Los Angeles County Sanitation Districts’ Odor Control Practices

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Los Angeles County Sanitation Districts
Organization of Presentation

• Background of Los Angeles County Sanitation Districts
• Wastewater treatment information
• Odor control in collection system
• Odor control in wastewater treatment plants
Los Angeles County Sanitation Districts

Districts founded in 1923 to handle cities and unincorporated areas outside of the City of Los Angeles.

23 separate Districts working cooperatively under joint administration.

Provide water pollution control and solid waste management for 78 cities and unincorporated areas of the County of Los Angeles.
Los Angeles County Sanitation Districts
Wastewater Collection & Treatment System

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>▼</td>
<td>3 - Landfills</td>
</tr>
<tr>
<td>□</td>
<td>11 - Treatment Plants</td>
</tr>
<tr>
<td></td>
<td>1,328 miles of regional trunk sewers</td>
</tr>
</tbody>
</table>
Los Angeles County Sanitation Districts
Wastewater Collection & Treatment System

- Treating 500 mgd of wastewater
  - 200 mgd at 10 WRP
  - 300 mgd at JWPCP
- 2012-2013 operation budget ~$565 M
Typical LACSD WRP Design
70 MGD of LACSD Secondary and Tertiary Effluents Are Reused
LACSD Joint Water Pollution Control Plant (JWPCP)
Odor Control in Collection Systems
Hydrogen Sulfide is the Typically the Most Odorous Compound Generated in Sewers
Compounds Other Than Hydrogen Sulfide That Could Contribute Collection System Odors

- Sulfur compounds
  - mercaptans, organic sulfides
- Volatile Acids
  - fatty and carboxylic acids
- Nitrogen Compounds
  - ammonia, amines, diamines
Odor Chromatogram
Example Odor Chromatogram

- Overpowering
- Very Strong
- Strong
- Moderate-Strong
- Moderate
Testing Conducted at Los Angeles County Sanitation Districts
LACSD Manhole MH18

![Geometric Mean Odor Chromatogram](image)

- Dimethyl selenenyl sulfide
- Dimethyl trisulfide
LACSD Manhole MH18

Mass Spectrometric Chromatogram Scaled for Injection Volume, Dilution, and Instrument Response

- Dimethyl selenenyl sulfide 1 ppb
- Dimethyl trisulfide 20 ppb
## LACSD Manhole MH18

### Analysis for Fatty and Carboxylic Acids

<table>
<thead>
<tr>
<th>Compound</th>
<th>Concentration (ppb v/v)</th>
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<tbody>
<tr>
<td>Acetic Acid</td>
<td>&lt; 5.6</td>
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<tr>
<td>Propionic Acid</td>
<td>&lt; 1.2</td>
</tr>
<tr>
<td>Isobutyric</td>
<td>&lt; 0.99</td>
</tr>
<tr>
<td>Butyric</td>
<td>&lt; 0.97</td>
</tr>
<tr>
<td>Isovalreic</td>
<td>&lt; 0.85</td>
</tr>
<tr>
<td>Valeric</td>
<td>&lt; 0.86</td>
</tr>
<tr>
<td>Caproic</td>
<td>&lt; 0.76</td>
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</table>
## LACSD Manhole MH18

### Analysis Organic Nitrogen Compounds

<table>
<thead>
<tr>
<th>Compound</th>
<th>Concentration (ppb v/v)</th>
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<tbody>
<tr>
<td>Dimethylamine</td>
<td>&lt; 1.5</td>
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<tr>
<td>Ethylamine</td>
<td>&lt; 1.5</td>
</tr>
<tr>
<td>Trimethylamine</td>
<td>1.4</td>
</tr>
<tr>
<td>Diethylamine</td>
<td>&lt; 0.89</td>
</tr>
<tr>
<td>Butylamine</td>
<td>&lt; 0.92</td>
</tr>
<tr>
<td>Triethylamine</td>
<td>&lt; 0.67</td>
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</table>
Methods for Controlling H₂S in Collection Systems

- Chemical addition
  - Preventers
  - Binders
  - Oxidizers
  - pH change
- Vapor phase treatment
  - Wet scrubbers
  - Activated carbon
  - Biological treatment
- Neutralize acid formation
Collection System Odor & Corrosion Control

- Continuous ferrous chloride addition
- Sodium hydroxide (caustic) shock dosing
- Activated carbon scrubbing
- Mg(OH)$_2$ crown spray
Odor Control in Collection Systems
Ferrous Chloride Addition

Dissolved Sulfide Concentration, mg/L

Without Treatment

With Treatment

Distance from FeCl₂ Injection Point, miles

1986 Districts’ Study

Sulfide in Wastewater Collection and Treatment Systems, ASCE No. 69
Ferrous Chloride Addition

• 30,000 gpd of FeCl₂ added to collection system

• Maintain sewer headspace H₂S to less than 20 ppmv/v
Ferrous Chloride Addition

Annual cost of ~$12 million
Caustic Shock Dosing
Activated Carbon Scrubbing
Activated Carbon Use Inside Manholes

Carbon Canister  Manhole with Activated Carbon
Crown Spray Program

- Crown Spray Process Developed by the Districts
- Magnesium Hydroxide: pH ~10
- Only RCP and NRCP Sewers With Moderate to Severe Corrosion
- 420 Miles Crown Sprayed Annually
- Cost ~$3 million/yr
Mg(OH)$_2$ Crown Spraying
Odor Control in Wastewater Treatment Plants
Population Encroachment Near JWPCP

<table>
<thead>
<tr>
<th>Distance From Plant Boundary (Miles)</th>
<th>Total Population</th>
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<tr>
<td>0.25</td>
<td>10,100</td>
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<tr>
<td>0.5</td>
<td>26,100</td>
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<tr>
<td>0.75</td>
<td>48,700</td>
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<tr>
<td>1.25</td>
<td>93,500</td>
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</table>
JWPCP Odor Control Areas

- Primary
- Secondary
- Biosolids Handling
Joint Water Pollution Control Plant (JWPCP)
Methods for Control of Odors from Wastewater Treatment Facilities

- Chemical Treatment of Wastewater
- Thermal Destruction
- Wet Chemical Scrubbing
- Adsorption
- Biological
  - Biotrickling Filters
  - Biofilters
Chemical Addition for H2S Control

Ferrous Chloride

\[ 2\text{FeCl}_2 + 2\text{H}_2\text{S} \rightarrow 2\text{FeS} + 4\text{HCl} \]

Dissolved Sulfides < 0.2 mg/L

Caustic Addition

\[ \text{pH} > 9.0 \]
## Air Process Stream Treatment

<table>
<thead>
<tr>
<th>Odor Control Alternative</th>
<th>Ability to Remove</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>H₂S</td>
<td>Organic Sulfur Compounds</td>
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<tr>
<td><strong>Thermal Destruction</strong></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td><strong>Wet-Scrubbing</strong></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td><strong>Carbon</strong></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td><strong>Biofilter</strong></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td><strong>Biotrickling Filter</strong></td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>
Thermal Destruction

Thermal/Catalytic Oxidization

- Basic Incineration technology, VOC’s destroyed at high temperatures (>1400° F)
- Generally achieves >95% destruction efficiency.
- Consumes significant quantities of fuel (natural gas).
- Discharges NOx and large quantities of CO₂.
Caustic Packed Tower

Sodium Hydroxide Consumption for H2S Removal

\[
\text{CO}_2 \rightarrow \text{H}_2\text{CO}_3 \rightarrow \text{HCO}_3^- \rightarrow \text{CO}_3^{2-}
\]

H2S
Odorous

HS-
Non-Odorous

Maintain
pH 11

S2-
Non-Odorous

Figure 2
Ionization of Hydrogen Sulfide

Sodium Hydroxide Consumption for H2S Removal

- H2S (18.7%)
- H2O (7.8%)
- CO2 (73.5%)

CO2 -> H2CO3 -> HCO3 -> CO3
Activated Carbon Scrubber

CHANGEOUT BASED ON VOC BREAKTHROUGH
Two-Stage Treatment
Chemical Scrubbing and Activated Carbon
Biotrickling Filters or Bioscrubbers
Old and New Covers
Los Angeles County Sanitation Districts’ Lava Rock Biotrickling Filtration Schematic

- Foul Air In
- Recirculation Pump
- Make-Up Water
- Blowdown Water
- Random Packed Lava Rock Media
- Clean Air Out
Sulfur Oxidizing Bacteria

\[ \text{H}_2\text{S} \rightarrow \text{H}_2\text{SO}_4 \]

Sulfur Oxidizing Bacteria

Oxygen
Los Angeles County Sanitation Districts’ 1500 cfm Biotrickling Filter
Removal of Hydrogen Sulfide by LACSD Lava Rock Biotrickling Filter During the First Year of Operation
Some Basic Concepts Used in the Design of the JWPCP Central Odor Station

• Use a two-stage system to achieve maximum removal of odors
• Employ high ventilation rates to keep primary treatment areas under negative pressure
• Use of secondary treated effluent as a source of nutrients for biotrickling filters
• Design of redundant units to allow maintenance and repairs
JWPCP Central Odor Biotrickling Filters Process Flow Diagram
Biotrickling Filters After Completion of Concrete Form Work
Two Stage Treatment of Air from Plant Headworks, Channels and Grit Chambers

60,000 cfm of foul air treatment
Sedimentation Tank Odor Control Project

- Primary sedimentation tanks and the primary effluent channels
- Three (3) odor control stations
- Biotrickling and activated carbon scrubbers
- 160,000 cfm total ventilation rate
Sedimentation Odor Control Station
Process Flow Diagram
Sedimentation Tank Odor Control Project

E1 Odor Control Station

E2 Odor Control Station

E3 Odor Control Station
### Full-Scale Biotrickling Filter and Activated Carbon Design Criteria

<table>
<thead>
<tr>
<th></th>
<th>Odor Control Stations</th>
<th>E-1</th>
<th>E-2</th>
<th>E-3</th>
<th>Central Odor</th>
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</thead>
<tbody>
<tr>
<td><strong>Biotrickling Filters’</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>Rectangular</td>
<td>Rectangular</td>
<td>Rectangular</td>
<td>Cylindrical</td>
<td></td>
</tr>
<tr>
<td><strong>Media Depth (ft)</strong></td>
<td>12.5</td>
<td>12.5</td>
<td>12.5</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td><strong>Media Volume (ft³) / Vessel</strong></td>
<td>5,317</td>
<td>4,513</td>
<td>6,050</td>
<td>4,752</td>
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<td><strong>Design EBRT (sec)</strong></td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
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<tr>
<td><strong>No. BTFs</strong></td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td></td>
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<tr>
<td><strong>Carbon Scrubbers’</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>Rectangular</td>
<td>Rectangular</td>
<td>Rectangular</td>
<td>Cylindrical</td>
<td></td>
</tr>
<tr>
<td><strong>Media Depth (ft)</strong></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Media Volume (ft³) / Vessel</strong></td>
<td>1,323</td>
<td>1,134</td>
<td>2,523</td>
<td>1,473</td>
<td></td>
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<tr>
<td><strong>Vessel Height (ft)</strong></td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td><strong>No. of Units</strong></td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>No. of Operational Units</strong></td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>EBRT (sec)</strong></td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td><strong>Total Permitted Flow (cfm)</strong></td>
<td><strong>23,000</strong></td>
<td><strong>37,000</strong></td>
<td><strong>100,000</strong></td>
<td><strong>60,000</strong></td>
<td></td>
</tr>
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</table>
Average Removal of H$_2$S by Biotrickling Filters

Inlet H$_2$S, ppm

Percent Removal, %

Inlet H$_2$S

Percent Removal
Average Removal of VOCs by Biotrickling Filters and Activated Carbon

- Inlet VOCs, ppm
- Percent Removal, %

- VOCs Into Biotrickling Filters
- Percent Removal by Biotrickling Filters
- Percent Removal by Biotrickling Filters and Activated Carbon
Average Removal of Odor by Biotrickling Filters and Activated Carbon

Odor Into Biotrickling Filters | Percent Removal by Biotrickling Filters | Percent Removal by Biotrickling Filters and Activated Carbon

Inlet Odor, DT

Percent Removal, %

0 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 4,500 5,000 0 10 20 30 40 50 60 70 80 90 100
Biofilters
Typical Biofilter Schematic
Finished Cargo Container Modular Biofilters
Average Inlet Odor Concentration and Percent Removal of Odors

- Inlet Odor
- Lava Rock Media
- Perlite Media
- Wood Media

Inlet Odor Concentration, DT

Percent Removal of Odors, %

Average Inlet Odor Concentration and Percent Removal of Odors
Inlet and Outlet GC-MS Chromatogram Plots from Modular Biofilter With Wood Media
JWPCP Biosolids Handling
Odor Control Project

- Reduce odors associated with conveying and storage of dewatered biosolids
- Enclose and contain areas that generate odorous emissions
- Approx. 170,000 cfm of ultimate flow
JWPCP Biosolids Handling Large Scale Biofilters

Total Area 1.5 Acres

South Biofilter: 0.65 Acres

East Biofilter: 0.85 Acres
JWPCP Biosolids Handling Large Scale Biofilters
## JWPCP Large Scale Biofilter Design Criteria

<table>
<thead>
<tr>
<th>Description</th>
<th>South Biofilter</th>
<th>East Biofilter</th>
</tr>
</thead>
<tbody>
<tr>
<td>System flow</td>
<td>68,000 cfm</td>
<td>88,000 cfm</td>
</tr>
<tr>
<td>Number of cells</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Air flow capacity, each cell</td>
<td>17,000 cfm</td>
<td>17,400 cfm</td>
</tr>
<tr>
<td>Dimensions of each cell</td>
<td>60 ft x 100 ft</td>
<td>60 ft x 100 ft</td>
</tr>
<tr>
<td>Media depth, ft</td>
<td></td>
<td>6 ft</td>
</tr>
<tr>
<td>Contact time with all cells on-line</td>
<td>85 sec</td>
<td>83 sec</td>
</tr>
<tr>
<td>Contact time with one cell off-line</td>
<td>64 sec</td>
<td>66 sec</td>
</tr>
<tr>
<td>Media</td>
<td>wood chips</td>
<td></td>
</tr>
<tr>
<td>Pressure drop across cells</td>
<td>0.5 inches per ft of media</td>
<td></td>
</tr>
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JWPCP Biosolids Handling Large Scale Biofilters
Air Plenum Plates
JWPCP Biosolids Handling Large Scale Biofilters
Loading the Media
JWPCP Biosolids Handling Large Scale Biofilters

Organic Sulfur Removal

Inlet Concentration, ppb v/v

Percent Removal, %

Methyl Mercaptan
Dimethyl Sulfide
Dimethyl Disulfide

Methyl Mercaptan
Dimethyl Sulfide
Dimethyl Disulfide
JWPCP Biosolids Handling Large Scale Biofilters

Odor Removal

- Inlet Odor, DT
- Avg. Inlet Odor
- Avg. Removal
- Percent Removal, %
Inland Empire Regional Composting (IERCF) Facility Biofilter

3-Acre Biofilter

Air to be Treated

8-Acre Enclosed Composting Building
IERCF Biofilter Construction
Inland Empire Composting Facility

Indoor Composting Facilities

Biofilter
**IERCF Very Large Scale Biofilter Design Criteria**

<table>
<thead>
<tr>
<th>Description</th>
<th>Data</th>
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<tbody>
<tr>
<td>System flow</td>
<td>800,000 cfm</td>
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<tr>
<td>Number of cells</td>
<td>12</td>
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<tr>
<td>Air flow capacity, each cell</td>
<td>66,700 cfm</td>
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<tr>
<td>Dimensions per cell</td>
<td>85 ft x 135 ft</td>
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<td>Media depth, ft</td>
<td>6 ft</td>
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<td>Contact time with all cells on-line</td>
<td>62 sec</td>
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<tr>
<td>Contact time with one cell off-line</td>
<td>57 sec</td>
</tr>
<tr>
<td>Media</td>
<td>wood chips</td>
</tr>
<tr>
<td>Pressure drop across cells</td>
<td>0.5 inches per ft of media</td>
</tr>
</tbody>
</table>
Questions?