One Water, One Collection System Sustainable Design

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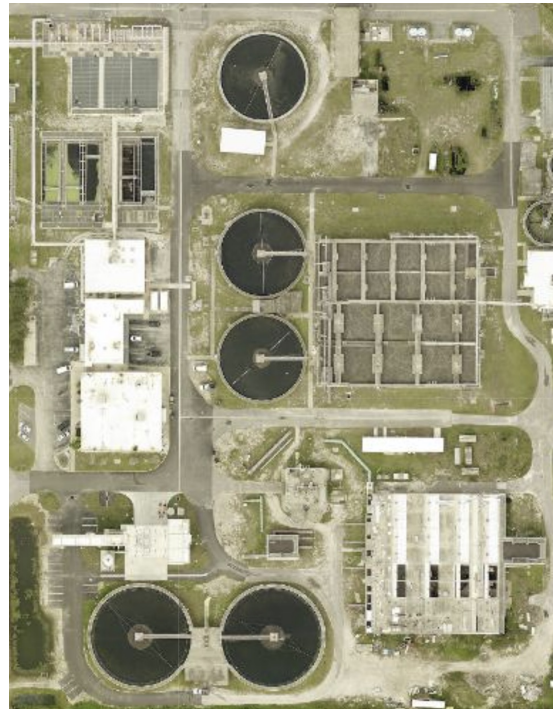
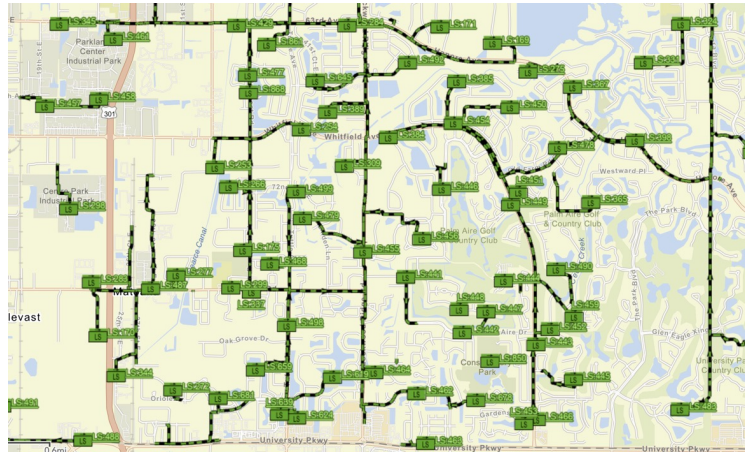
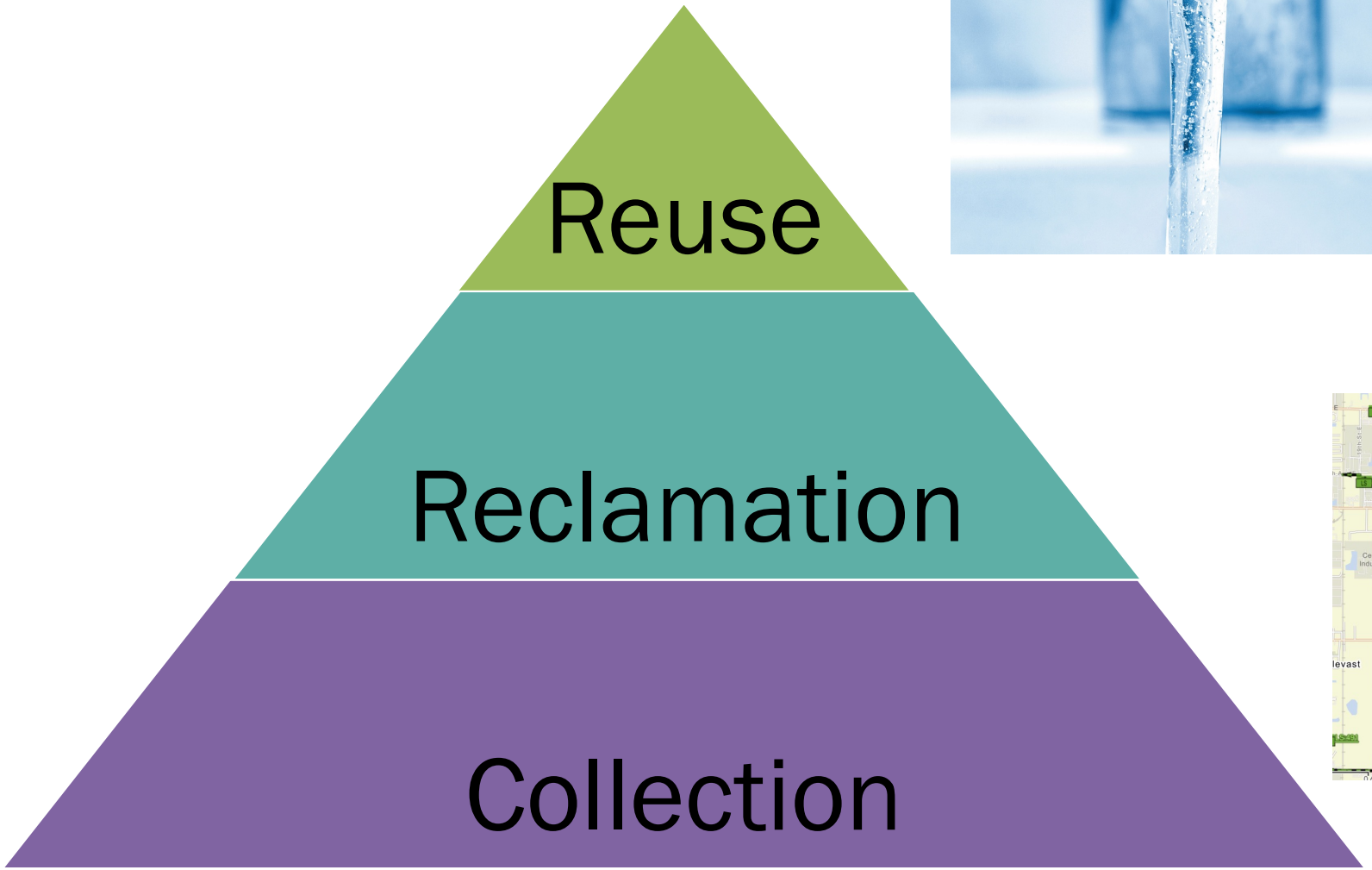
Collection System is at the Core







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Corrosion Risk

Sewer line collapse devours Lawton trash truck

▶ Autoplay 3 of 3

Sinkhole swallows trash truck in Lawton (KSWO)

Camera probe shows downt… sewer main in danger of col…

The portion of the sewer main that collapsed in December was built in the 1960s and had been heavily deteriorated by hydrogen sulfide gas, which is commonly referred to as sewer gas.

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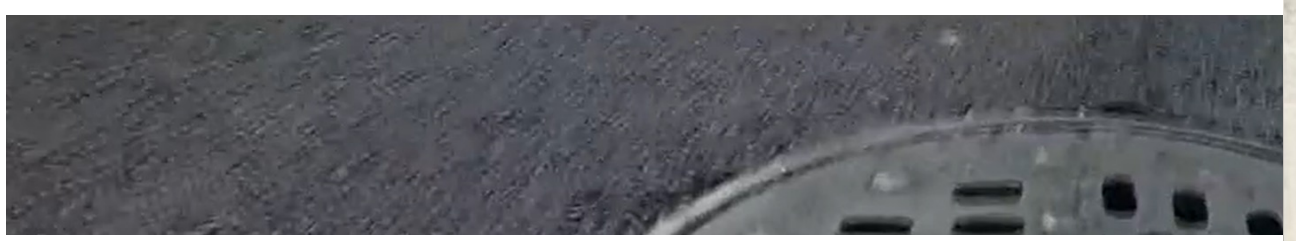
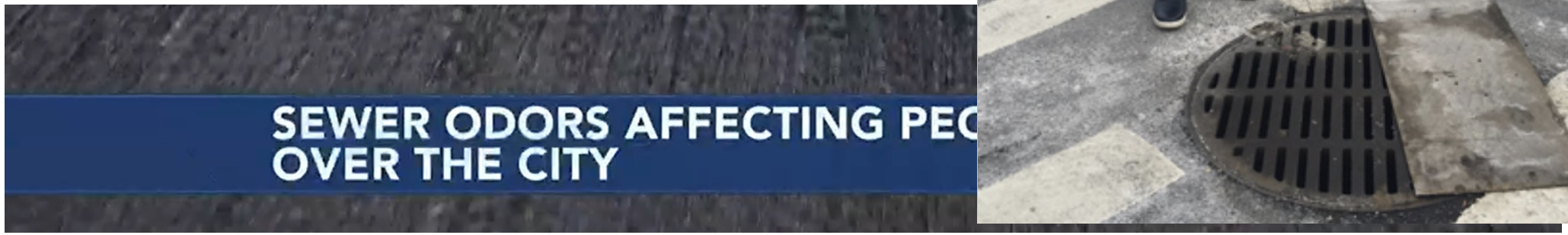
Odor – Public Nuisance



‘The odor was just unreal’: Ja h sewage issues

City troubleshoots persistent sewer odor a



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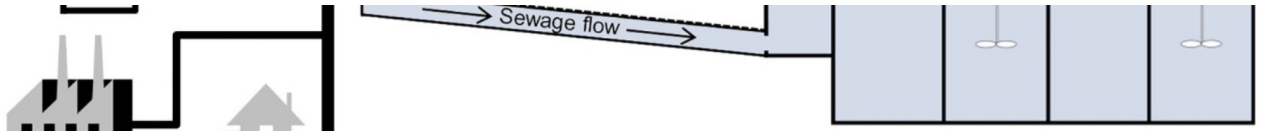
Greenhouse Gas Production

THE CONTENT

Manuscript: New GHG Methodology to Quantify Sewer Methane



THE CONTENT

Sustainability Within Collection Systems: Methane Mitigation as a Result of Odor and Corrosion Prevention Programs Utilizing Calcium Nitrate

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- Collection System is a Bioreactor
  - Hydrogen Sulfide
  - Methane
  - Volatile Fatty Acids
- Why Does it Matter? ESG Impacts
  - Environmental
  - Social
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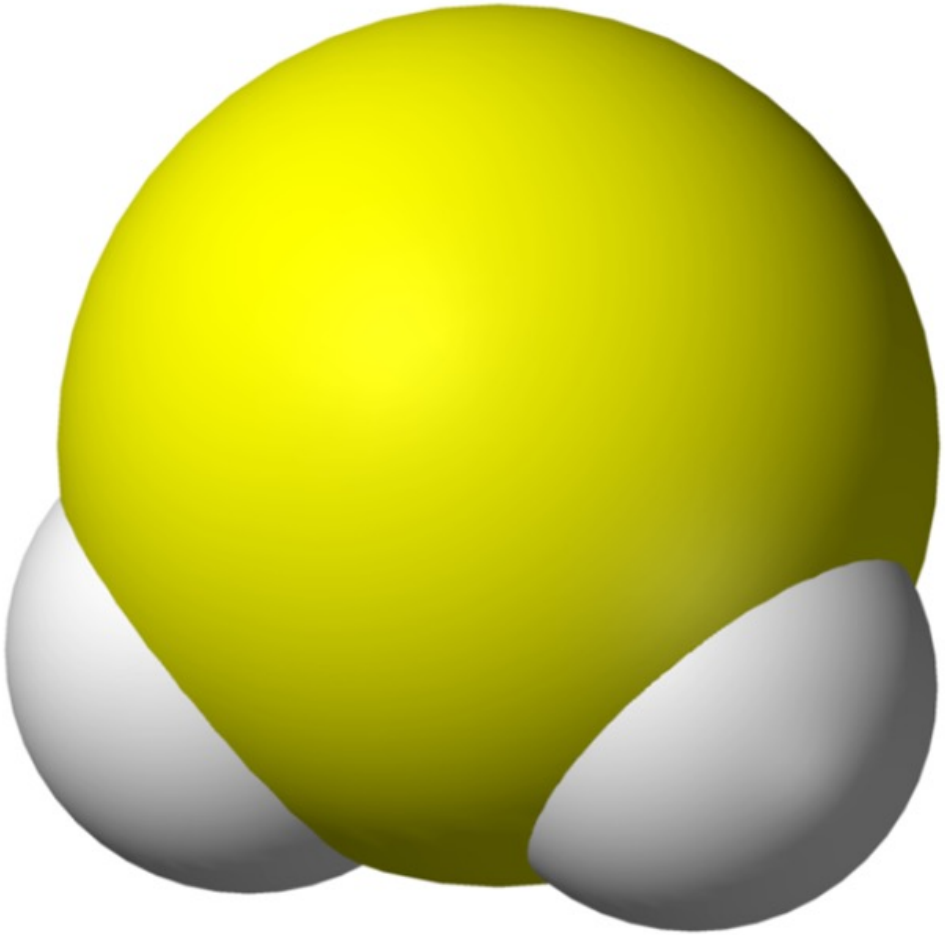
Hydrogen Sulfide – H_2S

- Safety concern in confined spaces
- Major cause of wastewater infrastructure corrosion
- Source of most (but not all) wastewater odor problems



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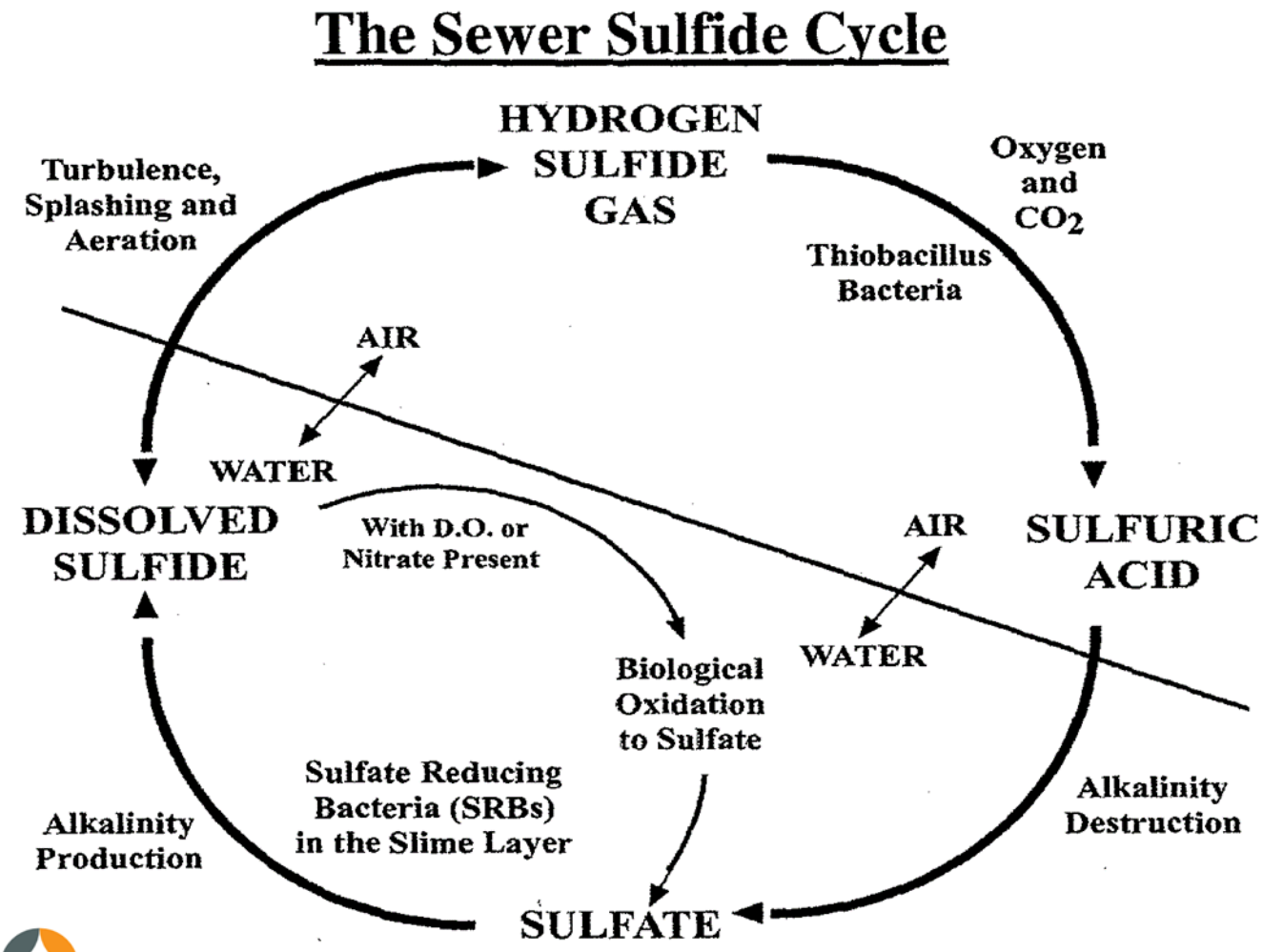
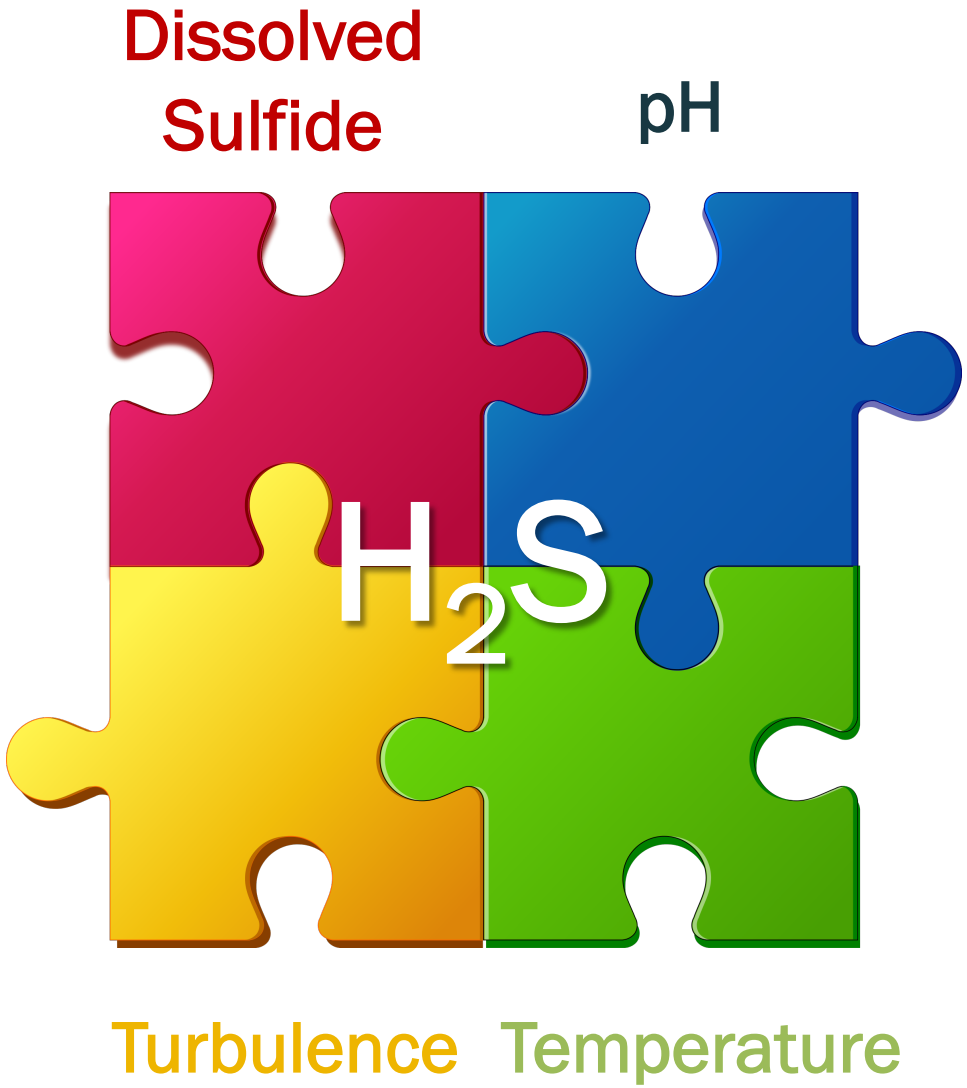
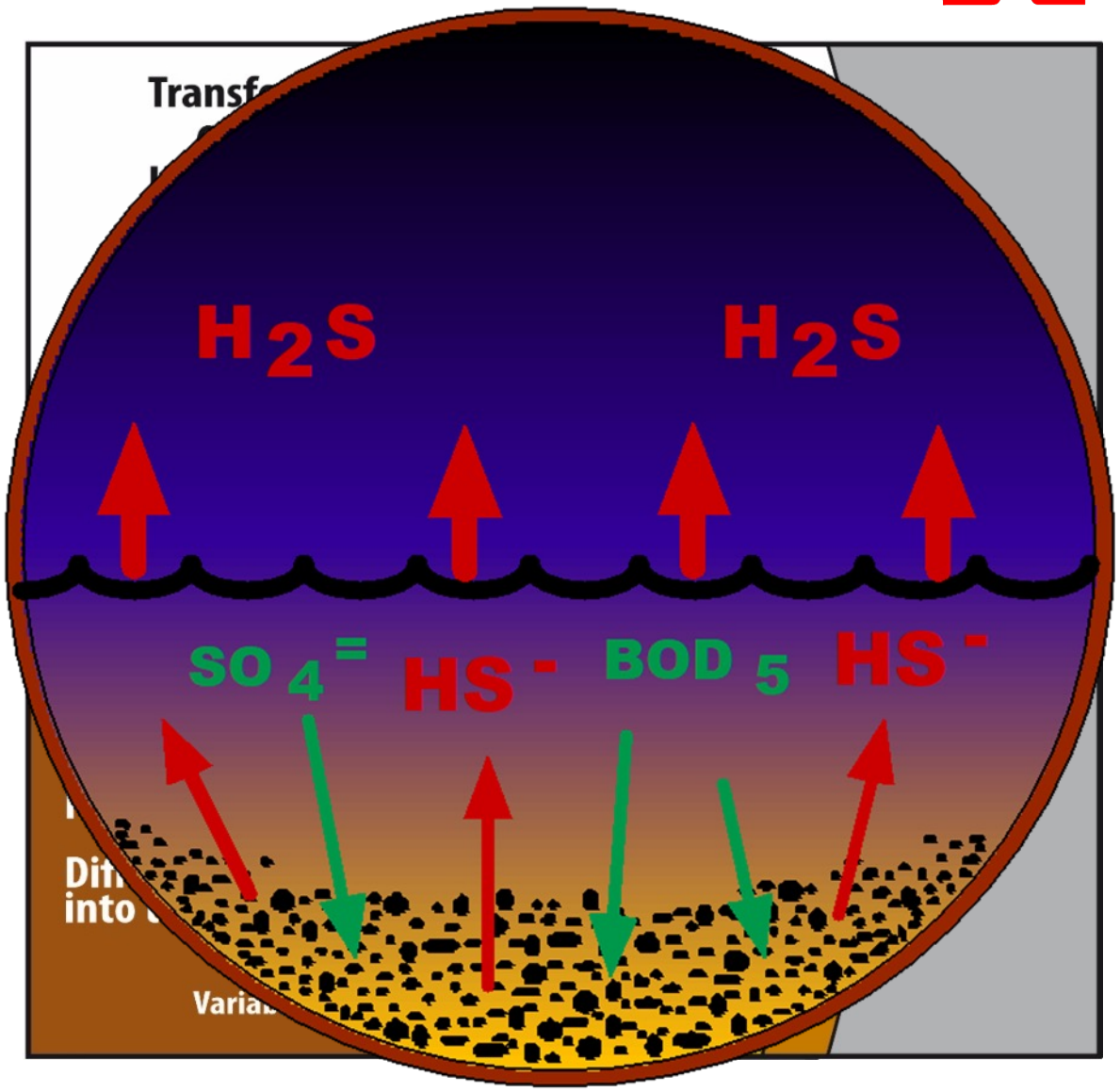
The H_2S Puzzle





Dissolved Sulfide



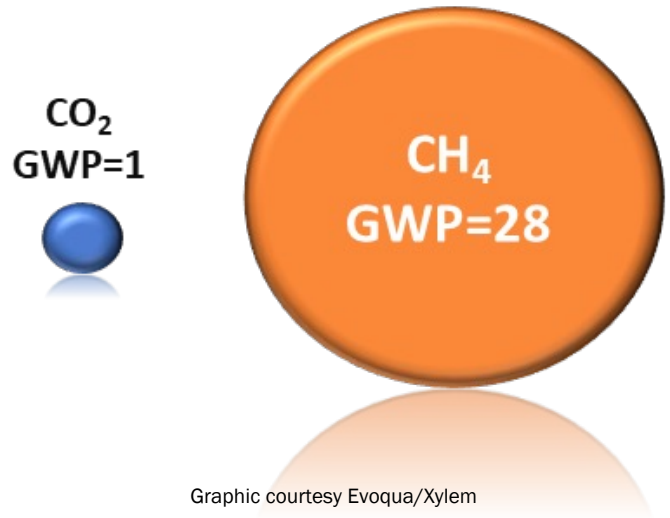
Force Mains	• 360-degree Wetted Surface • No Aeration
Detention Time	• Reaction is Time Limited • More Time = More Sulfide
BOD	• More Food • More Sulfate Uptake • More Sulfide
Temperature	• Warmer Temps • More Active Slime • More Sulfide
Slime Layer Surface Area	• Debris • All Wetted Surfaces Grow Slime • More Slime = More Sulfide

GHG - Methane

BOD Reduction in Sewers (Methanol Basis)

Process	Reaction	$CO_2e : CH_3OH$
Aerobic (O_2)	$3O_2 + 2CH_3OH \rightarrow 2CO_2 + 4H_2O$	1 : 1
Anoxic (NO_3)	$6NO_3^- + 5CH_3OH \rightarrow 5CO_2 + 3N_2 + 7H_2O + 6OH^-$	1 : 1
Anaerobic (SO_4)	$SO_4^{2-} + 4CH_3OH \rightarrow S^{2-} + 4H_2O + 2CH_4 + 2CO_2$	14.5 : 1

GWP = Global Warming Potential (CO_2e)



Graphic courtesy Evoqua/Xylem

Phosphorus Removal - VFAs

Phosphate Accumulating Organisms (PAO) Require Volatile Fatty Acids (VFA) as an energy source

VFAs are essential to Bio-P Removal

VFAs are formed via fermentation in anaerobic conditions

Design anaerobic stage in treatment process or depend on anaerobic conditions in collection system?

Align and Balance Collection System and Treatment Facility Needs

Impact of Odor and Corrosion Control Practices on the Influent Readily Biodegradable COD fraction and Biological Nutrient Removal System Performance, (Kobylinski, et al, 2010)

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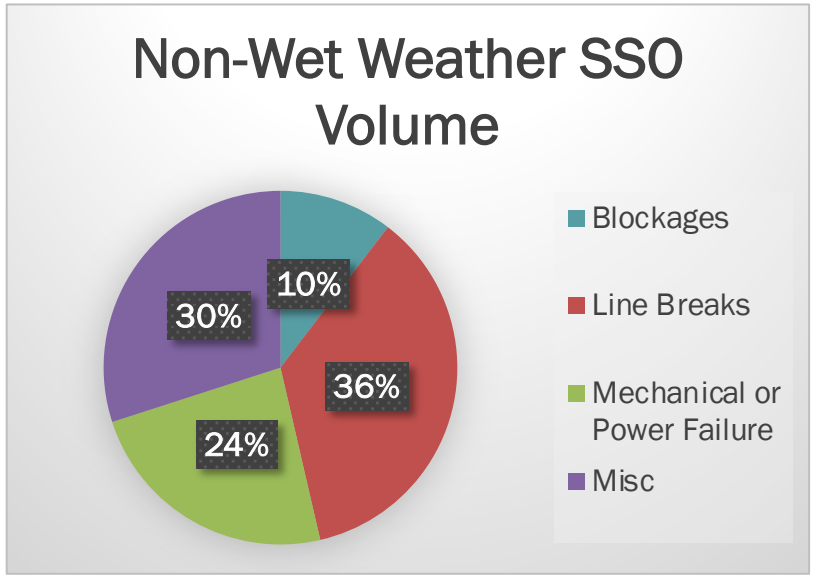
Environmental Impacts

Sanitary Sewer Overflows

USEPA estimates 3 to 10 billion gallons of SSOs each year

Significant fraction due to line breaks - Corrosion



Report to Congress, Impacts and Control of CSOs and SSOs (USEPA, 2004)

Greenhouse Gas Emissions

Water infrastructure generates 4.7% of global methane emissions

Mapping Water's Carbon Footprint (Global Water Intelligence, 2020)

Sewer (collection system) methane is estimated to produce 45% of wastewater scope-1 emissions

Sector-wide GHG Emissions with Normalized Process and Effluent N2O, Sewer CH4, and Methanol CO2 (Willis et al., 2020)

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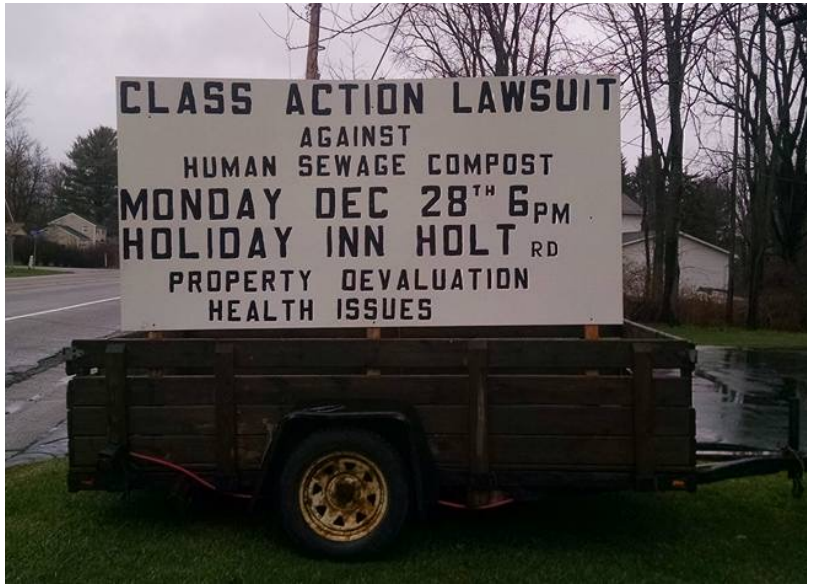
Social Impacts

Odor - Emotional

- Direct Connection to Limbic System
- Involuntary Memory Formation
- Emotional/Psychological Response



Disruption - Frustration

- Service
- Traffic
- Recreation

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Governance Impacts

SSO Enforcement

"EPA New England has issued a number of traditional administrative and judicial penalty actions assessing over $2 million in penalties."

Odor Regulations

Nuisance Violations:

Location	Off-site standard or guideline	Averaging times
Allegheny County Wastewater Treatment Plant (WWTP)	4 D/T (design goal)	2-minutes
San Francisco Bay Area Air Quality District	5 D/T	Applied after at least 10 complaints within 90-days
State of Colorado	7 D/T (Scentometer)	
State of Connecticut	7 D/T	
State of Massachusetts	5 D/T*	
State of New Jersey	5 D/T **	5-minutes or less
State of North Dakota	2 D/T (Scentometer)	
State of Oregon	1 to 2 D/T	15-minutes
City of Oakland, CA	50 D/T	3-minute
City of San Diego WWTP	5 D/T	5-minutes
City of Seattle WWTP	5 D/T	5-minutes

Mahin, T., Measurement and Regulation of Odors in the USA, 2003

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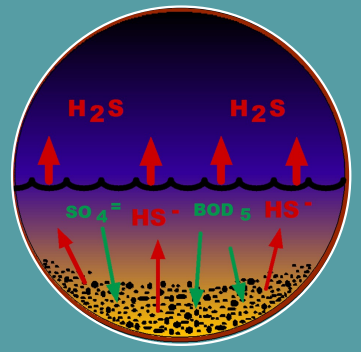
Limit Septicity – Limit H_2S and CH_4

Minimize force mains, maximize gravity

- Capacity exceptions

Don't over-size

- Limit detention time



Keep lines clean

- Minimize debris, surface area

Design WRRF for VFA production

- Don't rely on collection system

Use chemical dosing as needed

- Consider GHG impacts of chemistry

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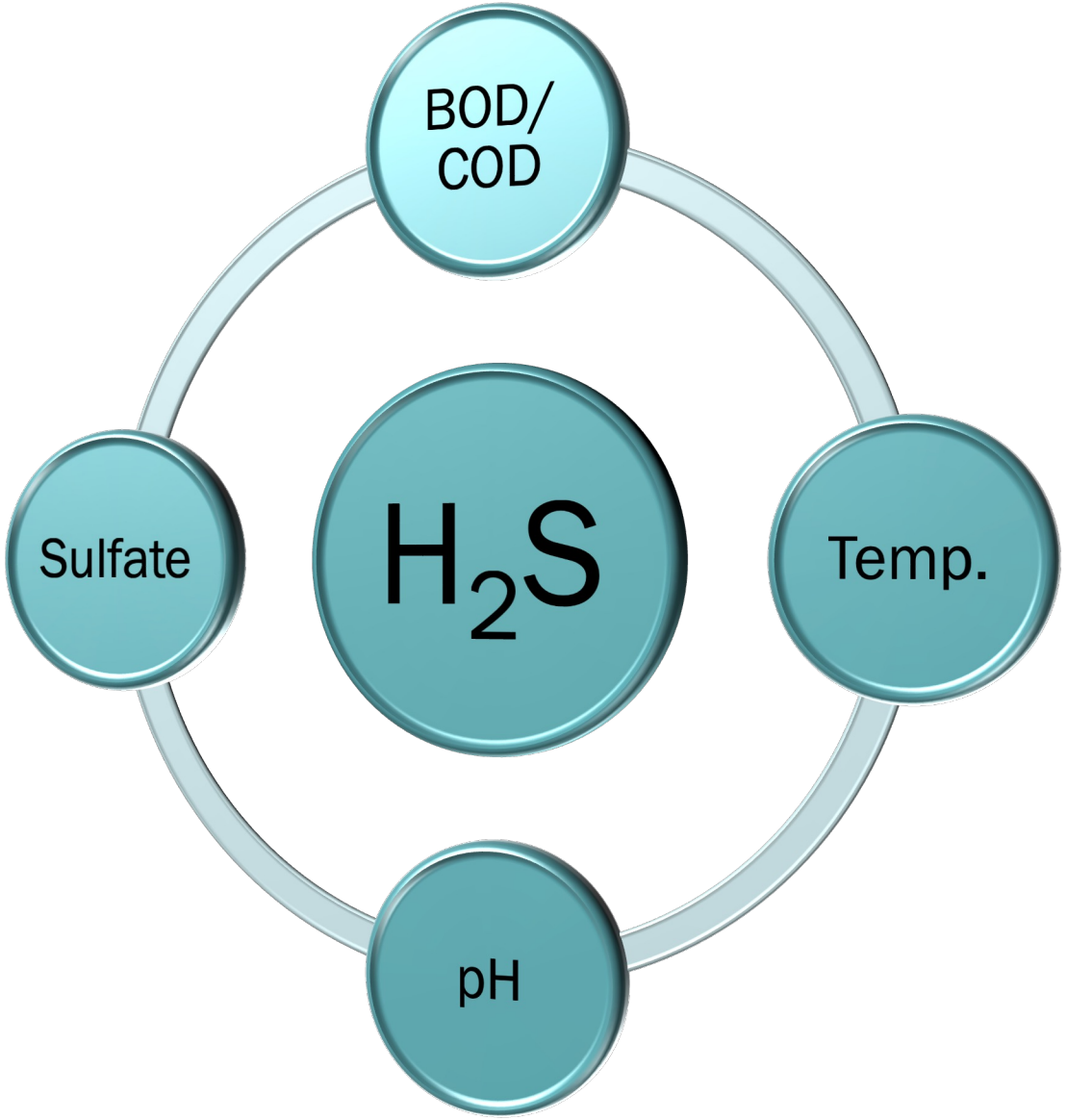
Minimize Turbulence

- Turbulence increases vapor-liquid surface area, accelerates gas release
  - Like CO_2 in a carbonated beverage
  - Turbulence strips H_2S
- Operate PS at inlet level
- Minimize drops
- Use drop pipes
- Wye flow connections

Enforce Pretreatment

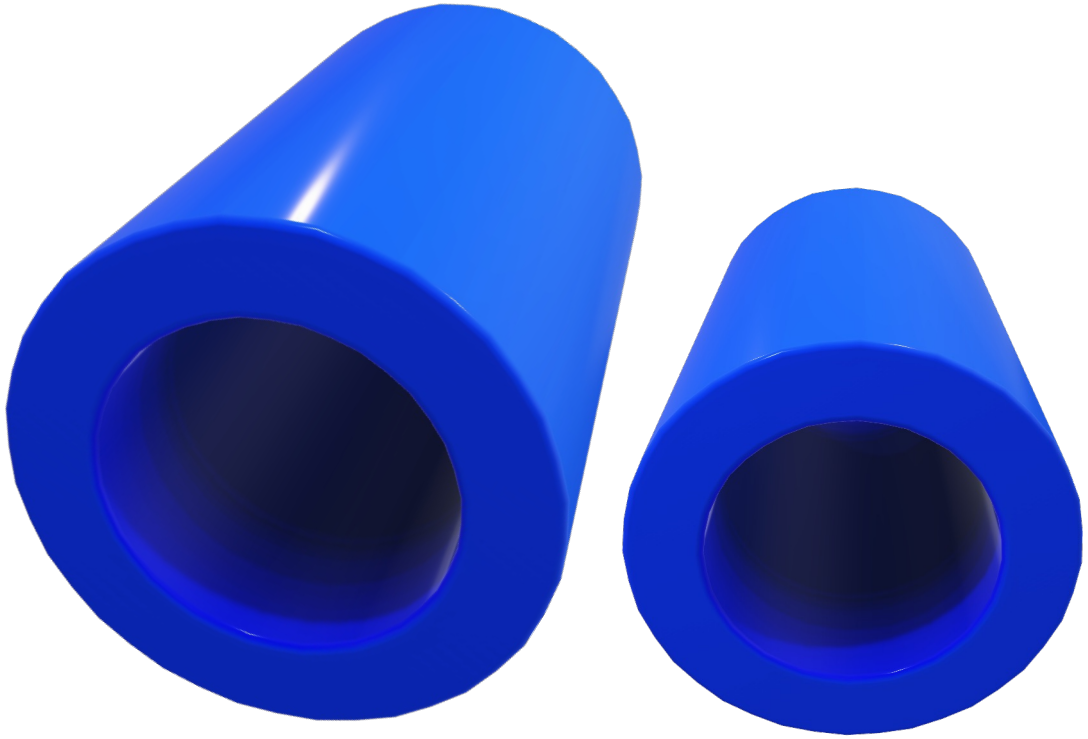


Design for Growth Curve

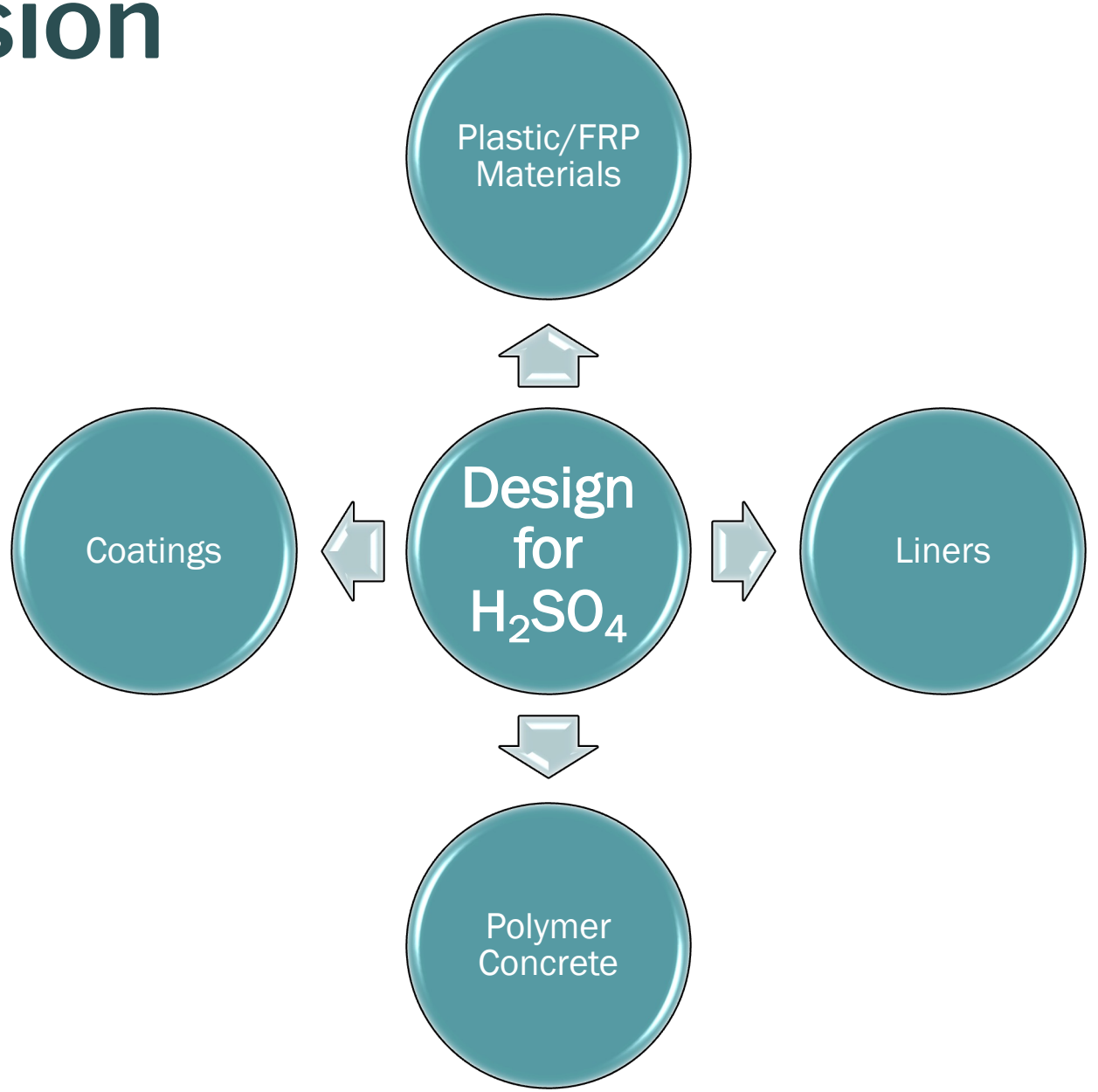
Parallel lines

Multiple pump sizes

Flush capability – clean and scour

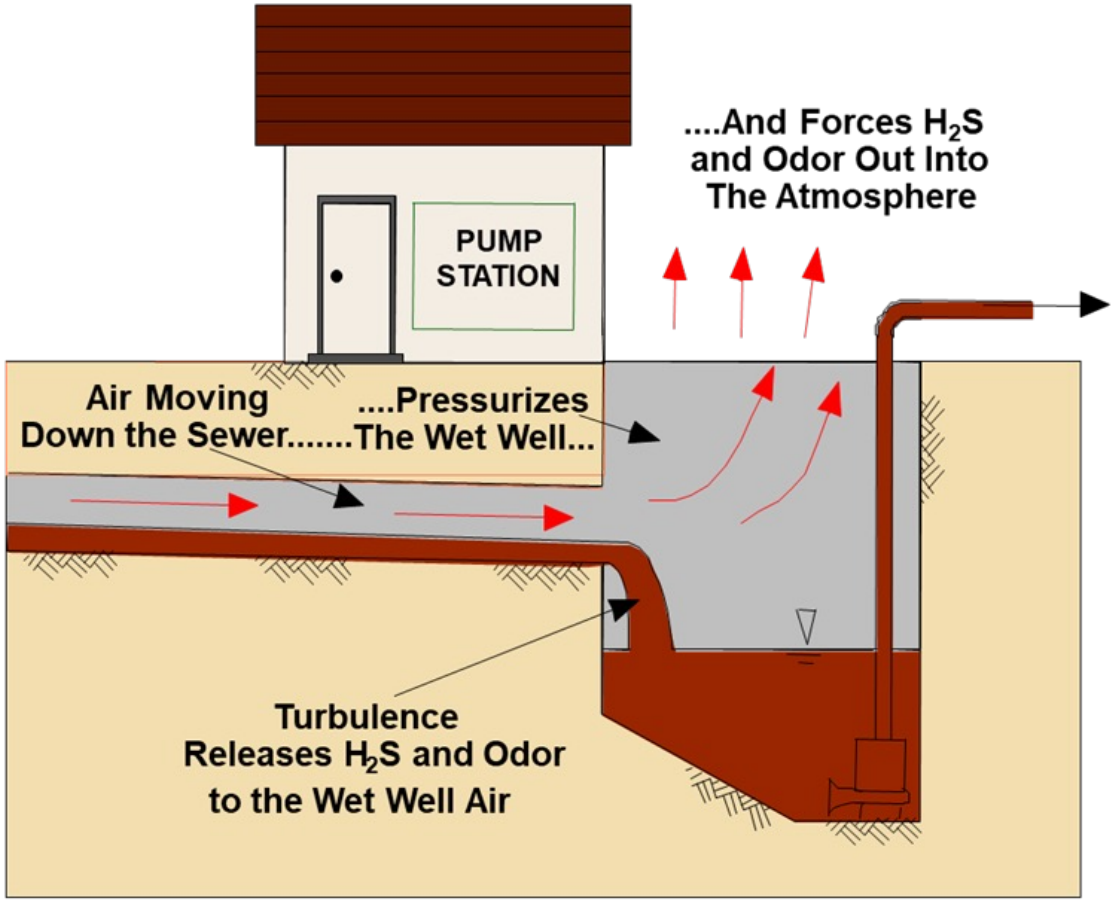


Design for Corrosion



Ventilation

- Use natural ventilation
- Supplement with mechanical
- Consider make-up air source and quality



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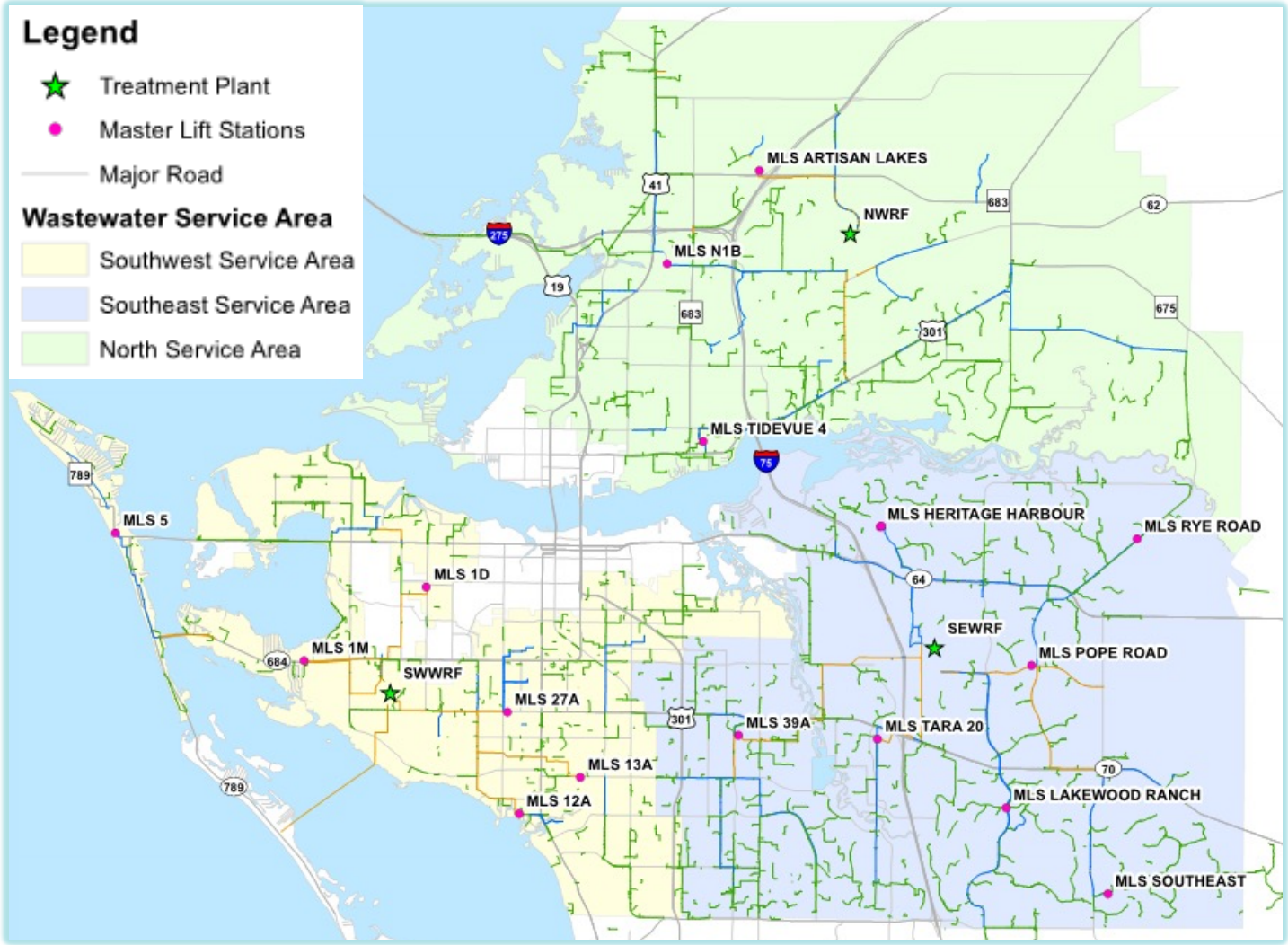
Manatee County, Florida Collection System

Key Stats

- 100,000 customers
- Covers unincorporated area, majority of County
- Flat terrain → majority of flow has long RT
- Warm temperatures → wastewater quickly loses DO
- Sulfide generation extensive, H_2S release opportunity widespread



Manatee County Approach

Historical Approach

- Hydraulics
  - Prevent spills
  - Efficient operation
- Control odors
  - Sensitive areas
  - Tourism economy
  - Keep the phone from ringing
  - Odor control measures
    - Chemical dosing
    - Ventilation & treatment

New Approach – Building on History

- Infrastructure protection
  - Prevent corrosion
- Collection system as bioreactor
- New tools in toolbox

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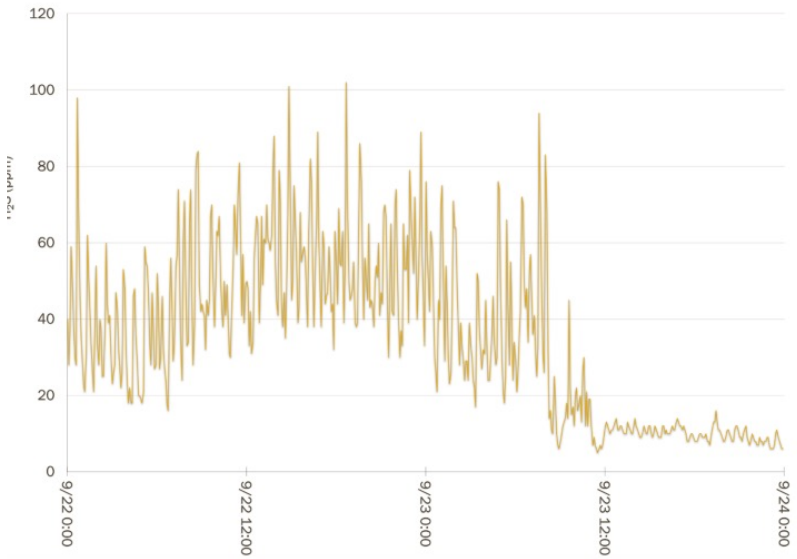
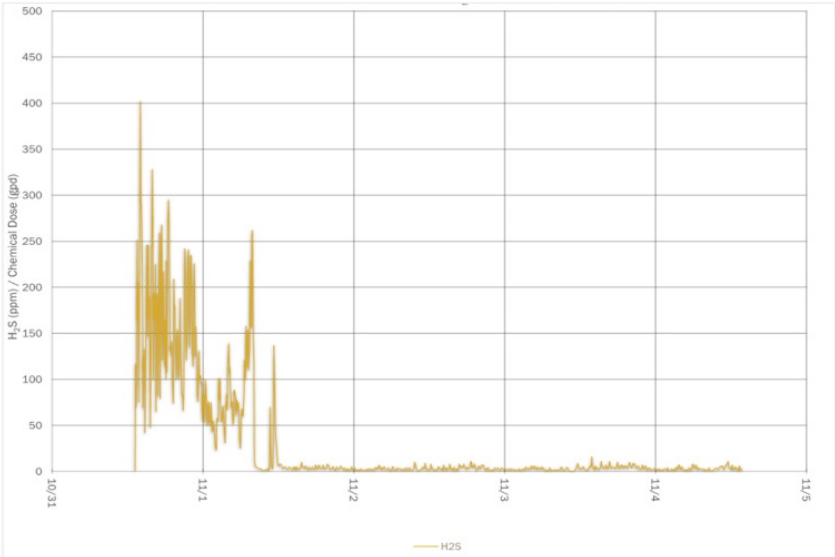
Manatee County New Approach

- Limit Septicity
  - Old and new chemistry
  - Clean lines
- Turbulence Reduction
  - Drop pipes
  - Raise wet well levels
- Design for corrosion
  - Plastic pipe
  - Polymer concrete
- Targeted ventilation
  - Pull from influent manhole instead of wet well

MLS CC6 H2S Before & After Covering Drop Pipe

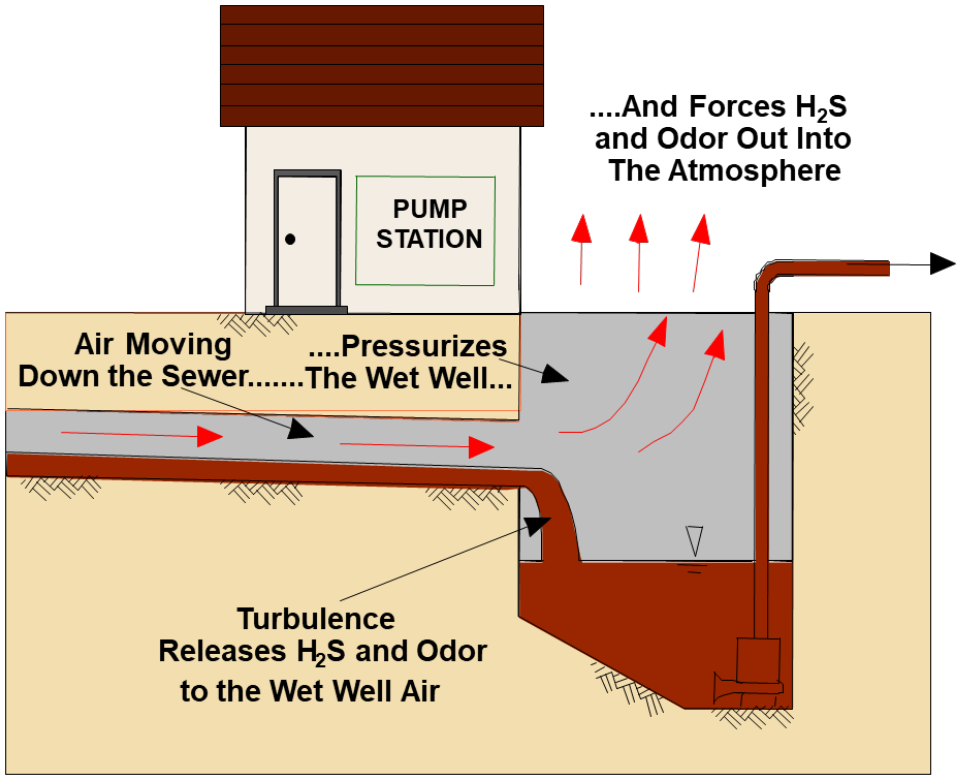
MLS Tara 20 H_2S Change With Well Level Rise



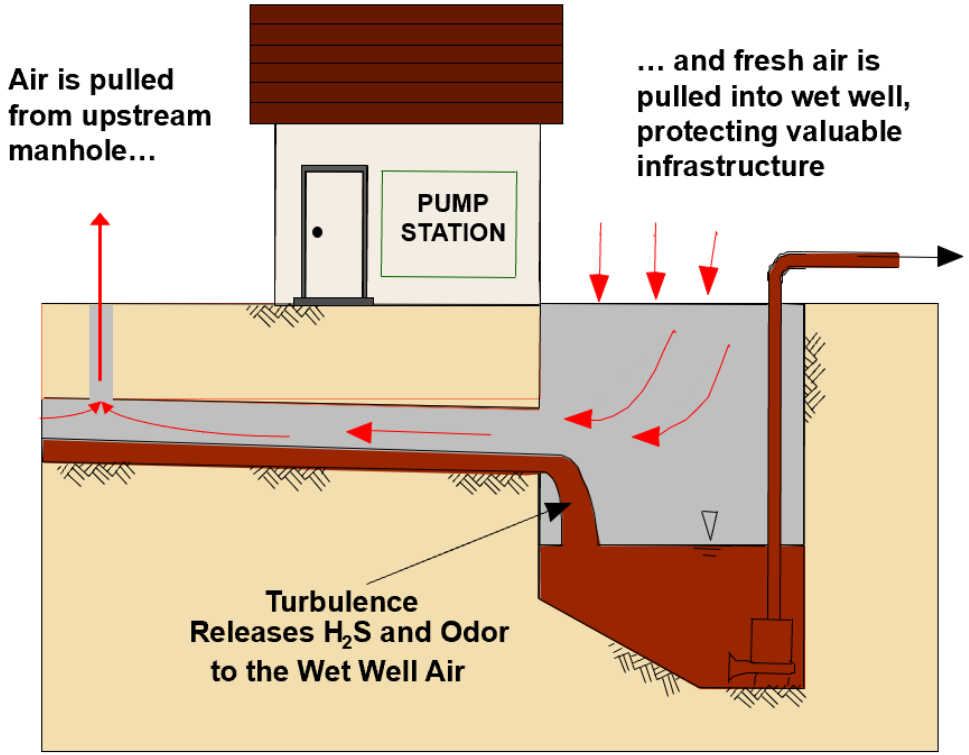


Targeted Ventilation

Old Approach – Capture Odor at Wet Well



New Approach – Capture Odor Upstream from Wet Well



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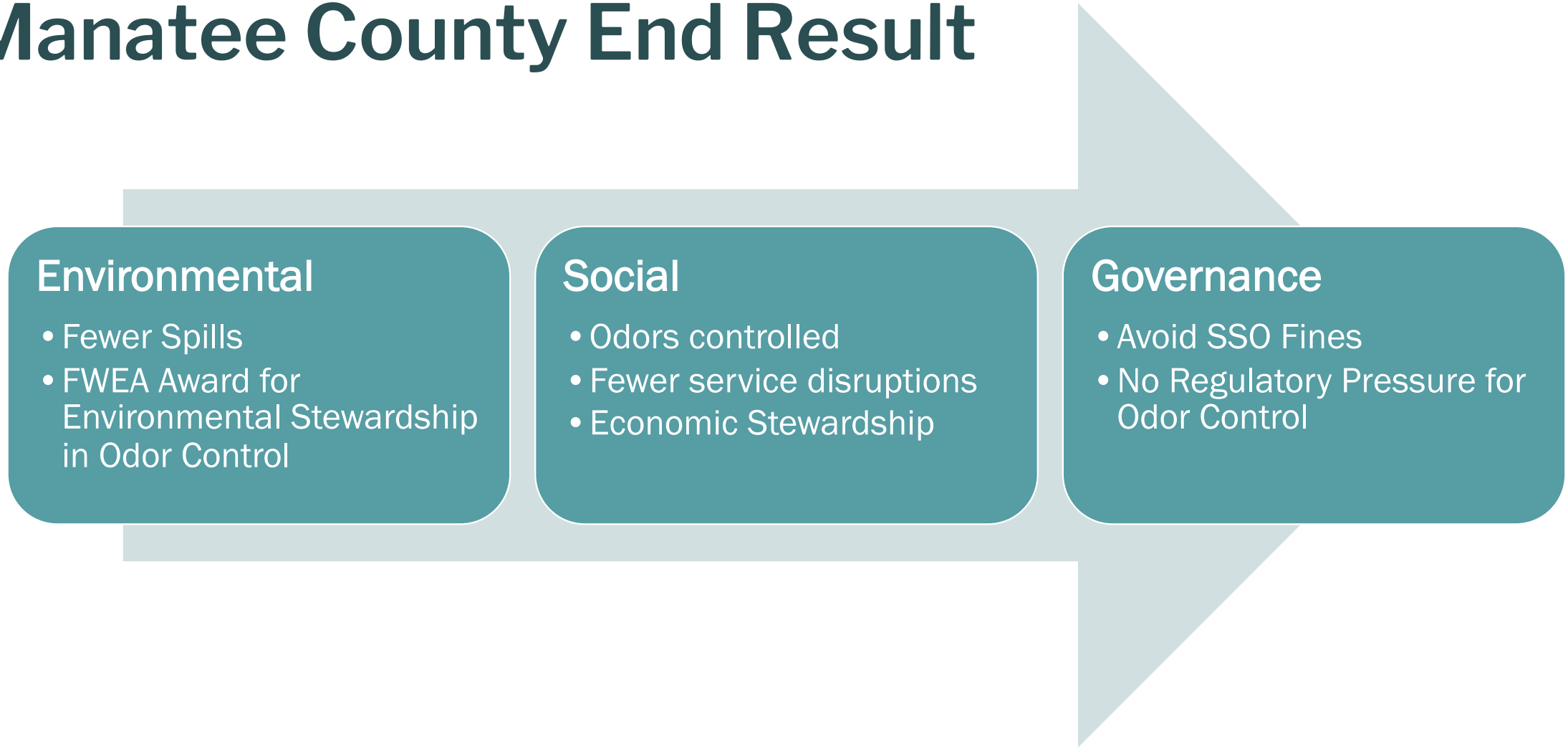
Corrosion Control - Odor Control - Sustainability

Manatee County End Result



Conclusion

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Collection System is a Bioreactor

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