InfoSense, Inc
Innovating Acoustic Inspection Technology™

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Rethinking Collection System Cleaning Using Acoustic Inspection

2012 NC AWWA-WEA Spring Conference

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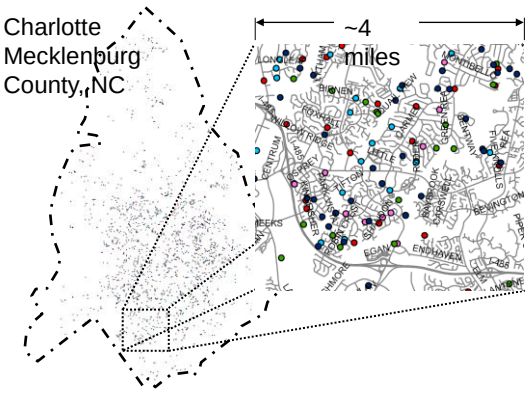
Rethinking Collection System Cleaning Using Acoustic Inspection

- 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

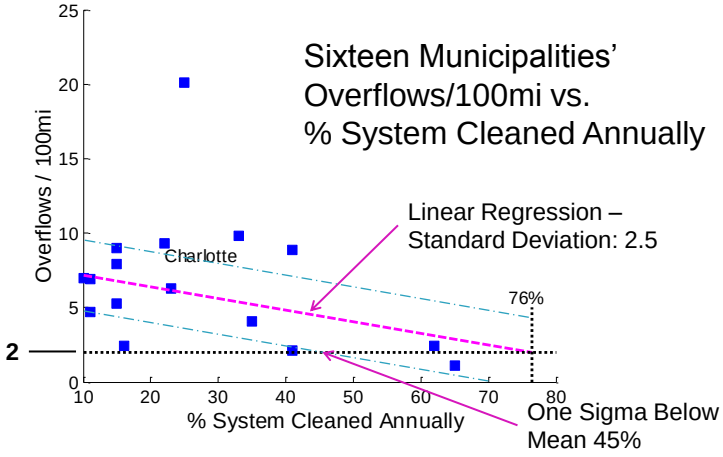
Problem –Condition Information



Five Year Overflow Record – Different Color / Year

- Overflow locations – "Random"
- Historical GIS – Helpful – But Insufficient
- Where & When to Deploy Cleaning Resources
- Cost Effective & Timely Condition Information

How Much Cleaning is Required?

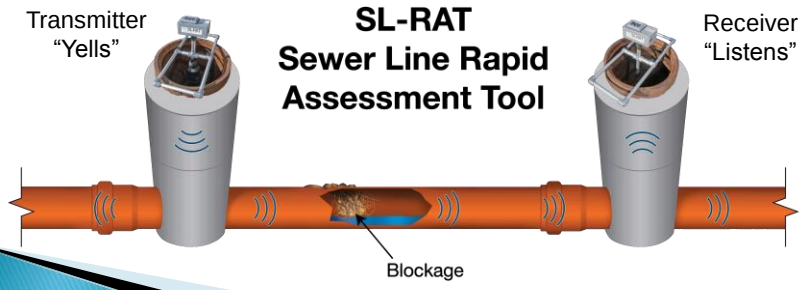


Condition Based Maintenance (CBM) - Collection System Cleaning

- 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



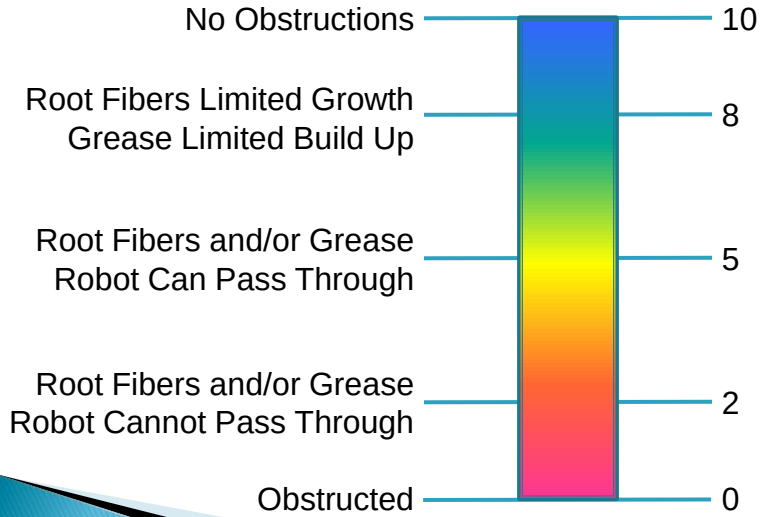
SL-RAT Key Features for Supporting Collection System Cleaning - CBM

- 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

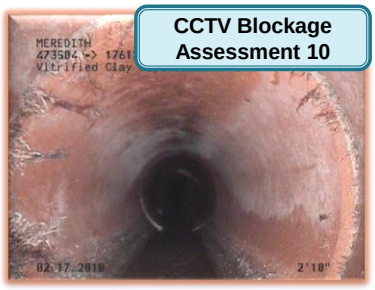
Blockage Assessment Performance?

- 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

CCTV Blockage Assessment



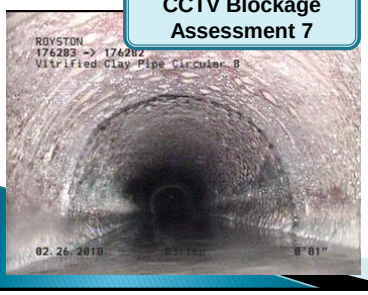
CCTV Blockage Assessment



CCTV Blockage Assessment 10

CCTV Blockage Assessment 5

CCTV Robot was Able to Pass Through Root Fibers



CCTV Blockage Assessment 7

CCTV Blockage Assessment 2

CCTV Robot was Not Able to Pass Through Obstruction

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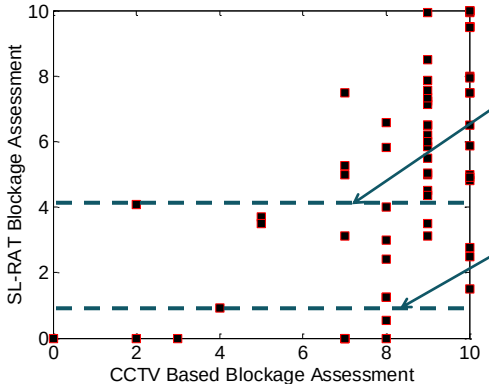
SL-RAT & CCTV Comparison



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**

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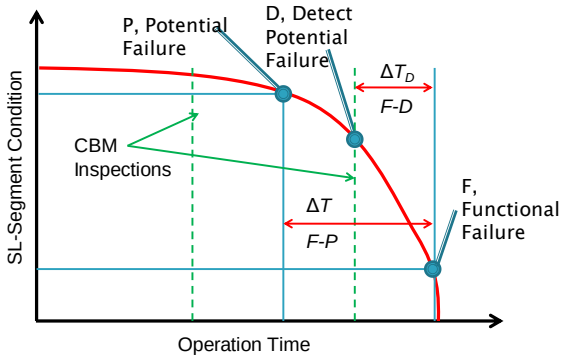
Cost Evaluation Assumptions

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

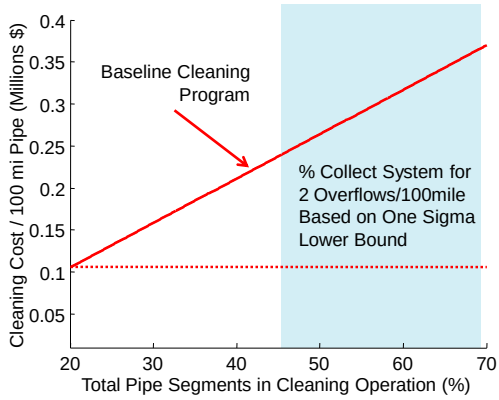
Number of Crew Members	2
Annual Fully Loaded Salary Per Crew Member	$68,000
Annual Equipment Costs (Including Truck & SL-RAT)	$24,000
Work Days Per Year	251
Onsite Work Hours Per Day	5.5
SL- RAT Average Number of Segments Inspected Per Hour	6
Average Sewer Line Segment Length in feet	220
Cost Per Foot	$0.09/ft

Collection System Cleaning - CBM



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

Baseline Cleaning Program

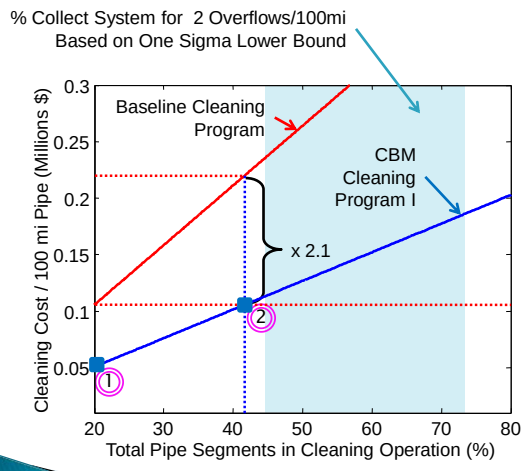


- Cleaning Program – Current Practice
- Cost Model
  - Cleaning Cost / Foot $1
- Performance Model
  - Linear Regression for 16 Municipalities Overflows vs %System Cleaned
- Benchmark
  - 2 Overflows/100mi
  - 45% System Cleaned – Low Confidence
  - 75% System Cleaned – Modest Confidence

CBM Cleaning Program I

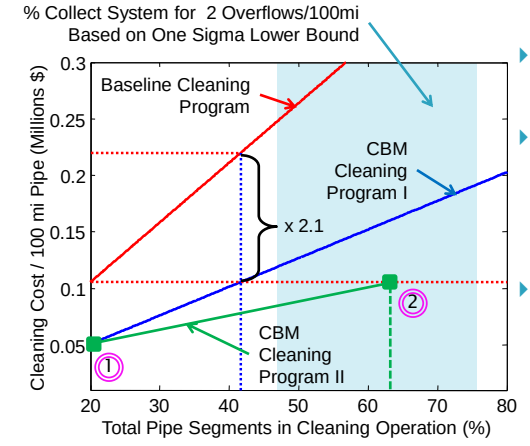
- SL-RAT Inspection Prior to Cleaning
- Only Clean Segments Below Standard Threshold
- Illustrative Case
  - 52,000 ft Basin
  - 30,000 ft Assessed by SL-RAT as “Clean”
  - 22,000 ft Below Threshold & Cleaned
  - 58% Reduction in Cleaning

CBM Cleaning Program I



- 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% Cleaned
- Point "2"
  - 63% Acoustic Inspection
  - ~14.1% Cleaned
  - ~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