Ventilation Causes of Collection System Odors

Mark M. Smith, P.E.
Two Causes of Odor Complaints

- Production of Hydrogen Sulfide
- Air Escape from Sewer to Atmosphere
Odor Emissions from Gravity Sewers to Atmosphere

- Positive Differential Air Pressure
  - Wastewater Drag Effect
  - Pipe Physical Characteristics
Wastewater Drag Effect in a Gravity Sewer

Headspace (Air)

Wastewater (Liquid)
Sufficient Headspace = No Positive Air Pressure

Example of Equal Air Pressure During Low Flows in a Gravity Sewer System
Insufficient Headspace = Positive Air Pressure Buildup
Physical Pipe Characteristics

Diameter Constriction

Positive Pressure Point

Slope Reduction

Positive Pressure Point
Physical Pipe Characteristics

Presence of a Siphon

Air Jumper

Pressure Point
How to Solve an Odor Problem in a Gravity Sewer System?

• Withdraw Odorous Air

• Treat in an Appropriately-sized Scrubber
Typical Air Treatment Systems in Collection Systems

- Biological
  - Biofilters
  - Biotrickling Filters
- Carbon Scrubbers
Existing “Maze” Sewer System
Resulting Odor Control

- Three New Locations Identified
- Airflow Withdrawal Rates Calculated
- Needed Confirmation of Rates ("Fan Test")
Fan Test Procedure

- Three Air Withdrawal Sites
  - La Cienega (LCSFVRS)
  - Rodeo (NCOS)
  - Culver City Park (NORS)

- 12 Pressure Data Loggers Installed in Sewers
Fan Test Procedure

- Baseline Pressures Recorded
- Fans Were Operated Over a 7-Day Period in 21 Possible “On-Off” Combinations
- Data Loggers Recorded Air Pressure Responses in the Sewer
Siphon Backpressure

- Diversion Structure 2
- Diversion Structure 1
- Diversion Structure 3
- Westlake Relief Sewer
- North Portal
- Maze
- Future ECIS Tie-in
- Direction of Flow
- Sewer Out of Service
- Siphon
- Path of Air Backpressure Effect

Sewer Out of Service
Diversion
Stoplogged
Abandoned
Air Pressurization Sources and Affected Sewers

To Hyperion WWTP
N. NOS
S. NOS
LCSFVRS
LCIS
NOTF
WRS
WLAIS
NOS
NOS
NOS
NOS
Stoplogged
Stoplogged
Stoplogged
Typical Baseline Air Pressures
Upstream of a Siphon

Air Pressure (in wg)

<table>
<thead>
<tr>
<th>Date</th>
<th>Cochran</th>
<th>Drakewood</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/27</td>
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<td>4/28</td>
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<td>4/30</td>
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Typical Baseline Air Pressures
Upstream of a Siphon (12 hr. Period)
Daily Airflow Extraction Rates

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Extraction Rate (cfm)</th>
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<tbody>
<tr>
<td>8 am - 4 pm</td>
<td>10,000</td>
</tr>
<tr>
<td>4 pm - 12 am</td>
<td>7,500</td>
</tr>
<tr>
<td>12 am - 8 am</td>
<td>5,000</td>
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</tbody>
</table>
Typical Air Pressure Responses
3 Fans Withdrawing 10,000 cfm Each

Vent Hole at Ivy Covered at This Time
Typical Air Pressure Responses
3 Fans Withdrawing 10,000 cfm Each

- Rodeo and Culver City Fans are Started
- La Cienega Fan is Started
- Short-Circuiting is Corrected
- La Cienega Connection is Short-Circuiting
# Summary of Test Results

**May 2, 2003**  
All Fans Running at 10,000 cfm

<table>
<thead>
<tr>
<th>Manhole Location</th>
<th>% Change in Avg Pressure</th>
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</thead>
<tbody>
<tr>
<td>Cochran (NOS)</td>
<td>-259</td>
</tr>
<tr>
<td>Vinton (WLAIS)</td>
<td>-183</td>
</tr>
<tr>
<td>Fairfax (LCSFVRS)</td>
<td>-167</td>
</tr>
<tr>
<td>Jackson (WRS)</td>
<td>-165</td>
</tr>
<tr>
<td>Kalsman (LCSFVRS)</td>
<td>-161</td>
</tr>
<tr>
<td>Corbett (LCIS)</td>
<td>-156</td>
</tr>
<tr>
<td>Ivy (NORS)</td>
<td>-152</td>
</tr>
<tr>
<td>Hannum (NORS)</td>
<td>-120</td>
</tr>
<tr>
<td>Grayburn (NOS, N. Branch)</td>
<td>-101</td>
</tr>
<tr>
<td>Imperial Hwy. (NORS)</td>
<td>-12</td>
</tr>
<tr>
<td>Somerset (NOS, S. Branch)</td>
<td>-4</td>
</tr>
<tr>
<td>Drakewood (NCOS)</td>
<td>28</td>
</tr>
</tbody>
</table>
Conclusions

• Siphons Were The Primary Cause of Positive Pressure

• Significant Reductions in Pressure were Achieved

• Greatest Success Occurred When All Fans Were Withdrawing 10,000 cfm Simultaneously
Recommendations

- Withdraw 12,500 cfm at Each of the Three ATF Locations (1.25 SF)

- Further Evaluate Pressure and Ventilation Dynamics in Areas Unaffected by Fan Testing
Force Main Odor Production

- Problems are made worse due to
  - Full Pipe Flow
    - 360° Slime Layer
  - Long Detention Times
    - In Wet Well
    - In Force Main
H$_2$S Release from Force Main

- Typically occurs at the point of discharge into a gravity pipe
- Turbulence Induced
How to Solve an Odor Problem in a Force Main?

- Chemical Feed
  - Calcium Nitrate
  - Sodium Hypochlorite
  - Sodium Hydroxide
  - Magnesium Hydroxide
  - Iron Salts
- Ferrous Chloride
- Ferric Chloride
Lake Las Vegas Resort

North Shore
• Hyatt Hotel
• High $$ Homes
• Golf Courses

South Shore
• High $$ Homes
• Golf Courses
South Shore Collection System

- 60,000 GPD
- 42,000 LF of pipe
  - 2 inches to 15 inches in diameter
- 5 Lift Stations
South Shore Odor Problem

- Very high hydrogen sulfide concentrations
- Housing construction has boomed recently
- Several odor complaints arose
Odor Investigative Team

• City of Henderson
  – Collection System Field Personnel
  – Engineers

• Lake Las Vegas
  – Management
  – Lift Station Operators

• HDR Engineering, Inc.
Project Approach

• Compile and map odor complaint locations

• Develop and execute a sampling plan

• Compile and analyze the resulting data

• Develop and implement an odor control plan
Sampling Plan

• Install 8 hydrogen sulfide monitors throughout collection system

• Data collected for 1 week

• Inspect and analyze existing lift stations, pipes and O&M procedures

• CCTV’d suspected problem pipes
Findings

- Hydrogen sulfide between 50 and 300 ppm
  - Regularly over 100 ppm
- Elevation problems and sags in pipes and manholes
- Out-of-service chemical feed facilities
- Detention times between 7 and 90 hours in lift stations(!)
H2S Concentrations at MH 283-013 (A)
Incoming 8-in Sewer

To Lift Station

Stub Out

Incoming 8-in Sewer

2004/09/29
Short Term Recommendations

- Restore BIOXIDE® feed facilities
- Periodically clean and flush problem manholes and pipes
- Install rubber flapper
Hydrogen Sulfide in MH 283-013 w/ Bioxide Addition & Flushing
Long Term Recommendations

• Continue feeding BIOXIDE®, monitoring hydrogen sulfide and force mains

• Perform chemical feed optimization study

• Find permanent solution to sags and manhole elevation problems