Using Acoustic Inspection to Prioritize Sewer Cleaning

Bob Hunn, Jr.

Duke's Root Control, Inc.

10/12/18

PRESENTATION OUTLINE

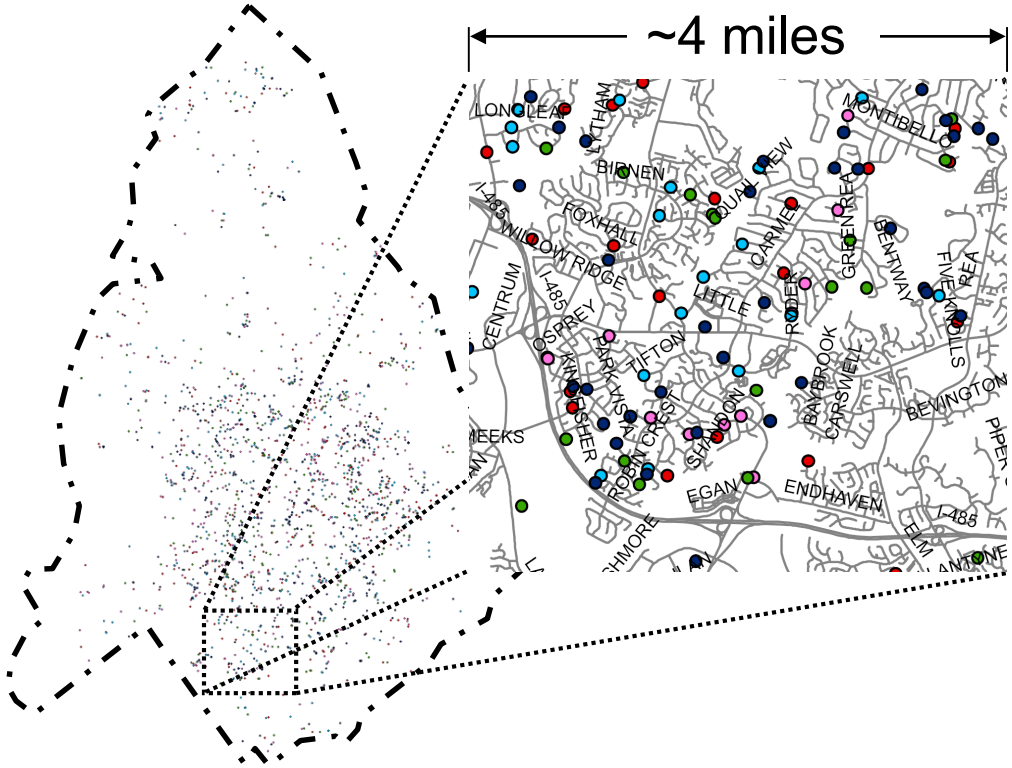
- Acoustic Inspection Overview
- Acoustic Inspection Economics
- Case Studies
- Data Management
- Conclusion

What Is The Problem?

- Overflows are a Symptom – Not the Problem

Problem – Condition Information

Example
Charlotte, North Carolina



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

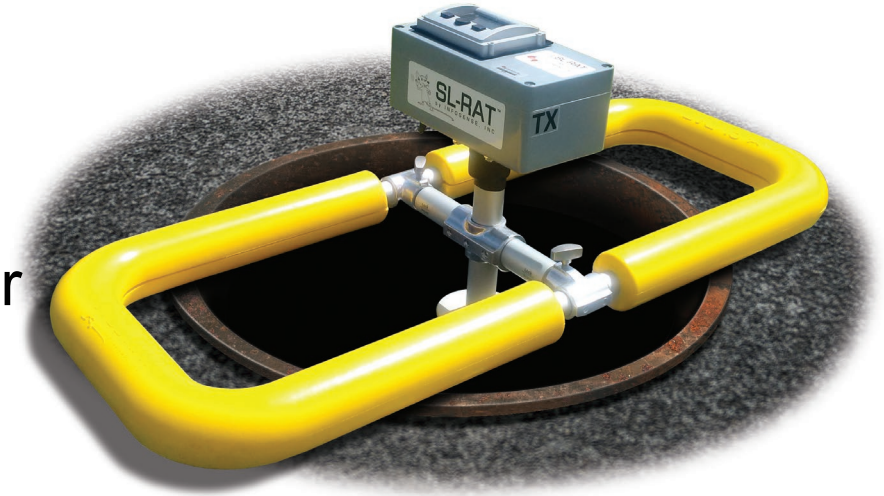
Zoom Camera

Push Camera

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

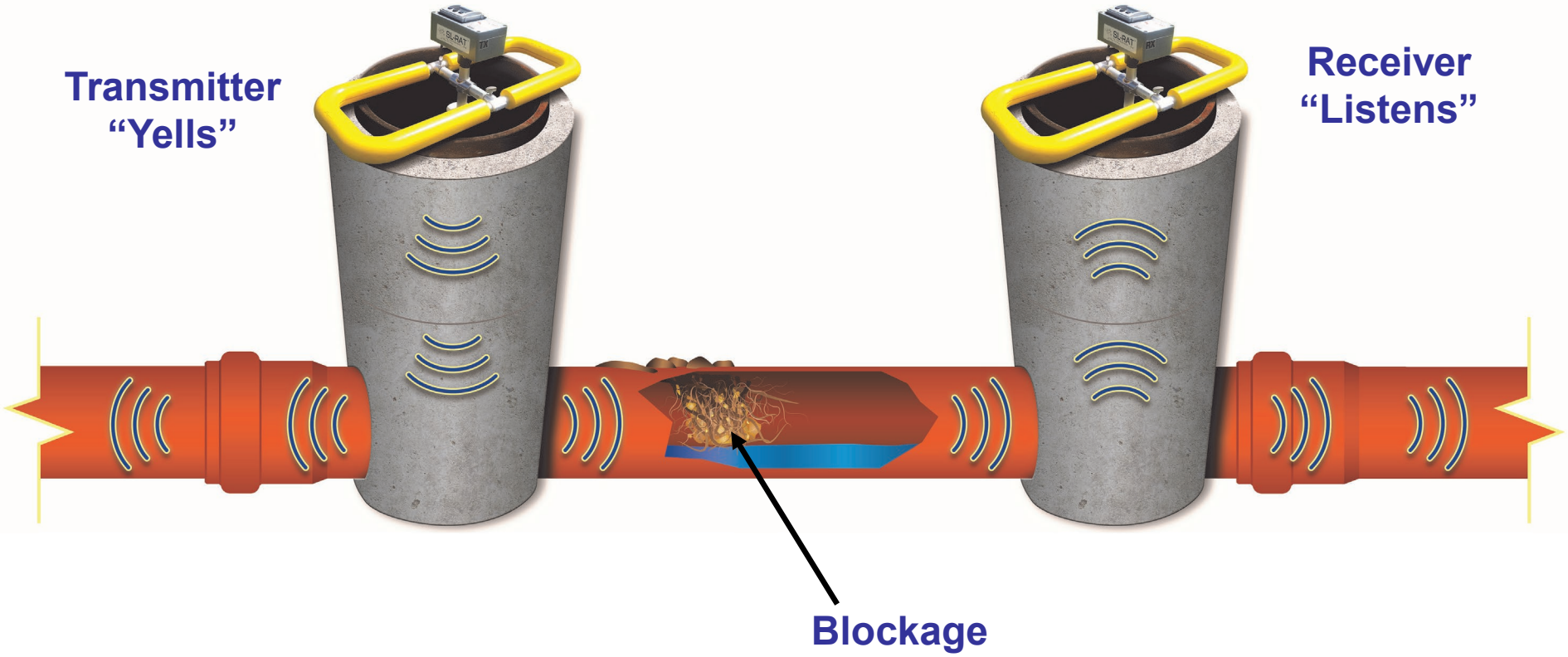
Active Acoustic Pipe Inspection Background

- 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 Assessment Scale

Legend:

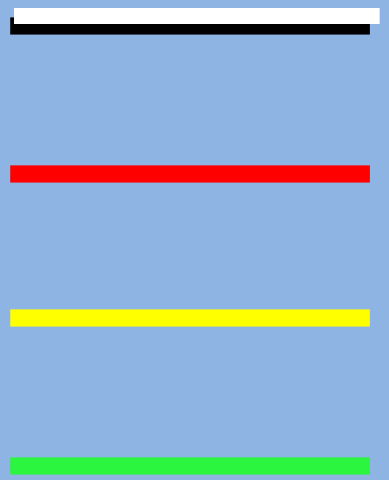
SL-RAT In Field Pipe Assessment

0:

1-3:

4-6:

7-10:



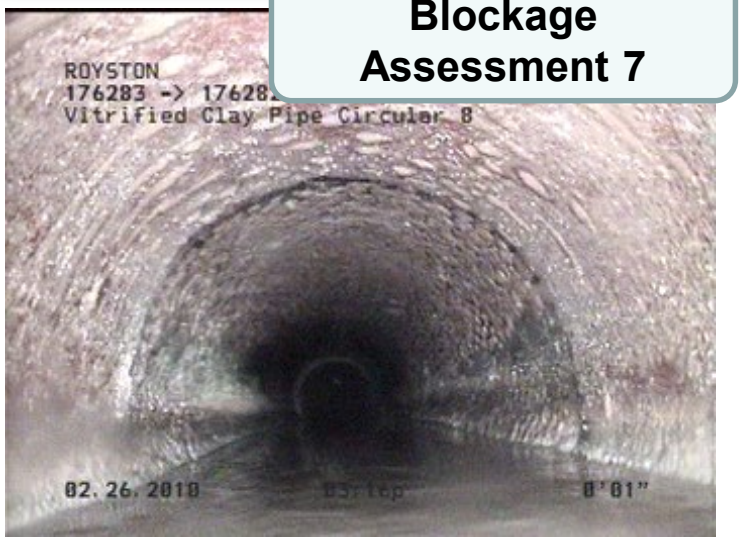
Visual Comparison

Blockage Assessment 10

Blockage Assessment 5

CCTV Robot was Able to Pass Through Root Fibers

Blockage Assessment 7

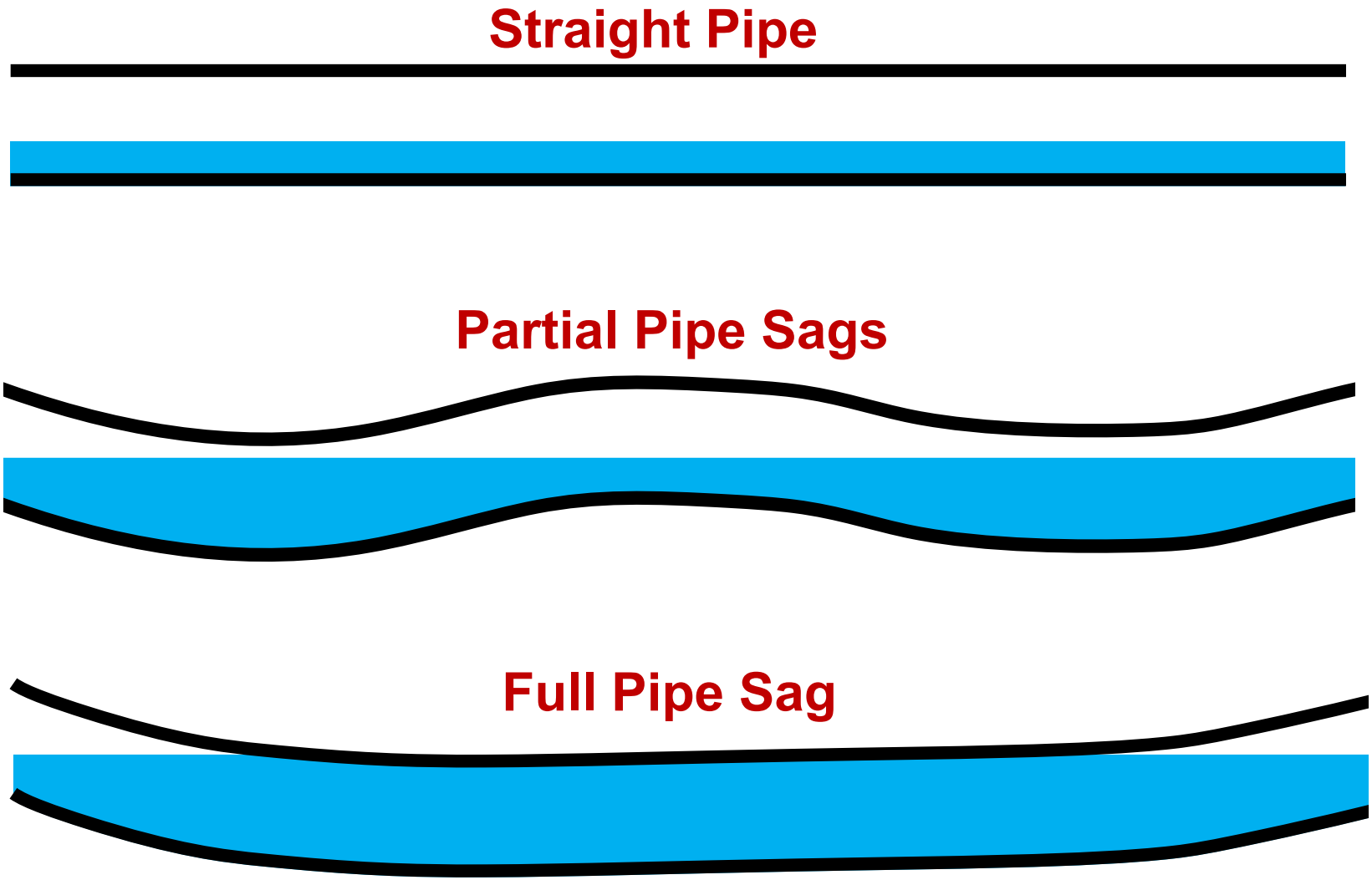


Blockage Assessment 2

Limitations of Acoustics

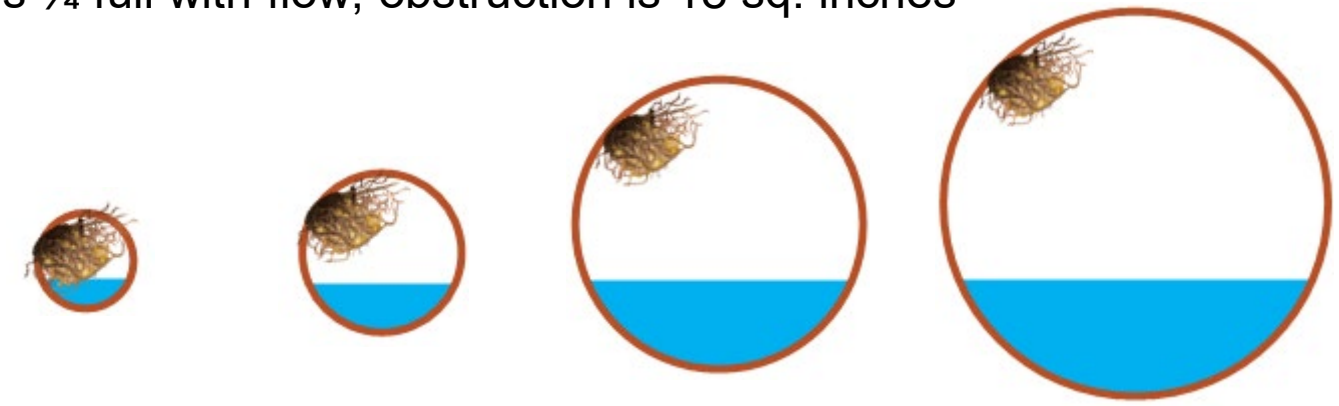
- What acoustic inspection does NOT tell you:
  - Type of blockages
    - Could be one big thing, or a lot of small things
    - Aggregate score of entire pipe segment
    - Roots, grease, debris, sags, missing manholes, hole or collapse in pipe or a lateral sticking in.
  - Location of blockage
  -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

Impact of Pipe Sags



IMPACT OF PIPE DIAMETER

- Comparison of open surface area at various pipe diameters
  - Assume pipe is ¼ full with flow, obstruction is 18 sq. inches



Diameter	6 inches	10 inches	18 inches	24 inches
Total surface area (sq.in)	28.3	78.5	254.5	452.4
% blocked	89%	48%	32%	29%

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.”

Source: U.S. EPA “**Demonstration of Innovative Sewer System Inspection Technology: SL-RAT™” June 2014**

Acoustic Inspection Applications

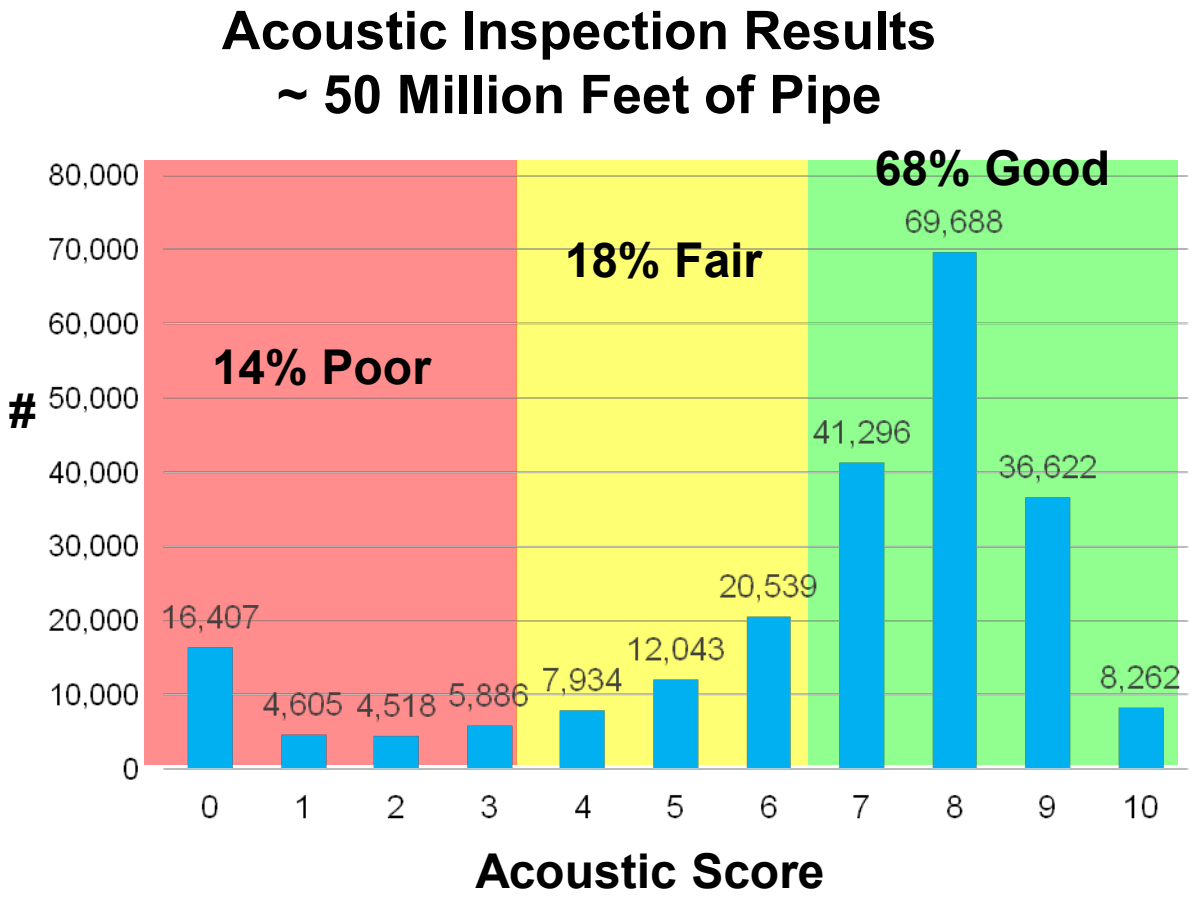
- **Focus Cleaning Effort – Reduce Cleaning by Over 50% and Enable Condition Based Maintenance**
- **Reduce Pre-Cleaning for CCTV inspection**
- Post Cleaning – Quality Assurance
- Quick Collection System Condition Assessments When Taking Over New Areas

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

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 → 50,000ft/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**

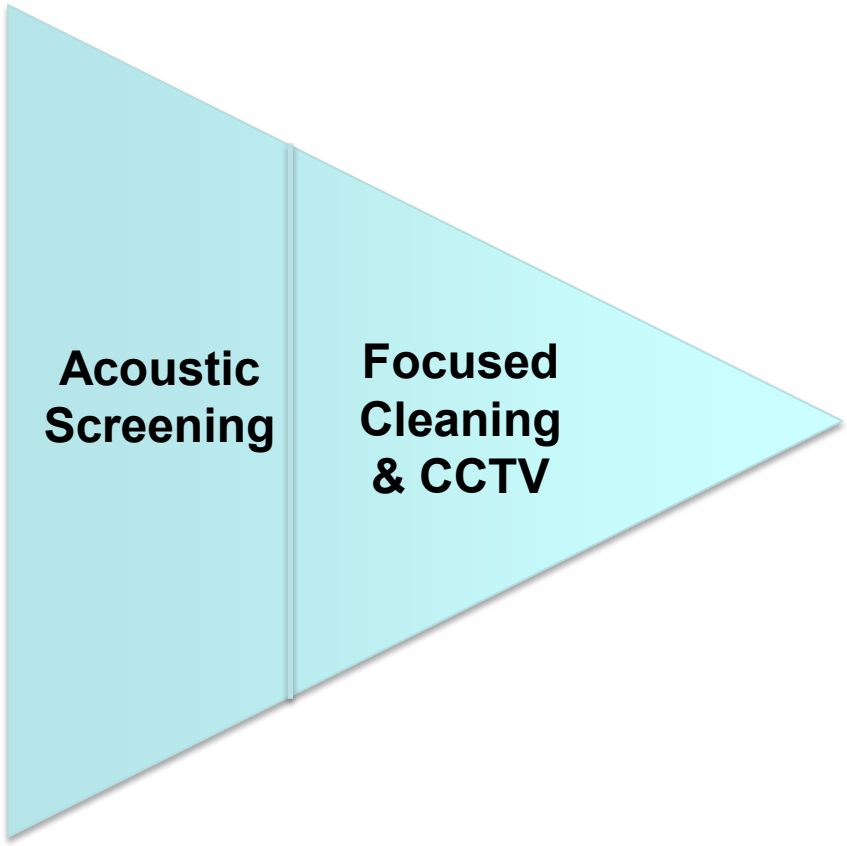
AUGUSTA, GA

- 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

System Screening – “Base of the Spear”

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



Process flow

Re-Charge SL-RAT

Conduct Inspections

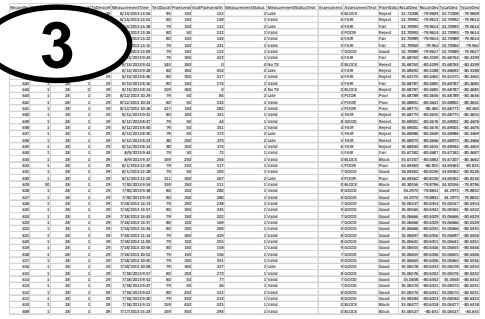
Print Maps & Give to Crew

1

- Street Name
- Parcel Address
- Line Sizes

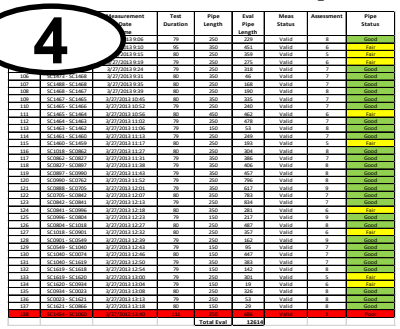
2

Download SL-RAT



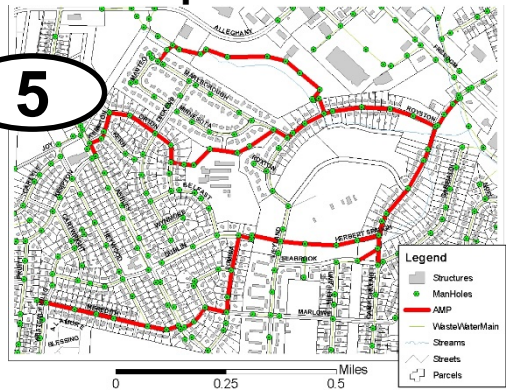
3

Create Base Report



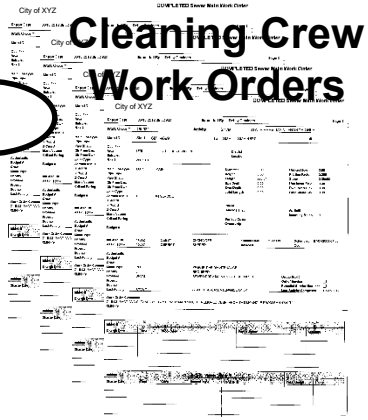
4

Map Out in GIS



5

Generate Cleaning Crew Work Orders



6

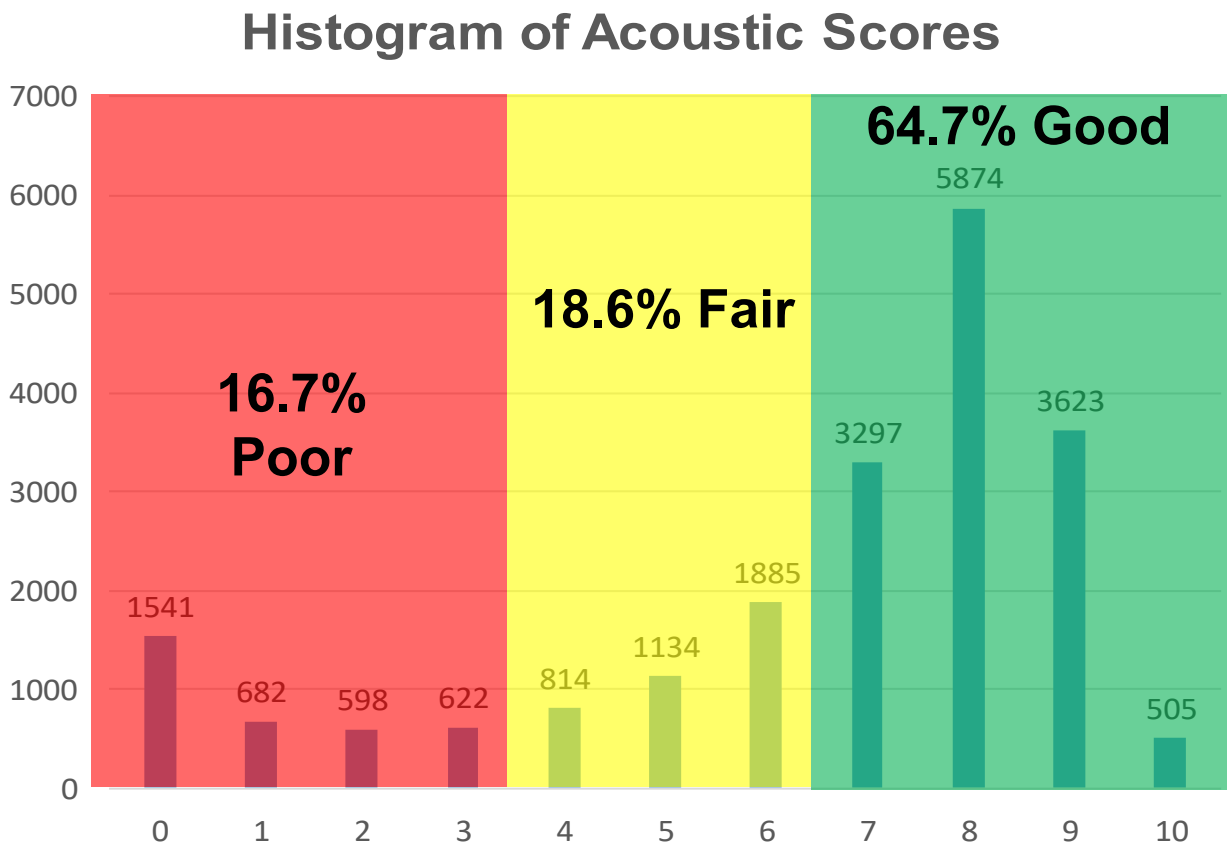
Close Out

- QA Cleaning
- Fix GIS Issues
- Update Records
- Schedule Next Inspection

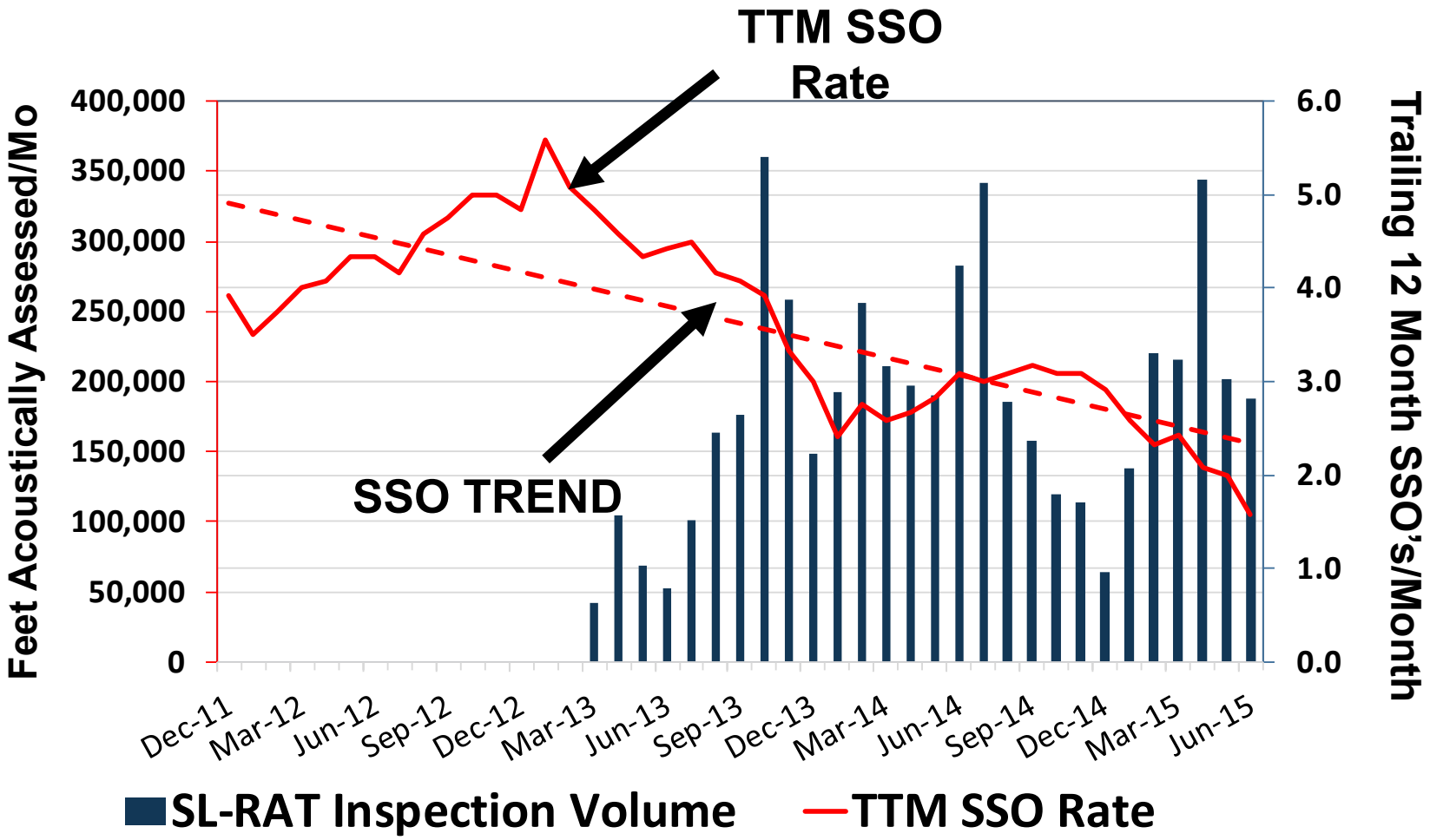
7

Inspection Results…

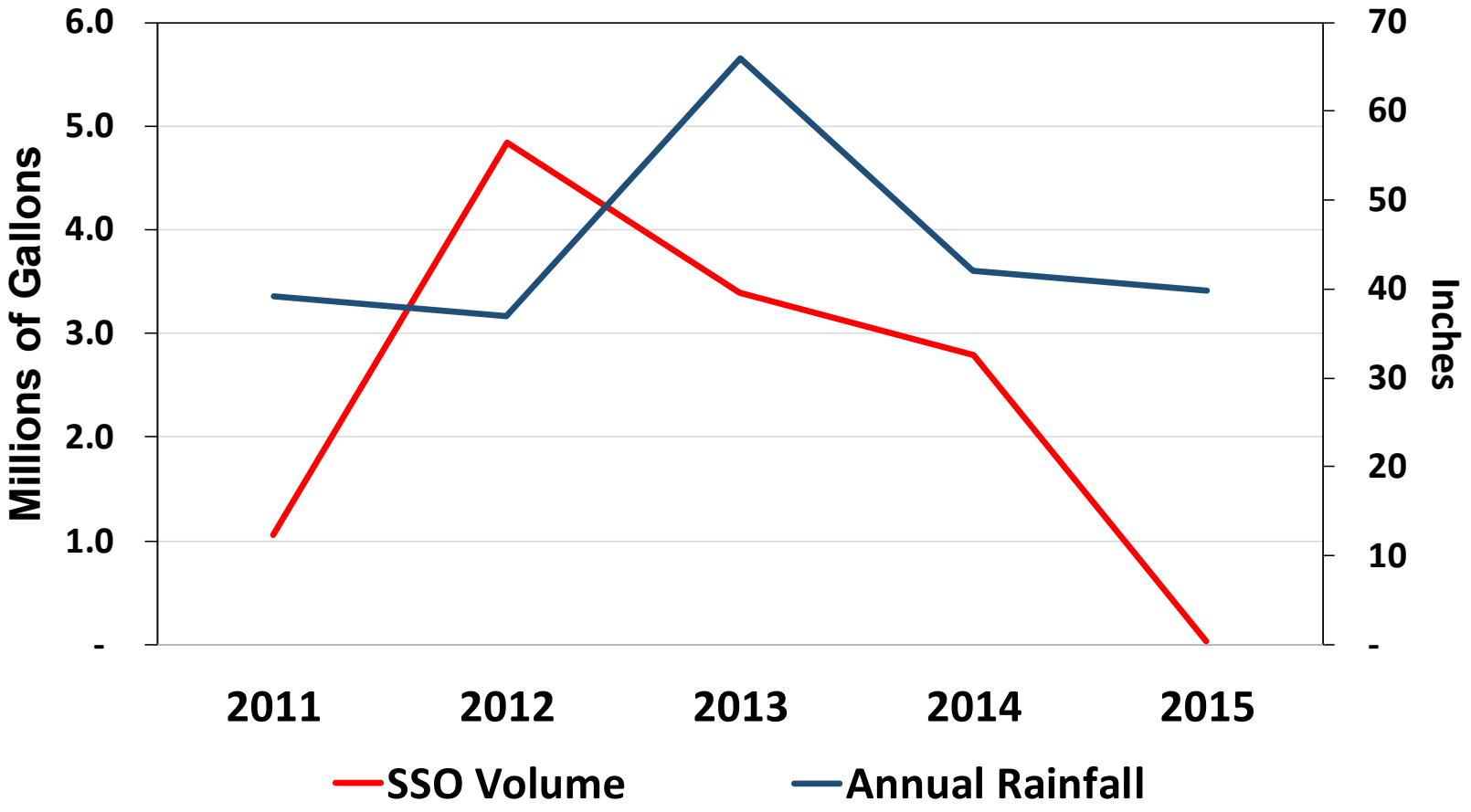
- >20,500 segments inspected in first ~30 months of work
- >20,000 manholes located and inspected
- >4.5 MILLION Feet (850 miles)



SSO Rate Went Down >50% Since 2011



Discharge Volumes Went Down Too

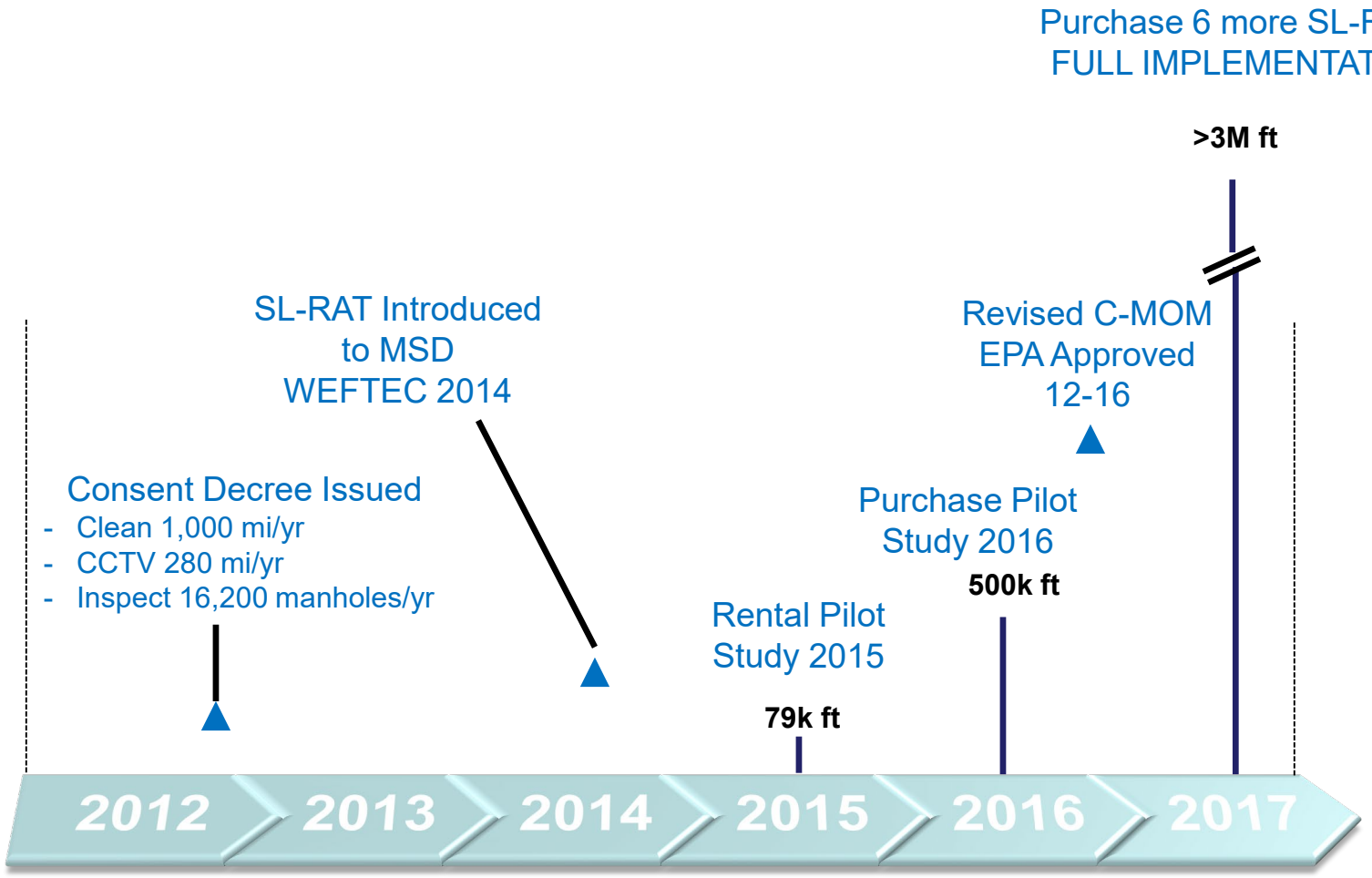


St. Louis MSD - MO

- 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



2016 Pilot Study Results

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

	Pre-SL-RAT	Post SL-RAT
Non-PVC Total	2,341 miles	2,341 miles
Acoustic Inspect/year	0	390
Clean per year	468	78
PVC Total	2,035 miles	2,035 miles
Acoustic Inspect/year	0	339
Clean per Year	204	68
Total Cleaned	**672**	**146**

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

Little Rock, AK @ WEFTEC 10/01/2018

- 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**

HOME | SUPPORT DOCUMENTS | REPORTS

› Home

Home

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

⊞ Import Edited Records

⊟ Measurement Criteria

Select Device(s):

☐ Select All

Select	Device ID	Initial Meas. Date	Last Meas. Date	Active	# of Measures
☐	280	5/5/2015	10/9/2018	Yes	860
			Total Company Measurements		860

Specific Record Numbers ⓘ

Start Date End Date

USING WEB PORTAL

Select All | Hide Selected | Unhide Selected | Show Hidden Measurements | Hide User Fields

Export to Google Earth | Export to CSV | Enhanced Export | Export SHP | Enhanced Export | Export PDF | 1 Meas. per File

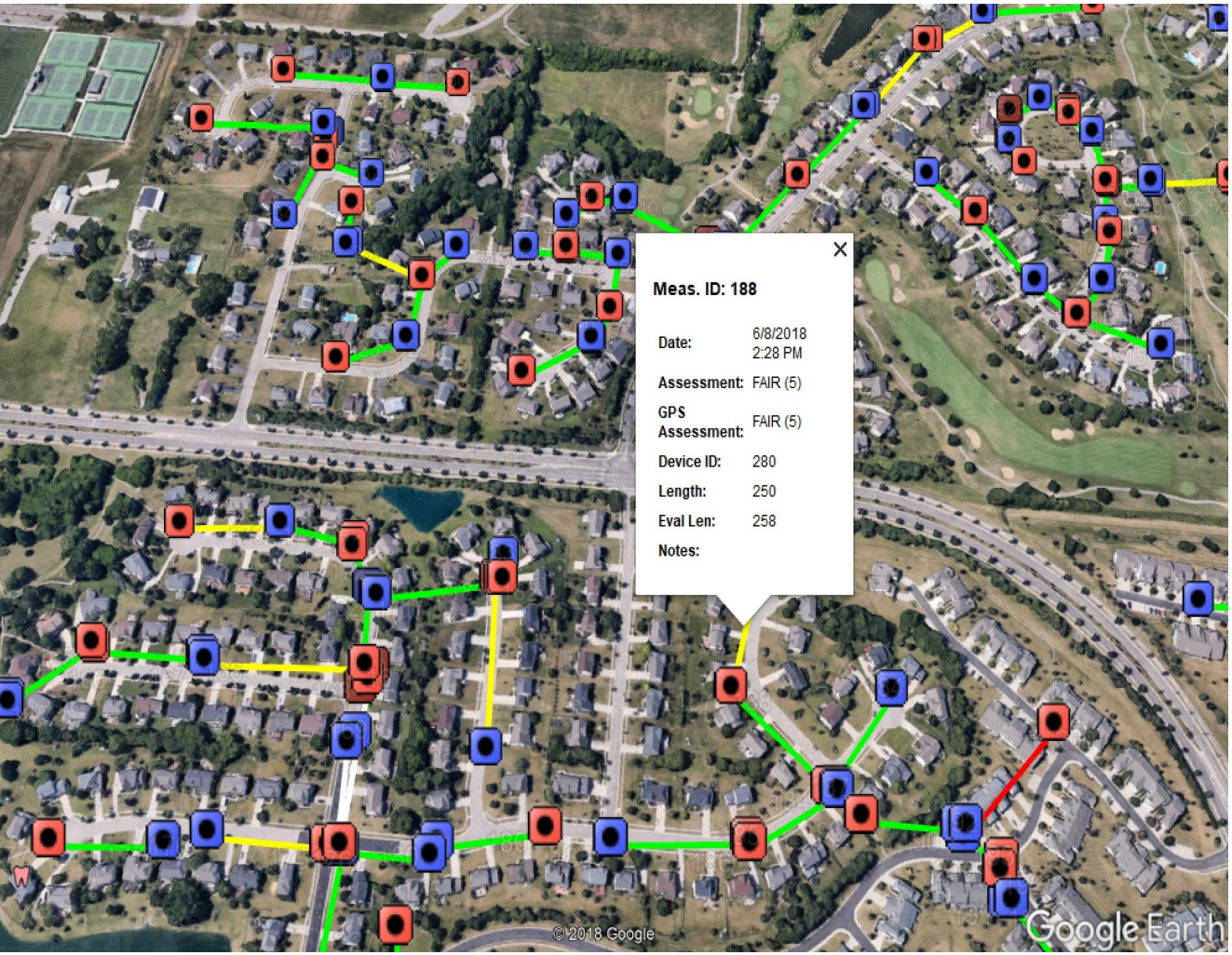
12345678910...>> Page Size: 50 860 measurements found

(Measurement Status) the SL-RAT receiving unit (RX) evaluates the conditions under which the pipe assessment is conducted and provides a warning concerning possible limitations in the measurement

Meas. ID	RX Oper. ID	RX Hw ID	TX Oper. ID	TX Hw ID	Date/Time * = estimated	Meas Dur. (sec)	(ft)	(ft)			GPS Assess	Notes	User Field 1	User Field 2	Rx Lat/Lon Sort Lat Sort Lon	Tx Lat/Lon Sort Lat Sort Lon
875	1	280	1	281	10/9/2018 1:01 PM	80	50	191	Valid	Good	8 GOOD	9 GOOD				Lat: 39.383048 Lon: -84.294523 ID:	Lat: 39.382526 Lon: -84.294586 ID:
874	1	280	1	281	10/9/2018 12:54 PM	80	350	263	Valid	Good	8 GOOD	7 GOOD				Lat: 39.383013 Lon: -84.294508 ID:	Lat: 39.383123 Lon: -84.293586 ID:
873	1	280	1	281	10/9/2018 12:49 PM	80	150	161	Valid	Good	8 GOOD	8 GOOD				Lat: 39.38301 Lon: -84.294523 ID:	Lat: 39.383436 Lon: -84.294663 ID:
872	1	280	1	281	10/9/2018 12:45 PM	80	350	141	Valid	Good	9 GOOD	8 GOOD				Lat: 39.38379 Lon: -84.294813 ID:	Lat: 39.38342 Lon: -84.294675 ID:
871	1	280	1	281	10/9/2018 12:41 PM	80	350	107	Valid	Good	8 GOOD	8 GOOD				Lat: 39.383276 Lon: -84.296028 ID:	Lat: 39.383185 Lon: -84.296388 ID:
870	1	280	1	281	10/9/2018 12:36 PM	80	350	385	Valid	Good	8 GOOD	8 GOOD				Lat: 39.383168 Lon: -84.296033 ID:	Lat: 39.383811 Lon: -84.294953 ID:
869	1	280	1	281	10/9/2018 12:31 PM	79	350	367	Valid	Good	9 GOOD	9 GOOD				Lat: 39.384638 Lon: -84.295606 ID:	Lat: 39.38378 Lon: -84.294931 ID:
868	1	280	1	281	10/9/2018 12:26 PM	79	250	228	Valid	Good	8 GOOD	8 GOOD				Lat: 39.384655 Lon: -84.295631 ID:	Lat: 39.384411 Lon: -84.296376 ID:
867	1	280	1	281	10/9/2018 12:20 PM	79	150	148	Valid	Good	9 GOOD	9 GOOD				Lat: 39.384681 Lon: -84.295615 ID:	Lat: 39.384885 Lon: -84.295163 ID:

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

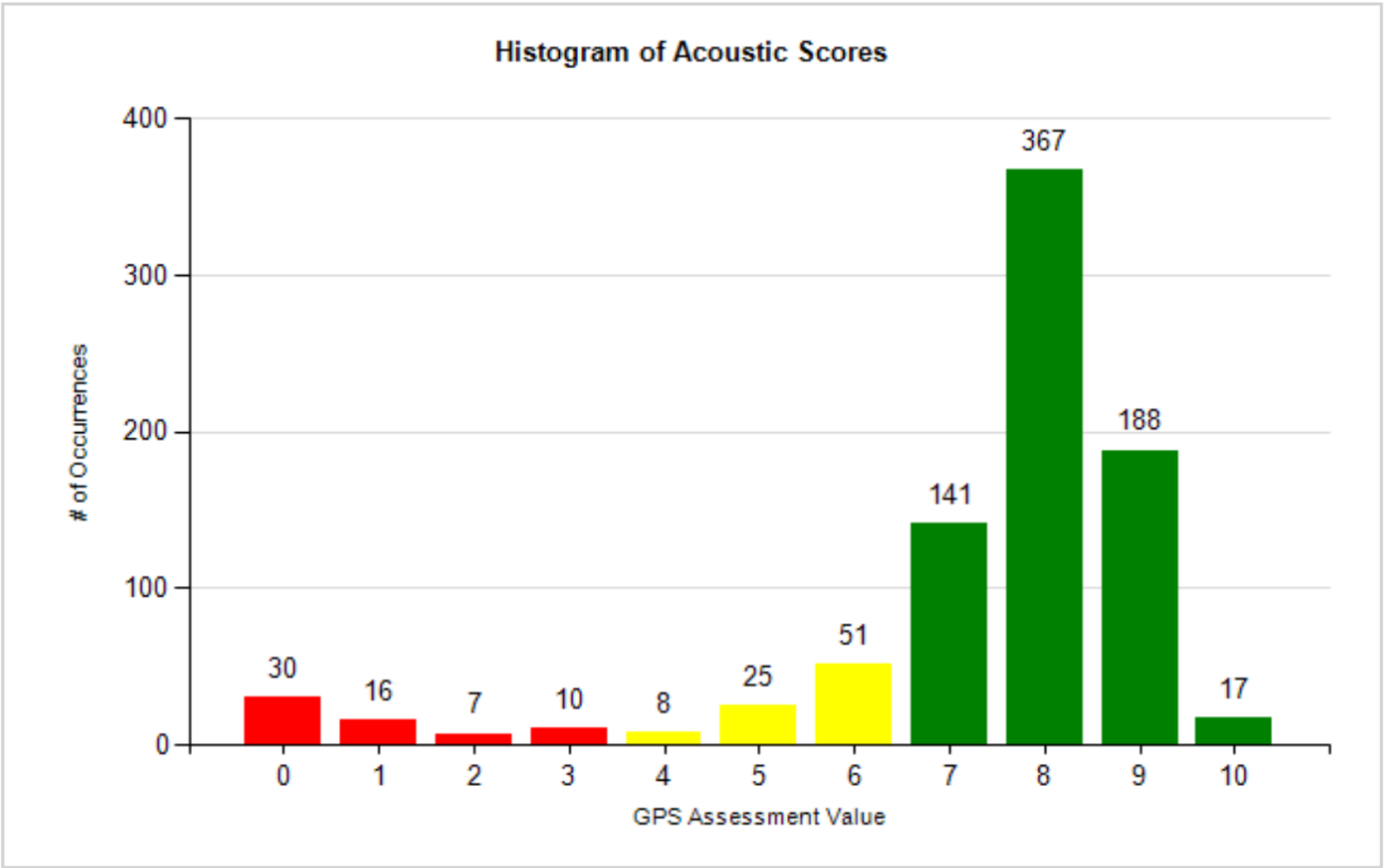
Device: 280

Start Date: 1/1/2000

End Date: 10/12/2018

Excluded Statuses:

Exclude None



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?

InfoSense, Inc
Innovating Acoustic Inspection Technology™

800-447-6687 or 614-354-3927
bob@dukes.com
www.infosense.com