Using Acoustic Inspection to Prioritize Sewer Cleaning

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Duke’s Root Control, Inc.
10/12/18
PRESENTATION OUTLINE

• Acoustic Inspection Overview
• Acoustic Inspection Economics
• Case Studies
• Data Management
• Conclusion
What Is The Problem?

- Overflows are a Symptom – Not the Problem
Problem – Condition Information

Example
Charlotte, North Carolina

~4 miles

Five Year Overflow Record – Different Color / Year

- Overflow locations – “Random”
- >90% in pipes less than 12”
- Historical GIS – Helpful – But Insufficient
- Where & When to Deploy Cleaning Resources
- Cost Effective & Timely Condition Information
Inspection Tool Portfolio

Manhole Inspection

ACOUSTIC

• CCTV/Robotic Camera
• Pipe Wall Defect Scanners
• Pipe Profiling / Robotic Multi-Sensor

Zoom Camera

Push Camera
Active Acoustic Pipe Inspection Background

- Patented technology
- Gravity-fed sewer focus
- Developed in Charlotte with Charlotte Water as key partner

- Over 95M feet inspected with over 200 municipalities
- Rapid assessment helps better focus cleaning and CCTV resources
How Does It Work?

SL-RAT® Sewer Line Rapid Assessment Tool

Transmitter “Yells”

Receiver “Listens”

Blockage
SL-RAT Assessment Scale

Legend:
SL-RAT In Field Pipe Assessment
0: 
1-3: 
4-6: 
7-10:
Visual Comparison

Blockage Assessment 10

Blockage Assessment 5

CCTV Robot was Able to Pass Through Root Fibers

Blockage Assessment 7

Blockage Assessment 2
Limitations of Acoustics

• What acoustic inspection does NOT tell you:
  – Type of blockages
    • Could be one big thing, or a lot of small things
    • Aggregate score of entire pipe segment
    • Roots, grease, debris, sags, missing manholes, hole or collapse in pipe or a lateral sticking in.
  – Location of blockage
  – Presence of small structural defects (fine cracks, joints, etc.)
Impact of Pipe Sags

- Straight Pipe
- Partial Pipe Sags
- Full Pipe Sag
IMPACT OF PIPE DIAMETER

- Comparison of open surface area at various pipe diameters
  - Assume pipe is $\frac{1}{4}$ full with flow, obstruction is 18 sq. inches

<table>
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<tr>
<th>Diameter</th>
<th>6 inches</th>
<th>10 inches</th>
<th>18 inches</th>
<th>24 inches</th>
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<tr>
<td>Total surface area (sq.in)</td>
<td>28.3</td>
<td>78.5</td>
<td>254.5</td>
<td>452.4</td>
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<tr>
<td>% blocked</td>
<td>89%</td>
<td>48%</td>
<td>32%</td>
<td>29%</td>
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</table>
IMPACT OF PIPE DIAMETER

• At larger diameters, more surface area available for sound to travel through and around blockages
• Roots, FOG, and other obstructions still reflect and absorb sound
• Acoustic inspection is still viable, but may need to be more conservative on acoustic values at larger pipe diameters
• Should focus on pipe diameters 6”-12”, especially when first using the technology
Validated by U.S. EPA Study

• “The results of this demonstration of the SL-RAT show promise for the application of this technology as a tool for cost-effective, pre-cleaning assessment and post-cleaning quality assurance. The application of this technology in an overall collection system O&M program should enable wastewater utilities to optimize their sewer cleaning efforts and free up valuable resources to more effectively implement critical CMOM and asset management programs.”

• “Rapid assessment approaches and tools provide an avenue to significant pre-cleaning inspection cost savings that could be achieved through reduced inspection and non-productive cleaning costs.”

Acoustic Inspection Applications

- Focus Cleaning Effort – Reduce Cleaning by Over 50% and Enable Condition Based Maintenance
- Reduce Pre-Cleaning for CCTV inspection
- Post Cleaning – Quality Assurance
- Quick Collection System Condition Assessments When Taking Over New Areas
Cost Evaluation

SL-RAT Acoustic Inspection Cost

• U.S. EPA Study (June 2014) $0.149/ft

• Less than 1/10th the cost of CCTV inspection cost performed in same study

• Cleaning cost is typically $1.00/ft
How Much Cleaning Is Wasted?

- Target Historical Problematic Areas
  - >65% Pipes Essentially Clean
  - <15% Need Immediate Action
- Cleaning a Clean Pipe ⇒ Wastes Resources
- Not Cleaning a Dirty Pipe ⇒ SSO

Acoustic Inspection Results
~ 50 Million Feet of Pipe

- 14% Poor
- 18% Fair
- 68% Good

Acoustic Score

0 1 2 3 4 5 6 7 8 9 10
16,407 4,605 4,518 5,886 7,934 12,043 20,539 41,296 69,688 36,622 8,262
FINANCIAL IMPACT

• Assumptions:
  
  – Cleaning cost is $1.00/ft
  
  – Acoustic inspection cost (SL-RAT) is $0.15/foot
  
  – Inspect 10,000 feet of sewer pipe per day (using acoustic inspection)
  
  – 50% reduction in cleaning
FINANCIAL IMPACT (cont’d)

- Upfront equipment cost ~$26,300
- 10,000 ft/day of inspections → 50,000 ft/week
  Acoustic operating cost – $7,500/week (@$0.15/ft)
- Cleaning reduction (50%)
  25,000 ft/week → ~$25,000/week (@$1.00/ft)
- Payback period is less than two weeks.
CASE STUDIES

• St. Louis, MO

• Augusta, GA

• Little Rock, AK
AUGUSTA, GA

- Founded 1822
- Combined operations with Richmond County in 1996
- Population Served 190,000

- 1,040 miles of sewer pipe
- Covers 280 square miles
- Under GA EPD Consent Order
Implementation History

- 4 SL-RAT’s – purchased between 2/13 and 7/15
- Run with 2 person crews per RAT Averaging ~7500 feet PER 8 hour crew day
- Plan out inspection areas based on tax-maps
- Combined with manhole inspection program
- Acoustically screening entire system ~ 1x per year
Inspection Results...

- >20,500 segments inspected in first ~30 months of work
- >20,000 manholes located and inspected
- >4.5 MILLION Feet (850 miles)
SSO Rate Went Down >50% Since 2011

Trailing 12 Month SSO's/Month

Feet Acoustically Assessed/Mo

SL-RAT Inspection Volume

TTM SSO Rate

SSO TREND
Discharge Volumes Went Down Too

![Graph showing discharge volumes and annual rainfall from 2011 to 2015. The graph indicates a decrease in discharge volumes and annual rainfall over the years.](image-url)
St. Louis MSD - MO

- Formed 1954
- Covers St. Louis and 93 other municipal entities ~80% of St. Louis County
- Population Served 1.3 Million
- 6,400 miles of sewer pipe
- Covers 525 square miles
- Under US EPA Consent Order
SL-RAT Implementation Timeline

- Consent Decree Issued
  - Clean 1,000 mi/yr
  - CCTV 280 mi/yr
  - Inspect 16,200 manholes/yr

- SL-RAT Introduced to MSD
  WEFTEC 2014

- Purchase Pilot Study 2016
- Rental Pilot Study 2015
- Revised C-MOM EPA Approved 12-16

- Purchase 6 more SL-RAT’s

2012 2013 2014 2015 2016 2017

- 79k ft
- 500k ft
- >3M ft
## Conclusions

- Investigations confirm that an inspection score of 6-10 indicates a clean sewer reach, and a score of 0-5 indicates a sewer reach that should be cleaned.

- Not recommended for Combined Sewer System based on large percentage of inspections with a 5 or less rating.

- Acoustic Inspection should only be used on small diameter pipe.

## Recommendations

- No change to combined sewer cleaning schedule.

- Acoustically inspected < 15” pipe on a 6 year cycle.

- Clean Pipes with 0-5 SL-RAT score – if cleaning leads to >1 bucket of material – then CCTV.

- No change for >15” pipes.

- Take to EPA for Approval to Change C-MOM.
## Before & After Program Stats

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<th>Pre-SL-RAT</th>
<th>Post SL-RAT</th>
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<td><strong>Non-PVC Total</strong></td>
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<td><strong>Acoustic Inspect/year</strong></td>
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<td><strong>Clean per year</strong></td>
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<td><strong>Clean per Year</strong></td>
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<td>68</td>
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<td><strong>Total Cleaned</strong></td>
<td>672</td>
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STOPPED CLEANING
CLEAN PIPE!!!!!!
Key Learnings

• The SL-RAT is simple, reliable, and easy to use
• Keep up with the data! Backlogs can get overwhelming
• Forces discipline in visiting every manhole – identify issues, LOCATE BURIED MANHOLES, update GIS records, etc
• Has focused efforts on the ~40% of segments that are Poor or Fair
• Requires teamwork to achieve full potential – cleaning crews, GIS, inspection crews – must all work together
Prior to SLRAT – Cleaning was a time-based pmp, 35%

Full time SLRAT program – Cleaning now a condition-based pmp, 80%

Five SLRAT’s, 4.8 Million Feet Inspected

80% of lines 5 or >
20% of lines 4 or <, cleaning ticket issued along with another test
90% if lines 5 or >
10% of lines 4 or <, cctv ticket issued, repairs methods varied

RESULTS
SSO’s 2016 (60), 2017 (32), 2018 (17), as of 10/01/18
Cleaning 2016 (2.27M) vs 2017 (1.54M), reduction of 32%
Man hours 2016 (32,026) vs 2017 (25,234) reduction of 21%
Debris removed 2016 (36cy) vs 2017 (78cy) increase of 54%
Staff levels same just reprioritized
Fuel, water and wear/tear on equipment savings
Again, they stopped cleaning clean pipe.
Data Management

• Mason, OH
DOWNLOADING DATA

• Step 1. Make sure data is synchronized between RX and TX devices
  This can be done manually from the menus on the devices, or by turning both units off and on again.

• Step 2. Connect SL-RAT (RX) to a PC using the USB connection
USING WEB PORTAL

- All historical data can be accessed on the SL-DOG web portal at [http://www.sl-dog.com](http://www.sl-dog.com)

SL-DOG Measurements

We have a new blog page that contains information about updates to the SL-DOG portal!

Click HERE to access the new SL-DOG Updates Blog
**USING WEB PORTAL**

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USING WEB PORTAL

• Plot of data using Google Earth

Legend:
SL-RAT In Field Pipe Assessment
0:
1-3:
4-6:
7-10:
City of Mason, OH

Device: 280
Start Date: 1/1/2000
End Date: 10/12/2018

Excluded Statuses:
Exclude None

Histogram of Acoustic Scores

# of Occurrences

GPS Assessment Value

- 0: 30
- 1: 16
- 2: 7
- 3: 10
- 4: 8
- 5: 25
- 6: 51
- 7: 141
- 8: 367
- 9: 188
- 10: 17
CONCLUSION

► Acoustic Inspection is an Effective Method to Assess Pipes for Blockages
  ► Quick / Simple Protocol
  ► Low Cost
  ► Easy / Safe
► Acoustic Inspection Makes Financial Sense
► Acoustic Inspection Enables Condition-Based Maintenance of Gravity Sewers
► Acoustic Inspection Does Not Replace Cleaning or Detailed Inspection
  ► Triage/Prioritization Tool
  ► Helps Focus Cleaning and CCTV resources
QUESTIONS?

800-447-6687 or 614-354-3927

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