Rethinking Collection System Cleaning Using Acoustic Inspection

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What is the Problem?

Acoustic Inspection
- What is it? / How does it work?
- CMU/InfoSense Field Trial Brief Summary

Condition Based Maintenance (CBM) for Collection System Cleaning
- Concept / Trade–Offs
- Scenarios
What is the Problem?

- Overflows are a Symptom – Not the Problem

Problem – Condition Information

- Overflow locations – “Random”
- Historical GIS – Helpful – But Insufficient
- Where & When to Deploy Cleaning Resources
- Cost Effective & Timely Condition Information
**How Much Cleaning is Required?**

![Graph showing Sixteen Municipalities' Overflows/100mi vs. % System Cleaned Annually.]

- **Sixteen Municipalities'**
- **Overflows/100mi vs.**
- **% System Cleaned Annually**

**Linear Regression**
- Standard Deviation: 2.5
- One Sigma Below Mean 45%

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**Condition Based Maintenance (CBM) - Collection System Cleaning**

- **Requirements**
  - Determine Where & When to Deploy Cleaning Resources
  - Cost Effective – Inspection Cost << Cleaning Cost

- **Benefit**
  - Reduce Wasted Cleaning Effort
  - Improved Performance
**Acoustic Inspection**

- How It Got Started – UNCC & CMU “Brainstorming” Session
- Sewer Lines – Natural Acoustic Wave Guides
- Obstructions – Acoustic Signals Absorb & Reflect
- Diagnostic Tool – Evaluates Aggregate Blockage

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**SL-RAT Key Features for Supporting Collection System Cleaning - CBM**

- No Flow Contact / No Confined Space Entry
- Low Cost – Pennies/foot
- Rapid Onsite Results – Under 3 min./segment
- Portable < 30 lbs
- GIS Integration – GPS Enabled
- Archive Pipe Segment Blockage Assessment
**Blockage Assessment Performance?**

- Two Central Questions Performance & Operational Cost
  - Evaluated During 2010 CMU / InfoSense SL–RAT Field Trial
  - NC–AWWA 2010 Spring Fling & Annual Meeting
- Blockage Assessment Performance Evaluation Based on Comparison with CCTV

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**CCTV Blockage Assessment**

- No Obstructions: 10
- Root Fibers Limited Growth, Grease Limited Build Up: 8
- Root Fibers and/or Grease, Robot Can Pass Through: 5
- Root Fibers and/or Grease, Robot Cannot Pass Through: 2
- Obstructed: 0
**CCTV Blockage Assessment**

- CCTV Blockage Assessment 10
- CCTV Blockage Assessment 5
- CCTV Blockage Assessment 7
- CCTV Blockage Assessment 2

- CCTV Robot was Able to Pass Through Root Fibers
- CCTV Robot was Not Able to Pass Through Obstruction

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**SL-RAT & CCTV Comparison**

- SL-RAT Standard Threshold
  - 61% Reduction in Cleaning
  - All Pipes Requiring Cleaning are Cleaned

- SL-RAT Critical Threshold
  - 85% Reduction in Cleaning
  - Identify Pipes in Critical Need of Further Action

- CCTV & SL-RAT Acoustic Inspect
  - >50% Pipe Segments Did Not Require Cleaning
- SL-RAT Assessment Correlated with CCTV
- SL-RAT Provides Conservative Assessment
Cost Evaluation Assumptions

- Typical Industry Values: Cleaning Crew $1.00/foot
- Estimated SL–RAT Inspection Crew

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<table>
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<tbody>
<tr>
<td>Number of Crew Members</td>
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<tr>
<td>Annual Fully Loaded Salary Per Crew Member</td>
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<td>Annual Equipment Costs (Including Truck &amp; SL-RAT)</td>
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<td>Work Days Per Year</td>
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<td>Onsite Work Hours Per Day</td>
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<td>SL- RAT Average Number of Segments Inspected Per Hour</td>
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<td>Average Sewer Line Segment Length in feet</td>
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<tr>
<td>Cost Per Foot</td>
<td>$0.09/ft</td>
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Collection System Cleaning - CBM

- Resource Efficiency Utilization Through Condition Assessment
- Trade–Off – Inspection vs. Cleaning
Baseline Cleaning Program

- Cleaning Program – Current Practice
- Cost Model
  - Cleaning Cost / Foot $1
- Performance Model
  - Linear Regression for 16 Municipalities Overflows vs %System Cleaned
- Benchmark
  - 2 Overflows/100mi
  - 45% System Cleaned – Low Confidence
  - 75% System Cleaned – Modest Confidence

![Baseline Cleaning Program Graph]

CBM Cleaning Program I

- SL–RAT Inspection Prior to Cleaning
- Only Clean Segments Below Standard Threshold
- Illustrative Case
  - 52,000 ft Basin
  - 30,000 ft Assessed by SL–RAT as “Clean”
  - 22,000 ft Below Threshold & Cleaned
  - 58% Reduction in Cleaning

![CBM Cleaning Program I Diagram]
CBM Cleaning Program I

- Evaluate CBM Cost/Performance
  - Use CMU/InfoSense Field Study Results
  - SL–RAT Cost/Ft $0.09

- Point “1”
  - 20% SL–RAT Acoustic Inspection
  - ~7.8% Cleaned

- Point “2”
  - 42% SL–RAT Acoustic Inspection
  - ~16.6% Cleaned

CBM Cleaning Program II

- Prioritize – Target High Risk Segments
- Point “1”
  - Same CBM Program I
  - 20% Acoustic Inspection
  - ~7.8% Cleared

- Point “2”
  - 63% Acoustic Inspection
  - ~14.1% Cleared
  - ~9.5% Evaluated as Critical
Summary

- Collection System Cleaning Operations
  Condition Based Management (CBM) Benefits
  ◦ Cleaning Resources Efficiently Deployed
  ◦ Reduces Non-Productive Cleaning Effort
  ◦ Prioritizes Cleaning & Provides Flexibility in Balancing Risk with Cost
- Acoustic Inspection Enabler for CBM Cleaning Program
  ◦ Inspection Cost << Cleaning Cost
  ◦ Assessment Correlated with Cleaning Requirements