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A Comparison of Technologies for Hydrogen Sulfide Control from a Lengthy Force Main

MWEA 93rd Annual Conference
Boyne Mountain Resort, Boyne Falls
June 26, 2018
LET’S TALK

1. What’s the Issue?
2. How We Got Here
3. Short Term Solutions + Data Gathering
4. Long Term Needs + Options Analysis
5. A Case for Oxygen Injection
6. Where We Are At Now
What’s the Issue?
Odor Issues & Corrosion Impacts

- Odor Issues
  - Force main discharge
  - Gravity MHs

- Corrosion Impacts
  - Gravity sewers & MHs

- Historical Odor Control
  - Safety Concerns
  - System Maintenance
  - On-going costs
Hydrogen Sulfide Formation
Sulfate-Reducing Bacteria

Sulfate-Reducing Bacteria → Dissolved Oxygen → Nitrate → Sulfate

Anaerobic Conditions
Our Baseline H₂S Levels
How We Got Here
Time Line

- 1986  – Construction of Pump Station w/ Chlorine Injection
- 1990s – Nitrate Addition System (Bioxide®) Online
- 2014  – Sanitary Sewer and MH Rehab + Bioxide® Offline
- 2016  – *Short Term* Solution Implementation & Options Analysis for *Long-Term* Solution
- 2017  – Design of Oxygen Injection System
- 2018  – Construction of Oxygen Injection System
Construction of Jackson Road Pump

• Constructed in 1986

• Lift Station Specifics
  • Receives ~90% of Scio’s total flow
  • Four (4) wet well pumps
  • Qpump = 750 gpm @ 130 ft TDH
  • Qfirm = 2250 gpm

• Force Main Specifics
  • 16,730 ft (3+ miles)
  • 16” diameter
Chlorine Injection

- **Operation Considerations**
  - Safety for Operators
  - Fire Department Inspections
Nitrate Addition via Bioxide®

• Intent
  • Eliminate dissolved H2S & prevent downstream formation of new sulfides.

• Operational Issues
  • FOG layer to build up in wet well causing mixers to go out of service
Sewer Televising Downstream of Outfall
Relining of MHs & Pipe
Our Baseline H2S Levels
Short Term Solutions + Data Gathering
Short Term Items for Consideration

- Bring Bioxide Back Online
- Add Adsorbing Media to Gravity MH Lids
  - Plug Gravity MH Lids
  - Monitor H2S at Outfall (continuously)
- Monitor H2S at Grade at Gravity MHs (periodic)
Jackson Road Force Main

- Jackson Rd PS Site for Injection
- Jackson Rd PS FM Outfall
- Odor Complaints
Data Gathering

- Force Main Specifics
  - 16,730 ft (3+ miles)
  - 16” diameter
  - $Q_{avg} = 400-500$ gpm
  - $Q_{min} = 220$ gpm
  - $Q_{peak} = 1,035$ gpm

- Hydraulic Residence Time
  (length of time water is within force main)
  - Average: 7+ hours

Pt A → Pt B
Time of Travel from A to B
Odor Absorbing Media @ Gravity MHs
Nitrate Addition via Bioxide®

- Refurbish Equipment
  - Pump Maintenance
  - Purge Tank
  - Utilize Pump Timers in Consideration of Flows
    - Pump 1 – Base Load
    - Pump 2 – Low Flow Periods

- New Formula
  - Reduces likelihood of FOG layer formation
Vapor Phase Sampling

- OdaLog H2S Data Logger @ Wet Well
Liquid Phase Sampling

- Liquid Phase Sampling Program
  - Wet Well
  - Outfall

<table>
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<tr>
<th></th>
<th>Units</th>
<th>Wet Well</th>
<th>Outfall</th>
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<tbody>
<tr>
<td>pH</td>
<td>STD</td>
<td>7.7 (avg)</td>
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<tr>
<td>Temperature</td>
<td>Deg F</td>
<td></td>
<td>50</td>
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<tr>
<td>DO</td>
<td>ppm</td>
<td>0.49</td>
<td>&lt;0.2</td>
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<tr>
<td>Nitrate</td>
<td>ppm</td>
<td>&lt;0.5</td>
<td>&lt;0.5</td>
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<td>Dissolved Sulfides</td>
<td>ppm</td>
<td>&lt;0.04</td>
<td>1.03</td>
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<td>Dissolved Sulfides (via Lamotte Sulfide Test Kit)</td>
<td>ppm</td>
<td>ND</td>
<td>4-6</td>
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<td>Conductivity</td>
<td>Umhos/cm</td>
<td>3,410</td>
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<td>ORP</td>
<td>mv</td>
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<td>-137</td>
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<tr>
<td>BOD5</td>
<td>ppm</td>
<td>308</td>
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Diurnal Flows + Concentrations

Graph showing diurnal flows and concentrations. The graph plots flow (gpm) and H2S concentration (ppm) over a 24-hour period. The flow graph shows a peak around 10 AM, while the H2S concentration graph peaks around 2 PM.
Long Term Needs + Options Analysis
Long Term Needs

- Liquid Phase Treatment
- Installation Point @ Pump Station
- Low-to-No Vapor Phase Hydrogen Sulfide
  - Reduce odor and corrosion
  - Max of 20 ppm
- Low Operating Cost
- Hands Off Operation
- No Disruption to Lift Station Operation
## Technology Options Considered

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<tr>
<th>Treatment Type</th>
<th>Product Manufacturer</th>
<th>Recommended Product</th>
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<tr>
<td>Nitrate Addition</td>
<td>Evoqua</td>
<td>Bioxide</td>
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<tr>
<td>Chemical Oxidation</td>
<td>GE Water</td>
<td>ProSweet</td>
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<td>DW3</td>
<td>PlanetBreeze/NanoMaxx</td>
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<td>Biological Treatment</td>
<td>BioScience</td>
<td>ANL</td>
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<td>Novoxymes</td>
<td>AOS2008 and OCM2020</td>
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<td>State Chemical</td>
<td>Pit Raider/Nutri-Pro</td>
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<td>Air/Oxygen Injection</td>
<td>BlueInGreen</td>
<td>SDOX 200</td>
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Technology Options Recommended for Trial

- Nitrate Addition
- Microbial Treatment
- Oxygen Injection

- Chemical Oxidation
Sulfate-Reducing Bacteria

Sulfate-Reducing Bacteria → Dissolved Oxygen → Nitrate → Sulfate

Anaerobic Conditions
Nitrate Addition

- Sulfate-Reducing Bacteria
- Dissolved Oxygen
- Nitrate
- Sulfate

Anaerobic Conditions
Nitrate Addition

- **Approach**
  - Inject calcium nitrate to prevent sulfide production

- **Advantages**
  - Proven system technology
  - Provides downstream control
  - Low-to-no capital cost

- **Disadvantages**
  - High annual and life cycle costs
  - Requires chemical handling
Bioxide Trial: March-April 2016

Graph showing the H2S concentration (ppm) vs flow (GPM) with data points for Baseline, Pre-Trial, and Trial conditions.
Microbial Treatment

NON Sulfate-Reducing Bacteria

→ Dissolved Oxygen

→ Nitrate

Anaerobic Conditions

→ Sulfate
Microbial Treatment

- **Approach**
  - Inject microbes that do not reduce sulfides

- **Advantages**
  - Provides downstream control
  - No chemicals
  - Lower capital cost

- **Disadvantages**
  - Not all microbes are ‘equal’; results vary
  - Long inoculation period
  - Microbes susceptible to kill-off due to spills

Existing FOG System Converted to Microbial Feed System for Trial @ Lift Station
Sulfate-Reducing Bacteria

Sulfate-Reducing Bacteria → Dissolved Oxygen → Nitrate → Anaerobic Conditions → Sulfate
Technology Ranking Considerations

- Sustainability Index
- O&M Staffing Needs
- Performance Efficiency
- Present Worth Cost
- Odor Control Approach
- Future Use
  - Transferability of system
  - Transfer of capital
- Impact on Ann Arbor
Results

- Microbial Treatment: BAD
- Nitrate Addition: BETTER
- Oxygen Injection: BEST
A Case for Oxygen Injection
Oxygen Injection

- **Approach**
  - Inject oxygen to prevent sulfide formation
  - Uses pressure head in FM to supersaturate oxygen into water

- **Advantages**
  - Proven technology
  - Provides downstream control
  - Beneficial annual and life cycle costs

- **Disadvantages**
  - Newer technology for conveyance systems
  - Proprietary systems
  - Requires oxygen generation or storage
Case Study – Raymore, MO

City of Raymore H2S Study "Madison Creek"

- ECO2 System OFF
  - Avg. H2S: 123ppm
  - Max. H2S: 939ppm
- ECO2 System ON
  - Avg. H2S: 1ppm
  - Max. H2S: 10ppm
Case Study – El Paso, TX

H₂S Concentration at Discharge of Frontera Dual Force Main

- Calcium Nitrate Feed
  - Avg. H₂S: 12 ppm

- SuperOxygation
  - Avg. H₂S: 1 ppm

Calcium Nitrate Feed During LOX Tank Upgrade
March 2015

SuperOxygation
May 2015
@ 40% of the Cost of CaNO₃
Case Study – Laguna Beach
Case Study – Laguna Beach

Laguna Beach Montage Dr. 8-29-2006 (OdaLog: OL45055993)

Period displayed: Sun Aug 27 - Tue Aug 29 (Oda File: Laguna Beach Montage Dr. 8-29-2006.oda)
Recommendation of **OXYGEN INJECTION SYSTEM**

- Preventative Form of Odor Control
- Preventative Form of Corrosion Control
- Environmentally Friendly
- Sustaining Aerobic Conditions

- Lower Life Cycle Cost
- Ability to Meet Control Objectives
Where We Are At Now
Process Flow Diagram
Design - Isometric
Construction
Construction
Construction
START UP IN AUGUST 2018
QUESTIONS?