# Assessing the Efficacy and Process Impacts of Odor Control Approaches Using Process Modeling

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# Agenda

- Background
- Model Development and Calibration
- Results
- Summary

# Background

# Facility Information

- Trinity River Authority Central Regional Wastewater System (CRWS)
- Located in Texas
- 189 mgd AADF
- BNR facility
- Significant solids process change at time of study
  - Thermal hydrolysis pretreatment + anaerobic digestion (THP+AD) solids management

# Project Objectives

- Assess odor mitigation at headworks through primary clarifiers with the application of:
  - Oxygen
  - Ferrous sulfate
  - Magnesium hydroxide
- Evaluate downstream impacts

# Project Approach

Liquid phase odor mitigation considered:

- Oxygen
- Ferrous sulfate
- Magnesium hydroxide

Field testing was not feasible – significant onsite construction and need for existing equipment rehabilitation

Plant modeling to assess odor mitigation and downstream impacts

- $H_2S$ mitigation
- Nutrient removal performance

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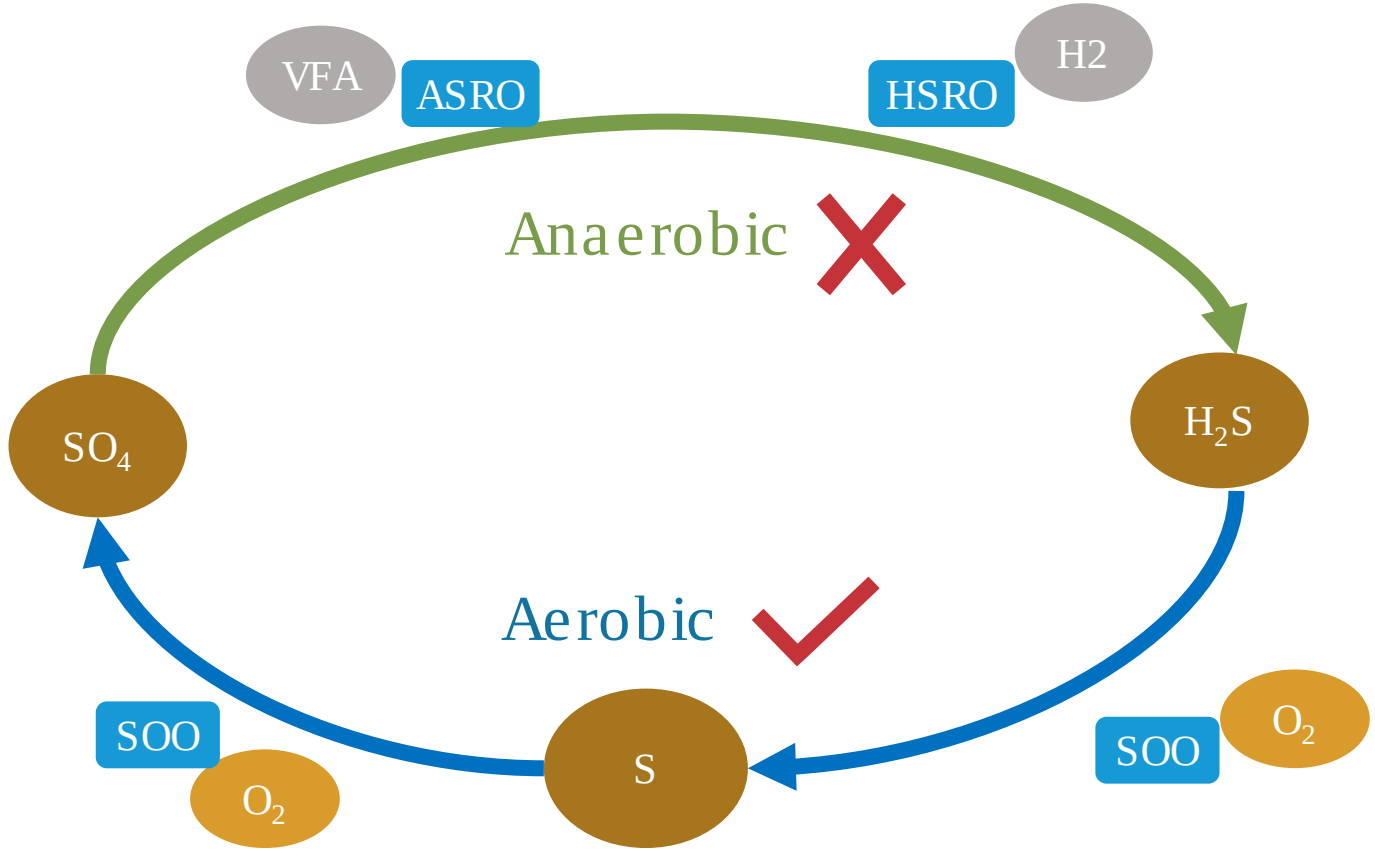
# Model Development

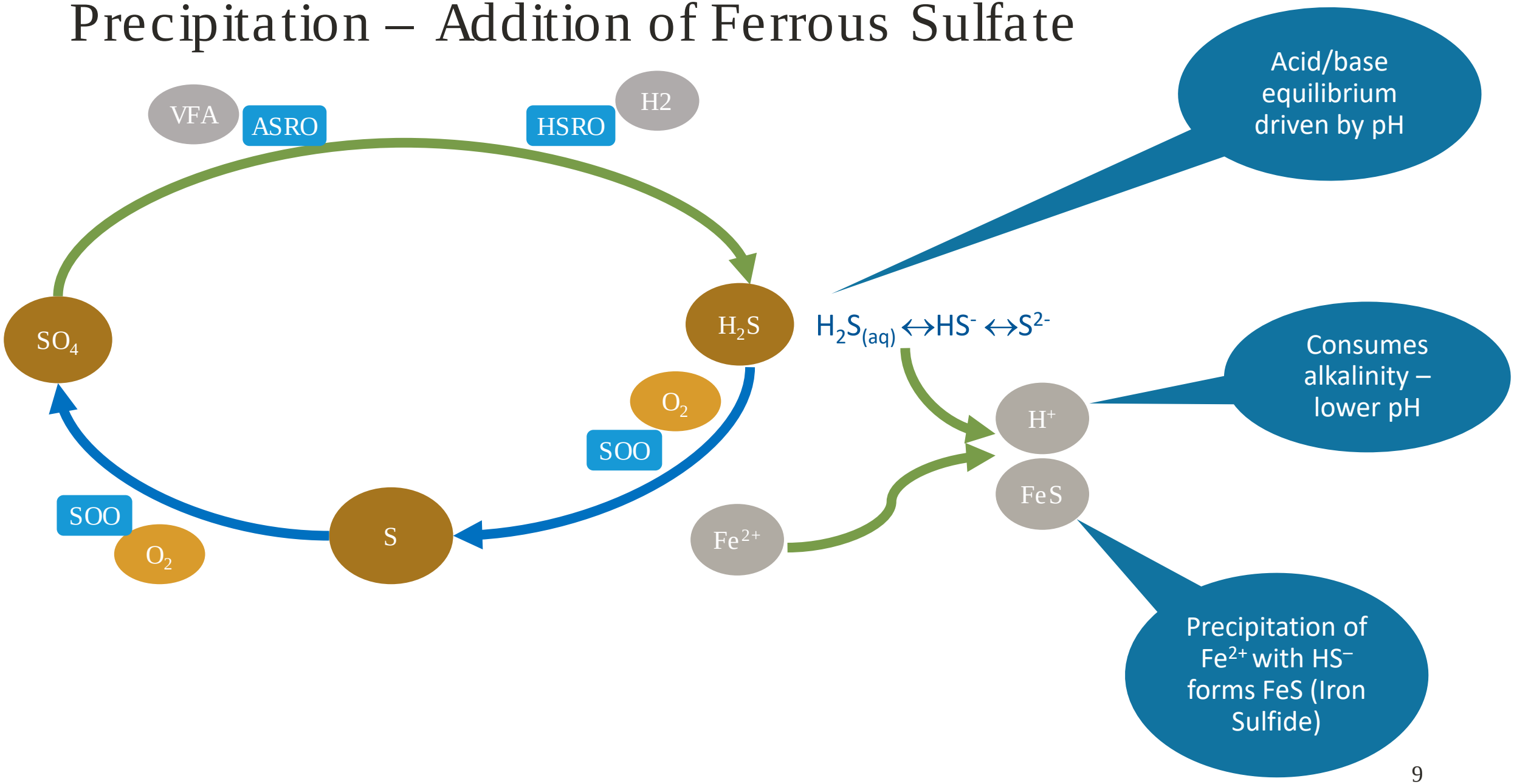
# Aerobic Environment – Addition of Oxygen

- Maintaining aerobic conditions in the liquid allows the bio-chemical oxidation of H2S to sulfur and sulfate
- Influent DO increase to concentration in excess and prevents H2S generation

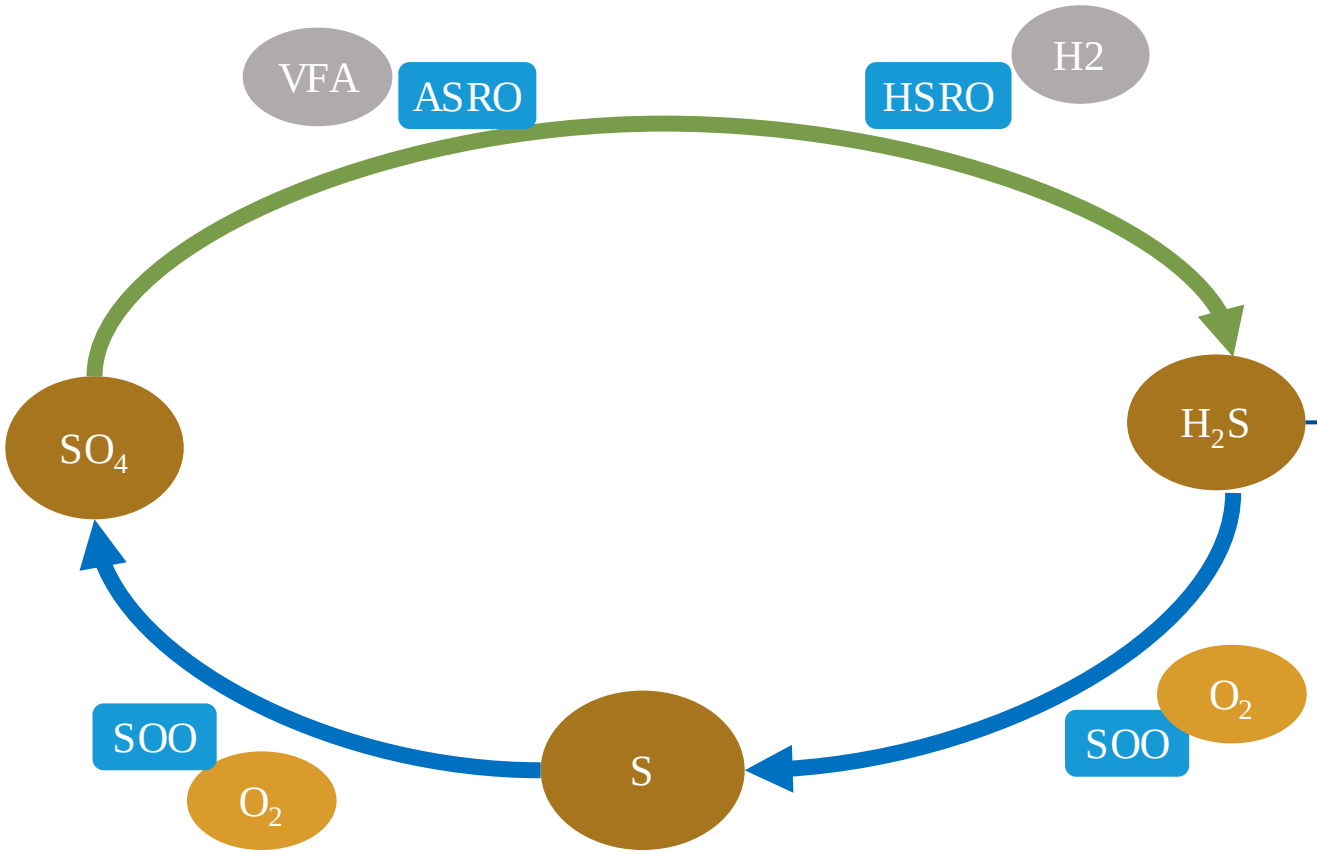
$H_2SO_4 \leftrightarrow HSO_4^- \leftrightarrow SO_4^{2-}$



# Precipitation – Addition of Ferrous Sulfate



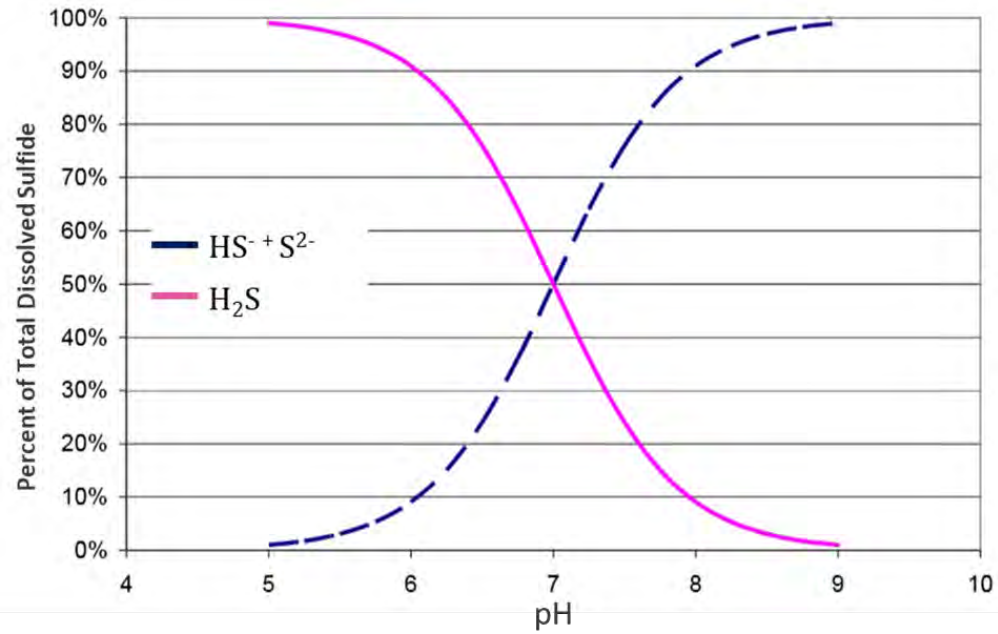
# pH Adjustment – Magnesium Hydroxide Addition




Acid/base equilibrium driven by pH

Magnesium hydroxide – pH shifting to keep $H_2S$ mostly in a form of $HS^-$

$H_2S \rightarrow H_2S_{(aq)} \leftrightarrow HS^- \leftrightarrow S^{2-}$



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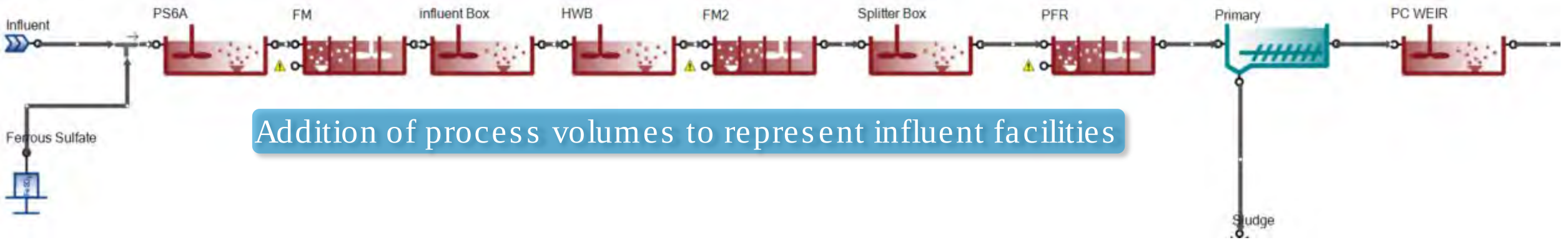
# Model Calibration

# Calibration and Existing Facilities

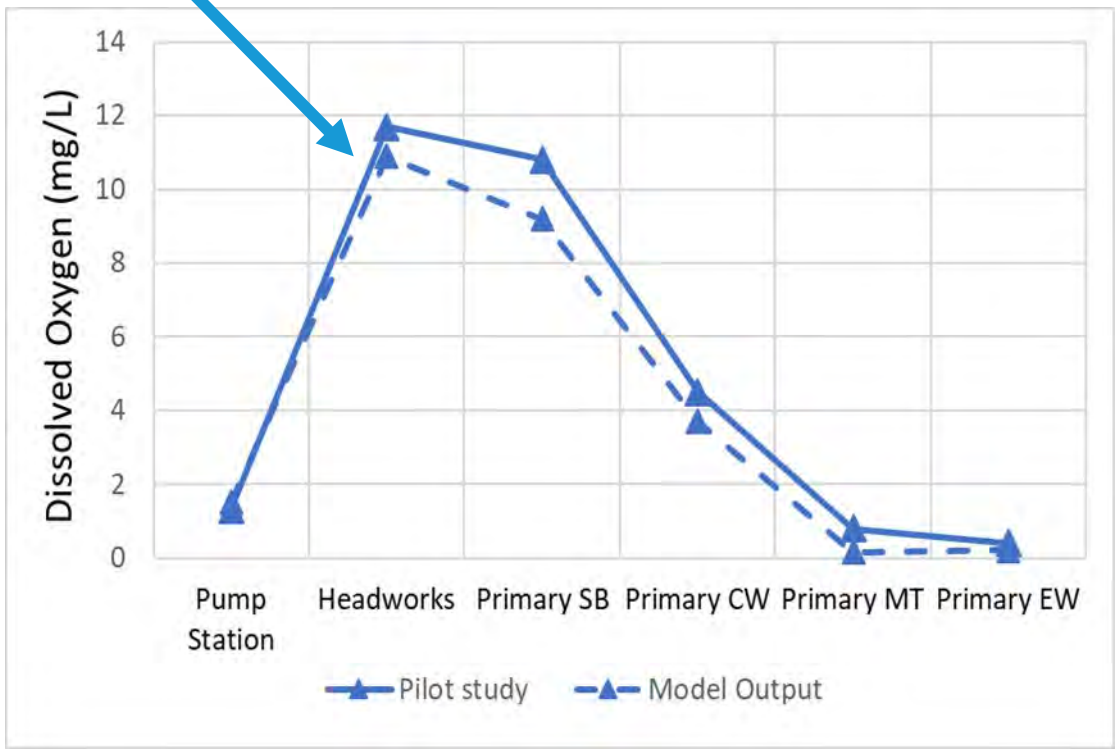


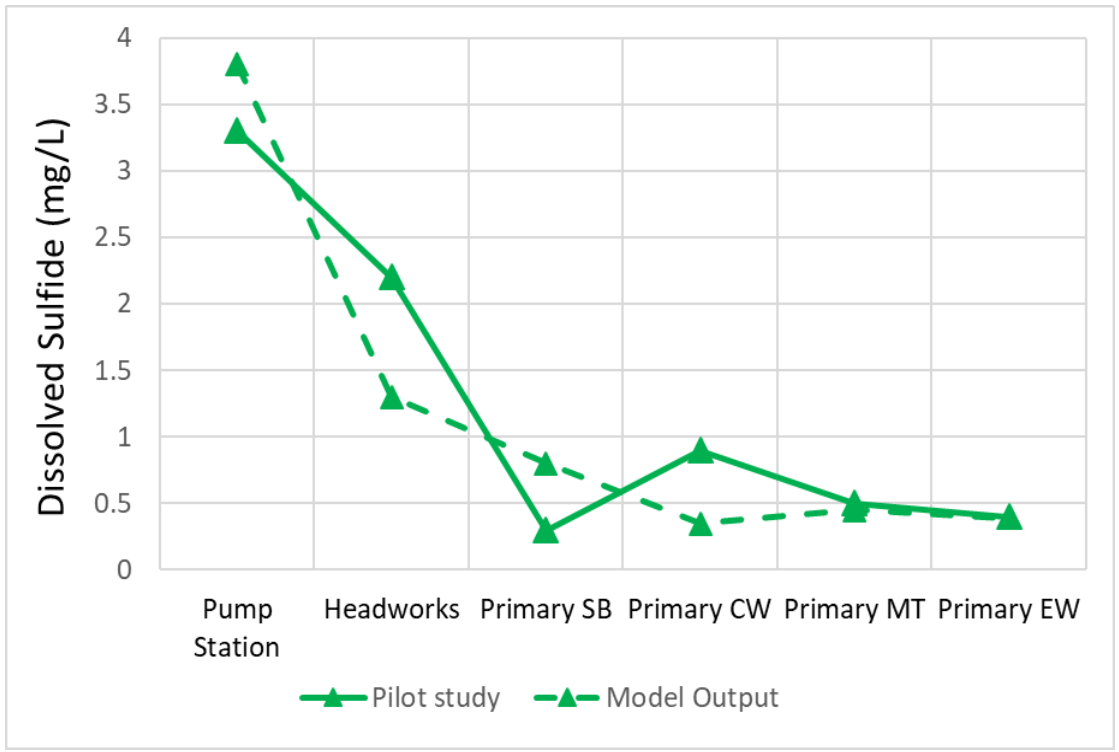

## Calibration approach

- Multiple flow rates
  - 75 – 150 mgd
- Dose ratios based on previous testing ($FeSO_4$ and oxygen)
  - $FeSO_4$ ratio sensitivity – 2:1 lbs Fe/lbs S
  - $Mg(OH)_2$ Target pH – 7.6 and 8.0
  - Oxygen target DO – 11 mg/L

# Oxygen Model Calibration

5,750 lbs $_{O2}$/d fed at PS6A in the model to match the 11 mg/L target DO in the field study



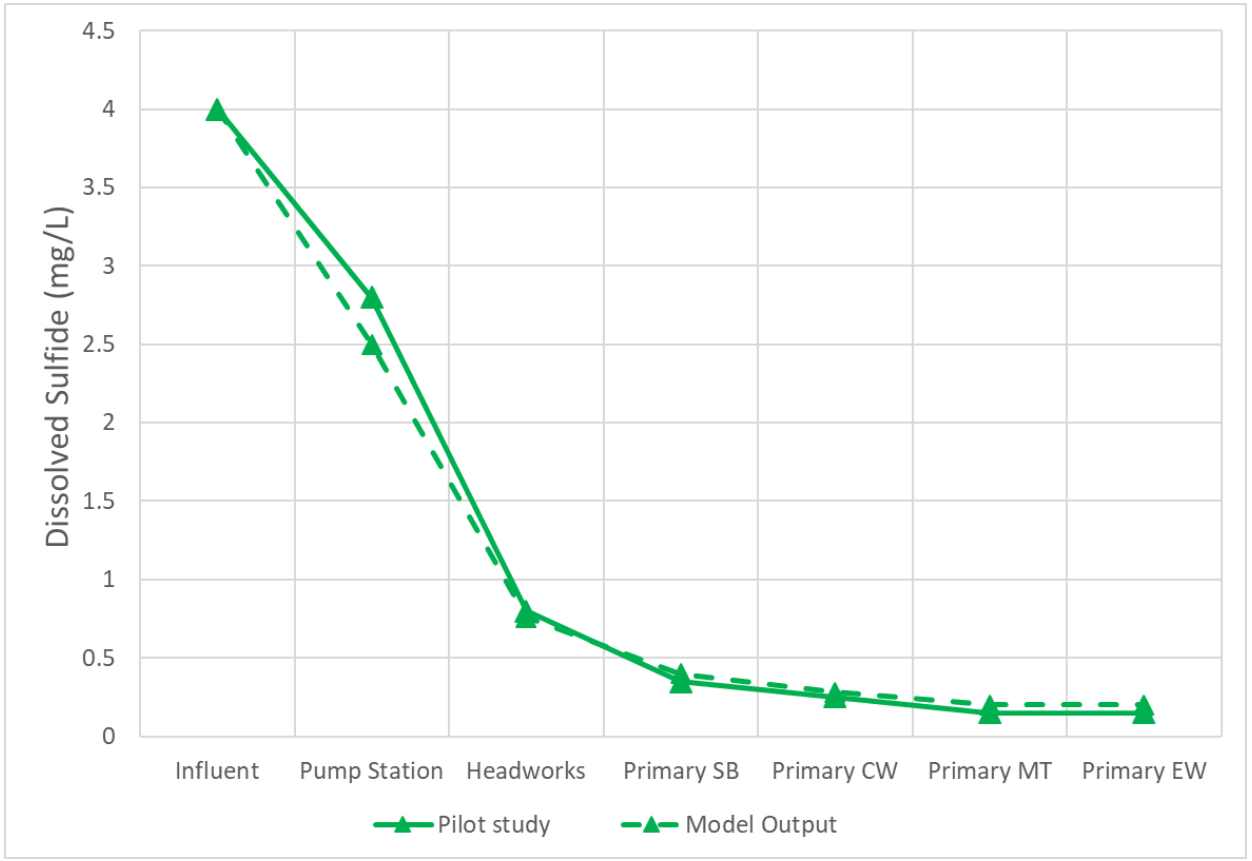




## Calibration Key Parameters:

- Influent bacteria (SOO)
- Airflows to represent turbulence

# Ferrous Sulfate Model Calibration

- Model calibration using pilot study
- 3,860 lbs Fe/d ferrous sulfate during pilot
  - 50 mgd influent flow (HWB)
  - 2:1 Fe/S




Calibration Key Parameters:

- Iron sulfide dissolution and precipitation rates

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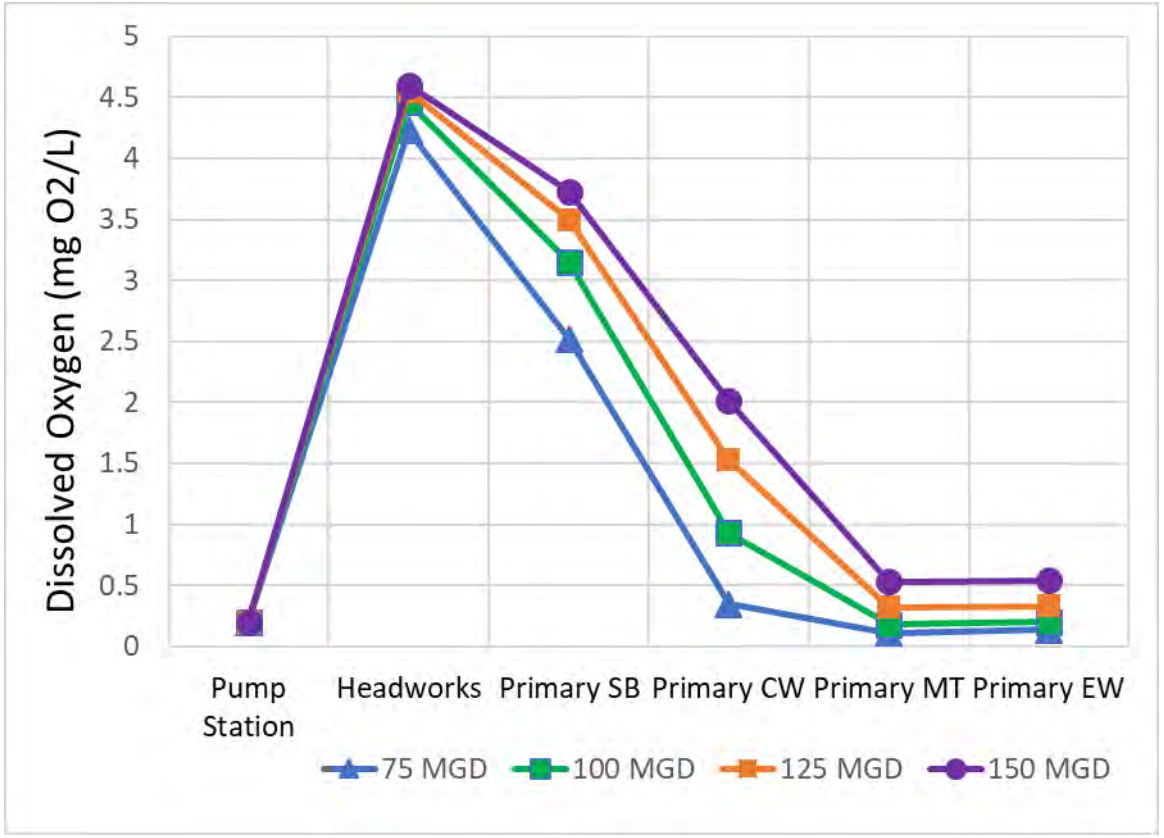
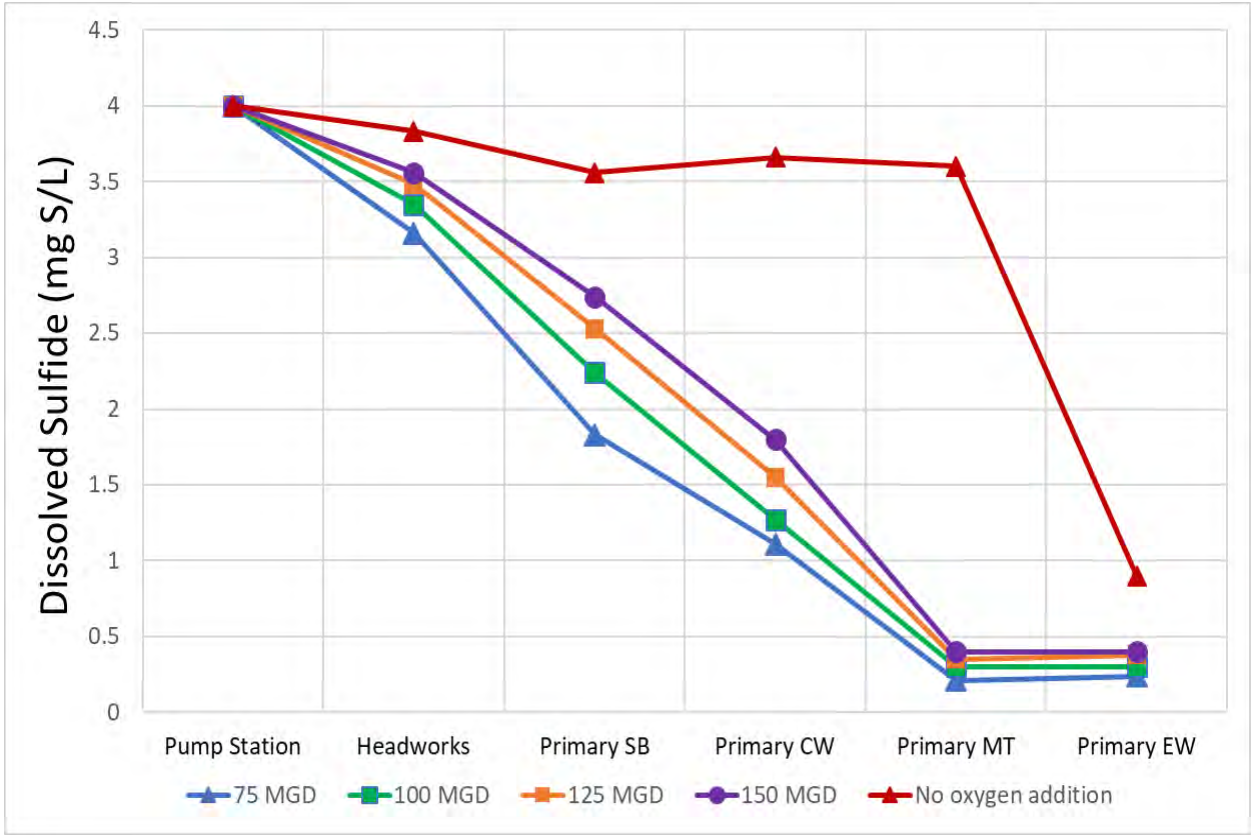
# Simulation Results

# Pure Oxygen Injection - Dissolved Sulfide Mitigation

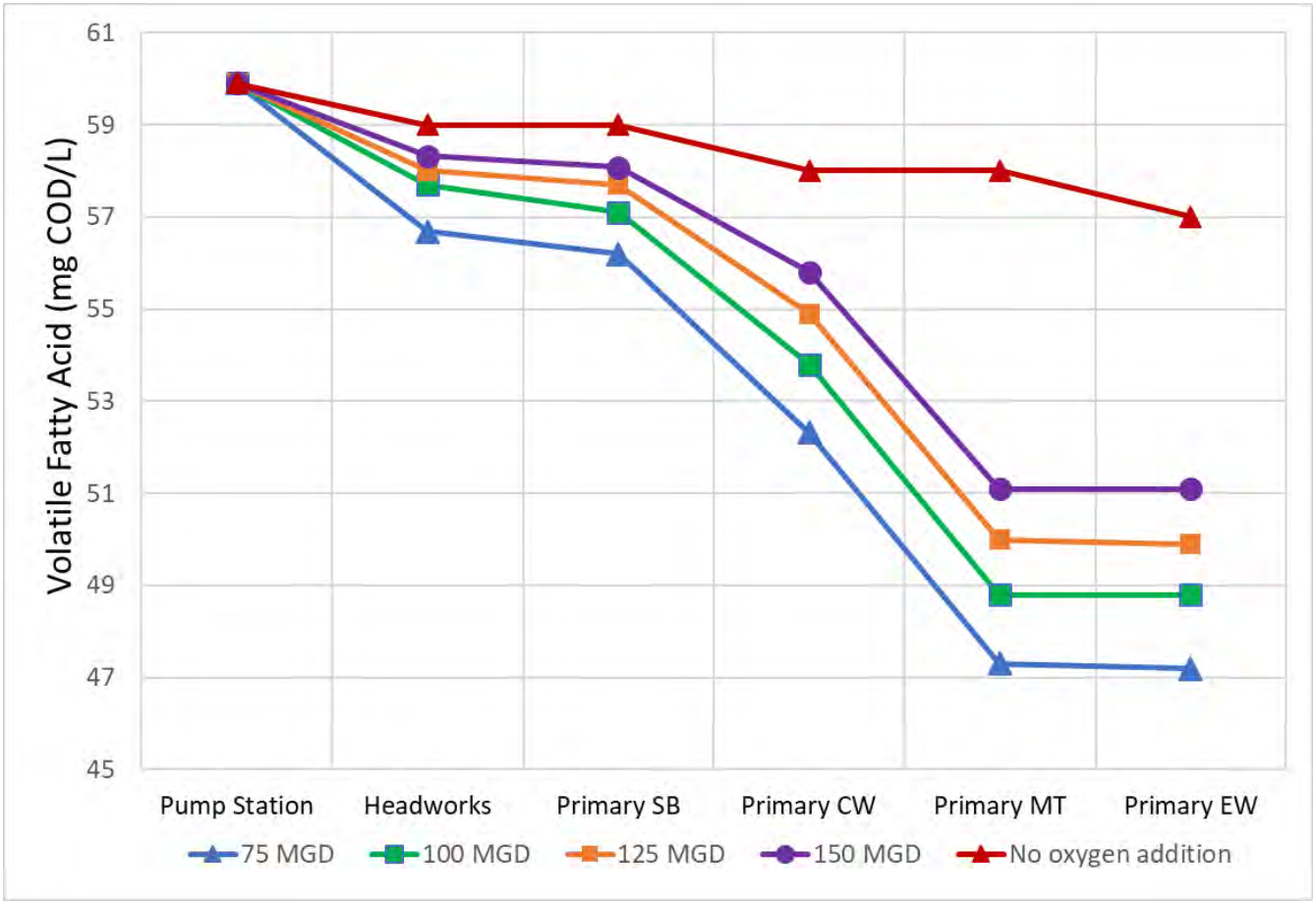
Target DO concentration of 5 mg/L




Effective sulfide reduction through primary treatment

# Pure Oxygen – Potential Whole Plant Impacts

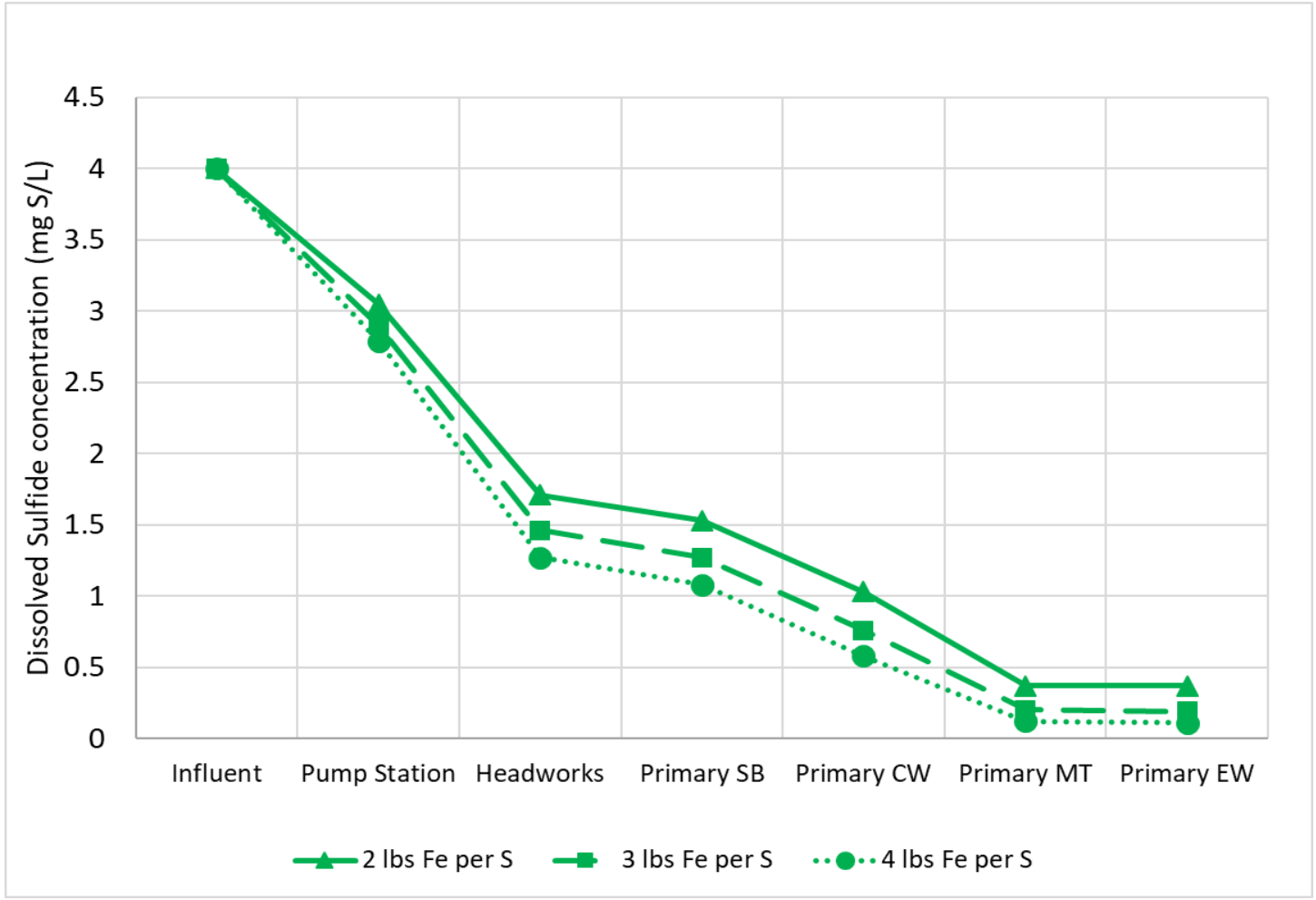



- VFAs – Key to stable EBPR performance (phosphorus removal)
- 10 mg/L VFA decrease with $O_2$ addition

Downstream impacts of pure oxygen could decrease BNR performance

# Ferrous Sulfate Addition – Dissolved Sulfide Mitigation

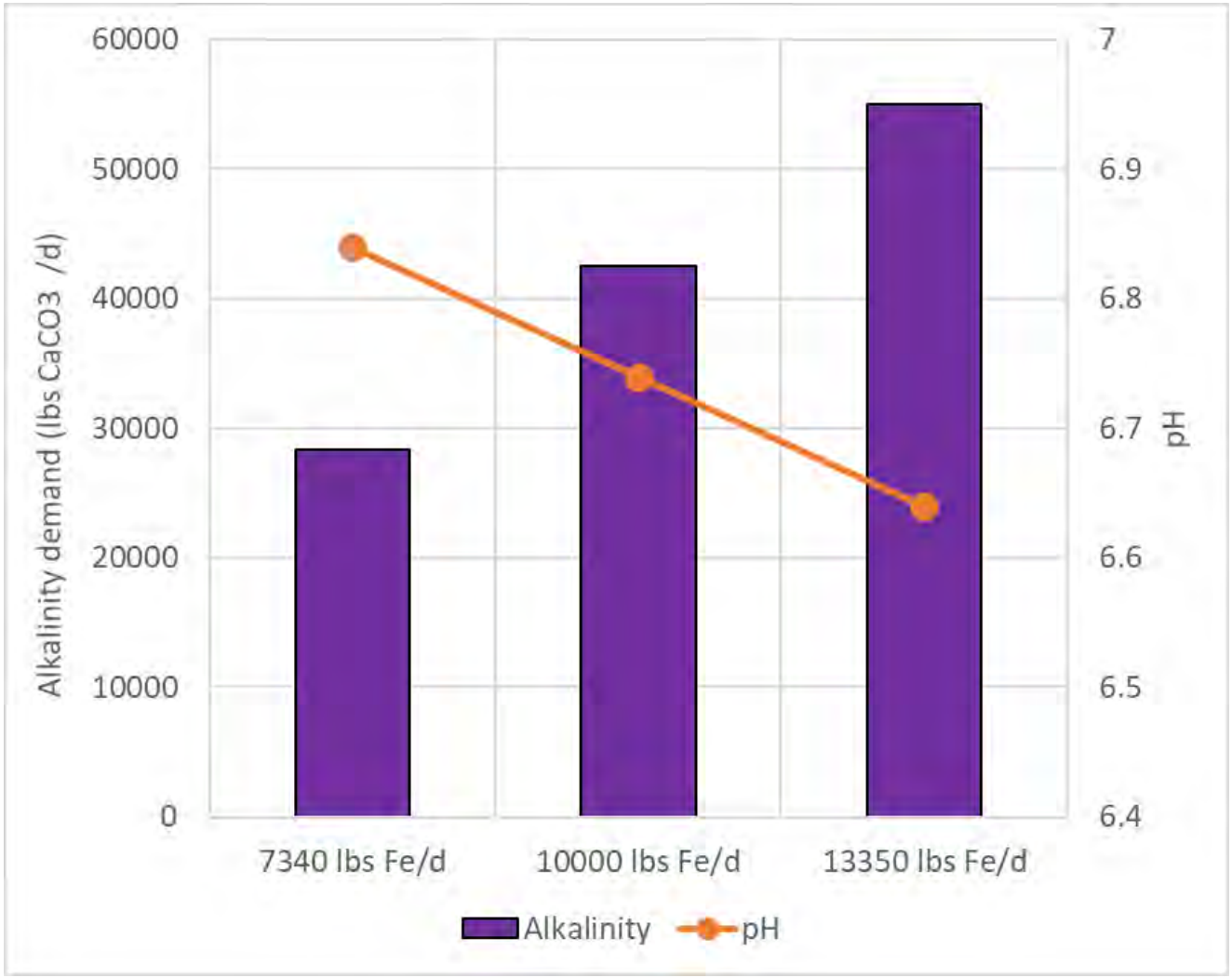
| Ferrous Sulfate Dose, lb/d | Ratio of lbs Fe per Lb S |
|---|---|
| 7,340 lbs Fe/d | 2 |
| 10,000 lbs Fe/d | 3 |
| 13,350 lbs Fe/d | 4 |




Removal becomes rate limited due to alkalinity and pH

# Ferrous Sulfate – Whole Plant Impacts

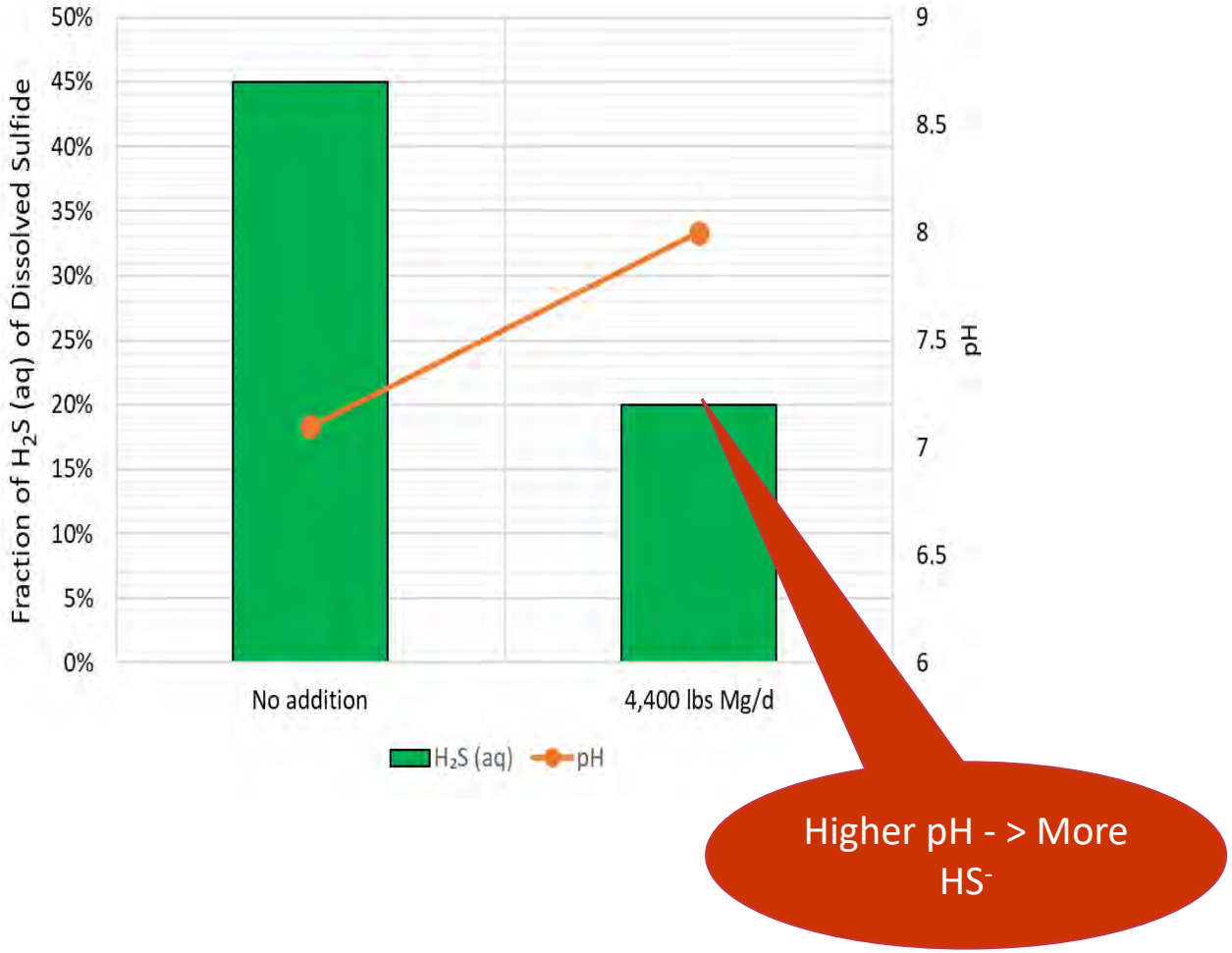
- Ferric and sulfide reaction consumes alkalinity
- Limitations to influent alkalinity can cause downstream process constraints




*Historically facility noted nitrification instability at pH <6.6

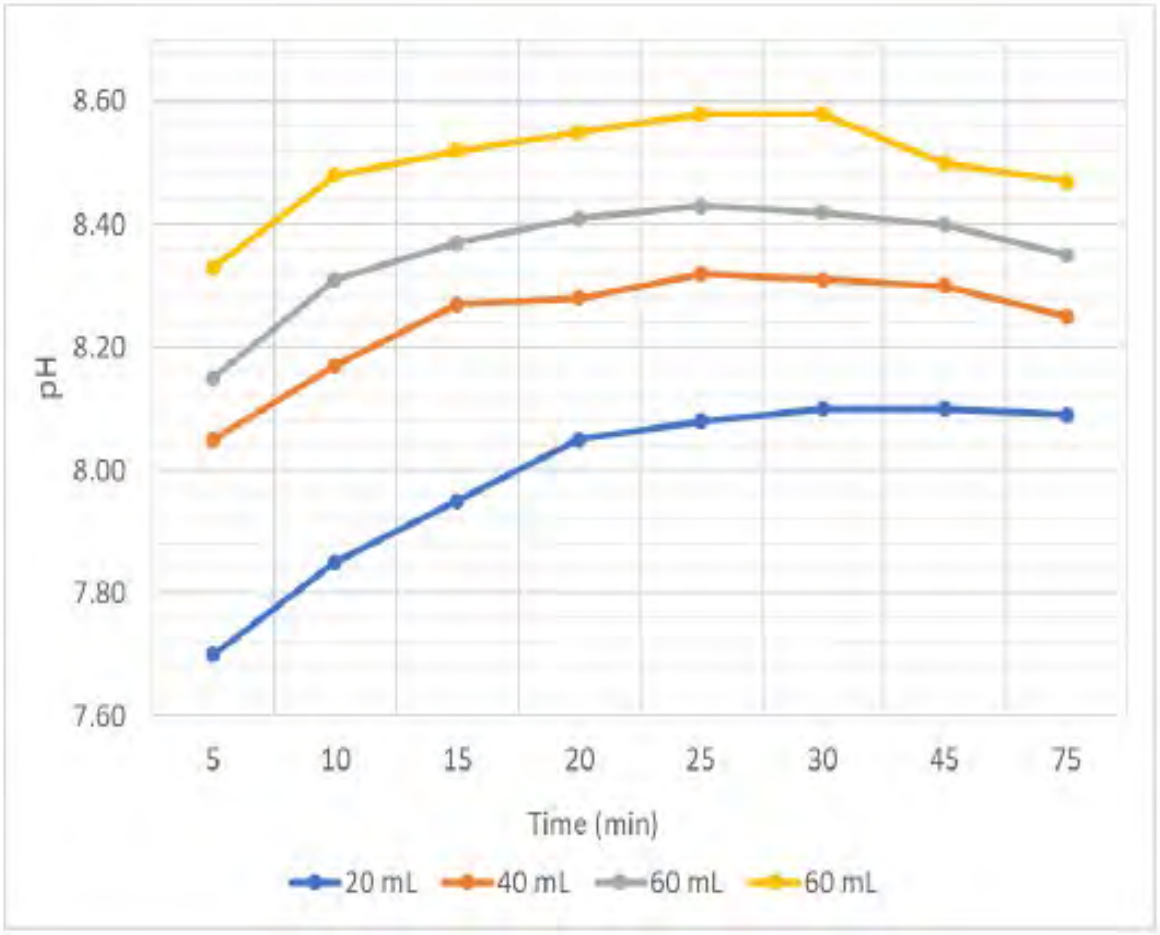
# Magnesium Hydroxide Addition – Dissolved Sulfide Mitigation

| Magnesium hydroxide dosage requirement at 100 MGD influent flow | Target pH |
|---|---|
| Baseline | 7.2 |
| 4,400 lbs Mg/d | 8 |




*Magnesium hydroxide increases alkalinity – downstream process benefits

# Magnesium Hydroxide Addition – Retention time




- Results indicate dosing location 30-min upstream to impact targeted location
- Dose ratios further confirmed model results

# Summary

- Simulations show 50-75% sulfide removal in comparison to baseline
- Process modeling help identify potential plant impacts
- Key parameters in model calibration are biological and chemical reaction rates
- Process modeling is an effective option in evaluating chemical addition

# Questions?

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