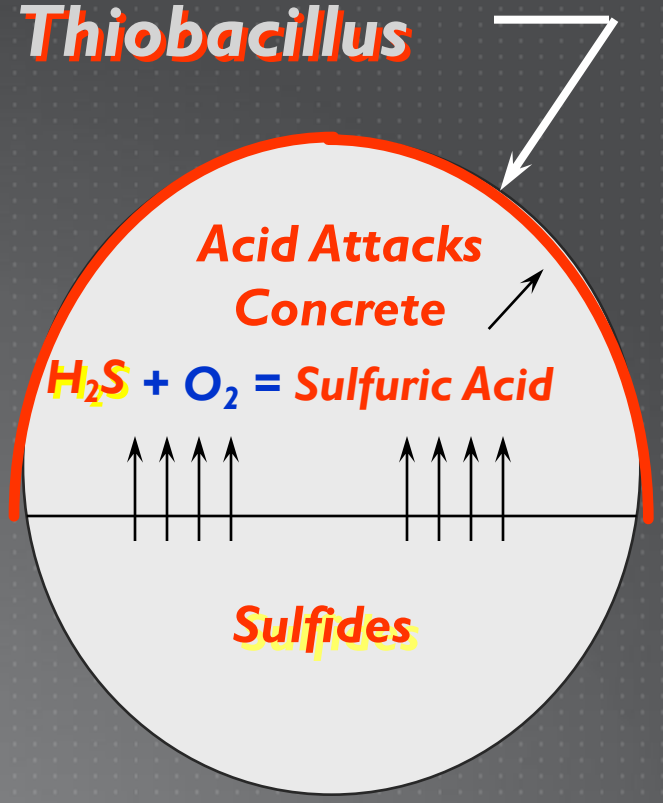
# CORROSION

**The severe corrosion of sewers that many are currently experiencing within their wastewater collection systems is the result of sulfuric acid, which is very corrosive to metal and concrete .**

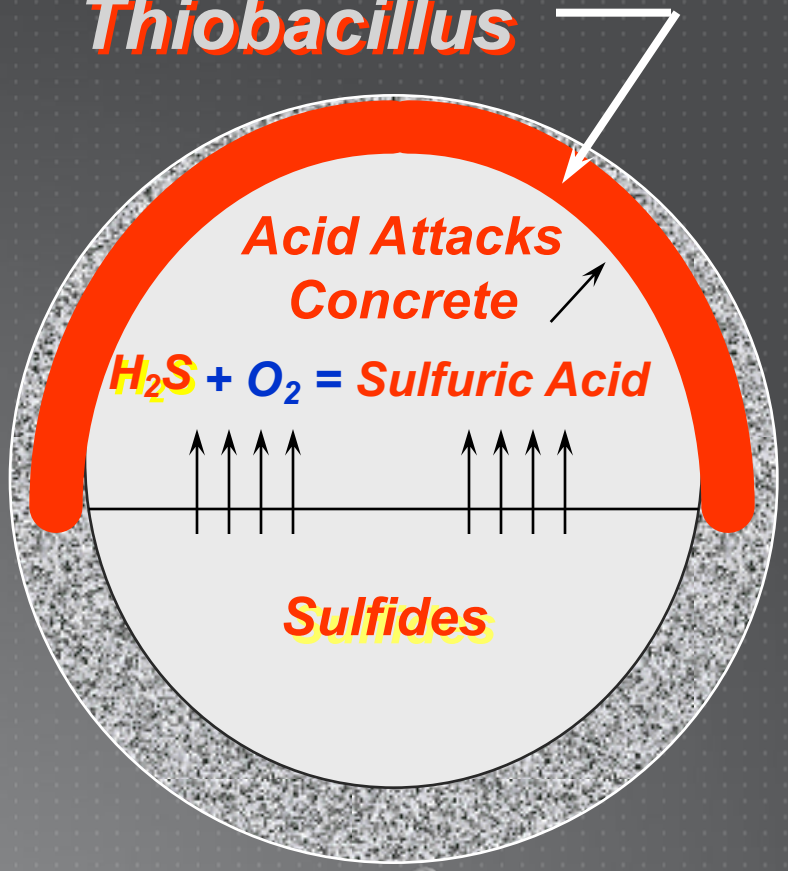
Under low oxygen conditions, such as in swamps and sewers (anaerobic digestion), sulfate-reducing bacterial breakdown of organic matter for fuel, producing hydrogen sulfide as a waste in the wastewater stream.



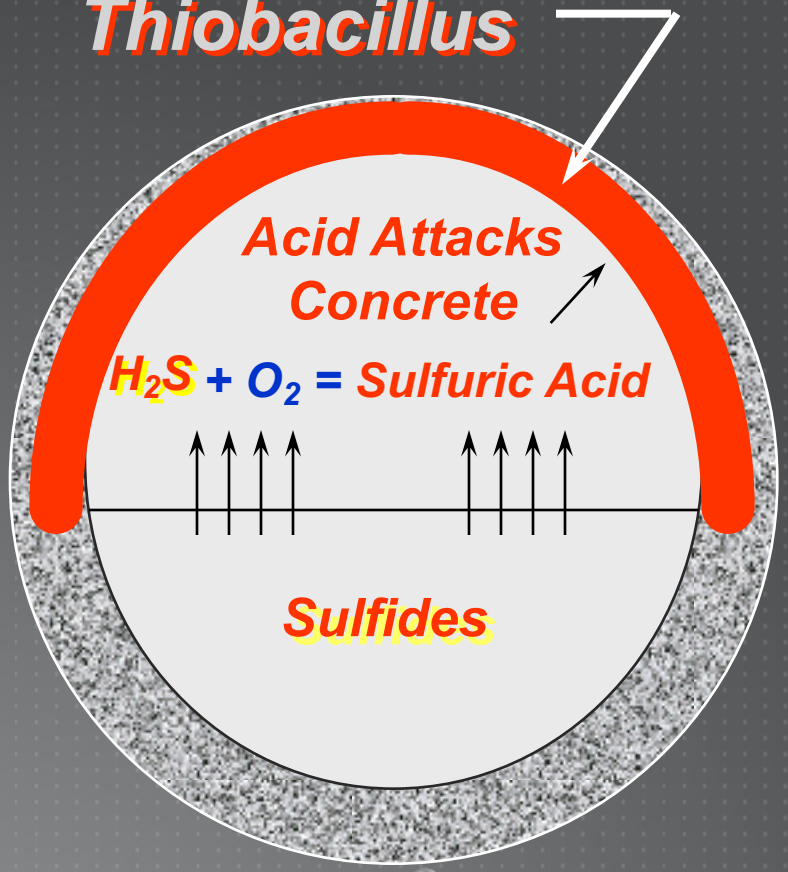
**Hydrogen-sulfide-gas consuming bacteria (Thiobacillus) excrete this sulfuric acid onto the collection system pipes and equipment.**



**Once rebar is exposed, the sewer is structurally compromised.**



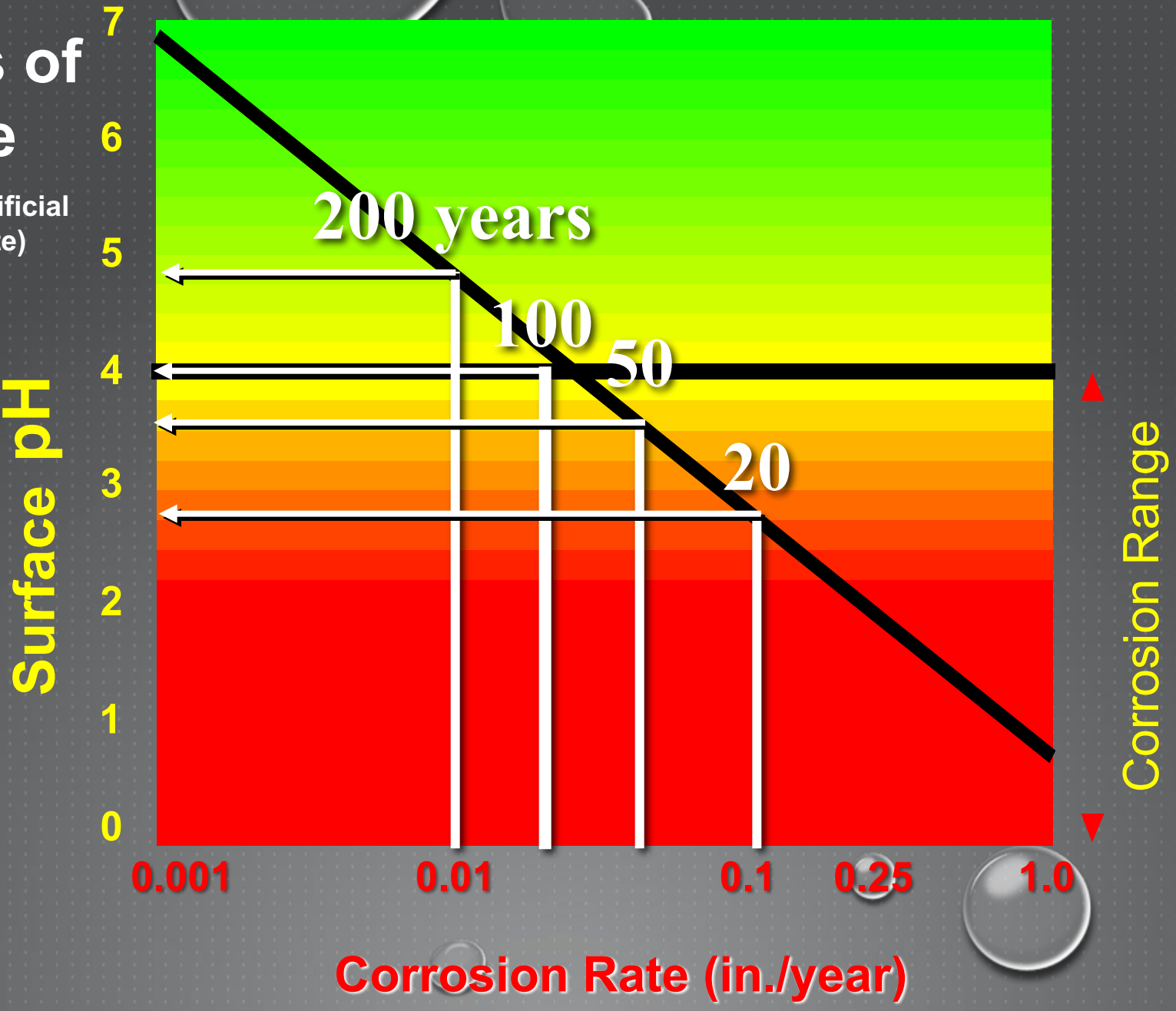
**Collapses routinely occur when preventable corrosion is allowed to continue unchecked.**




Surface pH
tells the whole story…

# Years of Life

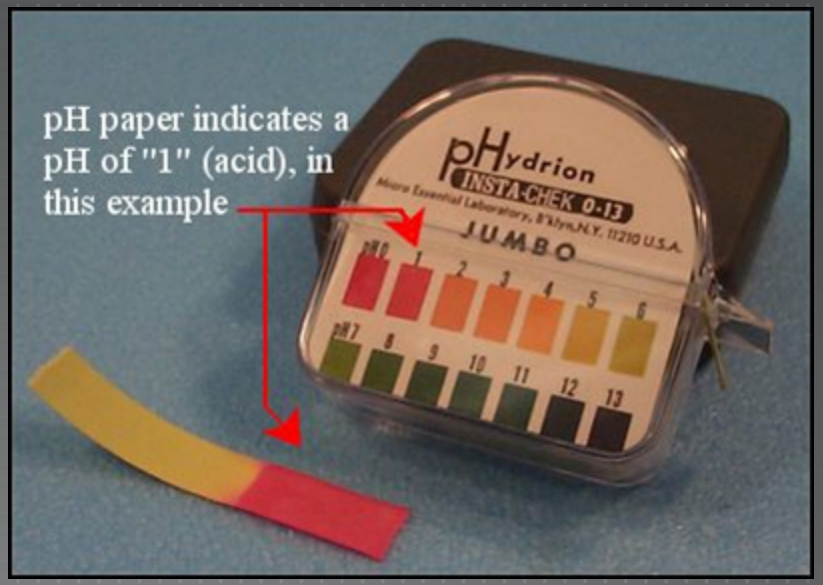
(2" of sacrificial concrete)

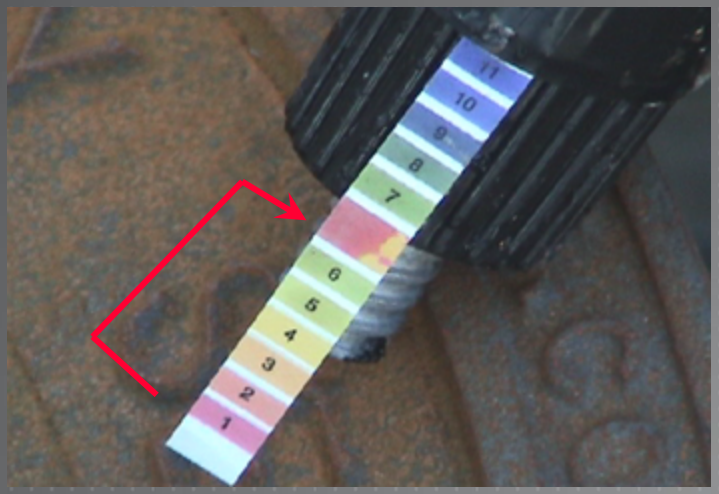



*Source Data L.A.County San District*

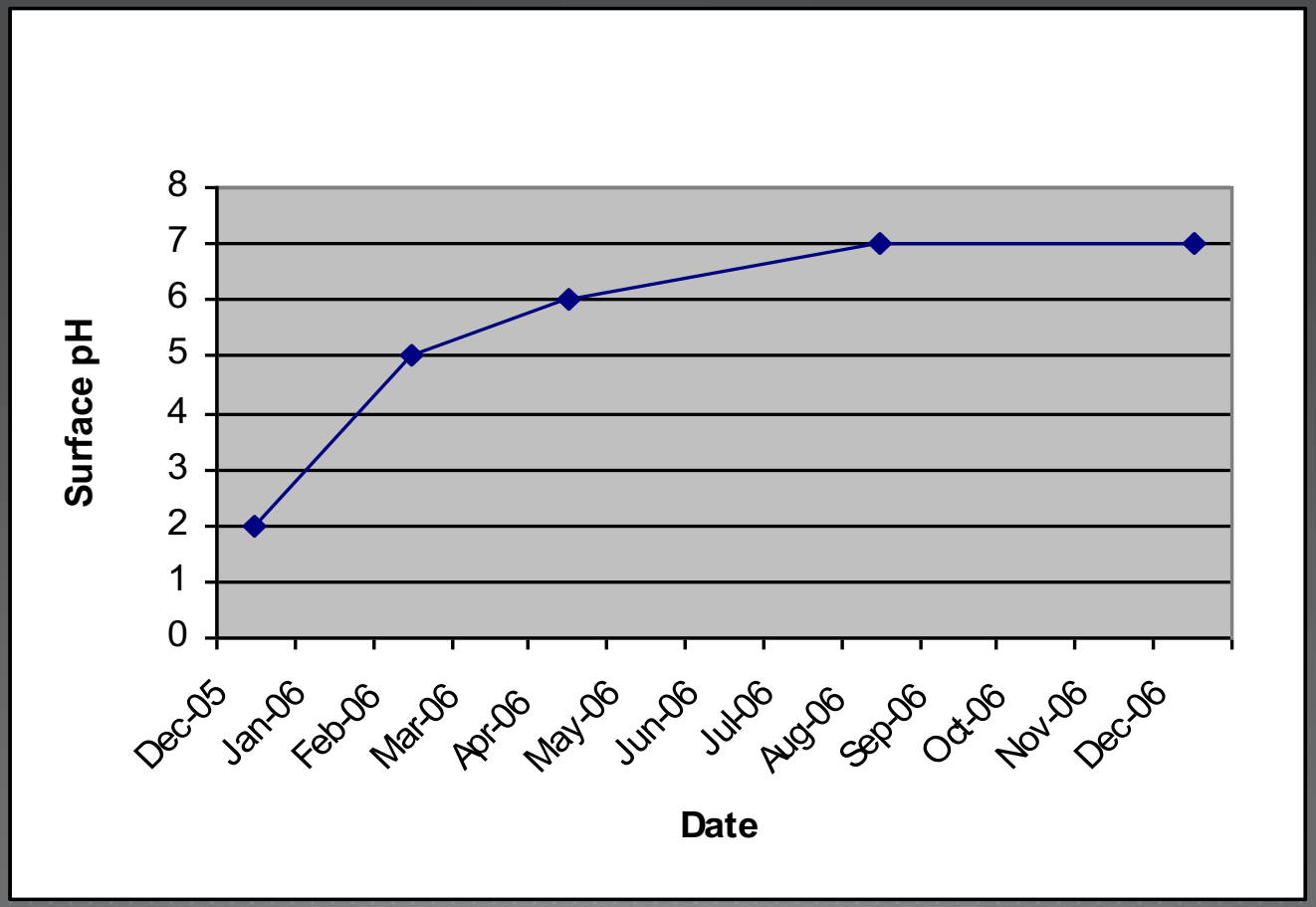
# RED IS BAD, GREEN IS GOOD.

**Nominal 7 = Neutral**
**Above 7 = Basic**
**Below 7 = Acidic**

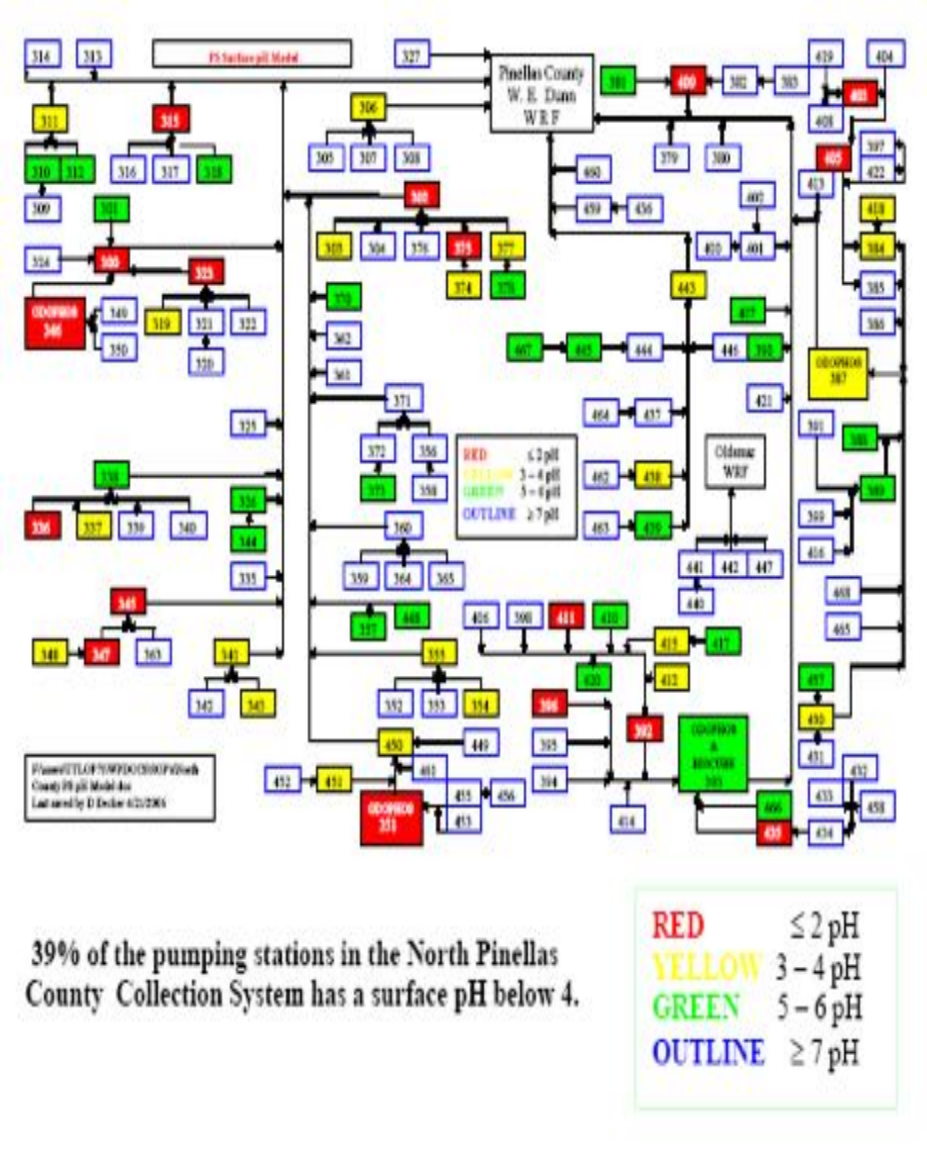


# NO OTHER TREATMENT TECHNOLOGY HAS BEEN SEEN YET TO IMPROVE SURFACE PH

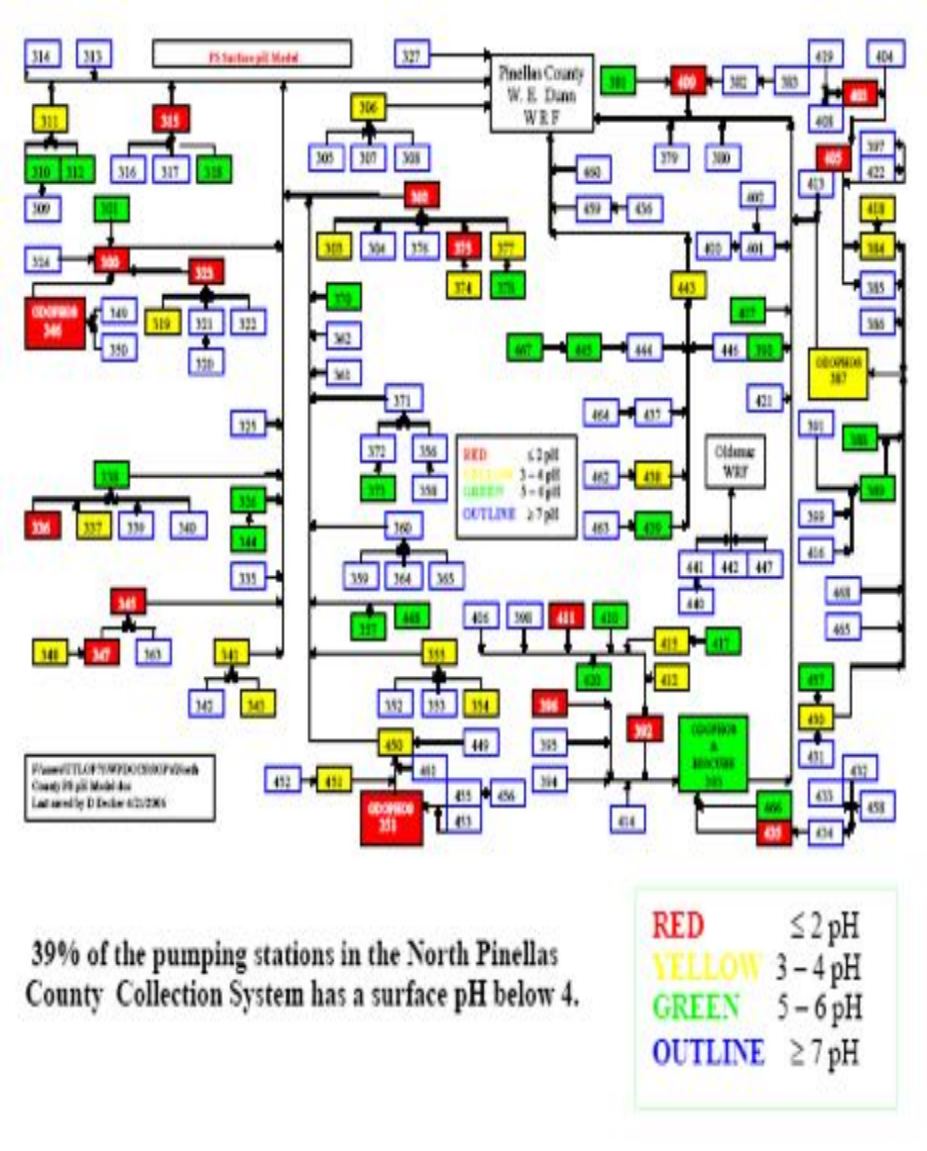


# COLLECTION SYSTEM PH STUDY AND MODELING



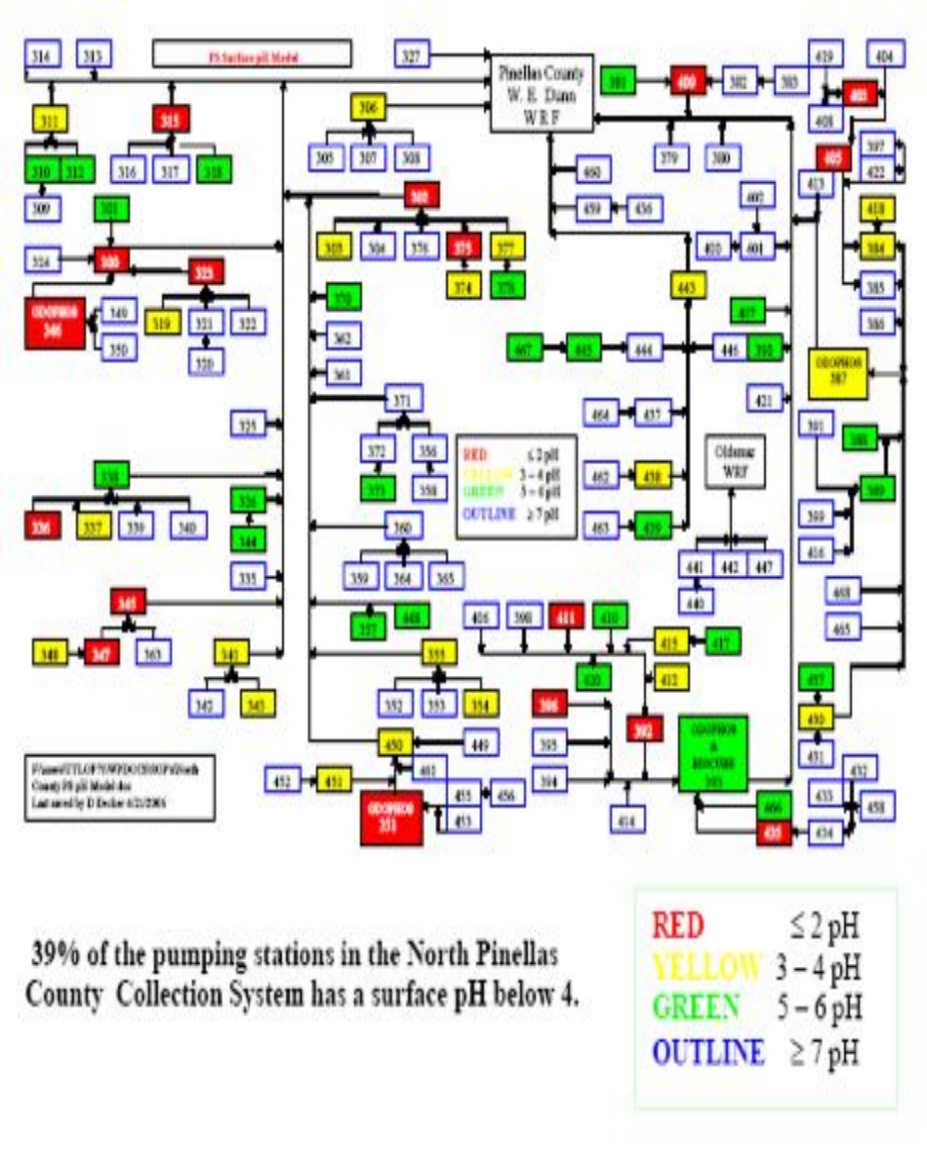

This collection system makes up ~35% of the flow received at the South Cross Bayou WRF with over 18 hr retention times in Pinellas County FL

# COLLECTION SYSTEM PH STUDY AND MODELING




The model, as shown here, was an eye opener insofar as the severity of corrosion rate within the system.

# COLLECTION SYSTEM PH STUDY AND MODELING

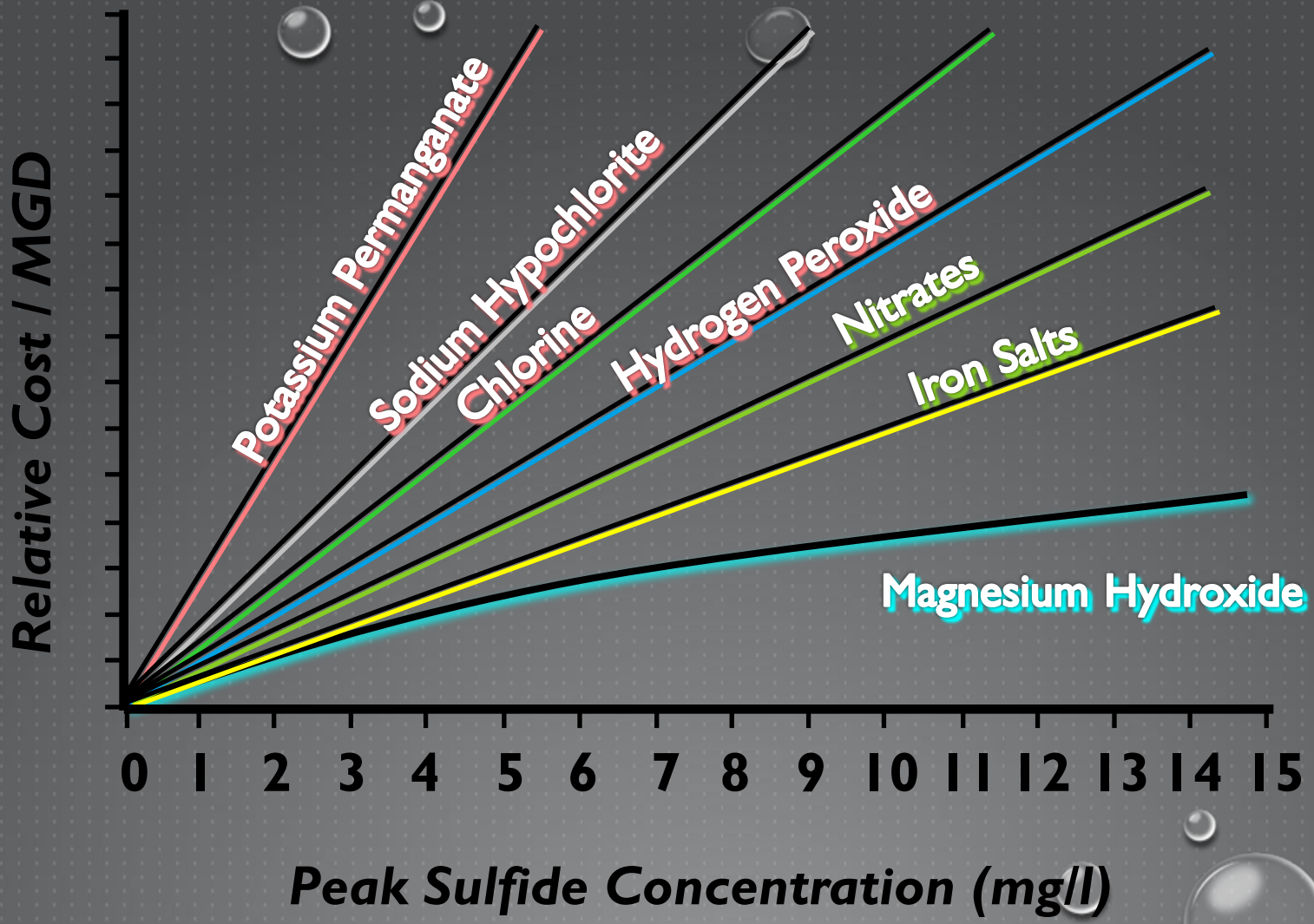



The WW Treatment Manager was able to identify a line segment within the north system to treat with Magnesium Hydroxide to curb the H2S gas and reduce the corrosion via surface pH elevation.

# COMMON CHEMISTRIES

When comparing unit cost of chemical some chemistries may appear much cheaper than others, the chemical potency and impact on the overall system operational cost should also be taken into consideration.

# Relative Total Treatment System Impact Costs



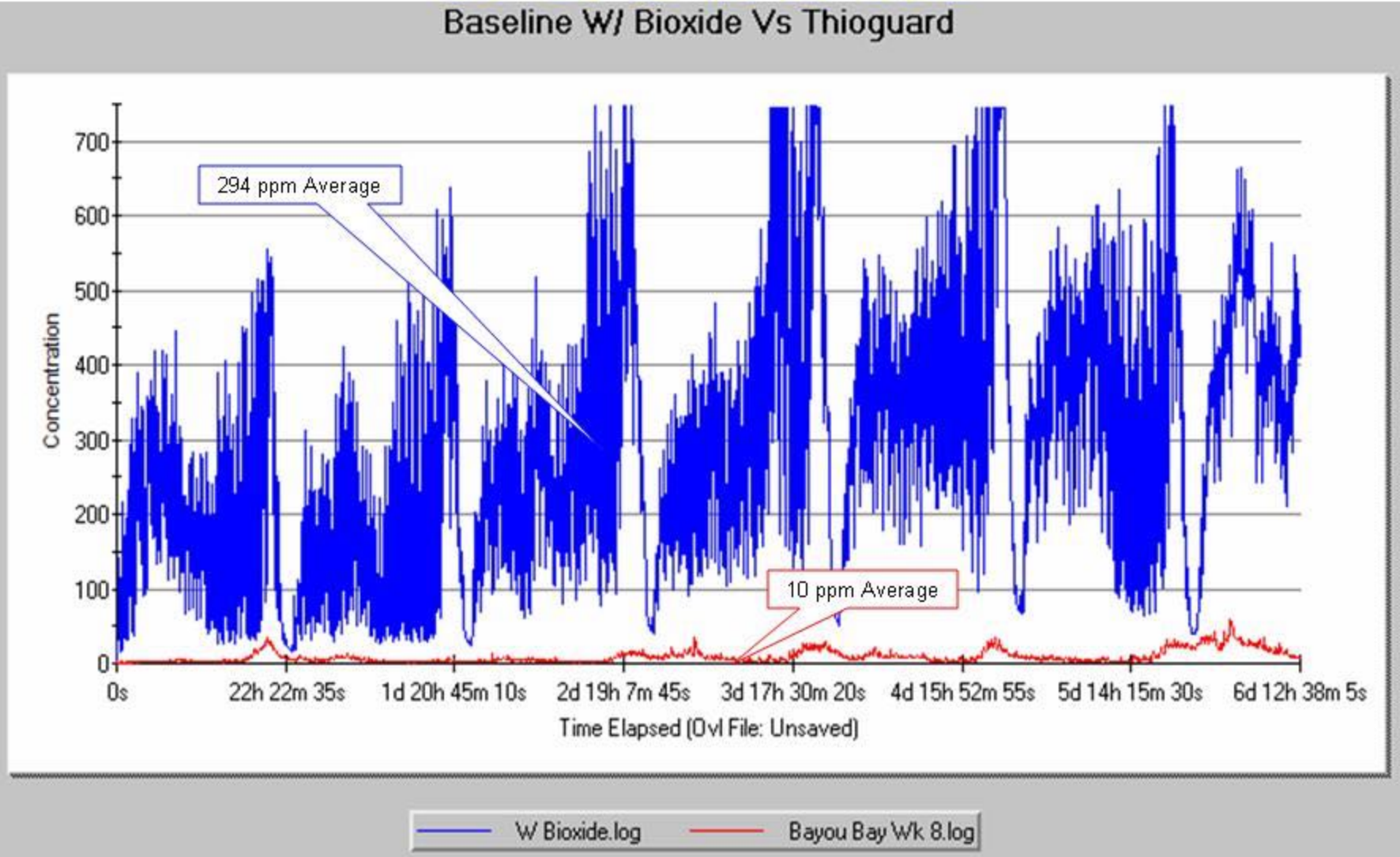
# IMPACT POSSIBILITIES OF SOME CHEMISTRIES

- **Potassium Permanganate** – Increases effluent manganese and oxidizes everything
- **Sodium Hypochlorite** – attacks all biology indiscriminately and chlorine gas corrodes
- **Chlorine** – forms hypochlorous acid and requires addition of alkali
- **Hydrogen Peroxide** – Breaks biological membranes and prematurely ages assets
- **Nitrates** – can cause a biological "grease" mat
- **Magnesium Hydroxide** – can consume man-hours

# Headspace Hydrogen Sulfide Gas Concentration

## Calcium Nitrate vs Magnesium Hydroxide

## 80 GPD vs 36 GPD



# EXAMPLE COST COMPARISON

- LET'S ASSUME THAT CALCIUM NITRATE AND MAGNESIUM HYDROXIDE HAVE THE SAME PER GALLON COST - $2.85

USING THE PREVIOUS EXAMPLE…

- $2.85 PER GALLON X 80 GPD OF NITRATE = $228 PER DAY

  @ 294 PPM AVERAGE GAS LEVEL

- $2.85 PER GALLON X 30 GPD OF MAGNESIUM HYDROXIDE SLURRY = $85.50 PER DAY

  @ 10 PPM AVERAGE GAS LEVEL

- MAGNESIUM HYDROXIDE IS CLEARLY THE BETTER CHOICE IN PERFORMANCE AND COST

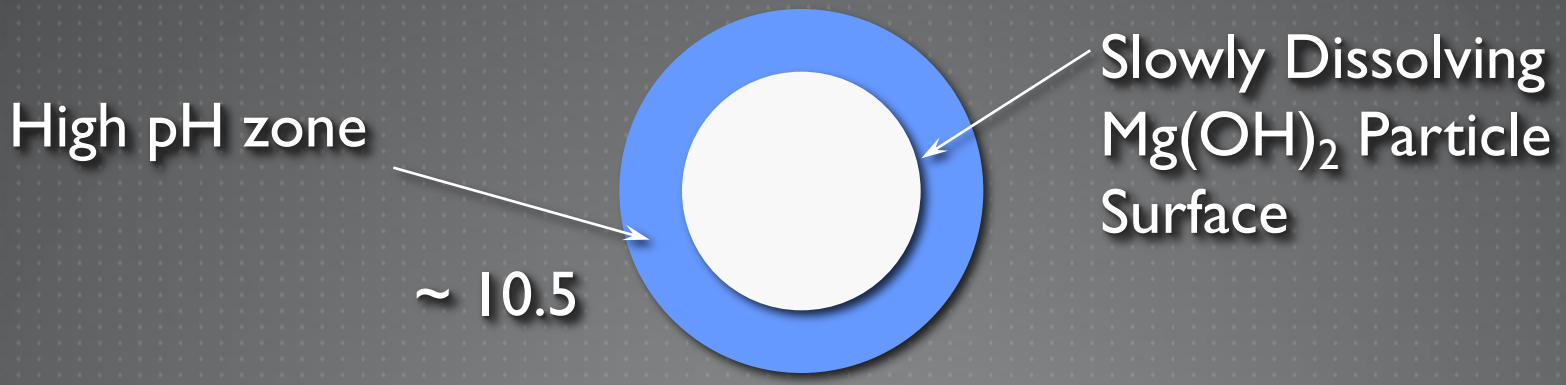
# HOW TO DOSE MAGNESIUM HYDROXIDE


**Magnesium Hydroxide is safe for personnel, the environment and the wastewater system.**

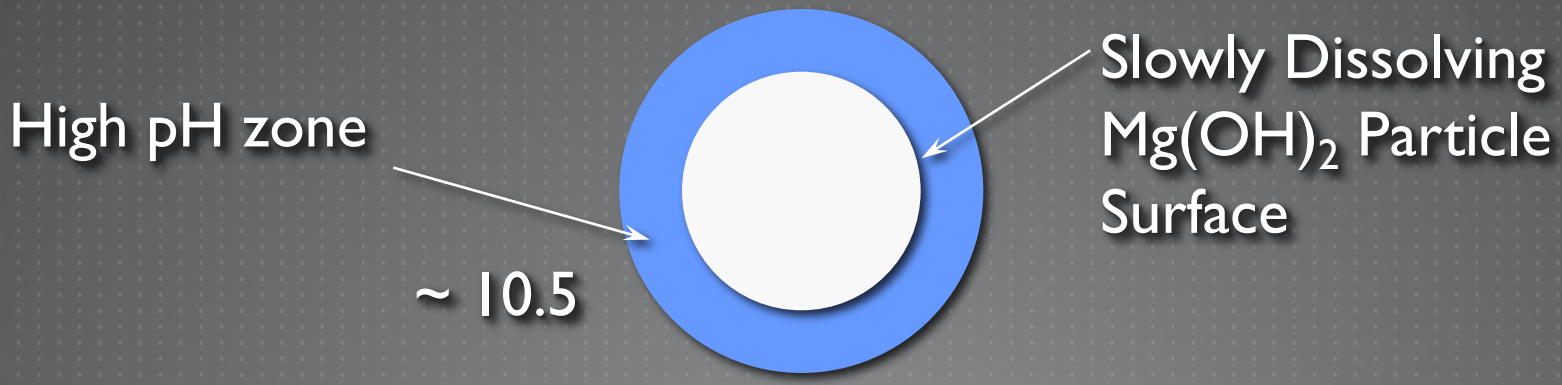
A properly engineered system is crucial to the successful application of Magnesium Hydroxide


NON-HAZARDOUS MATERIAL
EARTH FRIENDLY PRODUCT
Thioguard® TST
Premier Chemical
1-800-227-4287
WWW.PREMIERCHEMICALS.COM

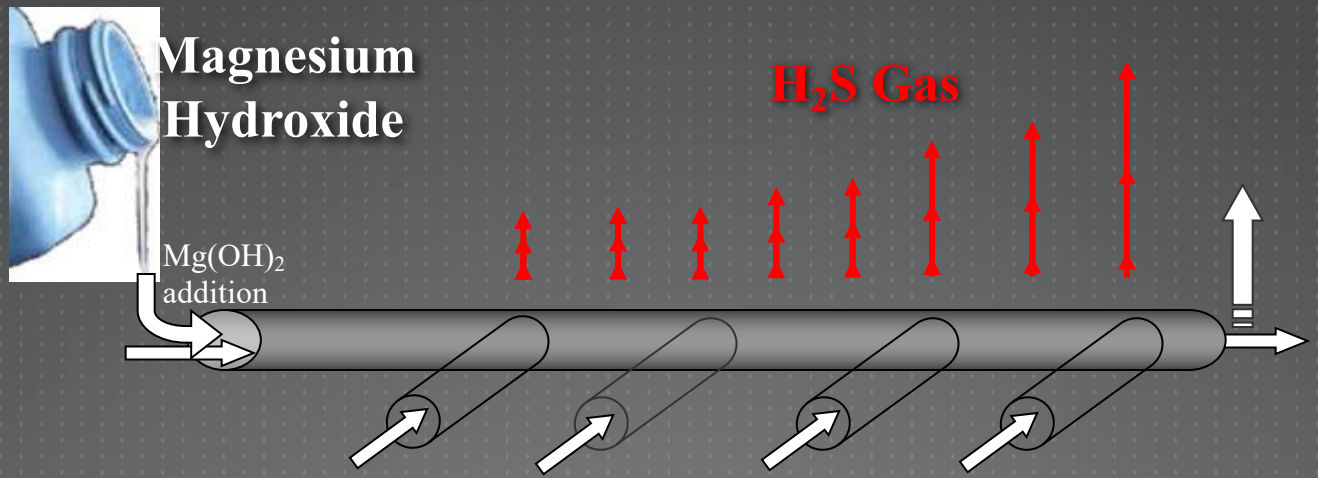
These particles dissolve as they travel through the collection system allowing for just a few addition points.

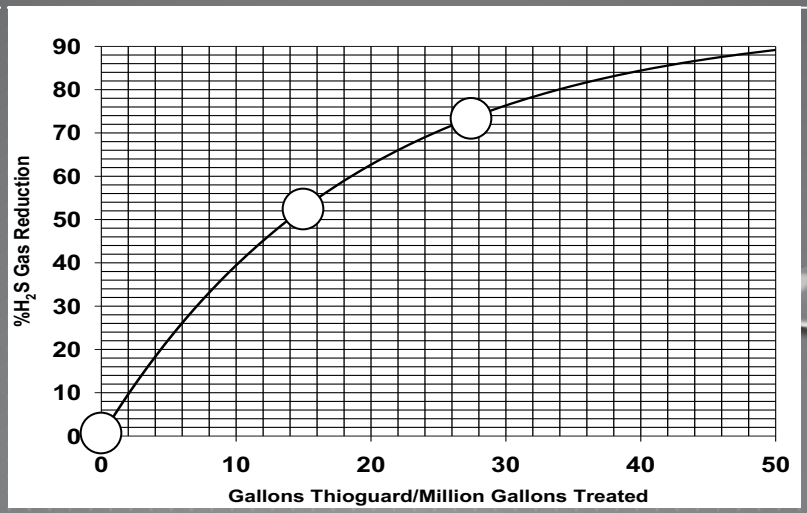


Undissolved Magnesium Hydroxide particles react directly with $H_2S$ converting $H_2S$ to magnesium polysulfide.



# Chose the dosage
# Chose the desired Hydrogen Sulfide Concentration



# CALCULATING/ESTIMATING DOSAGE

The best way to get a good approximation of how much magnesium hydroxide you will need for odor control is to do a jar test to an endpoint of 8.2 su with a wastewater sample from the point where the odor is a problem.

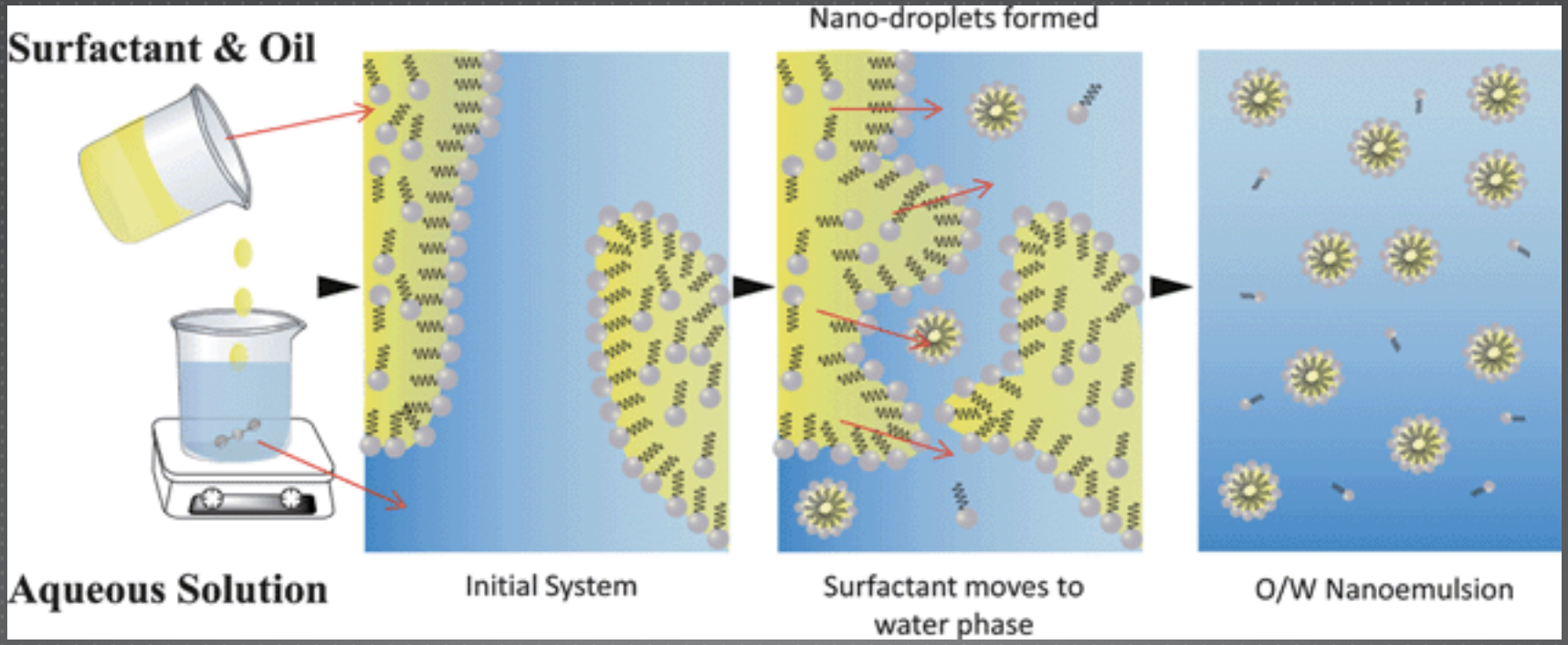
- **For odor control**: the rule of general thumb dosage for gravity or force-main odor control is 50-60 gallons of slurry per MGD. (Full range is 30-100 gallons per MGD). If using MgO powder, that is 30 dry lbs per 100,000 gallons of waste water.

- **For alkalinity supplementation**: 1 gallon of slurry provides approximately 13 lbs of alkalinity as Calcium Carbonate (that's about 5 lbs of MgO powder). So you get about 1.5 ppm carbonate alkalinity for every gallon (or 5 lbs of MgO) into 1 MGD of wastewater. Every ppm of Ammonia then requires about 7.14 ppm of alkalinity as Calcium Carbonate.

# APPLICATION FOR GREASE CONTROL

A large percentage of wastewater collection blockages (even in mains) can be traced to FOG. Blockages are serious, causing sewage spills, manhole overflows, or sewage backups in homes and businesses. You can disperse/emulsify to **BREAK UP** the grease (which may coagulate later) or **BREAK DOWN** by mild saponification to eliminate downstream FOG blockages and odor.

# EMULSIFY……..DISPERSE



# Saponification

## BREAK DOWN……Decompose

By raising the pH of the wastewater to 8 or higher, Magnesium Hydroxide breaks fats (FOG) down into a mild soap and glycerol. Glycerol is then consumed at the plant or in the collection system by the biology.

FATTY ACID

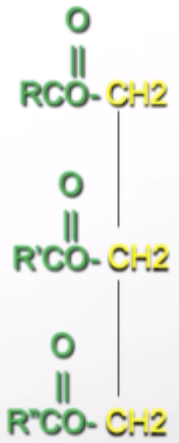
GLYCEROL

CARBOXYLATE SALTS - SOAP

DECOMPOSE GREASE

# SAPONIFICATION MECHANISM

Low-density, long-chain fatty acids accumulate on the water surface of low velocity structures and can build up on pipe walls causing occlusion and eventually SSOs.

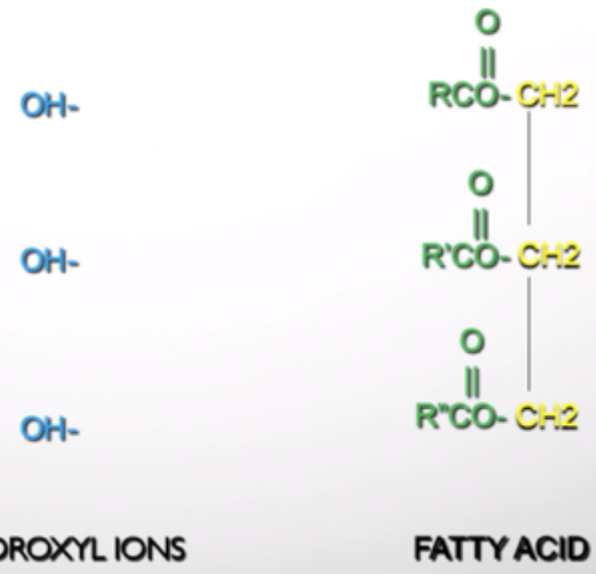



FATTY ACID

DECOMPOSE GREASE

# SAPONIFICATION MECHANISM

THIOGUARD ($Mg(OH)_2$) slowly releases hydroxyl ions which breakdown low-density, large-chain fatty acids (FOG) into glycerol and various types of soap, both of which are more readily digested by bacteria in wastewater.



DECOMPOSE GREASE

# SAPONIFICATION MECHANISM

THIOGUARD ($Mg(OH)_2$) slowly releases hydroxyl ions which breakdown low-density, large-chain fatty acids (FOG) into glycerol and various types of soap, both of which are more readily digested by bacteria in wastewater.


CARBOXYLATE SALTS - SOAP

GLYCEROL

DECOMPOSE GREASE

# SAPONIFICATION MECHANISM

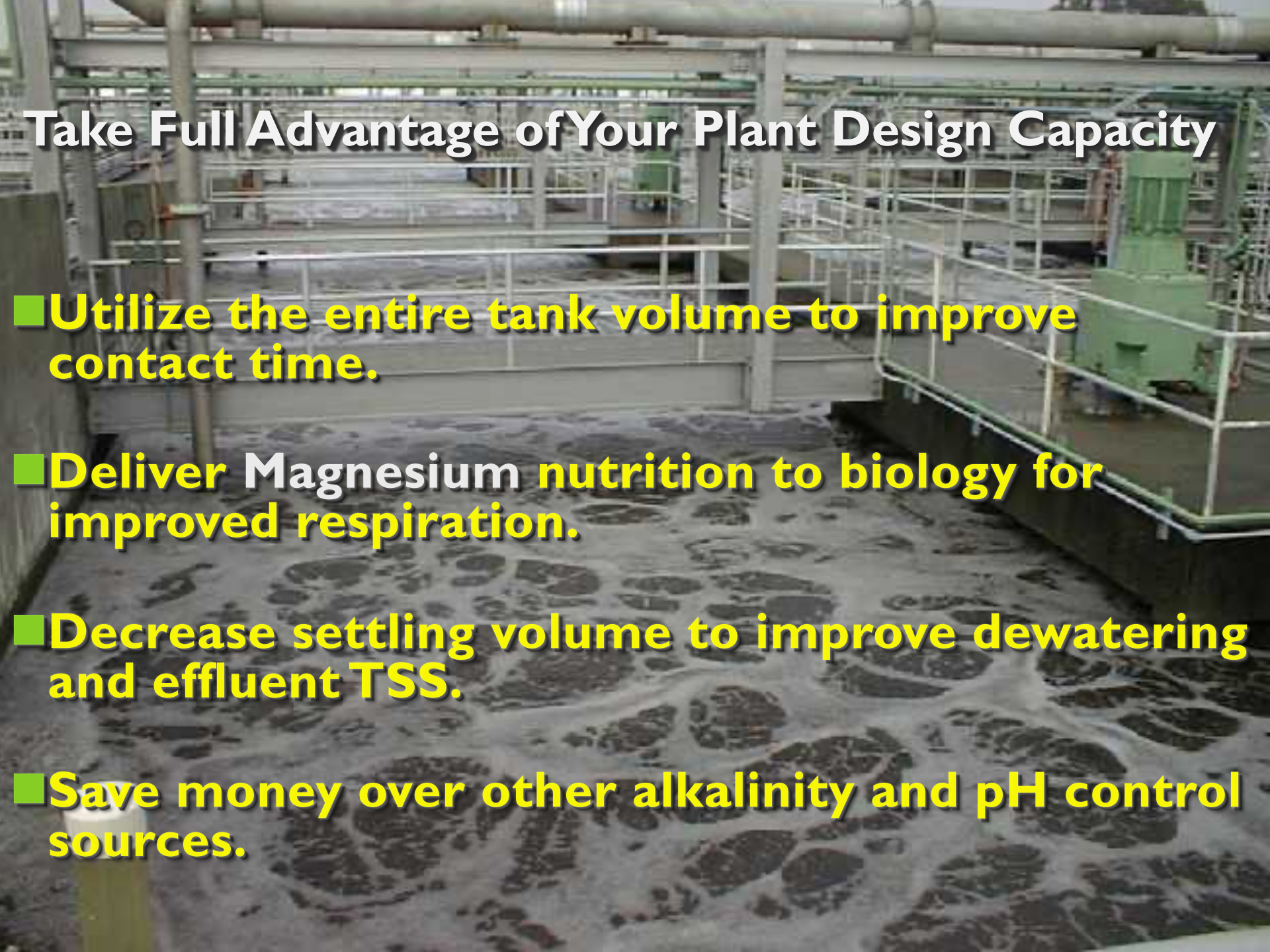
The mild soaps that are produced further facilitate the breakdown of accumulated blankets by solubilizing FOG's.


CARBOXYLATE SALTS - SOAP

GLYCEROL

# Wastewater Treatment Plant Effects

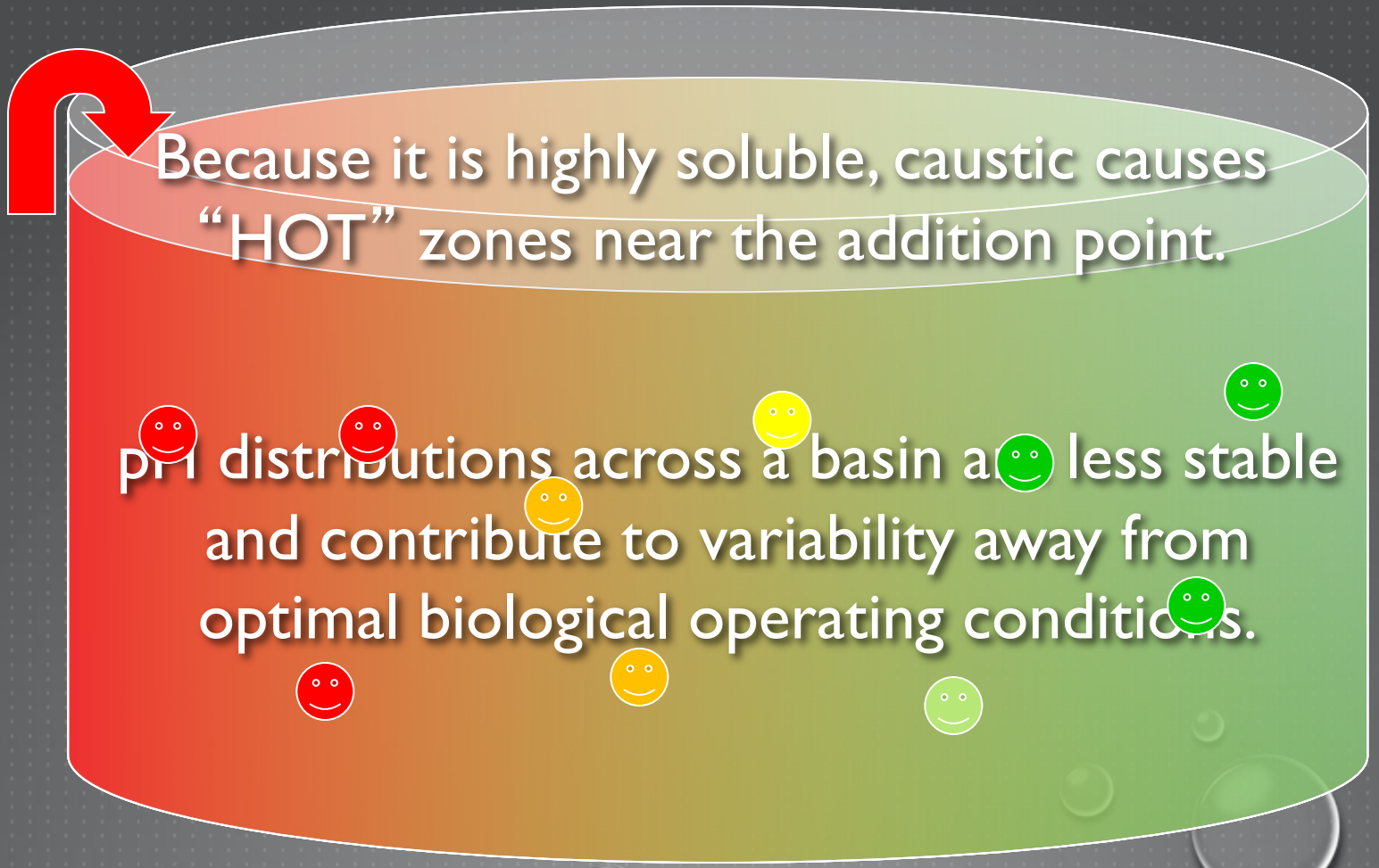
**Biological treatment plants and collection systems operate better with wastewater that has proper, stable pH, lower acidity and higher available alkalinity.**



# Take Full Advantage of Your Plant Design Capacity

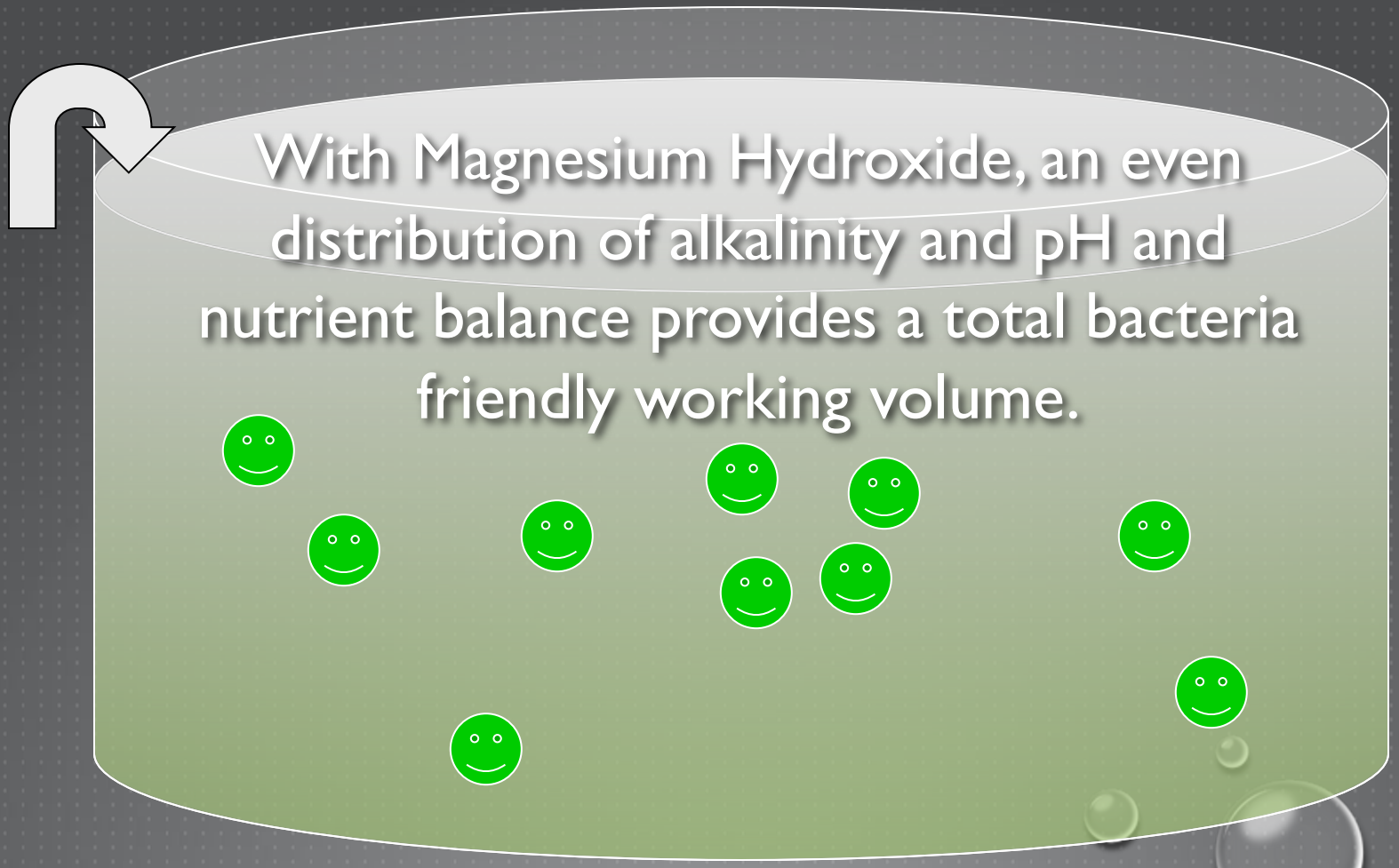
- Utilize the entire tank volume to improve contact time.
- Deliver Magnesium nutrition to biology for improved respiration.
- Decrease settling volume to improve dewatering and effluent TSS.
- Save money over other alkalinity and pH control sources.

# CAUSTIC SODA ADDITION

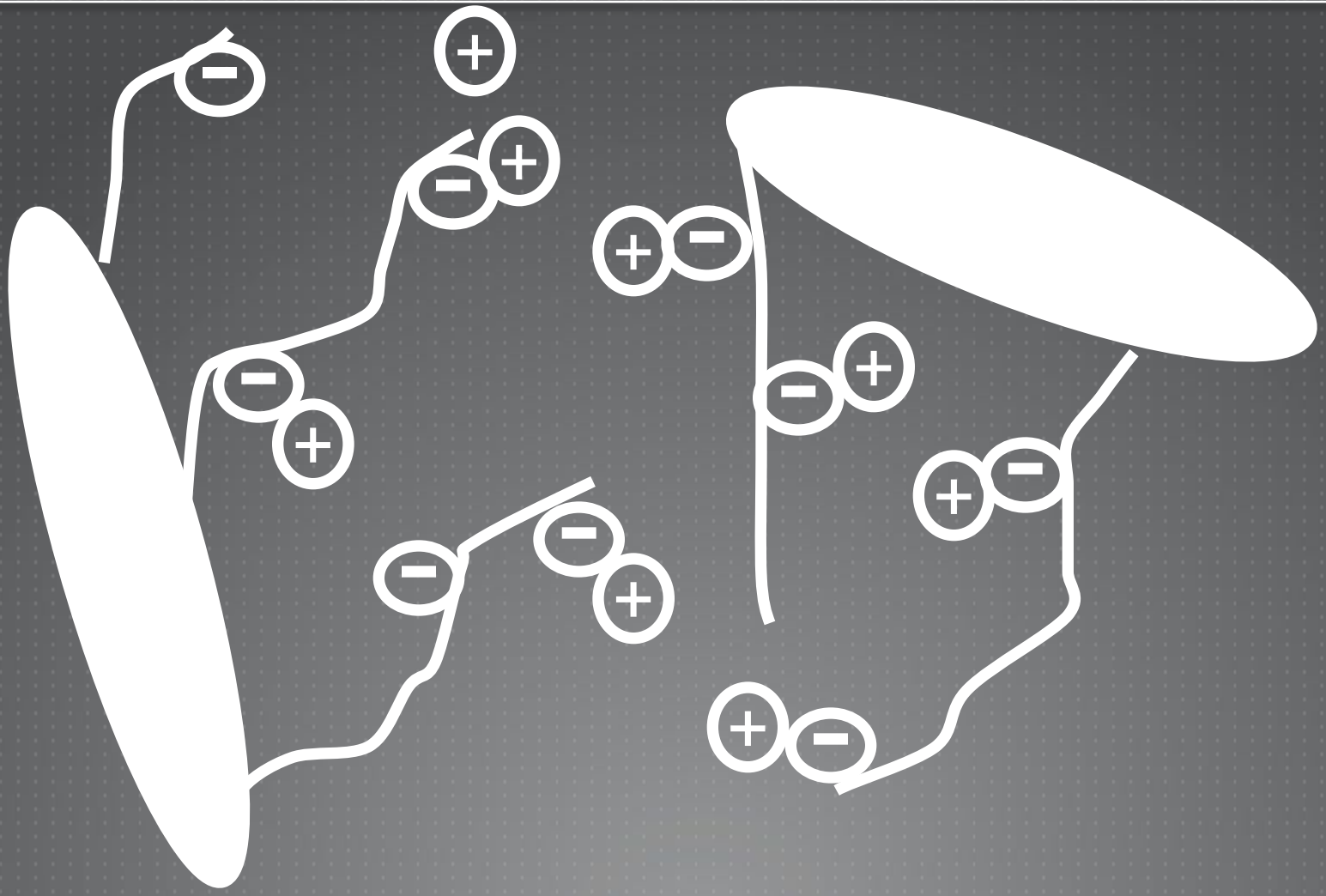



IF IT BURNS YOU, IT HURTS THEM

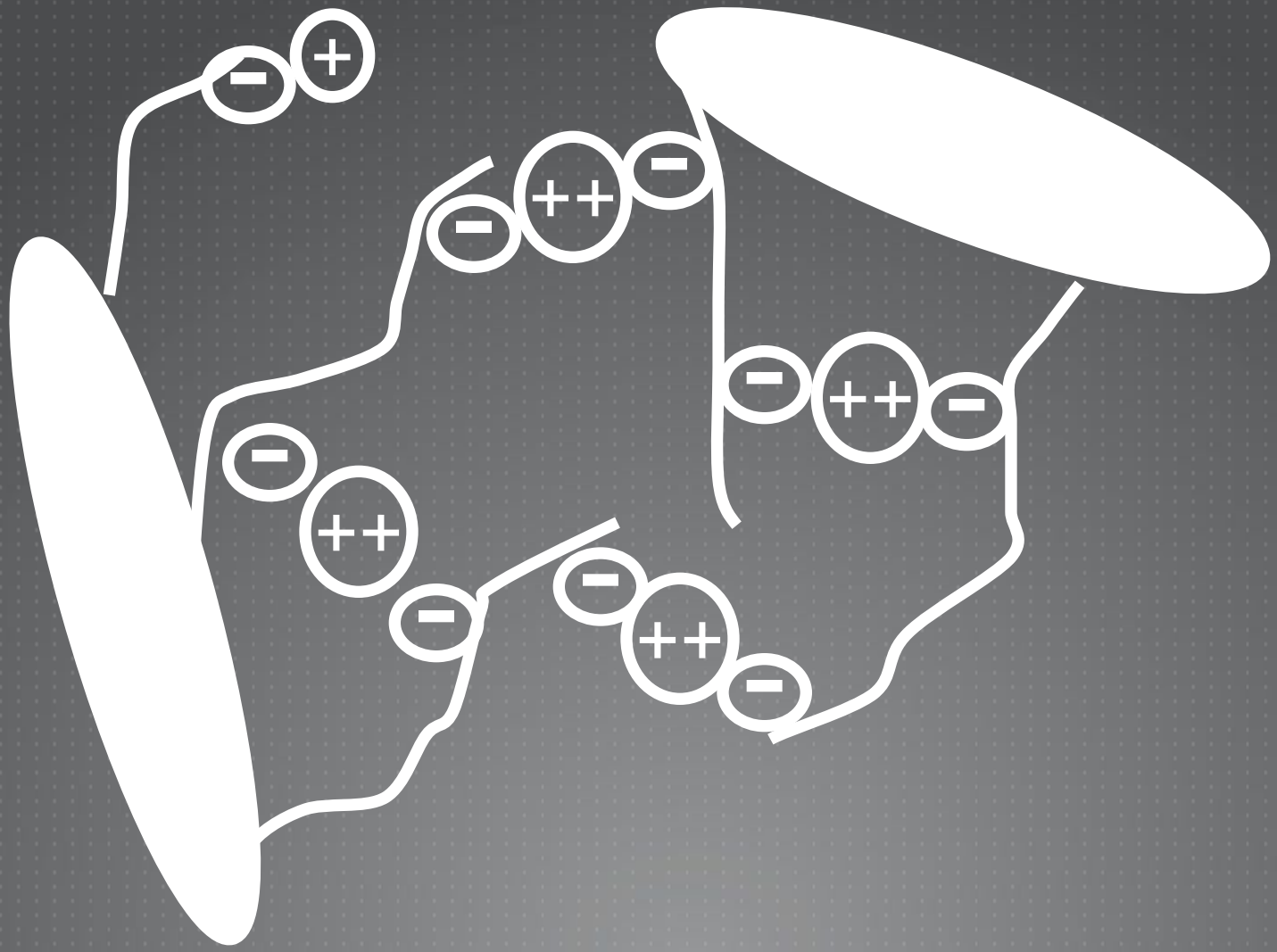
# WITH MAGNESIUM HYDROXIDE



# MONOVALENT CATIONS ($NA^+$) BOND TO NEGATIVE ANION SITES ON EXOCELLULAR BIOPOLYMERS



# DIVALENT BRIDGING IMPROVES FLOC MATRIX



# MAGNESIUM HYDROXIDE CAN IMPROVE SLUDGE DEWATERING


**When compared to calcium hydroxide (far left) and sodium hydroxide, magnesium hydroxide (far right) substantially reduces sludge volume as shown in this laboratory acid neutralization test.**

# IMPACT OF MAGNESIUM HYDROXIDE

| CHEMICAL | % REDUCTION | ANNUAL SAVINGS / MGD |
|---|---|---|
| Ferric Chloride $FeCl_3$ | 75-100% | $1,553 – 1,100 |
| Polymer | 75-100% | $533 - 400 |
| Chlorine $Cl_2$ | 20-30% | $496 - 330 |
| Sulfur Dioxide $SO_2$ | 20-30% | $377 - 250 |
| TOTAL ANNUAL CHEMICAL SAVINGS | | $2,960 – 2,147 |
| 5-YEAR SAVINGS | | $14,804 - 10,739 |

# Collection System Benefits

- **Non-Hazardous/G.R.A.S.**
- **Maintains pH and Odor control for miles from one addition point.**
- **Provides corrosion protect in addition to odor control.**
- **Reduces FOG**
- **Least Expensive**

# WWTP Benefits

- **Odor Control**

  Headworks, RBCs, Digesters, Sludge Holding, and Dewatering

- **Treatment Enhancement**

  Effluent Quality and Plant Capacity - BOD, COD, SVI, TSS, MLSS, MLVSS, RAS, DOC

- **Better Bio-solids Volume and Disposal**

- **Improved Safety and Environmental Compliance**

# Magnesium Hydroxide

## A More Natural Approach to Wastewater Total System Treatment.