It Doesn’t Have to Stink: Wastewater Odour Control 101

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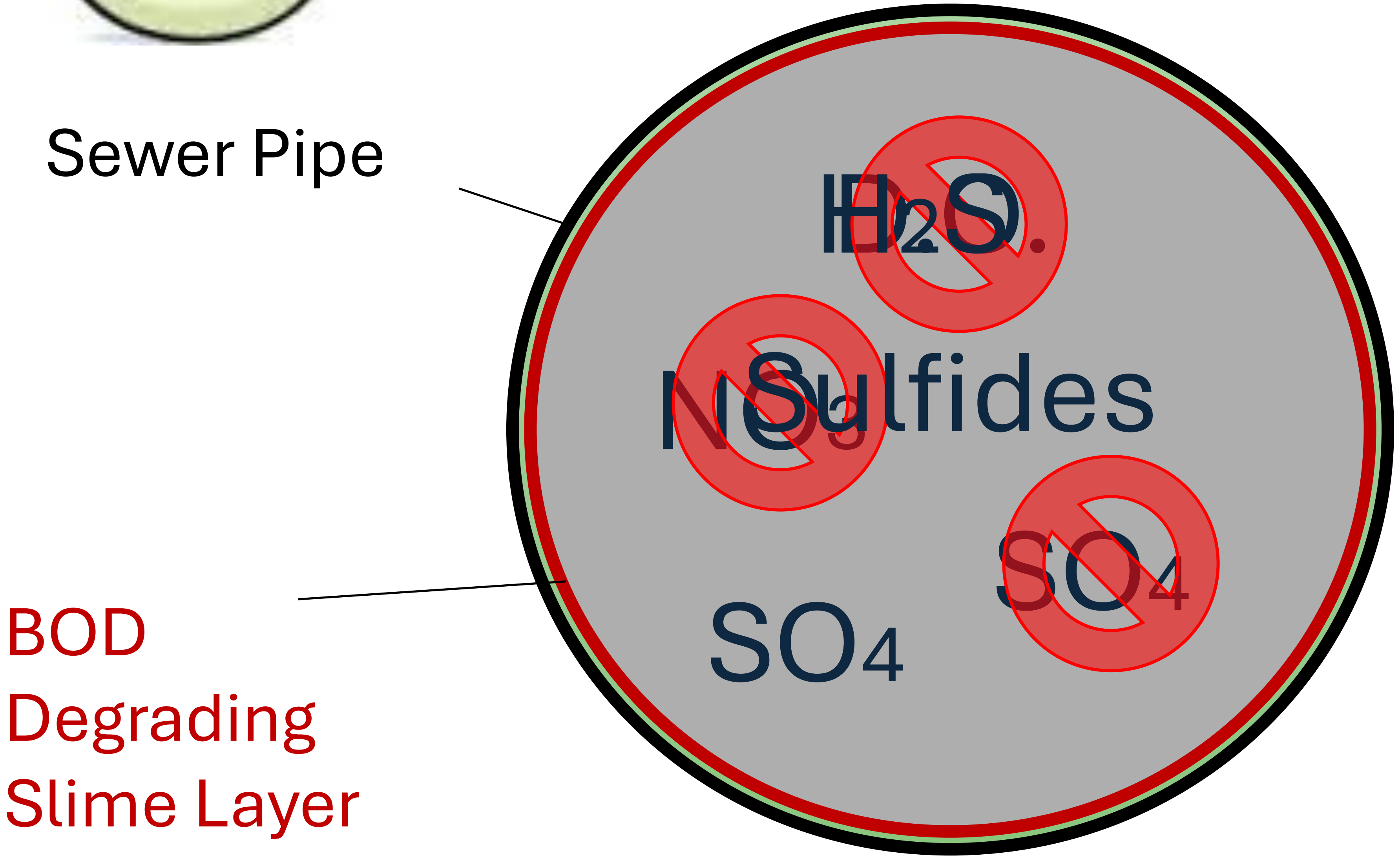
Agenda:

- Hydrogen Sulfide Generation
- Treatment options

ODOURS!



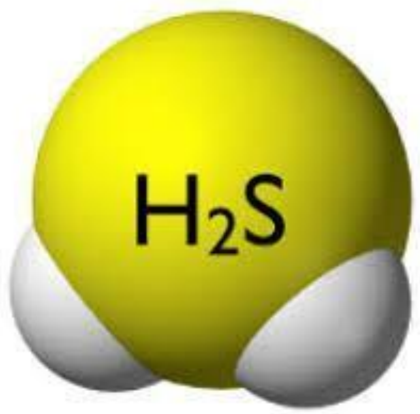
- Hydrogen Sulfide
- Mercaptans/Reduced Sulfur Compounds
- Indoles
- Skatoles
- Ammonia
- Amines
- Organic Acids

What does that mean for YOU?

Why Spend $$$ to Control H_2S?

Four major impacts of H_2S

1. Dominant nuisance odour (esp. collection systems)
2. Worker safety / health risks
3. Infrastructure corrosion
4. Treatment process impairment



$$H_2S \underset{OH^-}{\longleftrightarrow} HS^- \underset{OH^-}{\longleftrightarrow} S^{-2}$$

(volatile) (non-volatile) (non-volatile)

H_2S Toxicity Spectrum

PPM
0.1
0.2
3.0
5.0
10
50
100
300
500
1000
2000

‘Rotten Egg’ Odour

OSHA Limit (Time Weighted Average)

Threshold of Serious Injury
+
Loss of Sense of Smell

Imminent Life Threat

Immediate Collapse with Respiratory Paralysis

Aqueous vs. vapour Levels

Typical

Correlations

Aqueous **Dissolved Sulfide** mg/L		Vapor / Air **Hydrogen Sulfide** ppmV
> 15	Extreme	> 250
12 - 15	Severe	100 - 250
8 - 11	Very high	70 - 100
4 - 7	High	40 - 70
1 - 3	Moderate	15 - 40
0.3 - 1	Low	5 - 15
< 0.3	Very low	< 5

Direct correlations between liquid and vapor levels are not possible. The following factors increase vapor levels for a given liquid level …

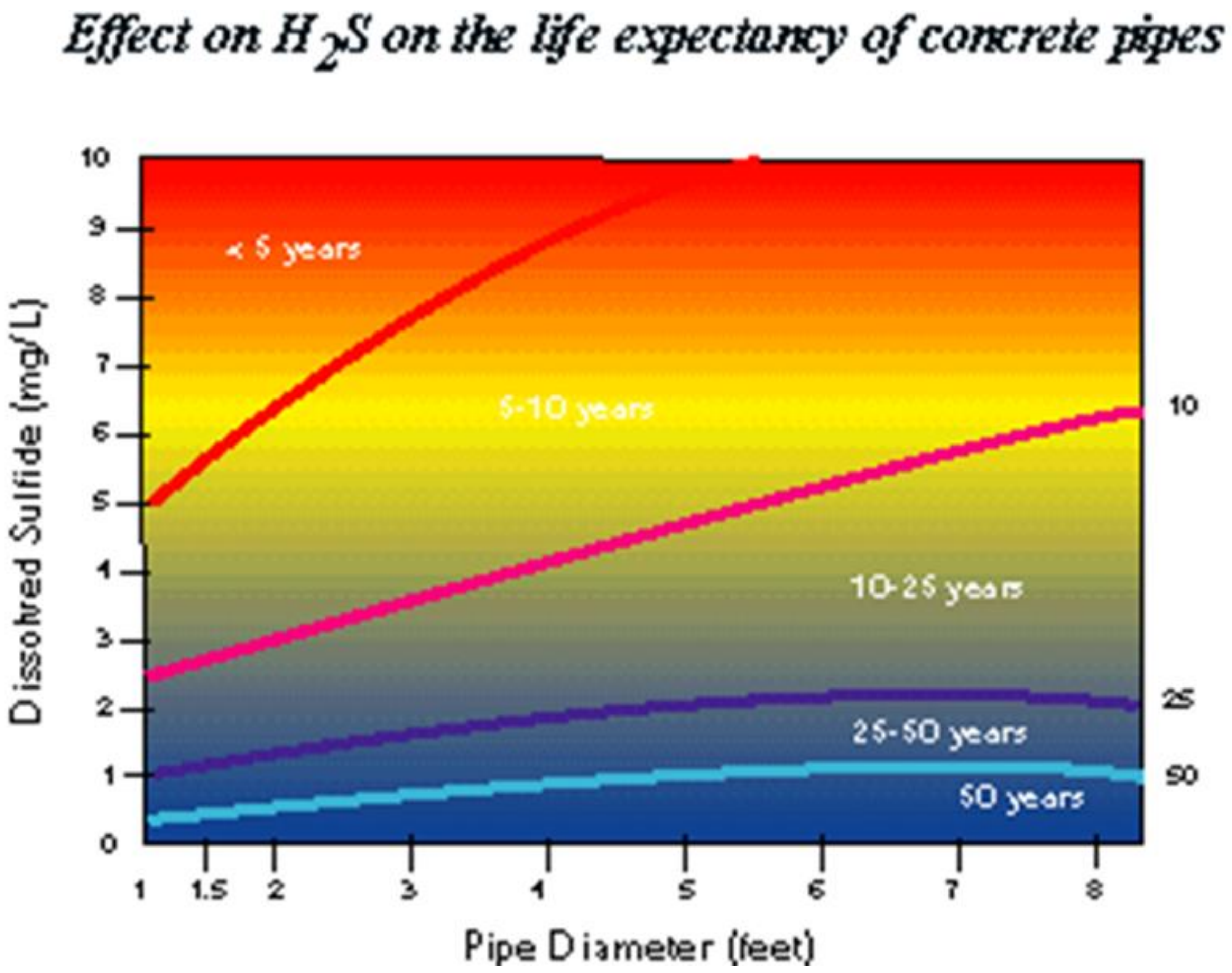
High turbulence
Poor ventilation
Low pH
High temperature

H_2S Corrosion Effects

Prevalence of the Hydrogen Sulfide Problem

(EPA Report to Congress, 1992)

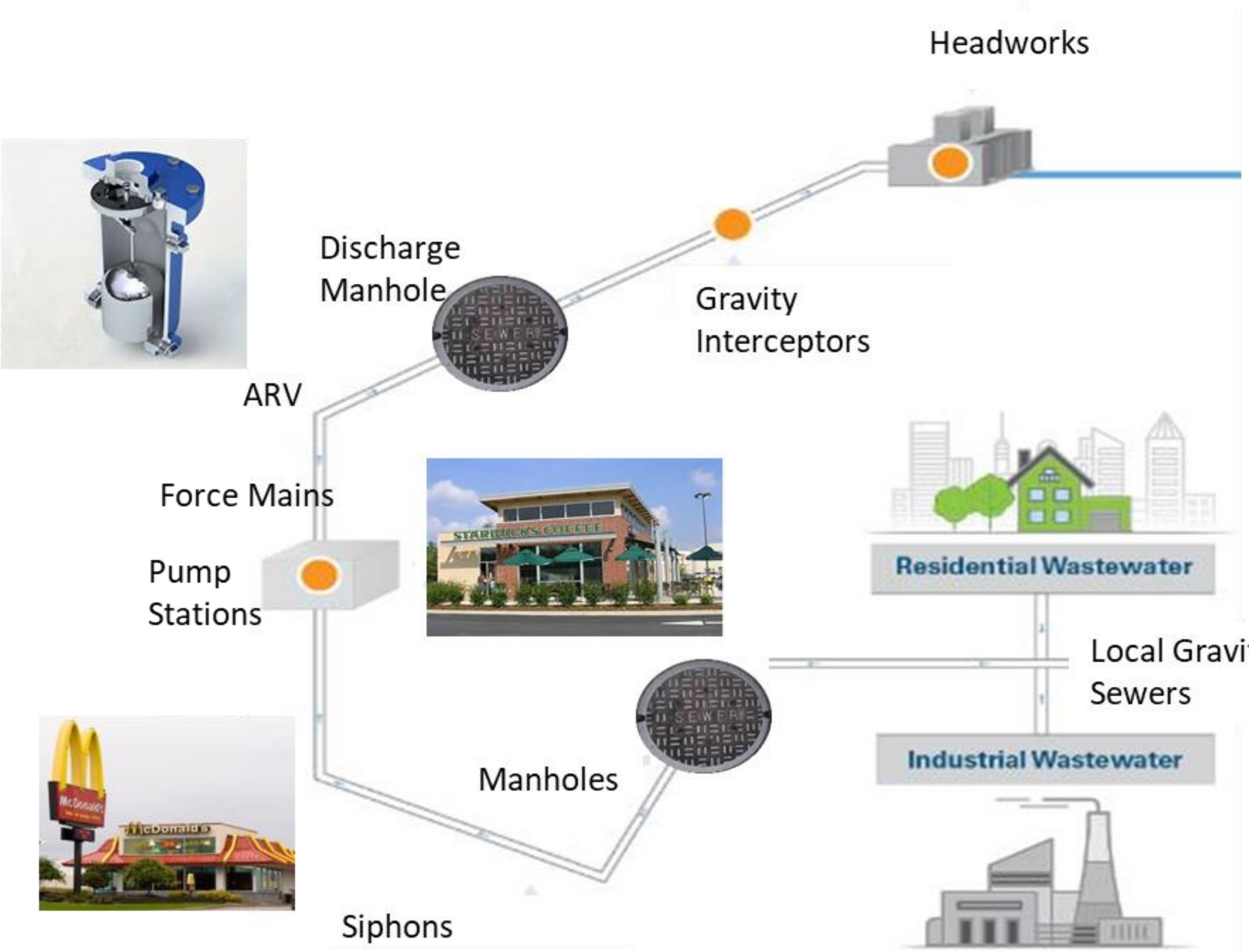
- Not limited to warm climates
- Can reduce infrastructure life from 50-100 years to <10 years
- >35% of cities surveyed report sewer collapses, 75% of which are attributed to sulfide-induced corrosion
- 60-70% report corrosion problems at the treatment plant



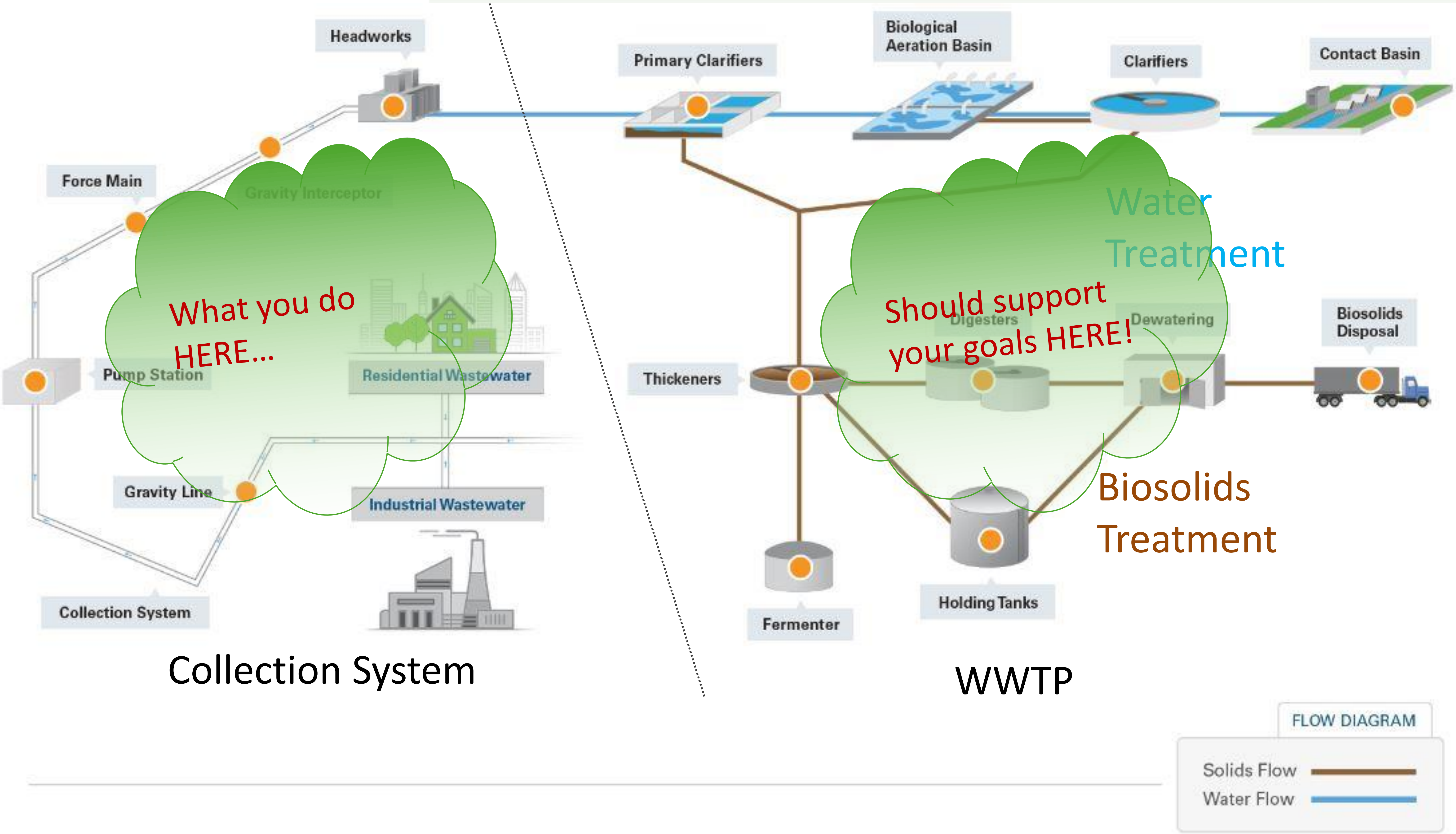
Questions to ask yourself:

- What are my goals?
  - Mitigate Odour Complaints
  - Infrastructure Protection
  - Worker Safety
  - Treatment process improvement
- What does success look like?
- What type of treatment to implement?

Where are my "Hot-Spots" ?



Everything is connected

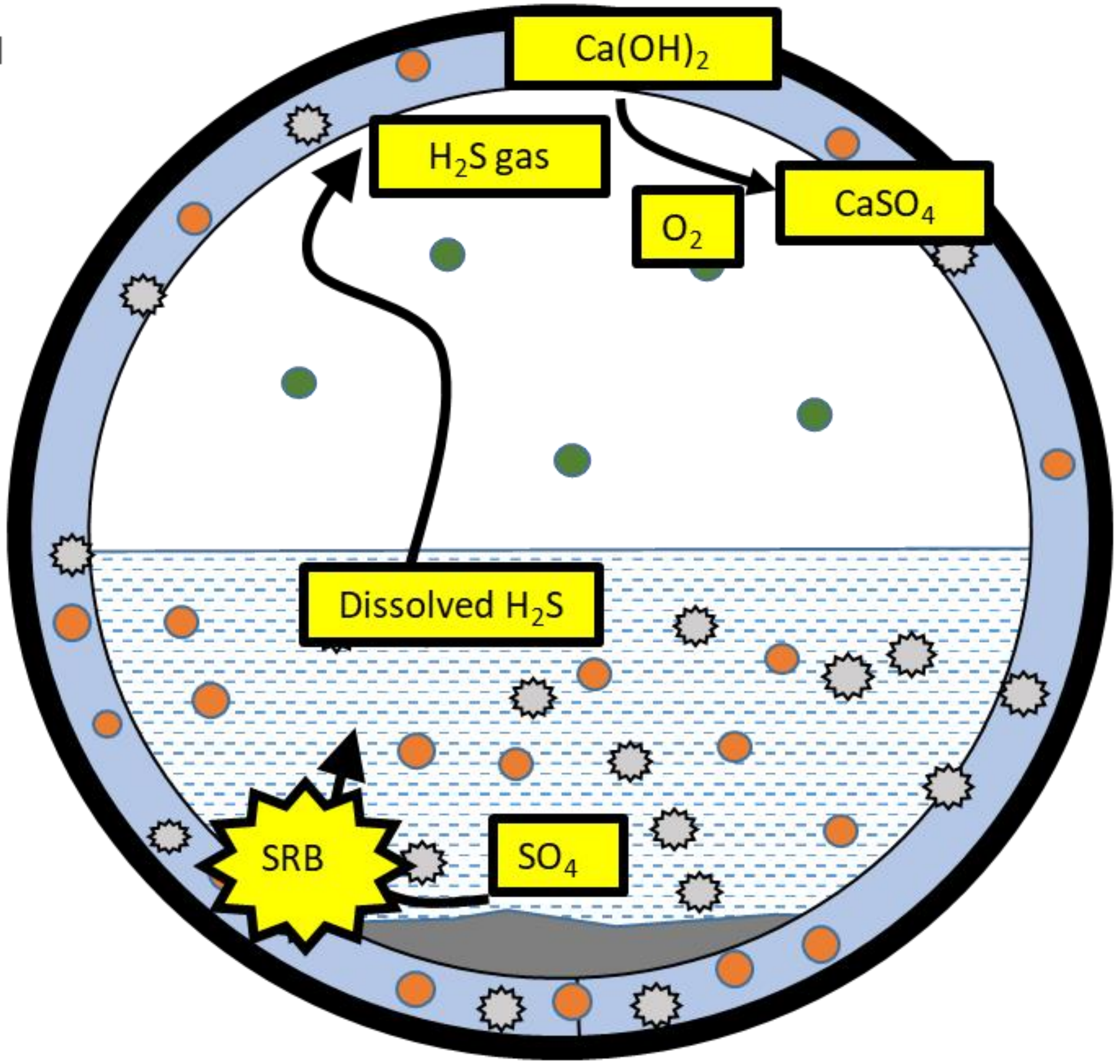


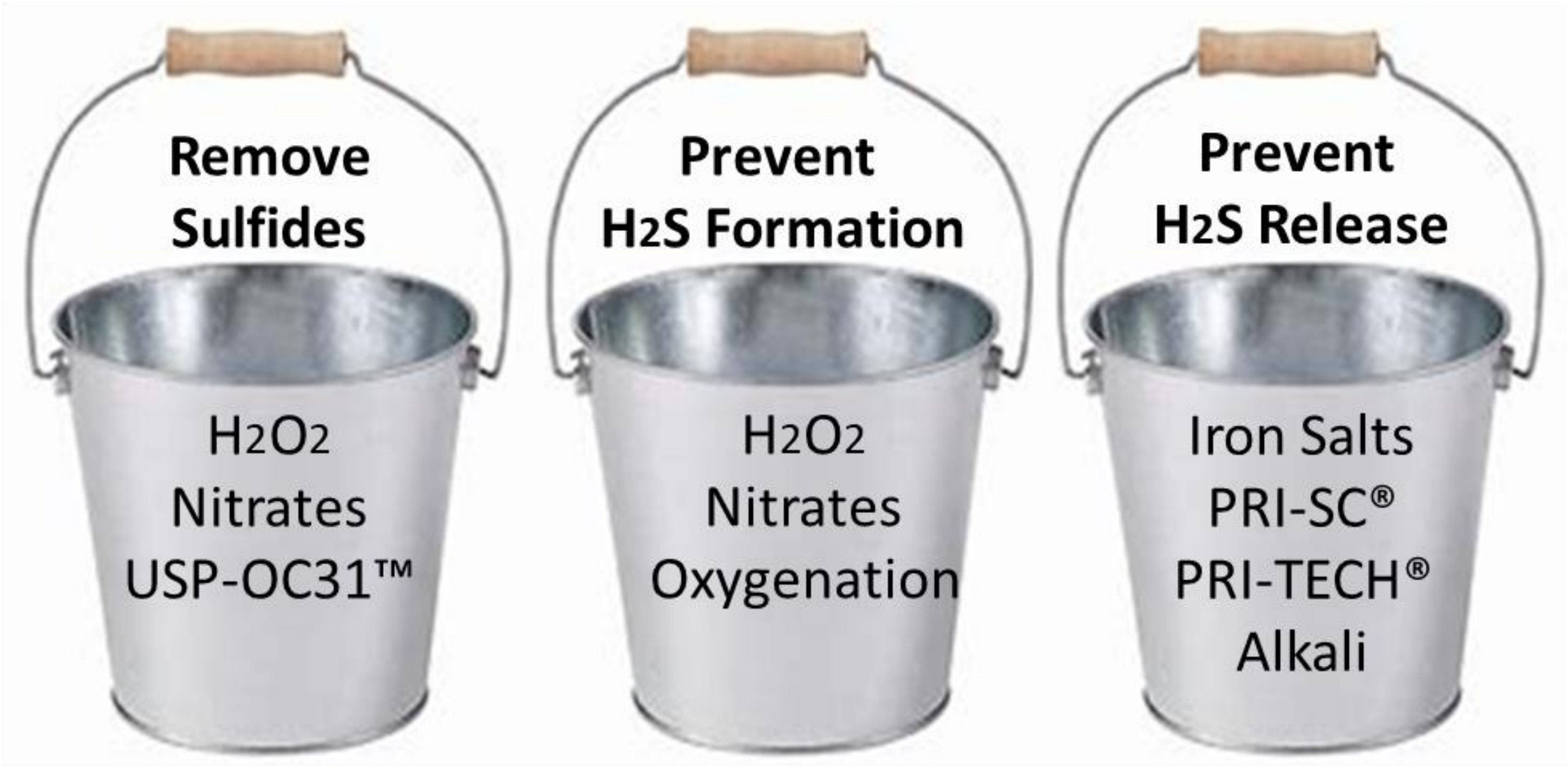
Collection System

WWTP

What's My Approach?

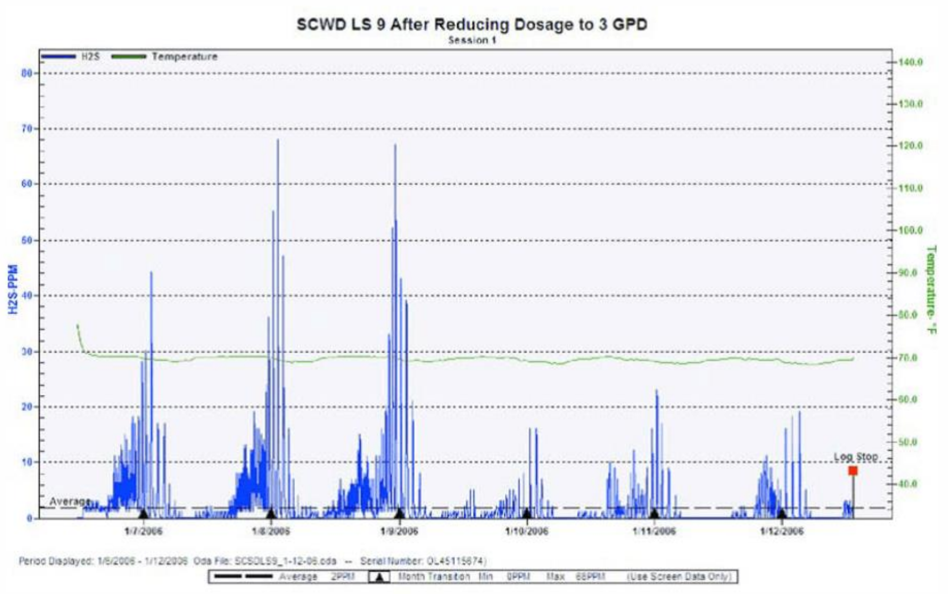
Sulfide and Corrosion



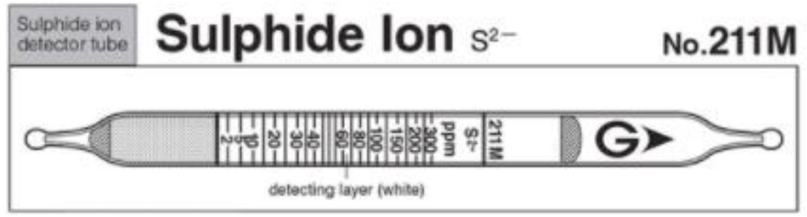


How Are You Going to Measure Performance?

- Vapour Monitoring



- Aqueous Monitoring



Point Source Odour Management

- Can the area be isolated and enclosed ?

Vapour Phase Odour Control:

- Remove H_2S / Odours from the air before it is released to the atmosphere.
- Relatively inexpensive
- H_2S still present in pipeline / wet-well, etc.

Multiple Point Odour Control

- Do multiple odour hot-spots exist?
  - Several manholes along an interceptor
  - Gravity lines with siphons
  - Several pump stations in series
- What’s going on downstream?
  - Durational odour control needs
  - Impacts to wastewater treatment processes

Water Quality Impact

Choice of odour Control in the collection system determines the water quality delivered to the plant:

<u>Nitrates</u>
ORP ↑
Soluble BOD ↓
VFAs ↓
Sulfides ↓
N-Load ↑

<u>Mag</u>
pH ↑
Sulfides ↑ (in Solution)
Struvite ↑

<u>Iron</u>
ORP ↓
VFAs ↑
Sulfides ↓
“Regenerable”

Nitrates

Control Mechanisms	Inhibits septicity Promotes bio-oxidation of sulfide & organic odours

Advantages

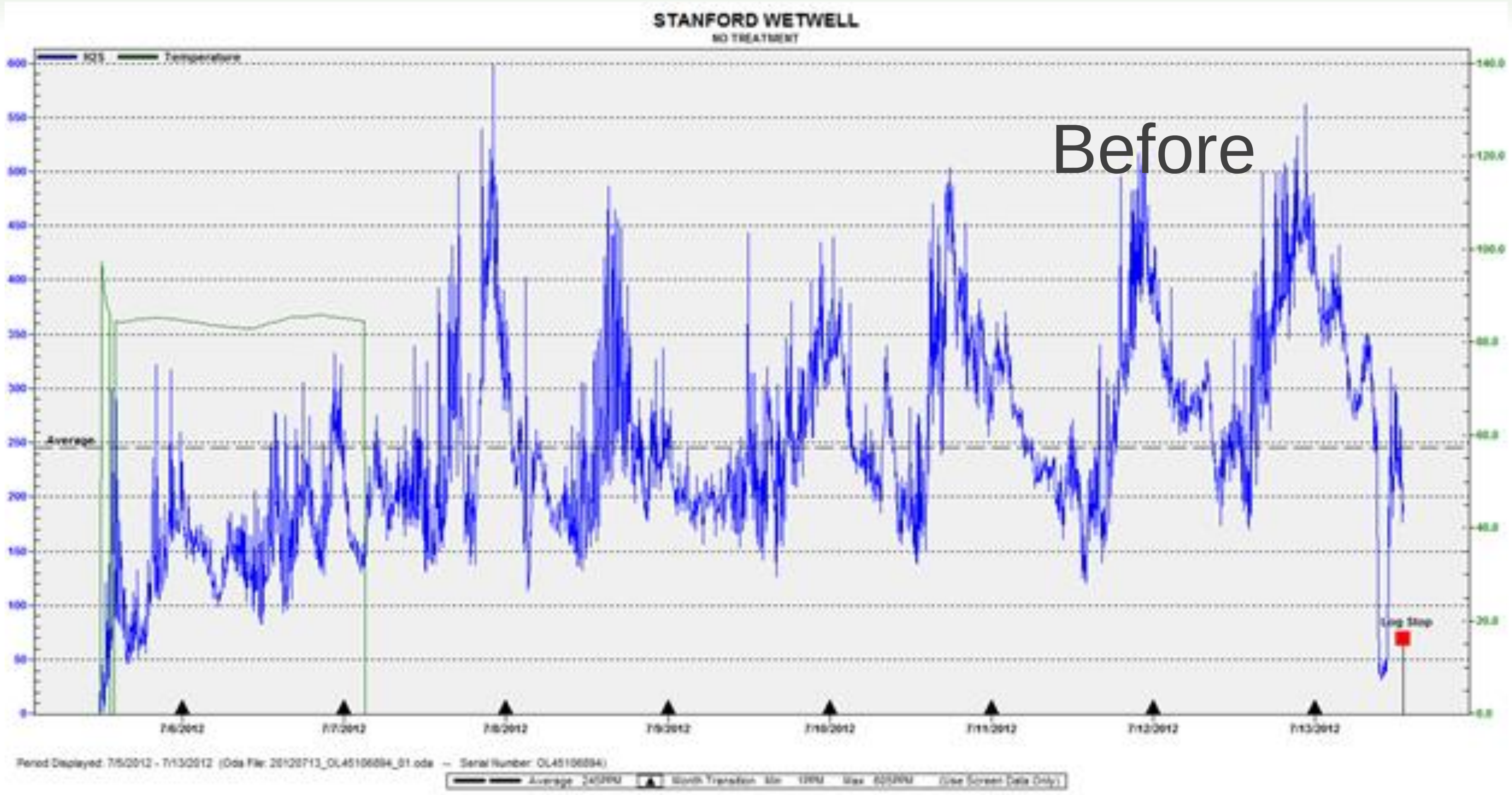
- Simple feed systems
- *Historical* benchmark for “non-hazardous” odour control

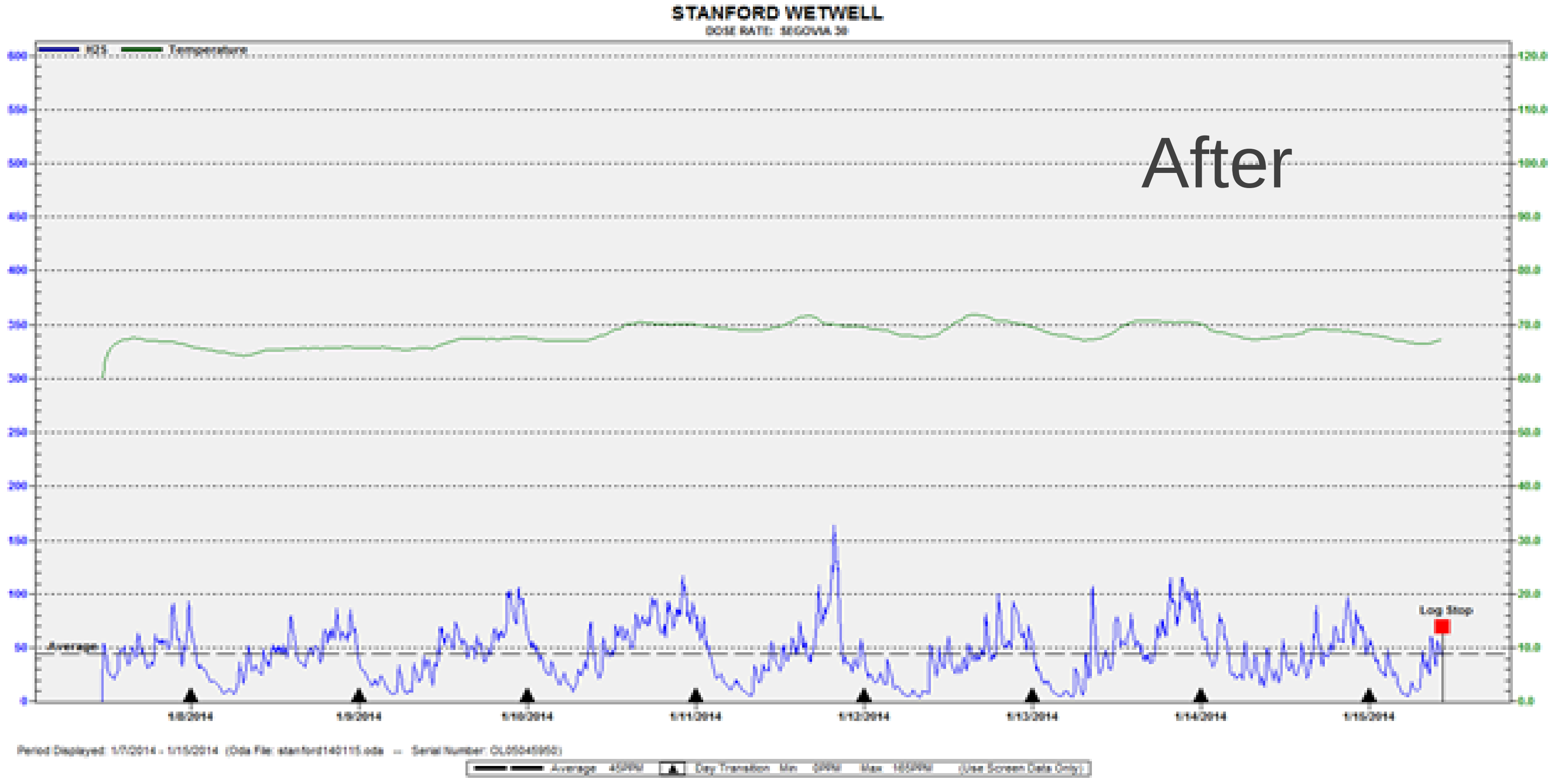
Disadvantages

- Reaction time requires several hours
- Consumes Volatile Fatty Acids & rbCOD
- May stimulate biogrowth / floating solids
- Can contribute to nitrogen load at plant
- May not be cost-effective for long durational control or high BOD/temperature lines

Nitrate Case Study

- Location – JEA, Jacksonville, FL
- Technology – Nitrate, dosed in neighborhood on Segovia Avenue
- Results – Gaseous H_2S went from 245 average & 600 peak ppm to 45 average & 160 peak ppm at downstream Stanford Wetwell control location, minimizing odour complaints





Iron Salts

Control Mechanism(s)

Ferrous salts precipitate sulfide
Ferric salts oxidize & precipitate sulfide

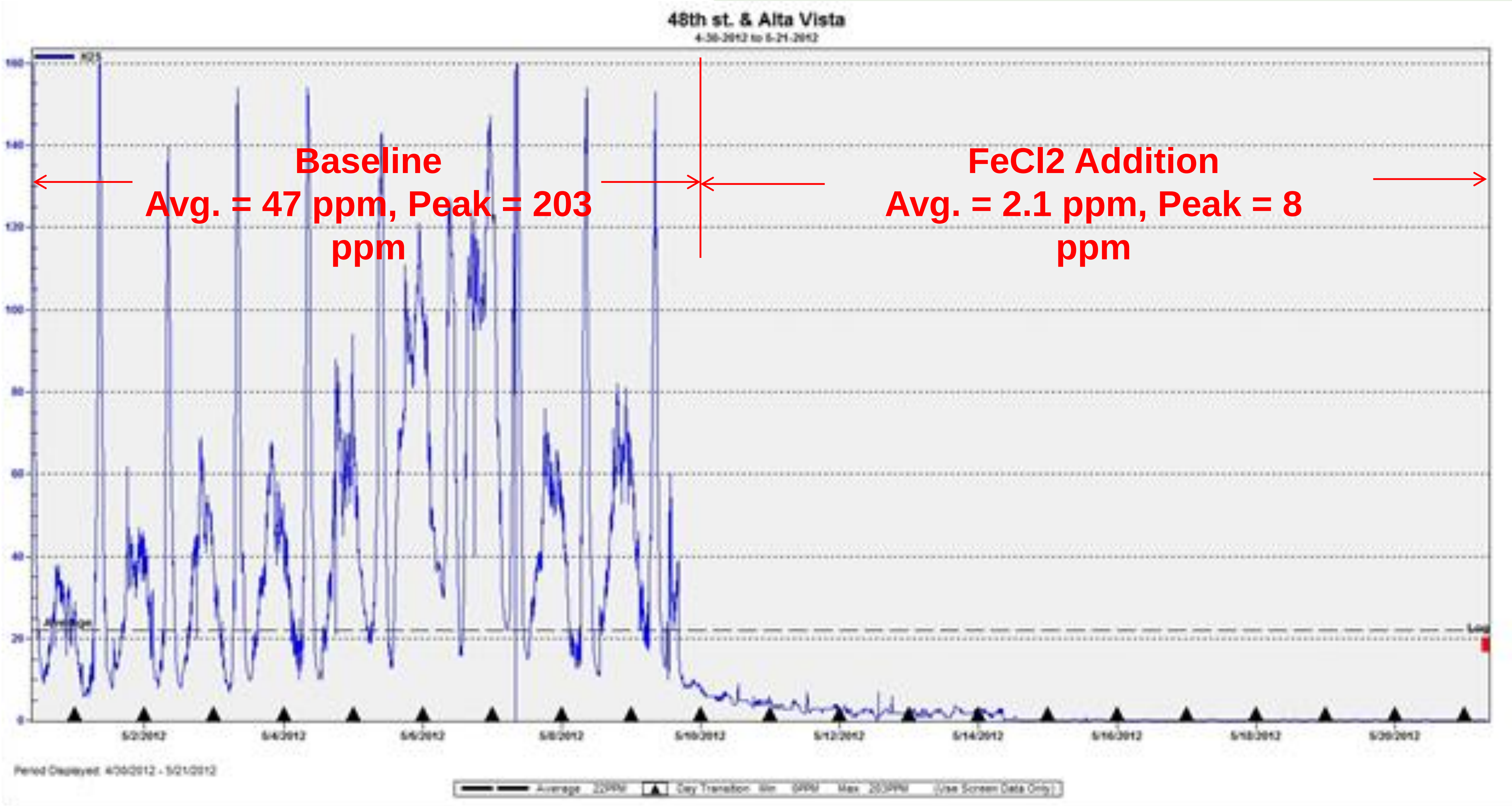
Advantages

- Extensive history / commonly used
- Effective for long duration control
- Assists in phosphate / struvite control
- Not affected by oxygen uptake rates

Disadvantages

- Contributes to solids loading
- Can deplete alkalinity & add salinity
- Does not destroy sulfide
- Overdosing may leave deposits on pipes/equipment

Iron Salt: Case Study



- **Location** – City of Phoenix, AZ
- **Technology** – Ferrous chloride, dosed at 48th Street & Alta Vista
- **Results** – Significantly reduced sulfides in collection system and decreased odour complaints

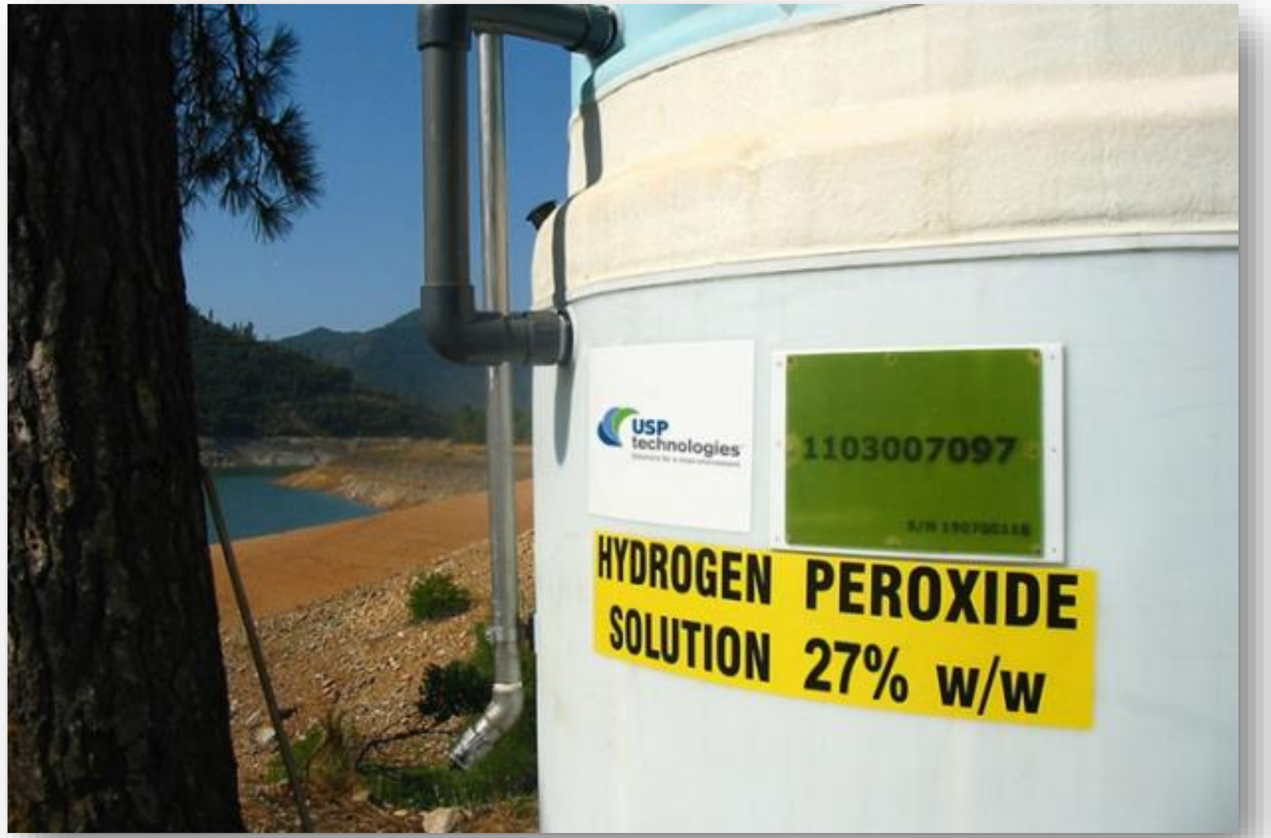
Hydrogen Peroxide

Control Mechanisms

Oxidizes sulfide
Adds dissolved oxygen
Regenerates iron (oxidizes FeS)

Advantages

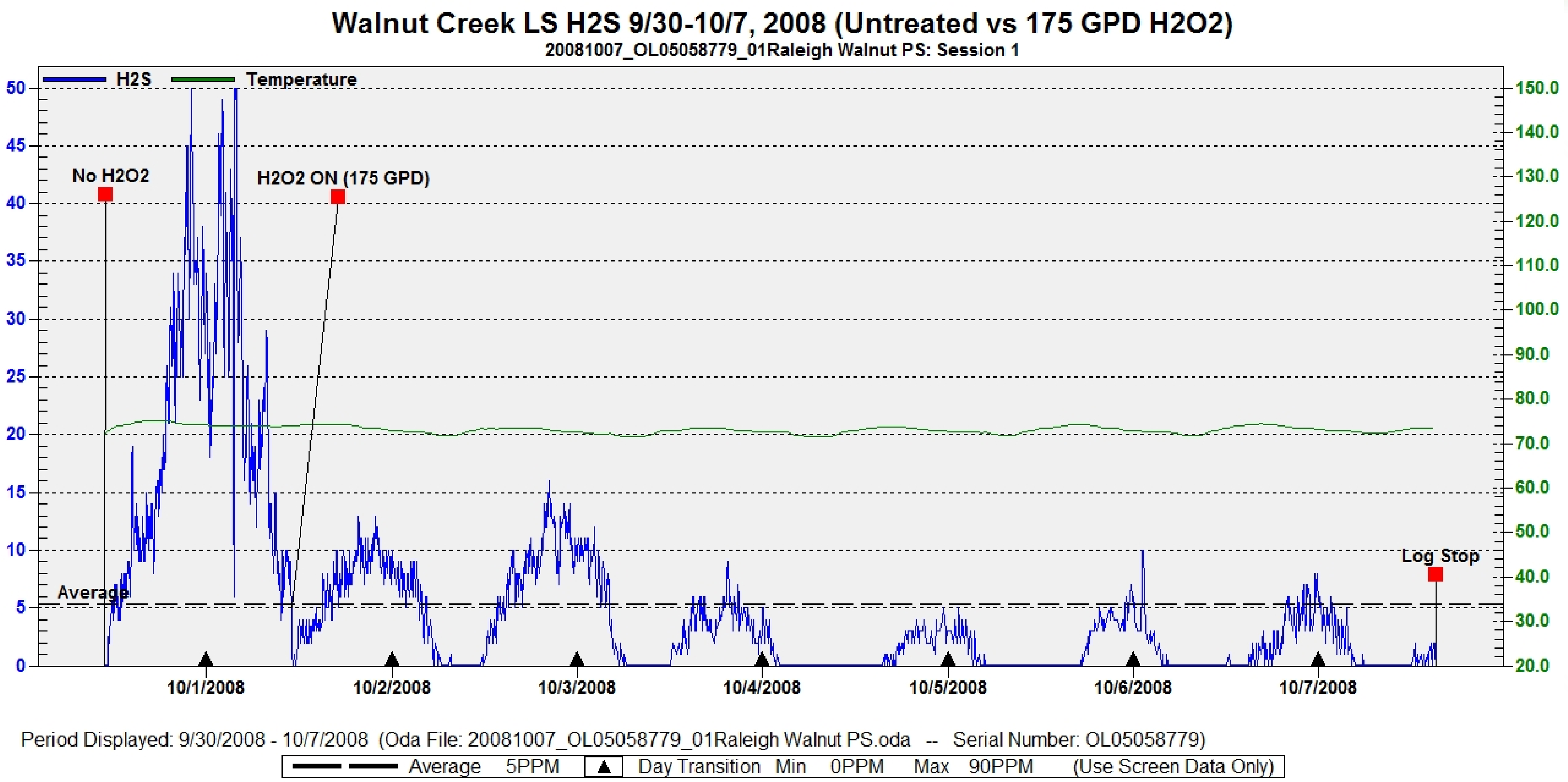
- Relatively short reaction time (5-20min) without catalyst
- Adds D.O. which inhibis septicity & promotes bio-oxidation
- Efficient and cost effective H_2S oxidant
- No troublesome by-products
- Selective for sulfide oxidation
- Simple feed systems



Disadvantages

- Limited durational control, < 3 hours

Hydrogen Peroxide Case Study



- Location – Walnut Creek Lift Station – Raleigh, NC
- Technology – Hydrogen peroxide, dosed before Archimedes screws
- Results – Improved collection system sulfide and odour control with reduced amount of iron salts while reducing alum demand for phosphorus removal

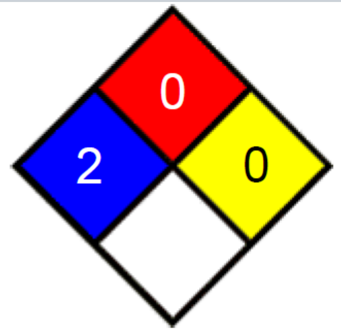
What is SulFeLox®?

- Low-hazard buffered iron solution:
  - Active Ingredient: Ferrous (Fe^{+2}) - 13%
  - pH: 4 ±0.5 @20°C, 100.0%
    1/10,000th acidity of standard $FeCl_2$
  - Specific Gravity: 1.330 @ 20°C
  - Density: 11.1 lbs/gal

- Lower hazard rating than calcium nitrate

- Equal performance to Ferrous Chloride ($FeCl_2$)

- Field applications consistently show superior performance to Calcium Nitrate
  - 50% to 75% less product required for equal performance

SulFeLox™	Calcium Nitrate
	

What is SulFeLox® (Cont'd)

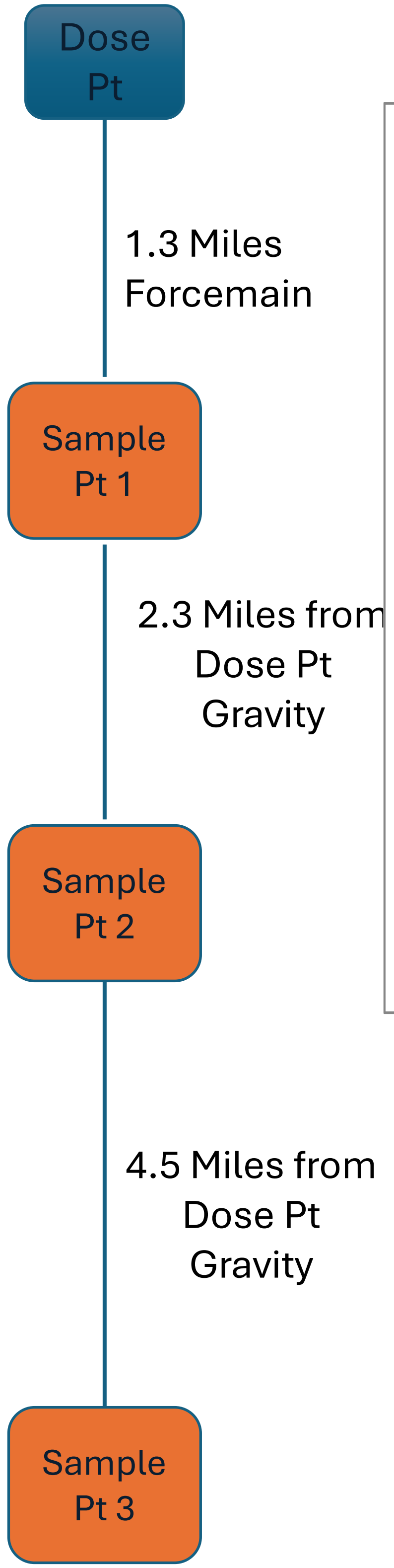
- Equal performance to $FeCl_2$ w/out pH suppression
  - Less H_2S volatilization & improved FeS binding efficiency
  - Superior durational control
  - Available for PRI-SC® regeneration and downstream H_2S control
- Ideal for hazard sensitive dose sites
  - Lower hazard level than calcium nitrate
  - Lower volumes = fewer deliveries

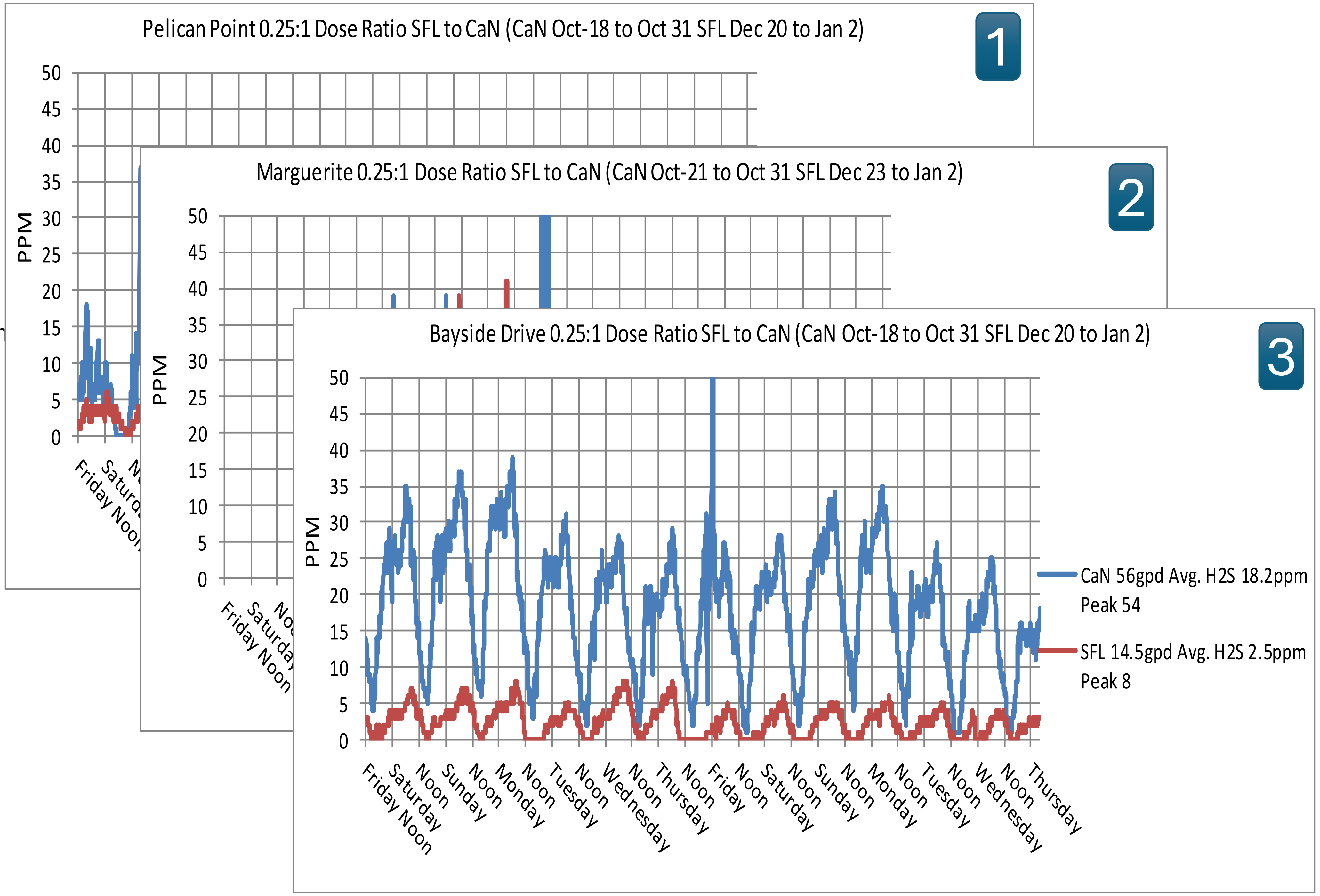
What is SulFeLox® (Cont'd)

- Complimentary to WWTP processes
  - Carbon preservation
  - Positioned to leverage PRI-TECH® applications
    - Headworks and plant wide (biosolids) odour and corrosion control
    - Improve P-removal
    - Help with Struvite control
    - Improve dewatering / reduce disposal costs
- Eliminates matting / scum build-up in wet wells or 'floating' of clarifiers due to N2-off-gassing

SulFeLox® Case Study

Background: Entire line in Southern California community with limited dose sites and history of odour complaints, especially at sample points 2 and 3. Dosing calcium nitrate to control at sample point 3 has been cost-prohibitive. SulFeLox™ durational control achieves better results with lower dose rates.





	Pt 1 (ppm)	Pt 2 (ppm)	Pt 3 (ppm)
CN – 56 gpd	3.6 avg 37 peak	7.1 avg 172 peak	18.2 avg 54 peak
SulFeLox – 14.5 gpd	2.7 avg 21 peak	8 avg 41 peak	2.7 avg 8.0 peak

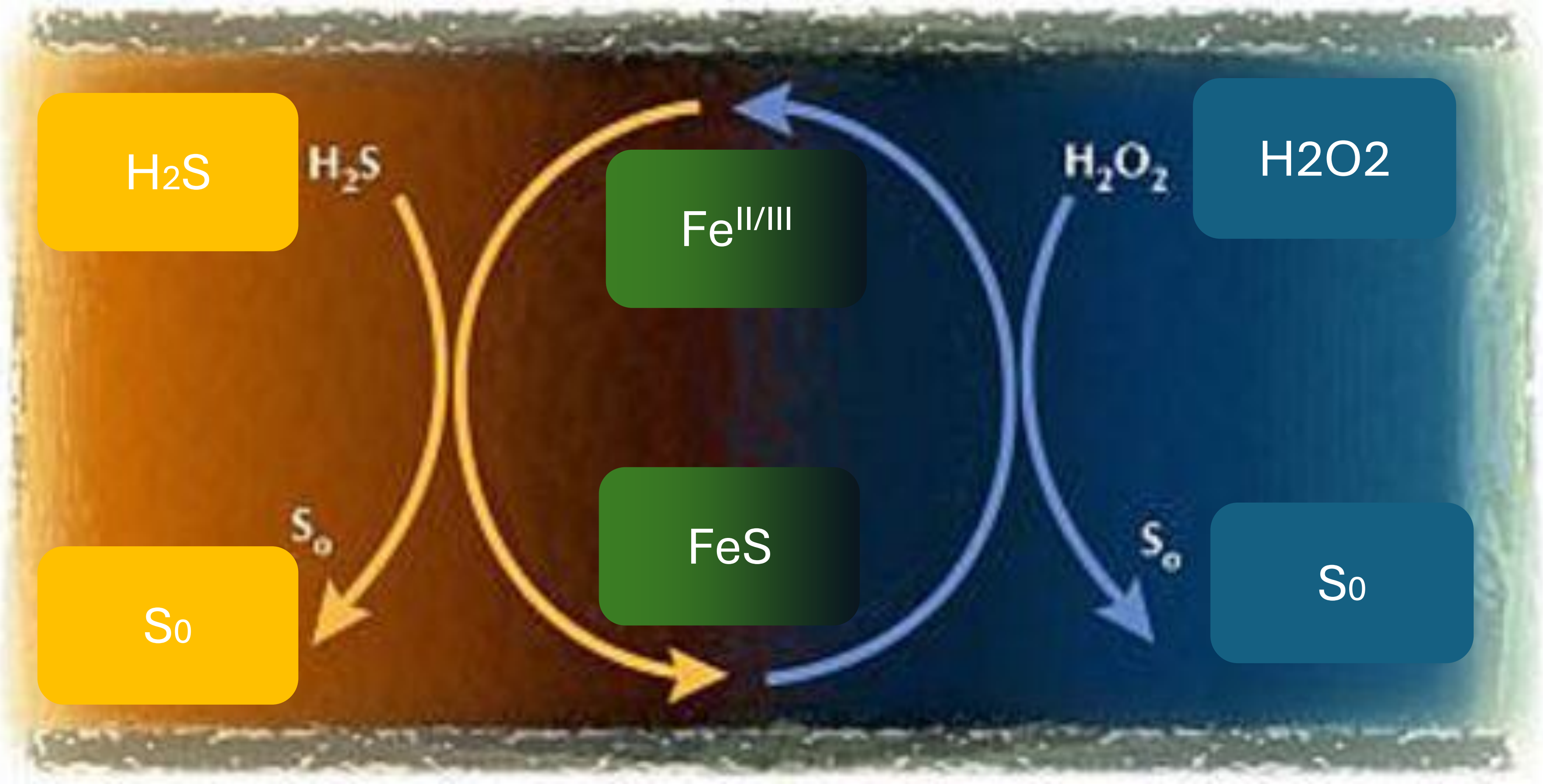
- Equal performance or better at pts 1&2
- Reduced peaks at pts 1&2
- 6x removal performance at pt 3
- 25% SFL volume required

Peroxide Regenerated Iron (PRI)

Iron
Addition

Regenerated
Iron free to bind H2S

Iron
Binds
H2S



Iron & H2S
Form FeS

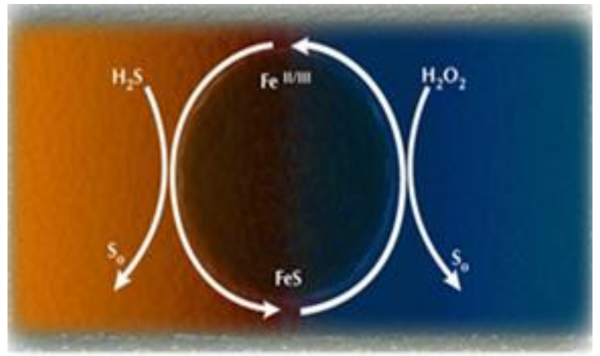
<u>2 Reactions</u>

- H_2O_2 Addition Oxidizes FeS to elemental Sulfur (inert) & Fe^{2+}/ Fe^{3+}
- Fe catalyzes & accelerates H_2O_2 reaction w/ H2S

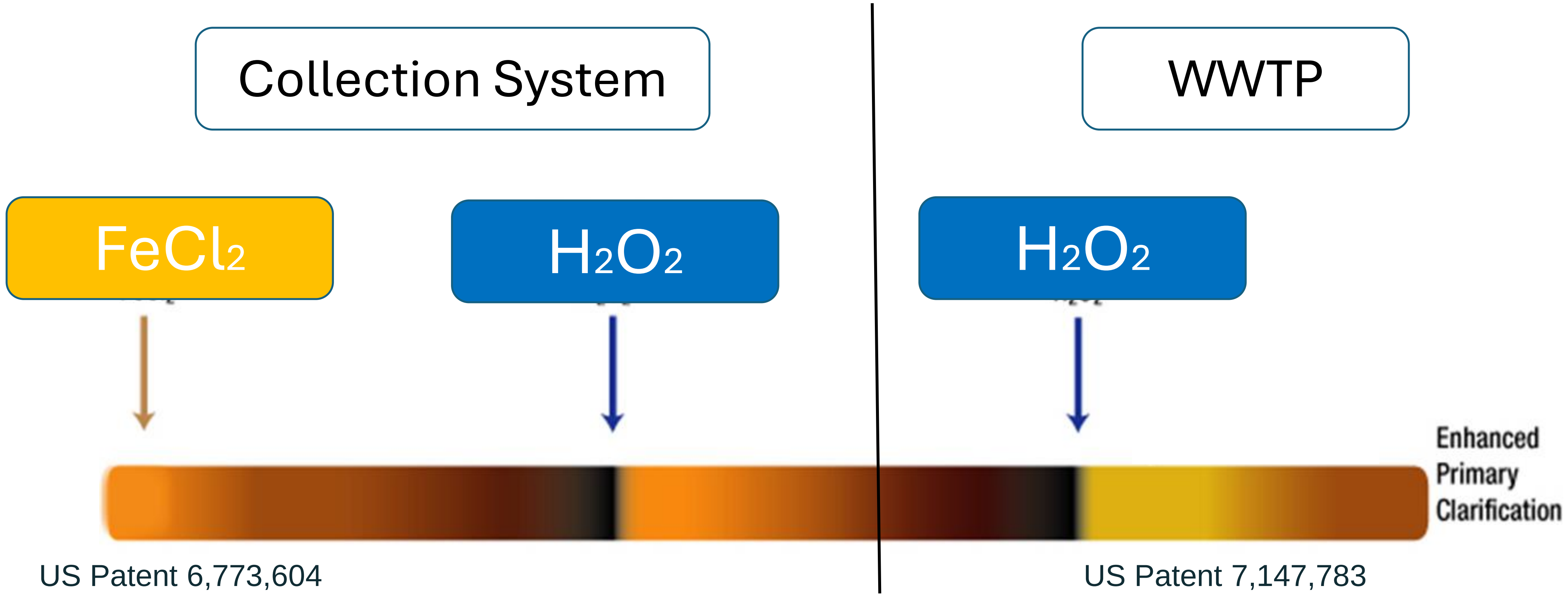
PRI-Tech™ in Practice

To get the most out of your iron use…

USE…… RE-USE…… and RE-USE again with PRI-TECH

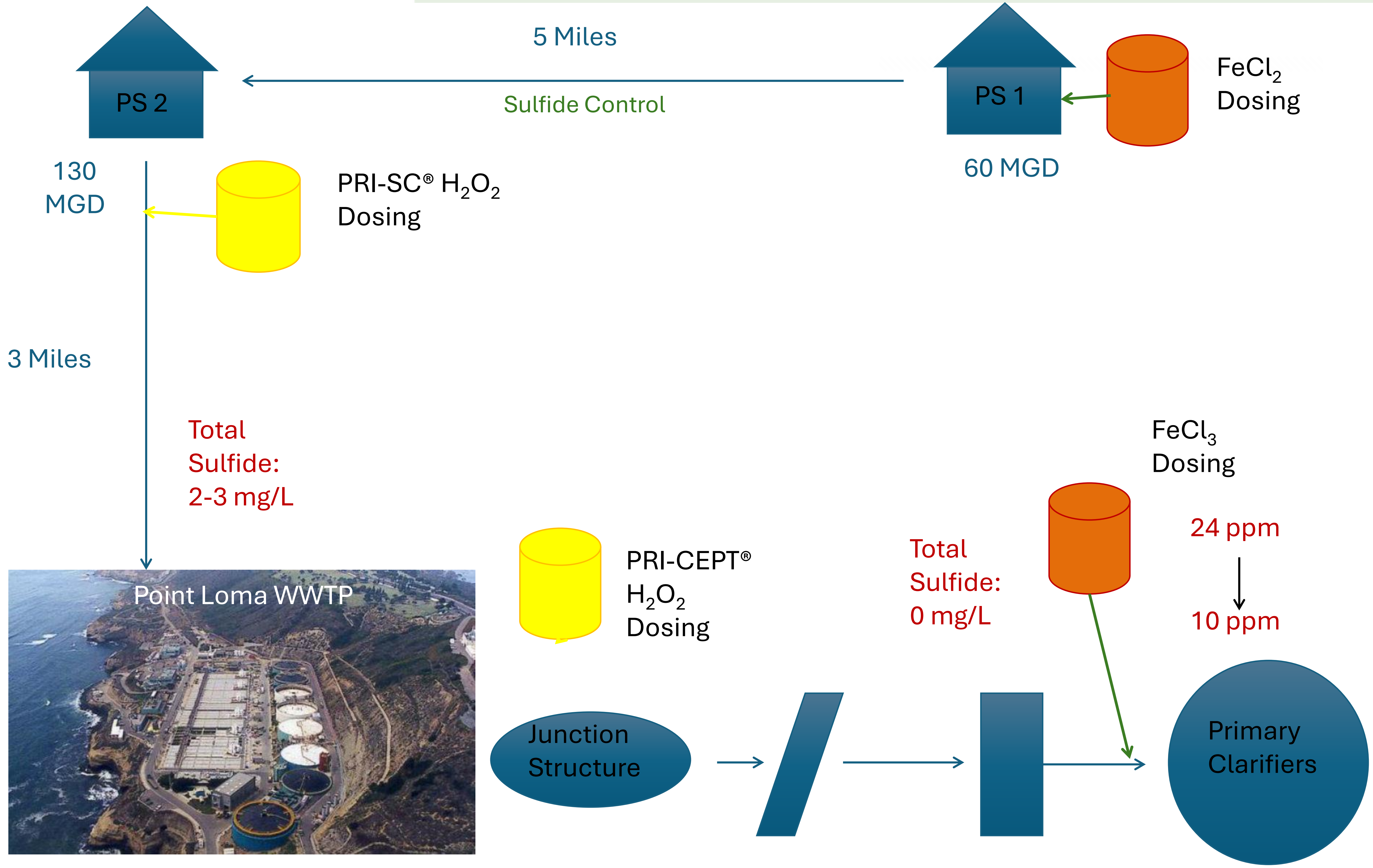


PRI·SC
Peroxide Regenerated Iron Sulfide Control



Iron is selective to binding with sulfide –
can be overfed upstream & will carry through until sulfides appear

PRI-Tech Case Study – City of San Diego, CA



Alkalinity: (Mag Hydroxide, Calcium Hydroxide, Carbonates)

Control Mechanisms	Controls sulfide through preventing off-gassing Suppresses biofilm activity Alkalinity ($Mg(OH)_2$, $Ca(OH)_2$, Carbonate)

Outcome in Sewer

- Provides alkalinity
- May prevent solubilization (at high pH)
- Local/limited biofilm suppression

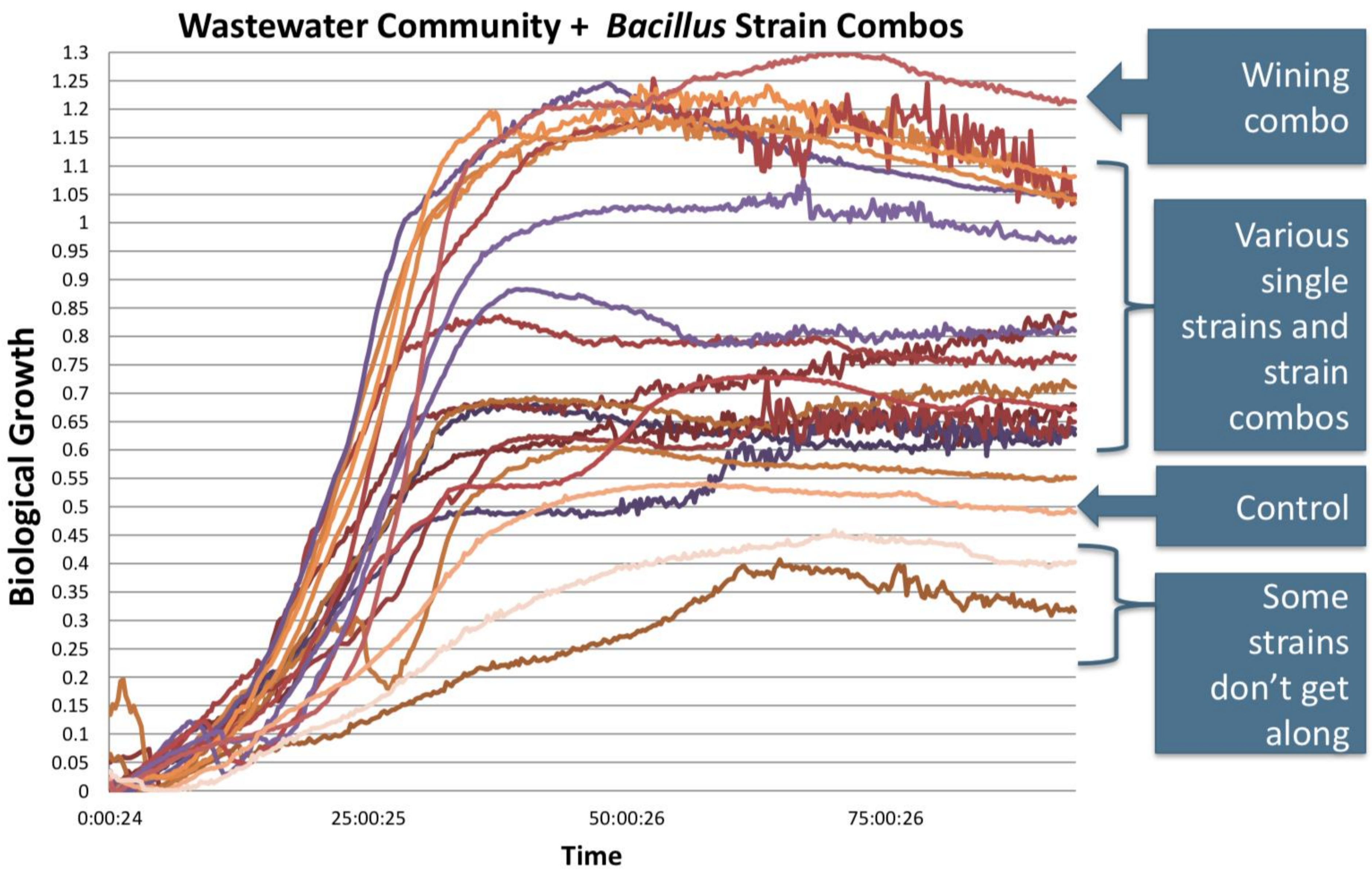
Impact to WWTP

- Delivers alkalinity
- Drives aqueous sulfide downstream (air demand, settleability impacts)
- Increased potential for scale (struvite)

Bioaugmentation

Control Mechanisms

Introduces alternative biology to improve sulfide control (or other goal?) through biological uptake



Outcome in Sewer

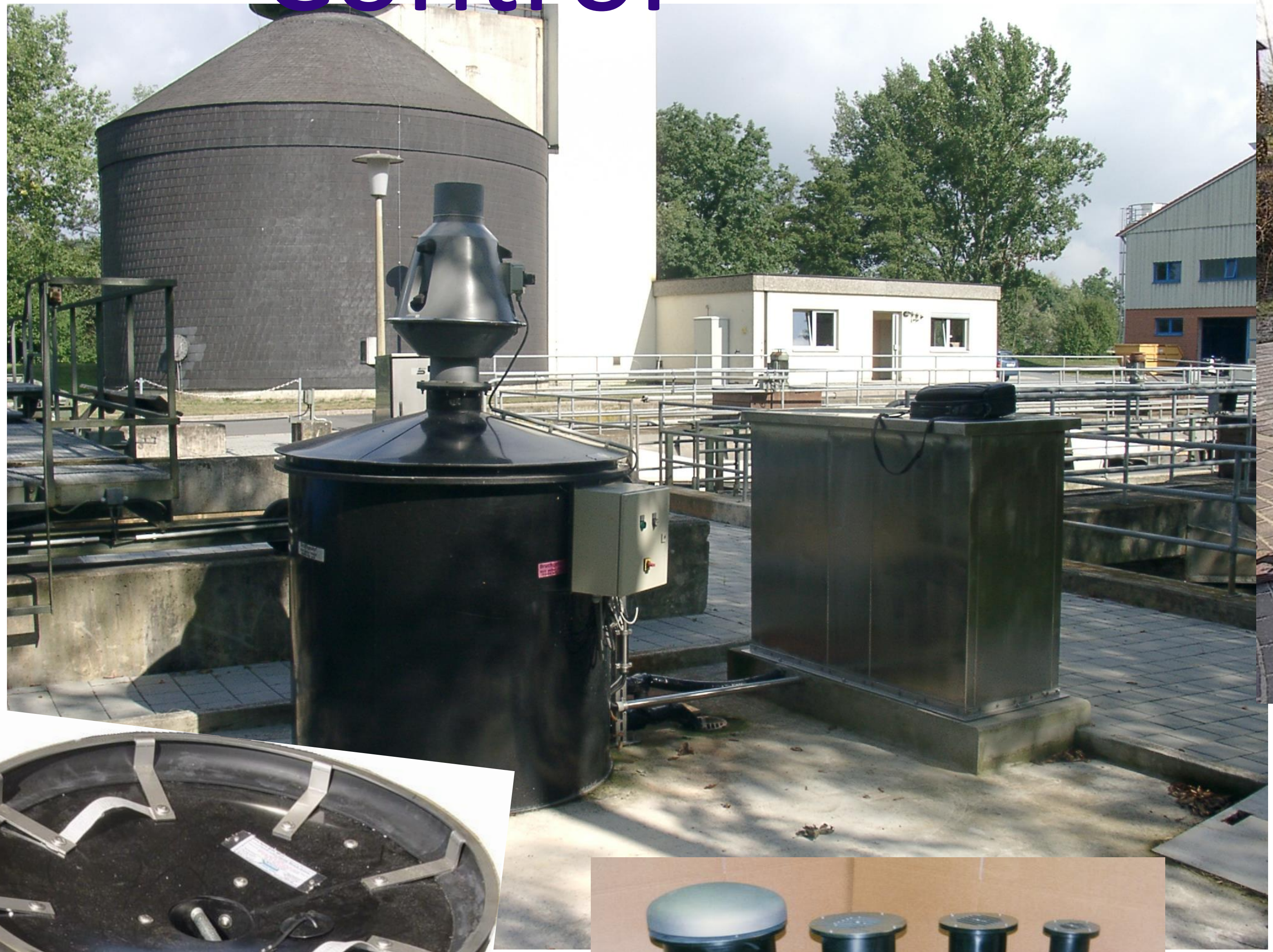
- Select for and deliver communities to enhance a desired uptake outcome (sulfide, VFA)
- Complimentary to other treatments strategies?
- FOG control?
- TBD!

Impact to WWTP

- Depends!

Point Source or Vapour Odour Control

- Activated Carbon
- Biofilter
- Bioscrubber
- Chemical Scrubber
- Vapour fogging

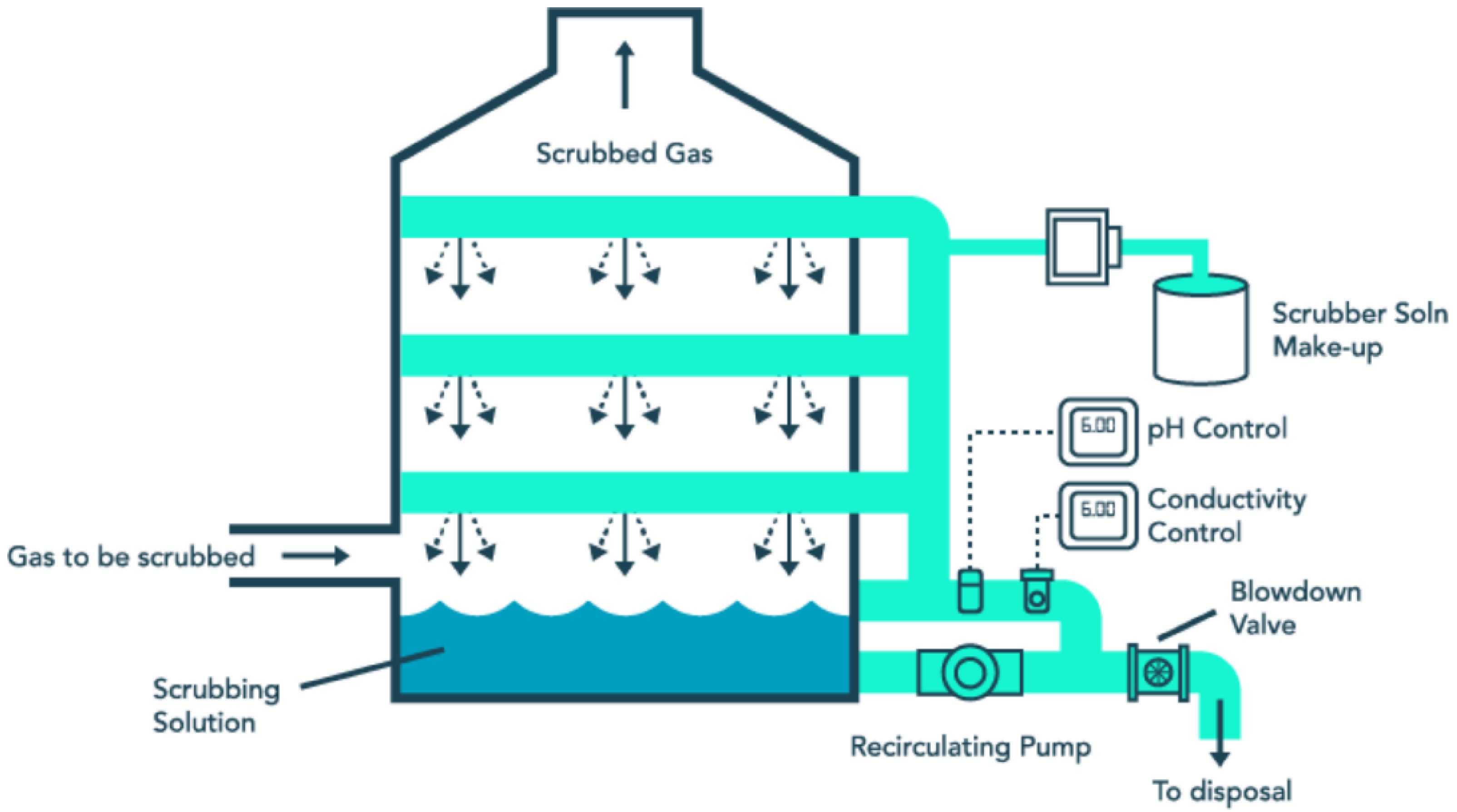


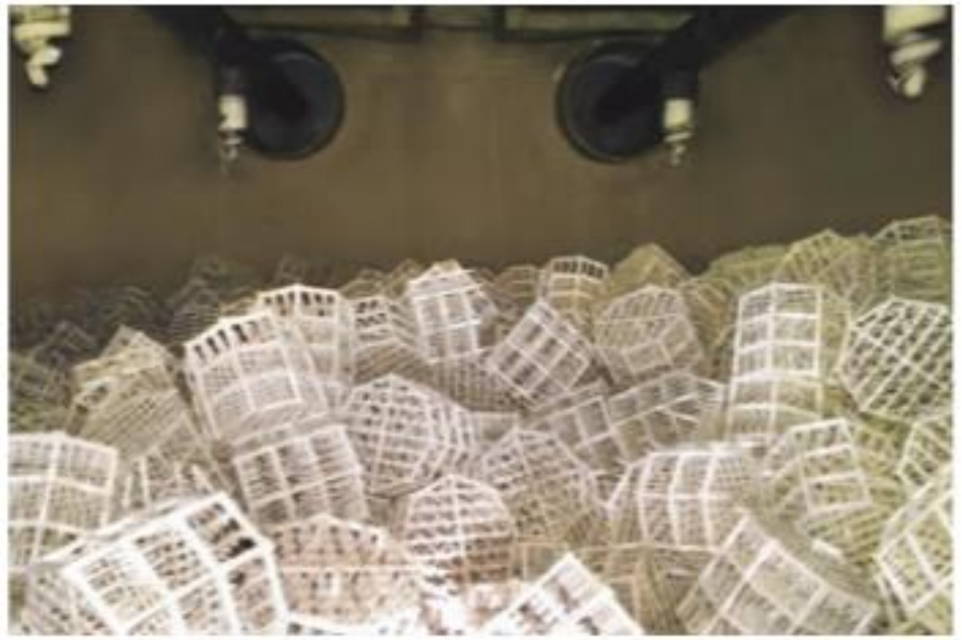


Vapour Phase: Chemical Scrubbers

Control Mechanisms	Convert odourous compounds to non-odourous salts either by acid/base reaction or oxidation

Category	Type	Advantages	Disadvantages
Chemical Scrubbers	> Caustic/ Hypochlorite > Acid > Other	1. High-efficiency H_2S removal 2. Can oxidize a wide range of odor compounds 3. Has been a commonly used treatment technology for decades	1. Storage/handling considerations, hazardous chemicals 2. Higher operating and maintenance costs/requirements 3. Operational attention for proper efficiency and minimized scaling 4. Additional instrumentation and controls, increased complexity

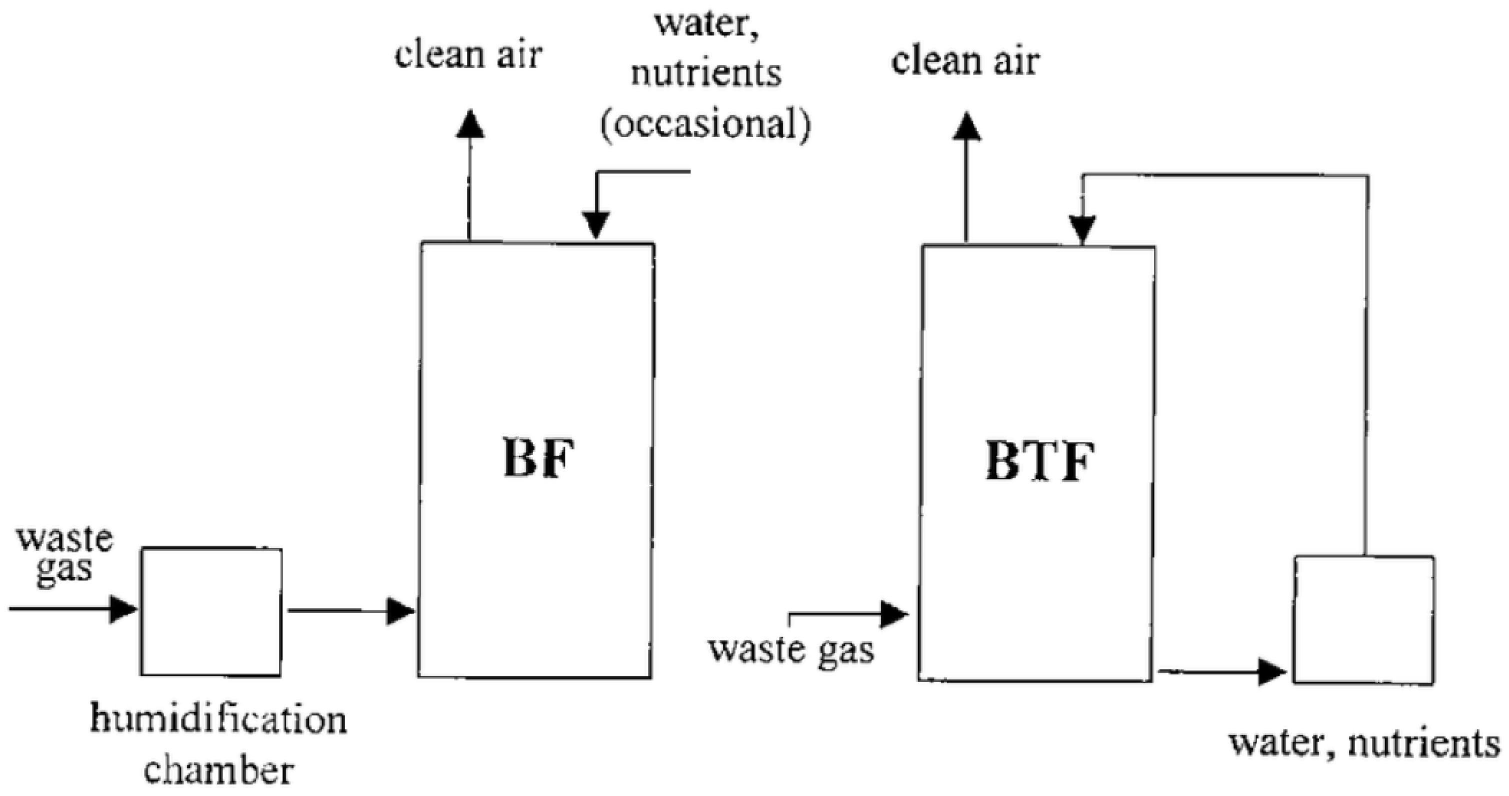




Vapour Phase: Biological Treatment Systems

Control Mechanisms	Growth of biological organisms on media and convert odourous compounds by metabolic processes

Category	Type	Advantages	Disadvantages
Biological	> Biofilter > Biological Trickling Filter	1. Green technology 2. High-efficiency H_2S removal 3. Lower operating and mainte-nance costs 4. No handling and storage considerations of hazardous chemicals	1. Acclimation period (up to a month) 2. Biological activity is somewhat susceptible to process fluctuations 3. Longer contact time required for odor compounds other than H_2S 4. Low pH blowdown



Vapour Phase: Adsorption Systems

Control Mechanisms	Adsorption of odourous compounds onto active media (Virgin Carbon, Activated Carbon, Impregnated Media)

Category	Type	Advantages	Disadvantages
Adsorption	> Virgin Activated Carbon > Catalytic Carbon > Impregnated Carbon > Specialized Media	1. High H_2S removal (at low concentrations) 2. Simple to operate and maintain 3. No continuous chemical, water, or nutrient consumption 4. No handling and storage considerations of hazardous chemicals	1. Periodic media replacement can be labor and equipment-intensive process 2. Rapid breakthrough of media depending on odor loading 3. Difficulty removing compounds other than H_2S (layered specialty media)

Vapour Phase: Ionizing Systems

Control Mechanisms

Generate highly reactive forms of oxygen (O_3, O_2^*, OH^*, O_2^+, O^- to oxidize odourants

Category	Type	Advantages	Disadvantages
Ionization	> Electro-Oxidation > Photoionization > Ionized Air	1. Can oxidize a wide range of odor compounds (ozone/ hydroxyl radicals) 2. No chemical, water, or nutri-ent consumption 3. Low maintenance require-ments 4. No handling and storage considerations of hazardous chemicals	1. Less commonly used historically 2. Less proven technology 3. Response time to fluctuations in odor 4. Potential for excess ozone in ex-haust stream

Thank You

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