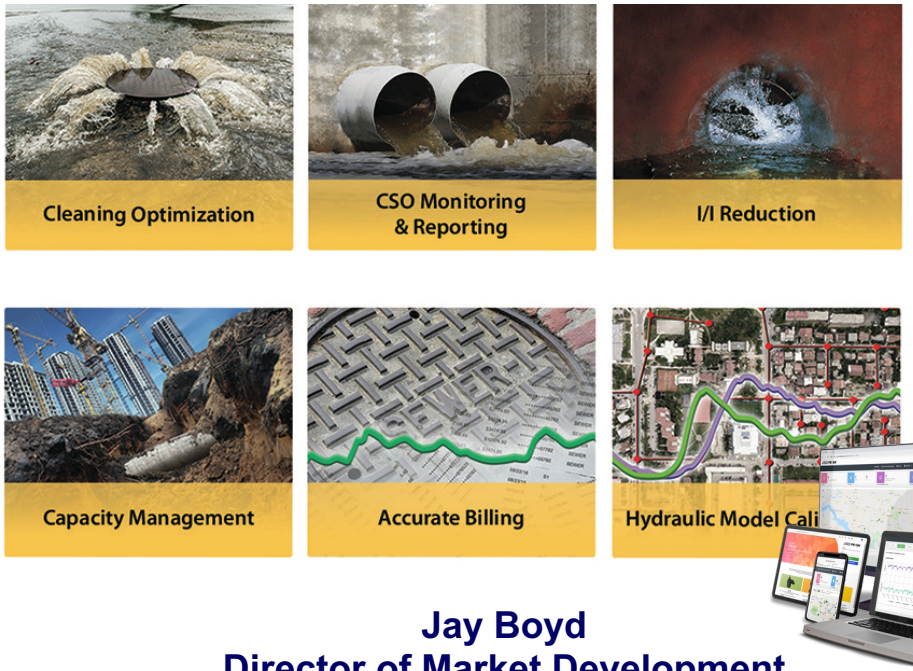
The Dollars and Sense for Adopting Optimized O&M Processes Leveraging Smart Technology

NEWEA
WORKING FOR WATER QUALITY



Jay Boyd
Director of Market Development

ADS

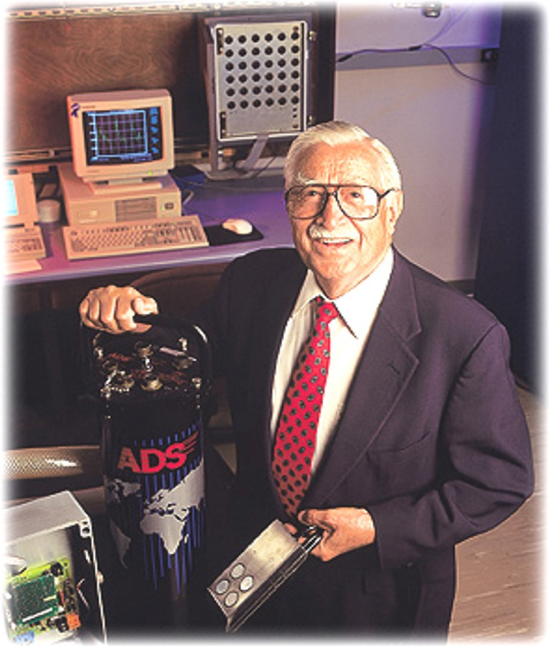
Agenda

Theme:
Optimize Collection System O&M Operations by Leveraging Proven, Smart Technology

- A Little About ADS
- Cleaning Practices & Their Issues
- Defining Cleaning Optimization
- Technology Supporting Optimization
- Case Studies: Practical Examples & Results
- Closing Thoughts and Q&A

ADS Overview

- Founded 1975 by former NASA R&D Director Peter Petroff
- The pioneer of the Digital Water Vision
- Awarded 25 national/international patents
- Firsts in Flow Monitoring…
  - 1st to Directly Measure Velocity & Using Doppler
  - 1st to employ Microprocessor-Based Systems
  - 1st to use Voice Grade Telemetry for Communication
- *Highly focused* on precision measurements



NASA R&D Director Peter Petroff establishes American Digital Systems

ADS Today

Success Achieved through *Comprehensive, Turnkey Services*:

- Design & manufacture meters/monitors/sensors
- Develop Software & Advanced Analytics
- Data Analytics Team
- Expert, Certified Field Services

- 300+ employees
- 29 Local Service Offices
- Concurrently manage >600 active projects
- Support >10,000 active meters

ADS Application Focus

Collection System- *Flow Data*

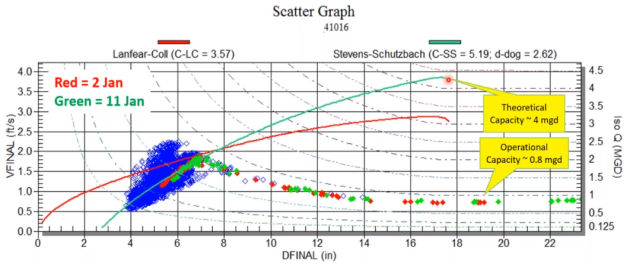
- I/I Assessment
- Capacity
- Model calibration
- Billing networks

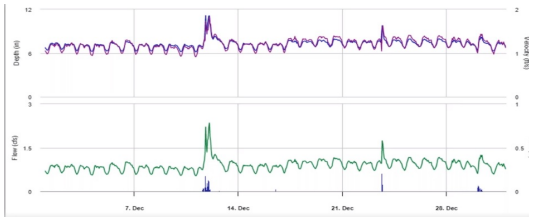
Collection System- *Level*

- Cleaning Optimization
- SSO mitigation
- Lift station back-up
- By-pass monitoring

Storm/Surface Water- *Level*

- Flood-Prone Warning
- River Levels
- Tidal intrusion
- Reservoir/Lake levels





Rain Data

- Cumulative
- Peak

Framing Today's Discussion

1 Cleaning Challenge

- Continuous, high-demand on resources
- Inconsistent remote site collection system visibility

2 Solution

- Optimization: ***site condition-based*** *cleaning* where:
  - *Cleaning frequency is right-sized*
  - *SSOs threats are reduced*

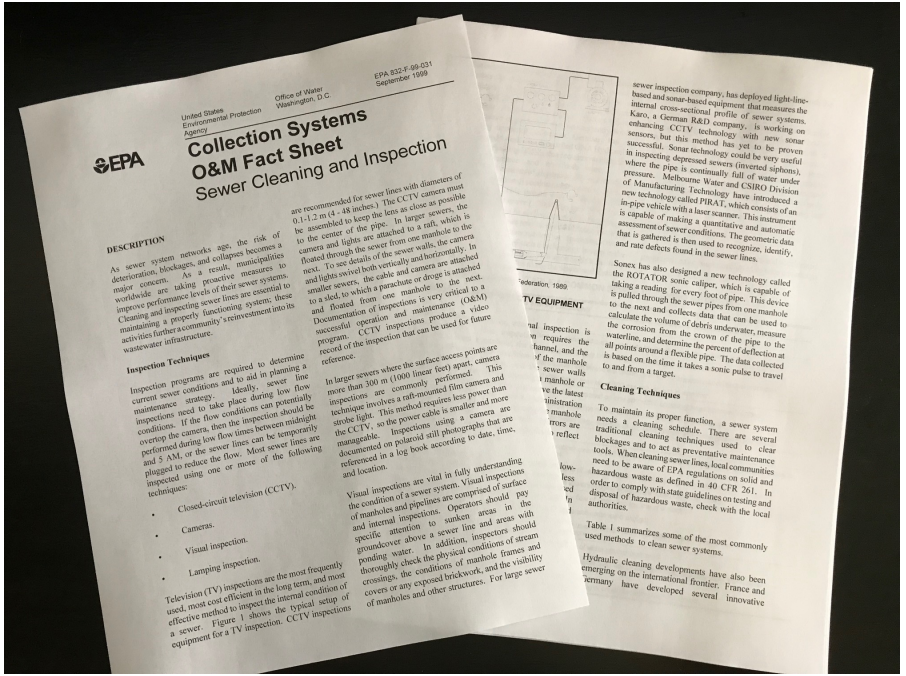
The Decades Old CMOM

Capacity, Management Operations and Maintenance (CMOM)

- Guidance for O&M ***Best Practices***
- First established in 1995

CMOM Goal:

- Prevent Sanitary Sewer Overflows SSOs



United States Environmental Protection Agency | Office of Water Washington, D.C. | EPA 832-F-99-031 September 1999

EPA

Collection Systems O&M Fact Sheet

Sewer Cleaning and Inspection

DESCRIPTION

As sewer system networks age, the risk of deterioration, blockages, and collapses becomes a major concern. As a result, municipalities worldwide are taking proactive measures to improve performance levels of their sewer systems. Cleaning and inspecting sewer lines are essential to maintaining a properly functioning system; these activities further a community's reinvestment into its wastewater infrastructure.

Inspection Techniques

Inspection programs are required to determine current sewer conditions and to aid in planning a maintenance strategy. Ideally, sewer line inspections need to take place during low flow conditions. If the flow conditions can potentially overtop the camera, then the inspection should be performed during low flow times between midnight and 5 AM, or the sewer lines can be temporarily plugged to reduce the flow. Most sewer lines are inspected using one or more of the following techniques:

- Closed-circuit television (CCTV).
- Cameras.
- Visual inspection.
- Lamping inspection.

Television (TV) inspections are the most frequently used, most cost efficient in the long term, and most effective method to inspect the internal condition of a sewer. Figure 1 shows the typical setup of equipment for a TV inspection. CCTV inspections are recommended for sewer lines with diameters of 0.1-1.2 m (4 - 48 inches.) The CCTV camera must be assembled to keep the lens as close as possible to the center of the pipe. In larger sewers, the camera and lights are attached to a raft, which is floated through the sewer from one manhole to the next. To see details of the sewer walls, the camera and lights swivel both vertically and horizontally. In smaller sewers, the cable and camera are attached to a sled, to which a parachute or drogue is attached and floated from one manhole to the next. Documentation of inspections is very critical to a successful operation and maintenance (O&M) program. CCTV inspections produce a video record of the inspection that can be used for future reference.

In larger sewers where the surface access points are more than 300 m (1000 linear feet) apart, camera inspections are commonly performed. This technique involves a raft-mounted film camera and strobe light. This method requires less power than the CCTV, so the power cable is smaller and more manageable. Inspections using a camera are documented on polaroid still photographs that are referenced in a log book according to date, time, and location.

Visual inspections are vital in fully understanding the condition of a sewer system. Visual inspections of manholes and pipelines are comprised of surface and internal inspections. Operators should pay specific attention to sunken areas in the groundcover above a sewer line and areas with ponding water. In addition, inspectors should thoroughly check the physical conditions of stream crossings, the conditions of manhole frames and covers or any exposed brickwork, and the visibility of manholes and other structures. For large sewer

sewer inspection company, has deployed light-line-based and sonar-based equipment that measures the internal cross-sectional profile of sewer systems. Karo, a German R&D company, is working on enhancing CCTV technology with new sonar sensors, but this method has yet to be proven successful. Sonar technology could be very useful in inspecting depressed sewers (inverted siphons), where the pipe is continually full of water under pressure. Melbourne Water and CSIRO Division of Manufacturing Technology have introduced a new technology called PIRAT, which consists of an in-pipe vehicle with a laser scanner. This instrument is capable of making a quantitative and automatic assessment of sewer conditions. The geometric data that is gathered is then used to recognize, identify, and rate defects found in the sewer lines.

Sonex has also designed a new technology called the ROTATOR sonic caliper, which is capable of taking a reading for every foot of pipe. This device is pulled through the sewer pipes from one manhole to the next and collects data that can be used to calculate the volume of debris underwater, measure the corrosion from the crown of the pipe to the waterline, and determine the percent of deflection at all points around a flexible pipe. The data collected is based on the time it takes a sonic pulse to travel to and from a target.

Cleaning Techniques

To maintain its proper function, a sewer system needs a cleaning schedule. There are several traditional cleaning techniques used to clear blockages and to act as preventative maintenance tools. When cleaning sewer lines, local communities need to be aware of EPA regulations on solid and hazardous waste as defined in 40 CFR 261. In order to comply with state guidelines on testing and disposal of hazardous waste, check with the local authorities.

Table 1 summarizes some of the most commonly used methods to clean sewer systems.

Hydraulic cleaning developments have also been emerging on the international frontier. France and Germany have developed several innovative

EPA Guidance Document:
'Collection System O&M Fact Sheet'
Sewer Cleaning and Inspection,
September 1999 Update

‘Best Practices’ for Cleaning

Basic Principle

- Prevent Overflows with Scheduled Cleaning
- Stay ahead of build-up cycles

Total Collection System Cleaning

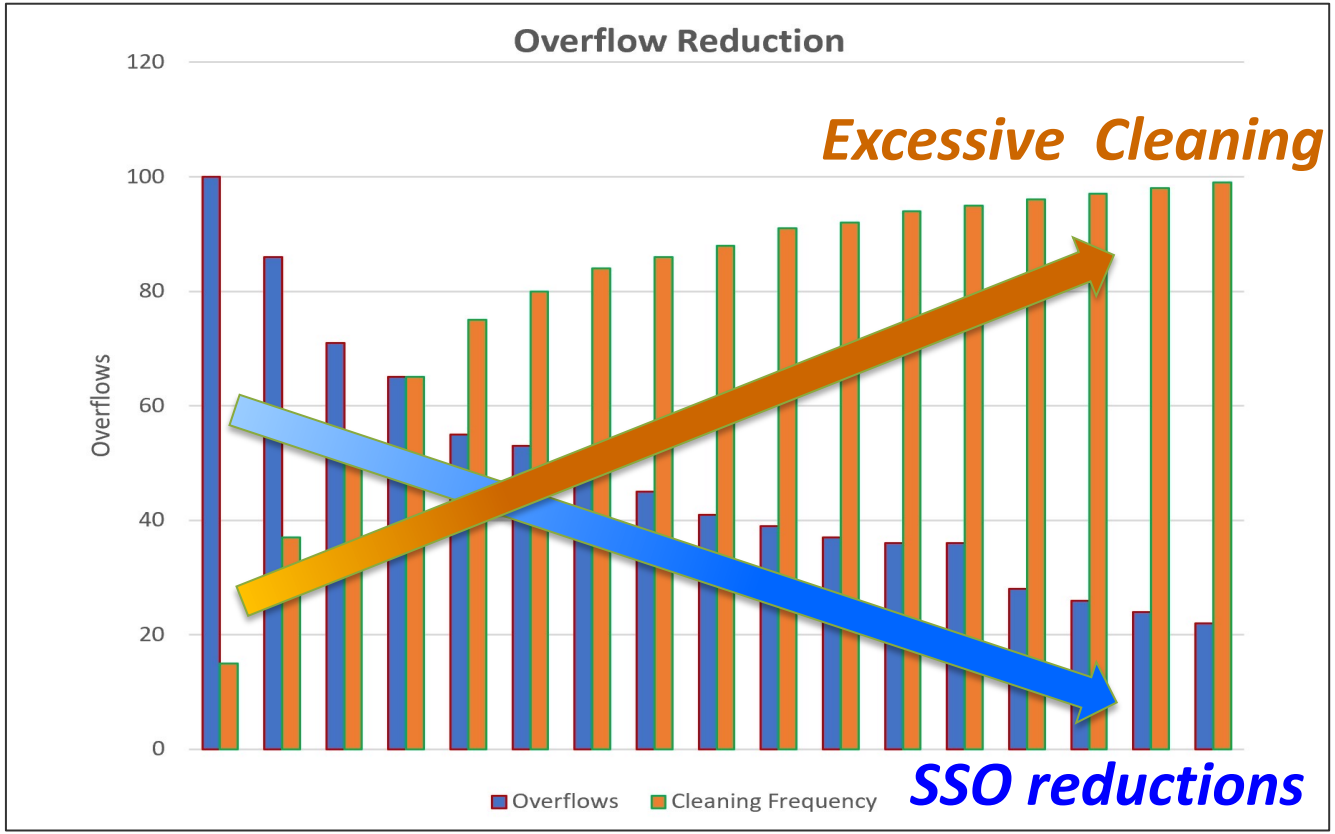
- Continuous cycle: single to multi-year cycles

High Frequency Cleaning

- Frequencies: weekly, monthly, quarterly, etc.
- Where: historic *hot spots*

Cleaning Frequency & SSOs

High Frequency Cleaning…



High Frequency Cleaning is Challenging…

Keeping up with the schedule

- High frequency cleaning is relentless
- Competes with projects, emergencies

Cleaning to reduce SSO has diminishing returns

- Greater investments has lower returns

Hiring and labor availability is challenging

- Retirements accelerating in industry
- Smaller labor pools in most of US

Aging infrastructure *increases* maintenance demands

- Utilities may be forces to do more with limited resources

Quotes from Three Operations Experts

Revealing quotes by three 20+ year veterans…

"We're busy so who wants to clean already clean pipes?"

"The schedule says to clean but it doesn't mean it needs it."

"When you can't see what's going on, you clean to be safe."

Common Theme?

Overclean *to be safe*, even if wasteful

Root-cause?

Site-conditions <u>not known</u> most of the time

Solution: Better visibility to site conditions

Cleaning Optimization: *Making Better Sense*

Creating a Better Future

“The most reliable way to predict the future is to create it.”

Creating the Future

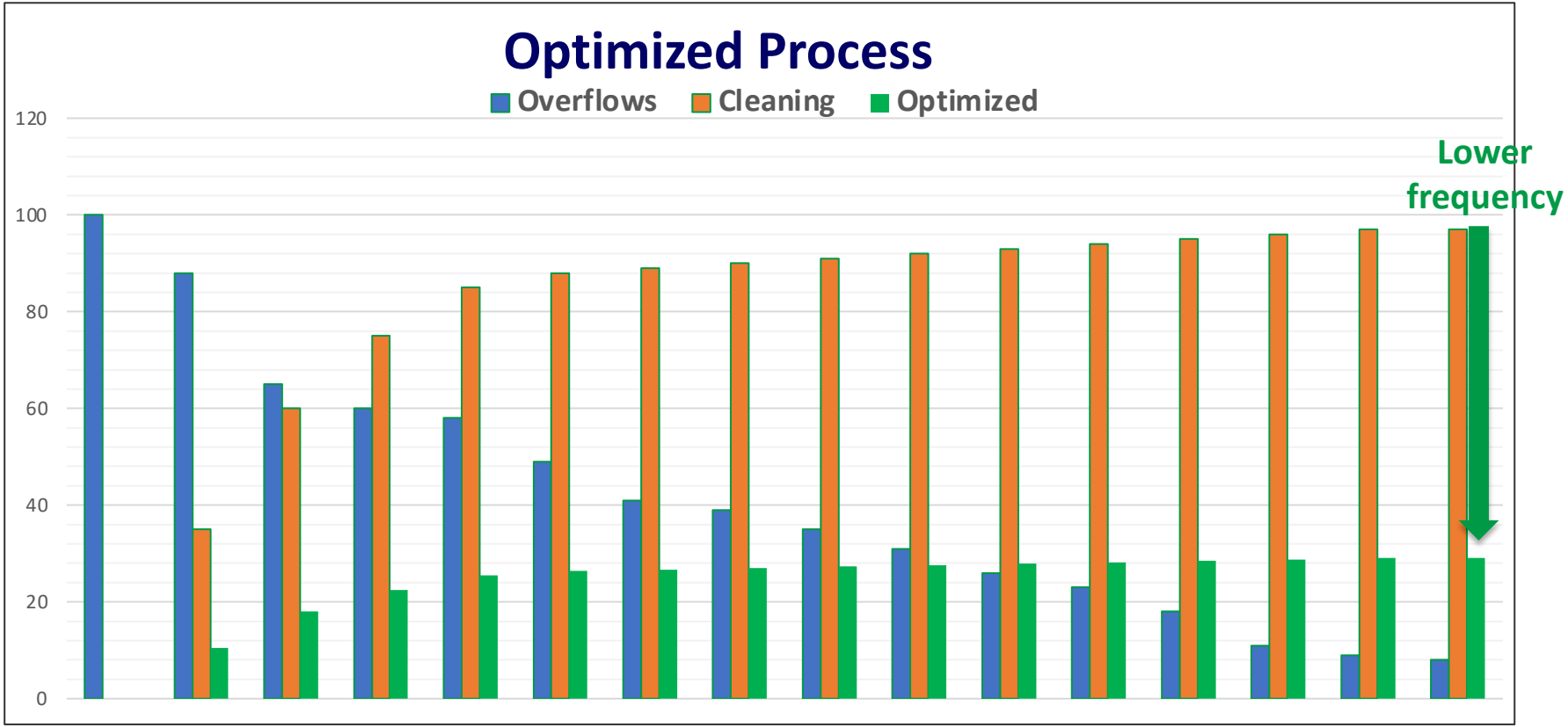
The Present	The *Future*
Schedule-driven cleaning	→ *Site condition-driven* cleaning as needed
Blind to remote site conditions	→ See & know what's happening

Hallmarks of Optimization

- Promotes *informed decisions:* where to productively apply resources
- *Sustainable process* able to do more with lower resource demand
- Improves SSO protection
- *Reduces asset wear* - eliminates unnecessary cleaning which may degrade the high-risk pipes
- Site condition-based cleaning *always on-time and right-sizes frequency…*

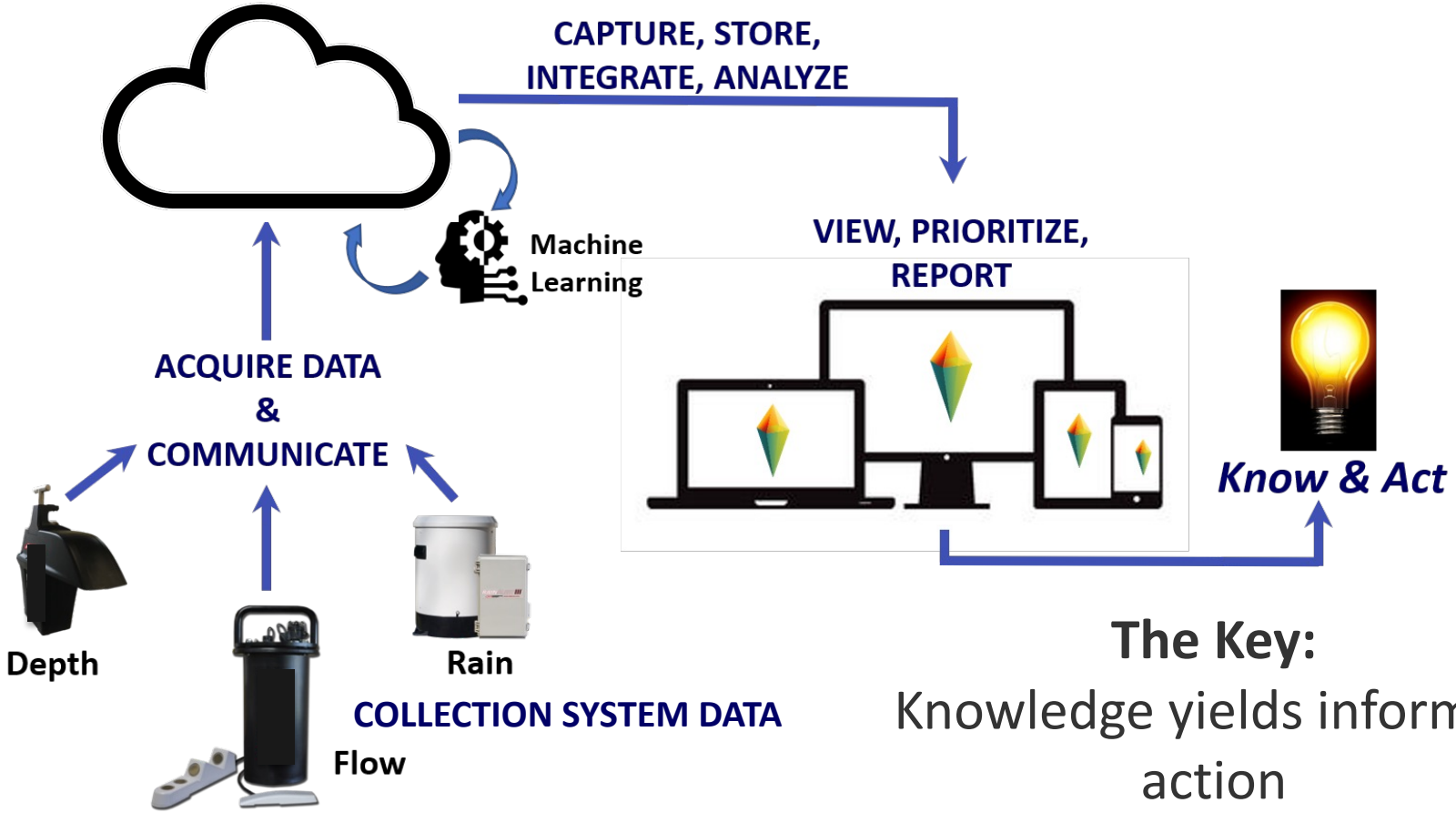
What We Are Achieving with Cleaning Optimization?

***Right-sized** cleaning frequency* based on remote site conditions



Outcome: *lower* cleaning frequency and *better* SSO prevention

Smart Technology: Creating Remote Site Visibility

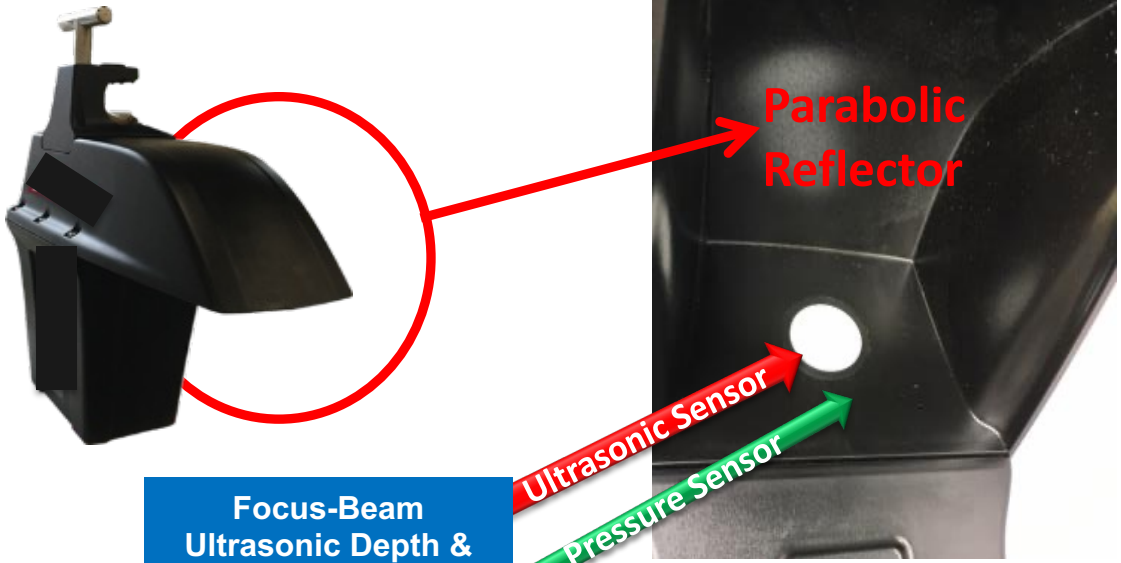


The Key:

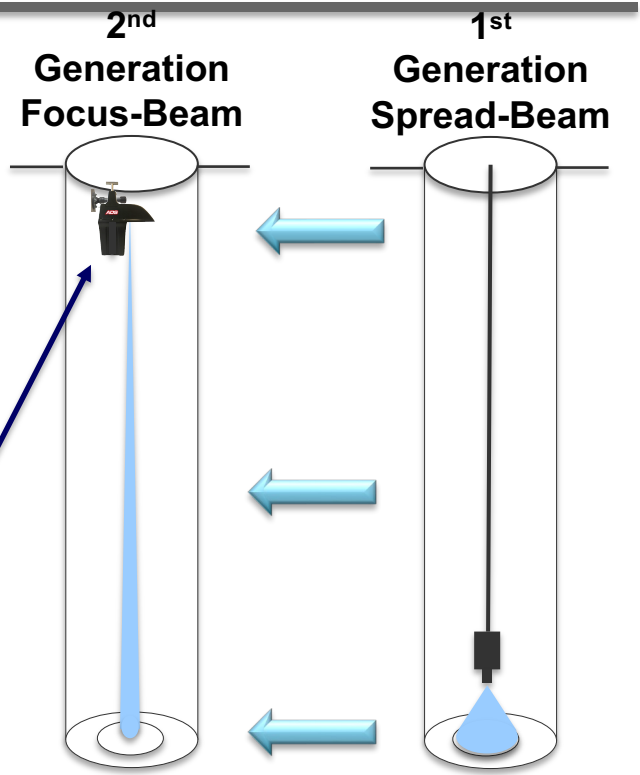
Knowledge yields informed action

2nd Generation of Level Monitoring Technology Advancements

Level Monitors



Focus-Beam Ultrasonic Depth & Pressure Sensors



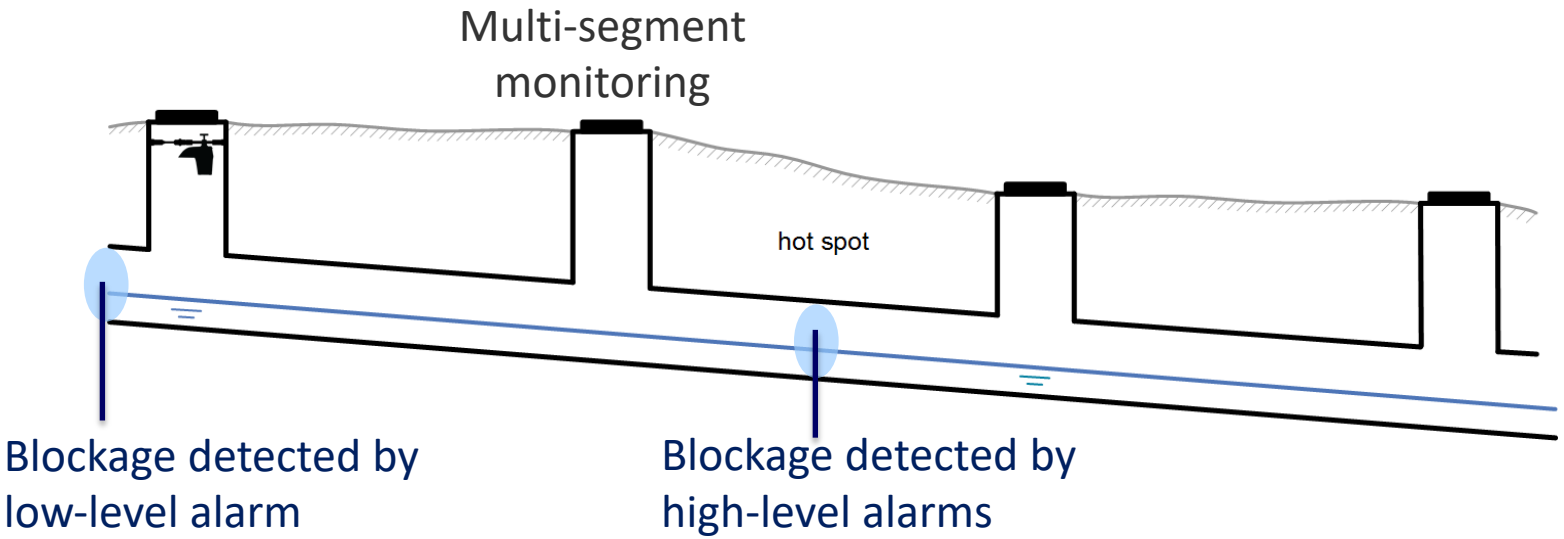
Stabilized mounting eliminates false alarms associated cable-counted sensor movement

Multi-Segment Monitoring: Up & Downstream

Bi-directional Monitoring:

Downstream Blockage creates backwater condition & increases level

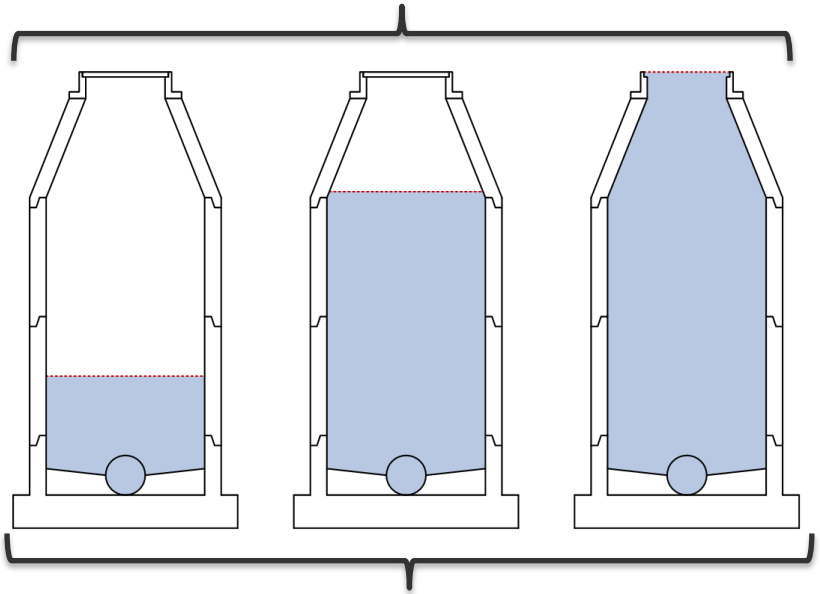
Upstream Blockage creates lower flow & decreases level



The Blockage Protection Continuum

Alarms:

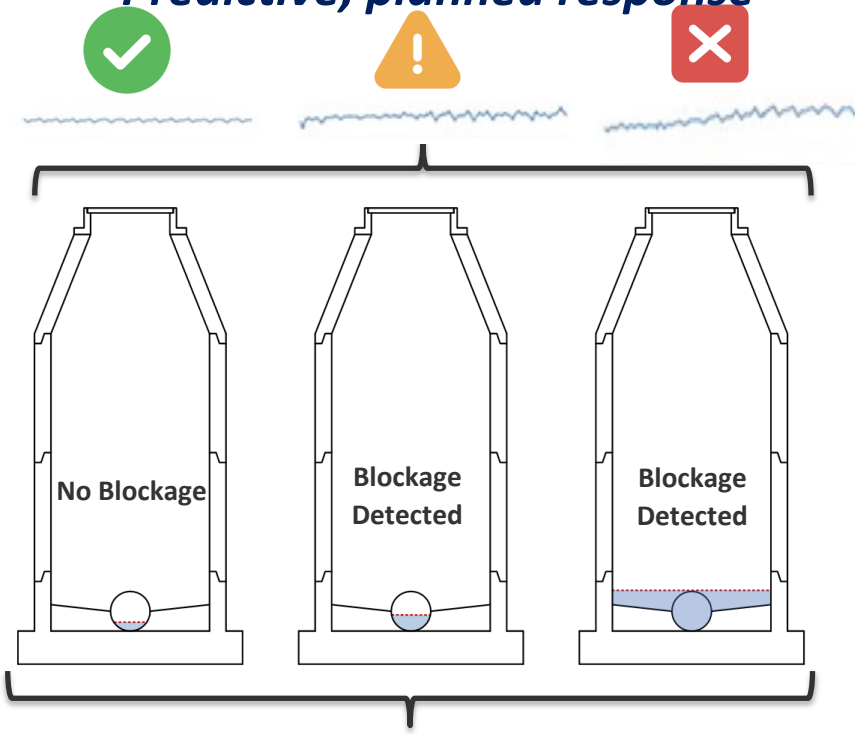
Reactive & Unplanned Response



The Blockage Protection Continuum

Proactive:

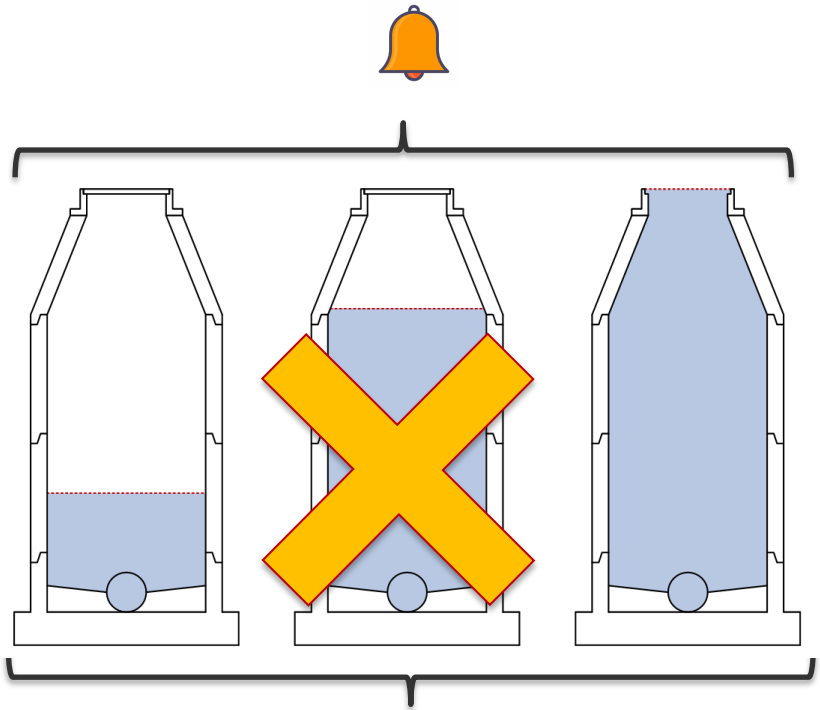
Predictive, planned response



React or Predict?

Alarms:

Reactive & Unplanned Response

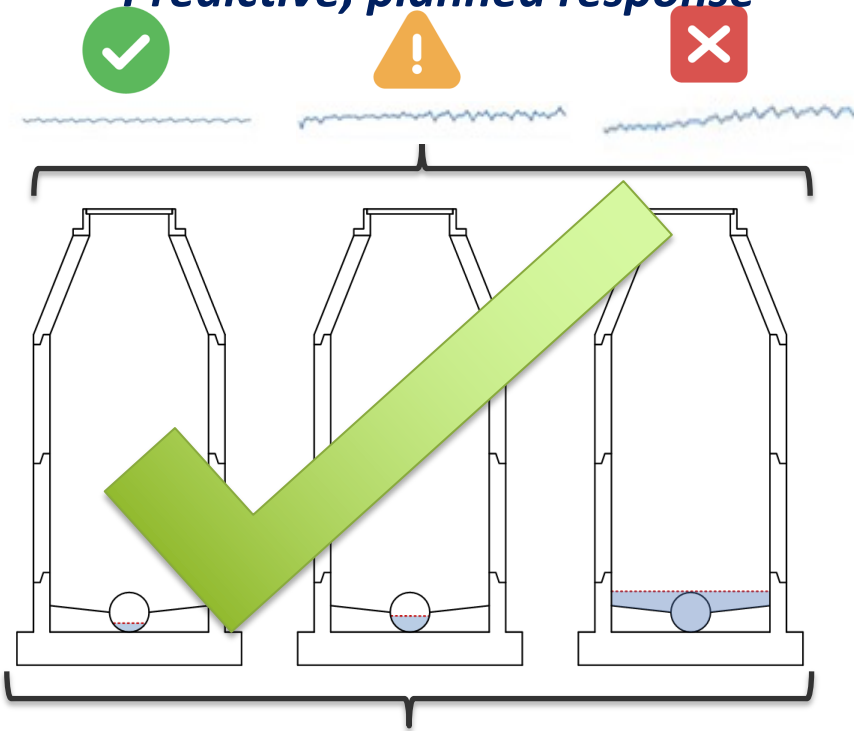


Alarms

Use for Back-up

Proactive:

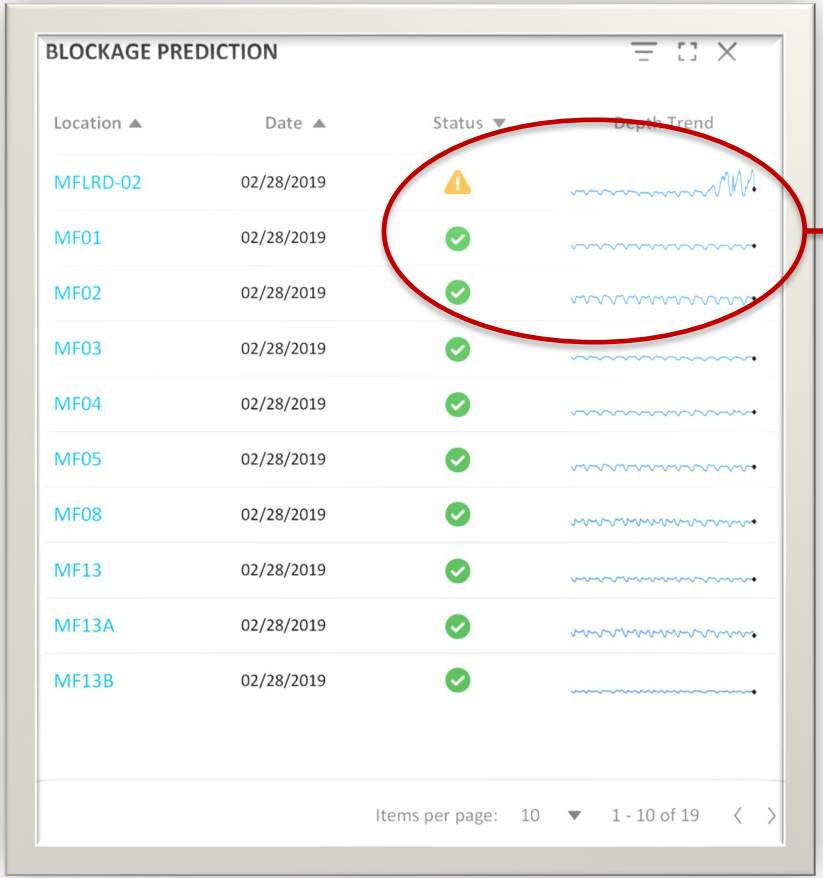
Predictive, planned response

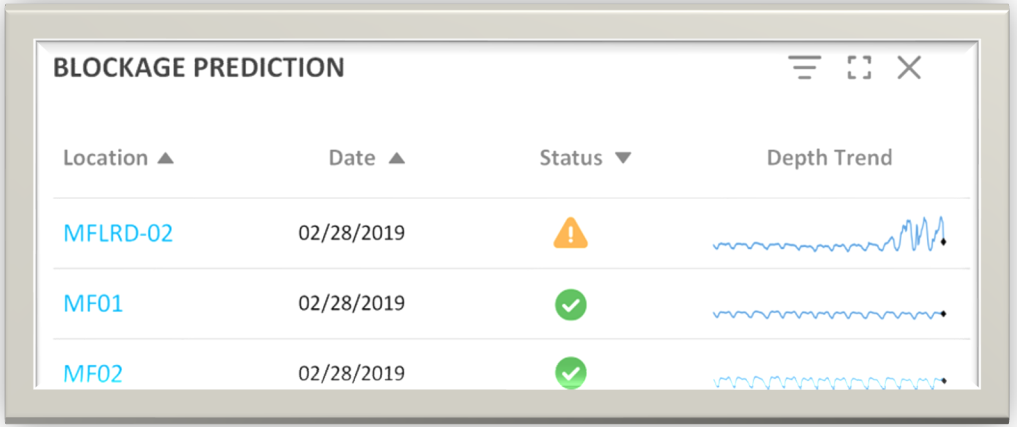


Predictive Analytics

Forward-looking Planning Tool

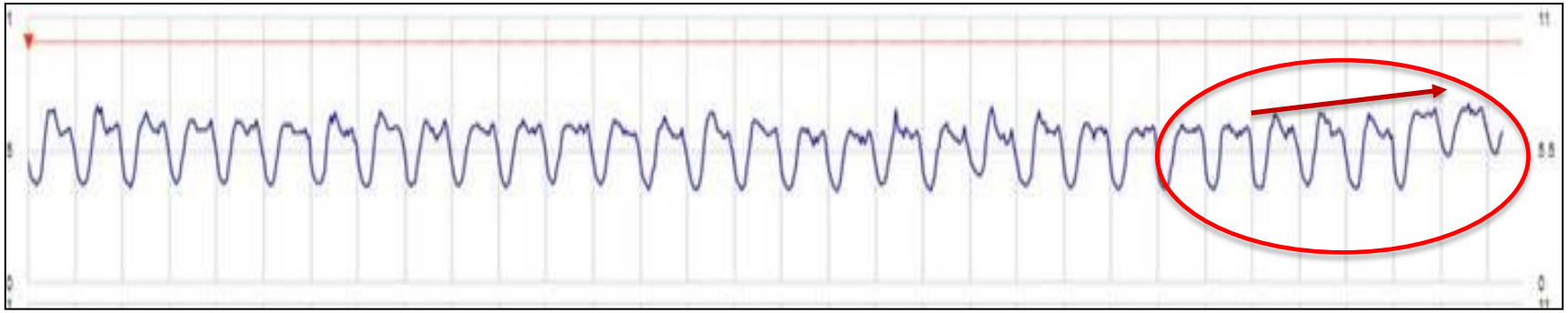
Prioritized Dashboard Predicts Blockages





Graph of Site Details: Detects Pattern Change

Subtle changes are detected by *machine learning*



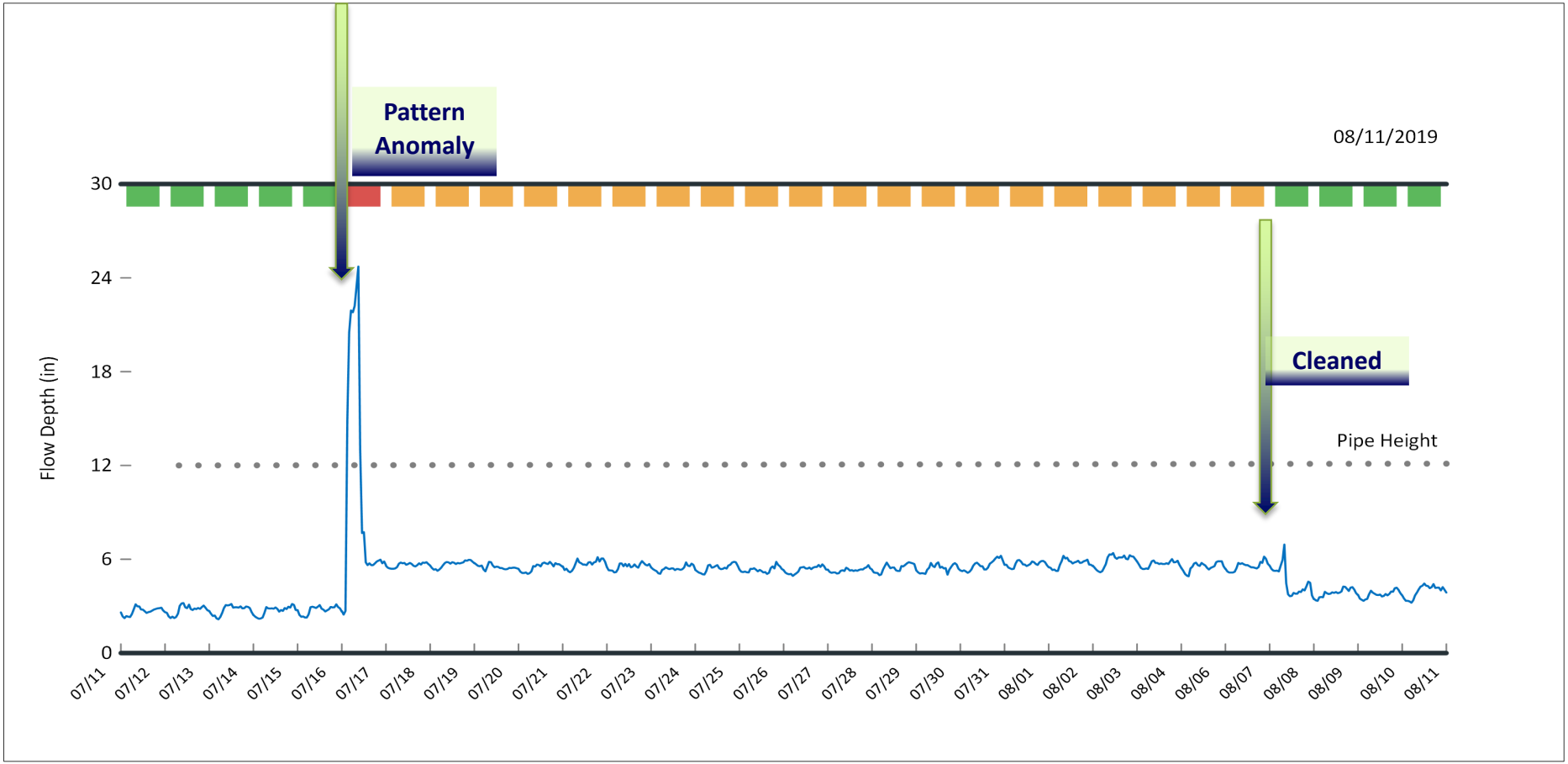
Algorithm uses *pattern recognition*

***Expert reviewed* data teaches the software**

System distinguishes *RDI/I vs. blockage*

How Machine Learning Detection Works: Example 1

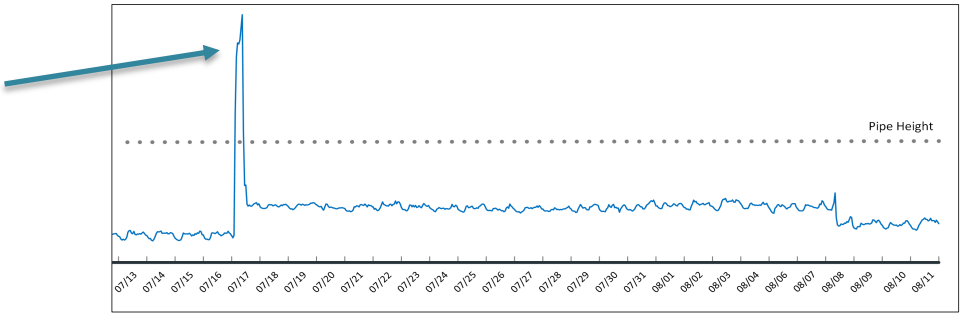
Software “machine learning” uses 1 million days of reviewed data to recognize anomalies



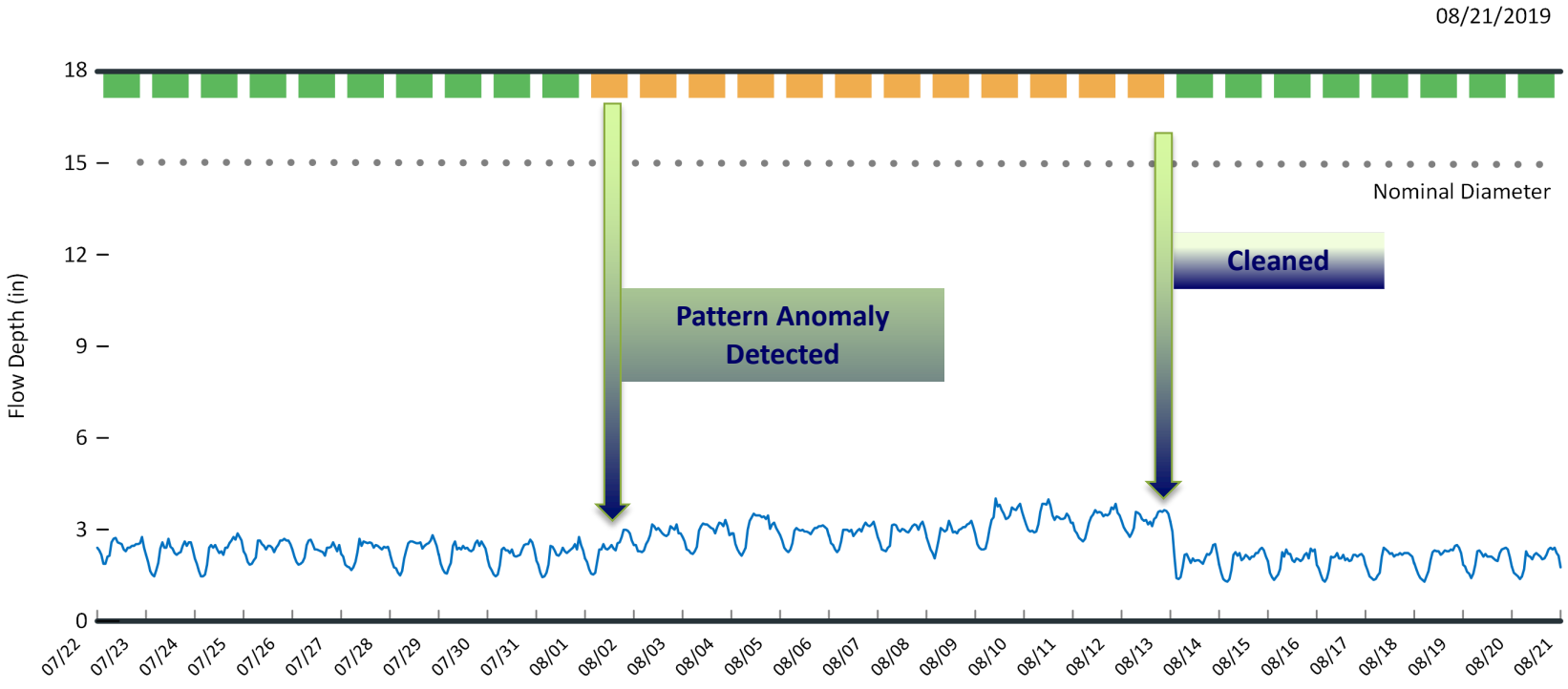
Example 1 Site Findings

Gravel and Rocks Observed in Manhole Channel

Cleaning pushed debris to next segment

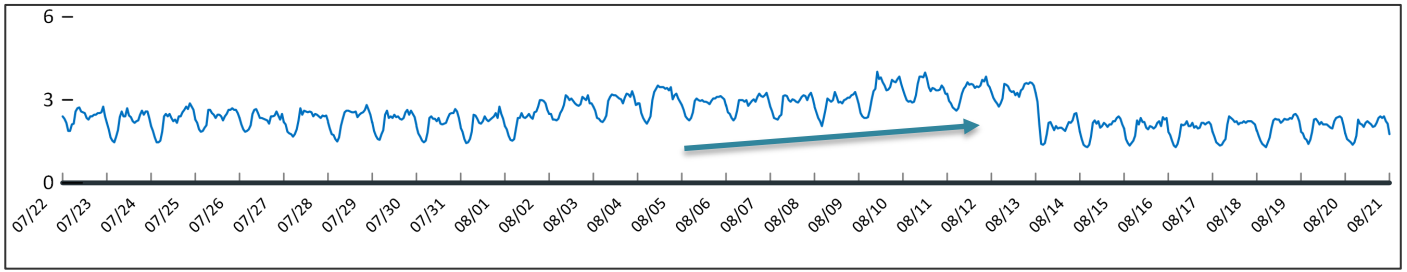


Machine Learning Detection: Site Example 2



Example 2 Site Findings

Stick catching debris
Stick created progressive blockage



Case Studies

Case Study: La Mesa, CA

Situation

System 153 miles sewer, 53 miles storm

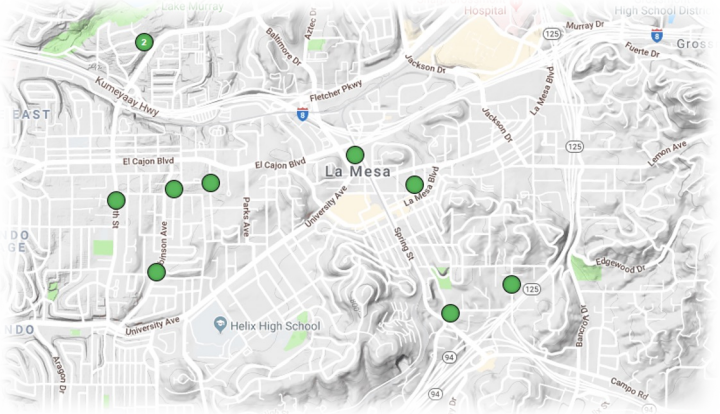
Process Annually: Total System Cleaning
Monthly: 100 High Frequency sites cleaned

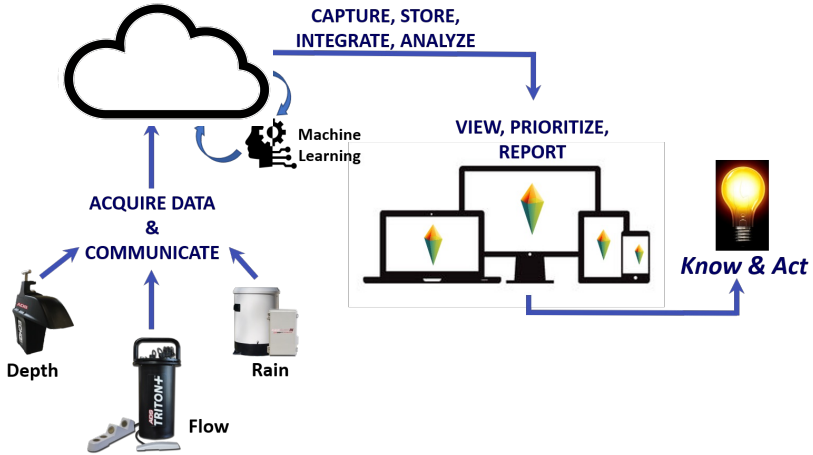
Challenges **80% maintenance time spent cleaning**
Difficult to address project, emergencies

Optimized Cleaning Study

Scope

- Ten (10) monthly cleaning segments monitored for six (6) months
- *Site conditions* communicated, software alerts & prioritizes
- Cleaning instances recorded and viewable via cloud-based software



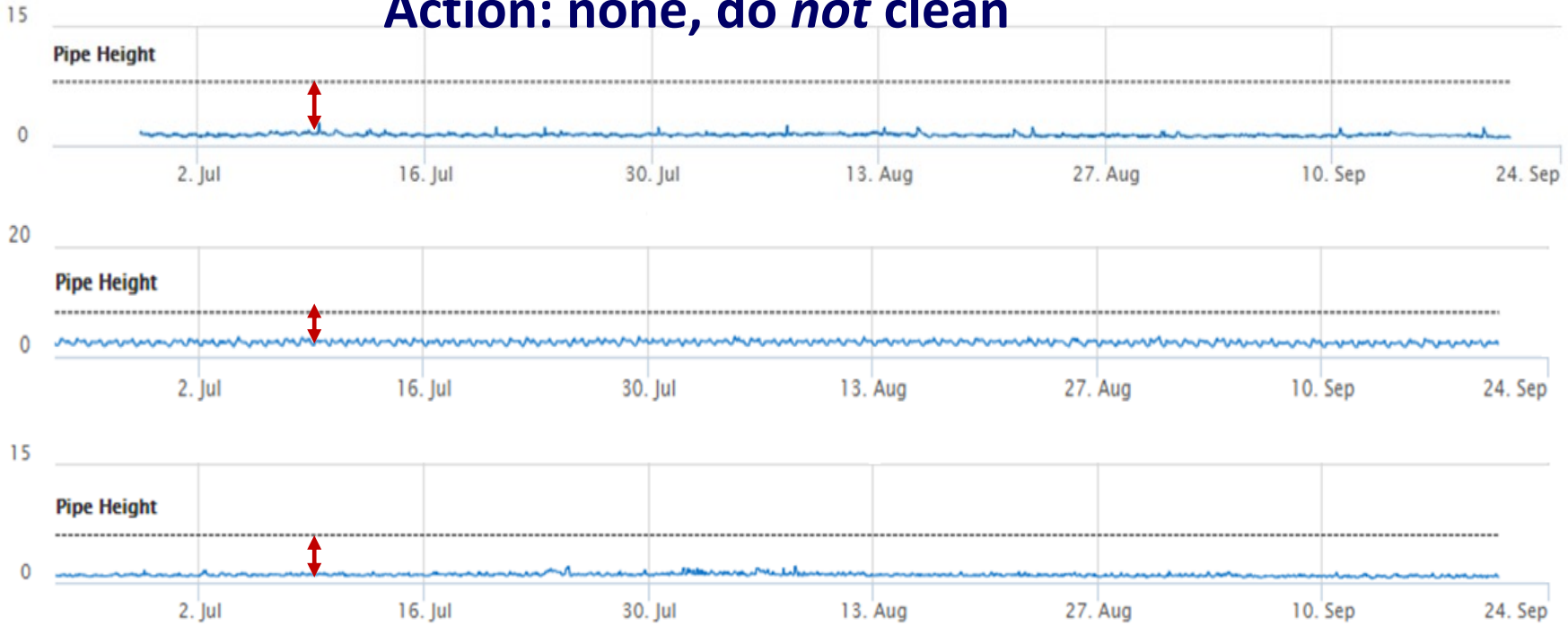


Typical Diurnal Patterns

First 4-months: stable depths at 8 locations

Pipe height (gray dotted line) never exceeded

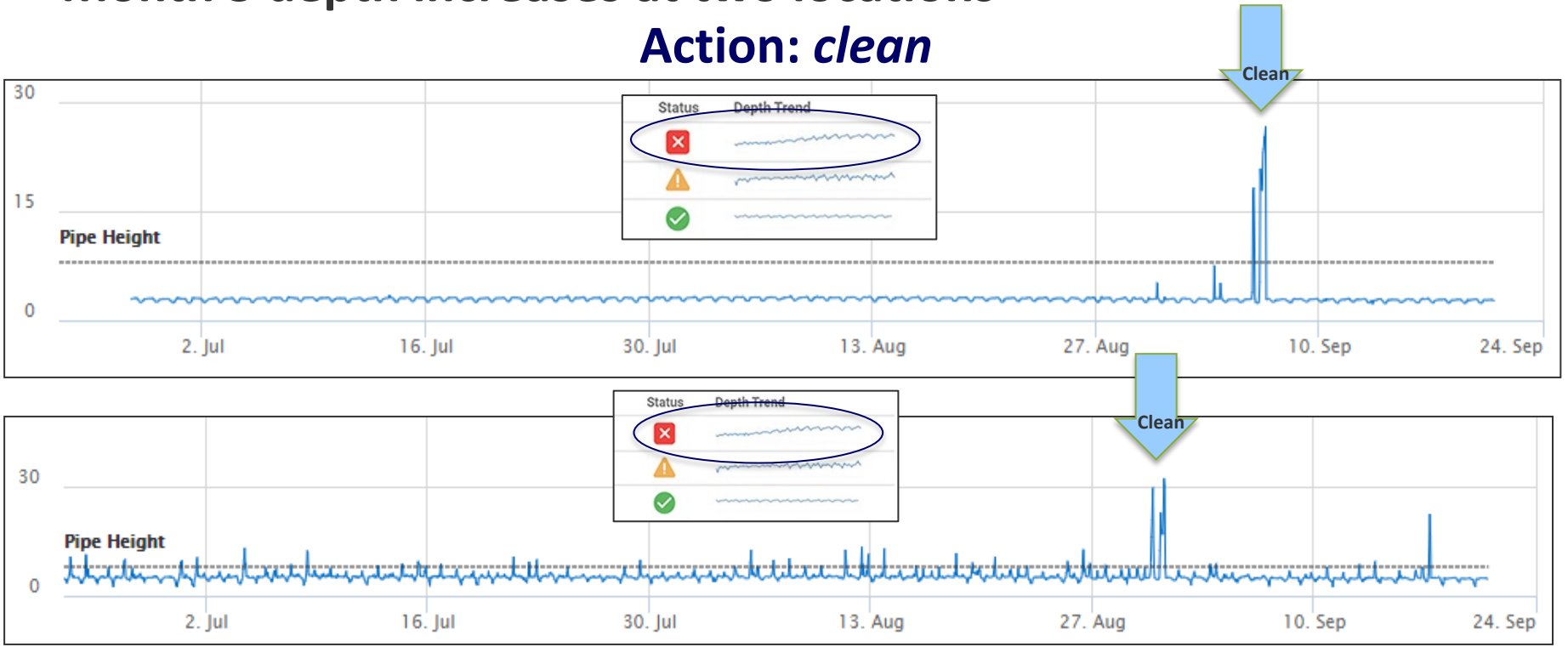
Action: none, do *not* clean



Segments Requiring Action

Stable depths Months 1 & 2
Month 3 depth increases at two locations

Action: *clean*



Take Away: optimization does *not* eliminate but right-sizes cleaning

Tabulated Results

Green = Not cleaned

Red = Cleaned

Site Location	Jul-18		Aug-18		Sep-18		Oct-18		Nov-18		Dec-18	
	Clean?	*Type*	*Clean?*	*Type*	*Clean?*	*Type*	*Clean?*	*Type*	*Clean?*	*Type*	*Clean?*	*Type*
70thSt	No		No		No		No		11/26/18		No	
Colorado	No		No		No		No		11/26/18		No	
EchoDr	No		No		9/17/2018	Grease	No		11/26/18		No	
HarbinsonAve	No		No		No		No		11/26/18		No	
JessieAve	No		No		9/11/2018	Grease/Roots	No		11/26/18		No	
JulliettePl	No		No		No		No		11/26/18		No	
LakeMurray	No		No		No		No		11/26/18		No	
NeboDr	No		No		No		No		11/26/18		No	
PanormaDr	No		No		No		No		11/26/18		No	
PineSt	No		No		No		No		11/26/18		No	

Monthly Results

Month 1: 0 cleaned
Month 2: 0 cleaned
Month 3: 2 cleaned
Month 4: 0 cleaned
Month 5: 10 cleaned
Month 6: 0 cleaned

Total 12 cleaned

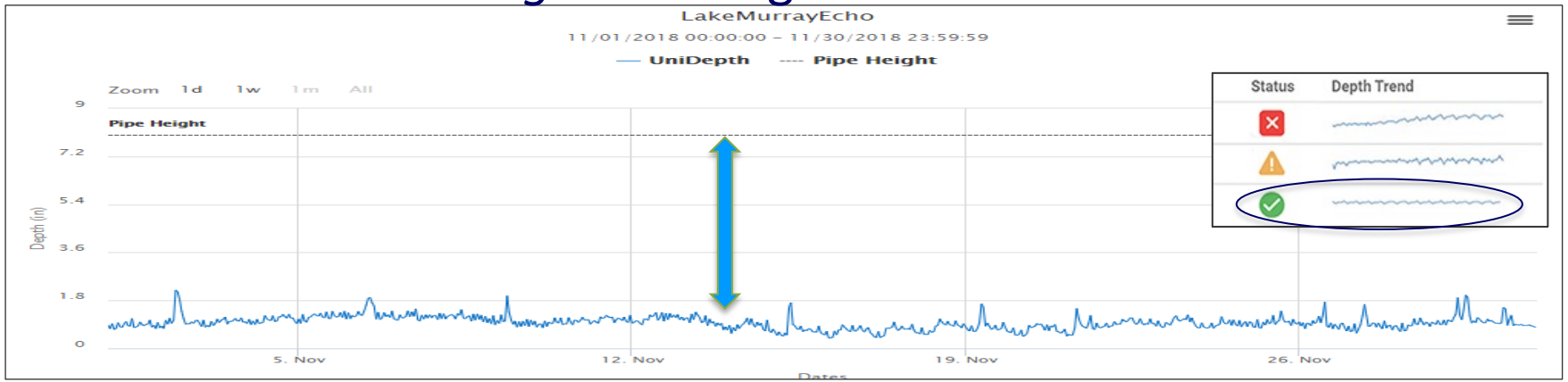
Summary for Six Months

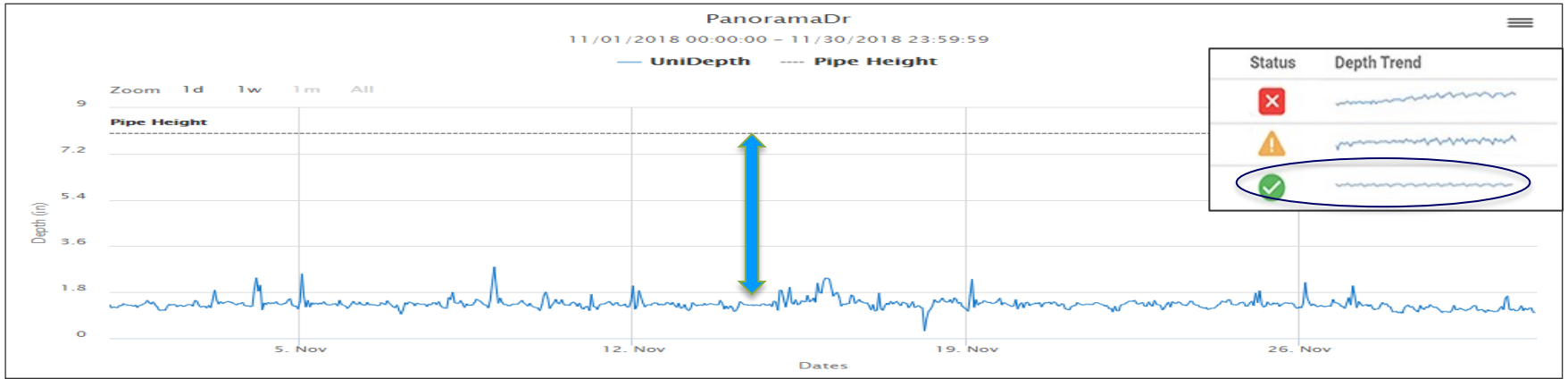
- Expected: Clean 60x (6 months x 10 sites)
- Actual: Clean 12x*
- Reduction: 48 cleanings (80%)

***Note: November all sites cleaned without necessity…**

November Cleaning Required?

Month-5: segments cleaned but *not* required *but*….
It's tough to change old habits!





Results and Return

Frequency	Scheduled Cleaning (6-months)	Actual Cleaning	Change (Reduction %)	Cost/Segment	Total Reduction
Monthly	6	1	83%	$ 400	$ 2,000
Monthly	6	1	83%	$ 400	$ 2,000
Monthly	6	2	67%	$ 400	$ 1,600
Monthly	6	1	83%	$ 400	$ 2,000
Monthly	6	2	67%	$ 400	$ 1,600
Monthly	6	1	83%	$ 400	$ 2,000
Monthly	6	1	83%	$ 400	$ 2,000
Monthly	6	1	83%	$ 400	$ 2,000
Monthly	6	1	83%	$ 400	$ 2,000
Monthly	6	1	83%	$ 400	$ 2,000
6-Months	**60**	**12**	**80%**		**$ 19,200**

Comprehensive Cost Assessment

- Cost of truck
- Insurance
- Vehicle maintenance parts and labor
- Fuel
- Tools and materials
- Personnel labor and benefits

Productivity Savings

Net Return

Year	Units	Total Cost	Annual Productivity Savings	Yearly Net Return
1	10	$36,950	$38,400	$1,450
2	10	$3,990	$38,400	$34,410
3	10	$5,990	$38,400	$32,410
3-Year Total		$46,930	$115,200	$68,270

Year 1

Purchase Hardware, Software, Comms

Year 2

Software, Comms

Year 3

Software, Comms, Battery*

Net Three-Year Return

Battery*: Conservative Calculation: 2-years for replacement

Case 2: Renton, WA

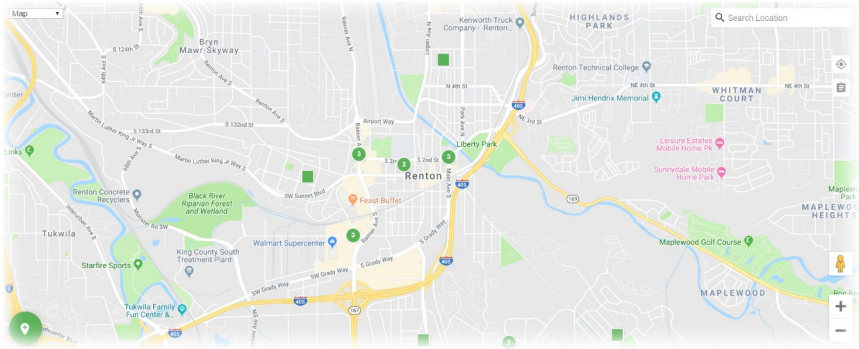
Situation

System 232 miles sewer

Process High Frequency Cleaning: weekly & monthly segments

Challenges They are unable to clean entire system

Study Scope Duration: 4-months
20 hot spots: 8 cleaned weekly, 12 monthly



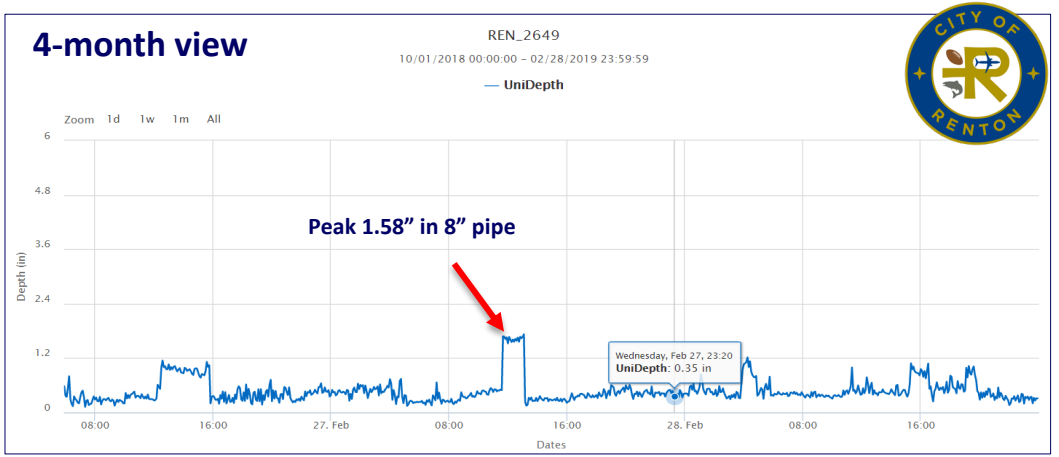
Typical *Weekly* Segment Pattern

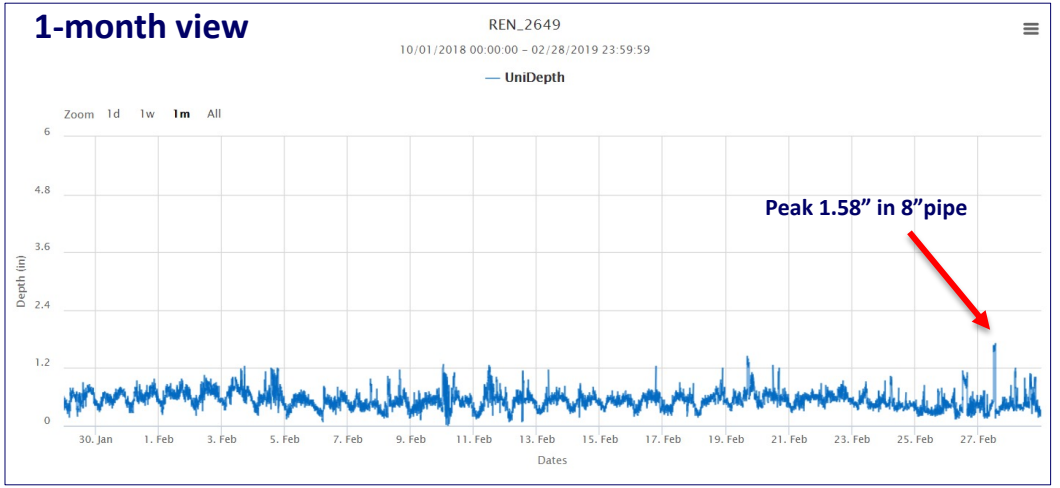
Site

Pipe Diameter:	8”
4-Month Peak Height:	1.58”
Action:	do not clean

Cleaning Frequency Change

Schedule-driven:	19
Actual:	0
Cleaning Reduction:	**100%**





Typical *Monthly* Segment Pattern

Site

Pipe Diameter: 10”

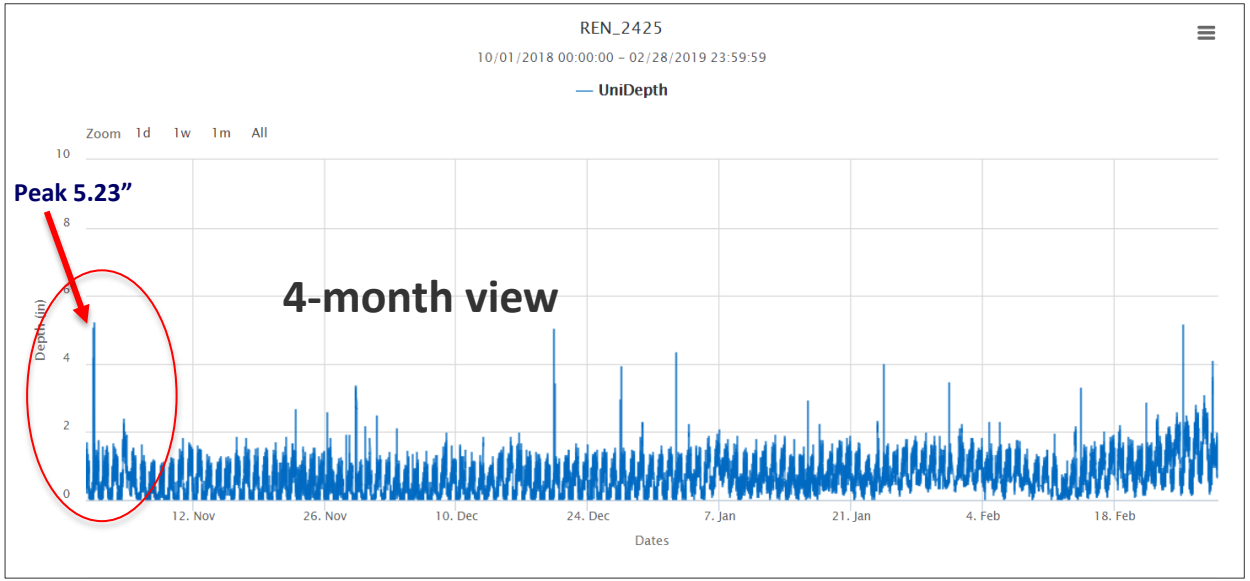
Peak Height: 5.23”

Cleaning Frequency

Schedule-driven: 4

Segment-Driven: 0

Reduction: **100%**



Renton - Results and Return

Site Name	Pipe Size	Frequency	Scheduled 4-Months	Actual	% Change	Cost/Segment	4 Month Savings
1	8	Weekly	19	0	100%	$ 400	$ 7,600
2	8	Weekly	19	1	95%	$ 400	$ 7,200
3	8	Weekly	19	0	100%	$ 400	$ 7,600
4	10	Weekly	19	0	100%	$ 400	$ 7,600
5	8	Weekly	19	3	84%	$ 400	$ 6,400
6	8	Weekly	19	2	89%	$ 400	$ 6,800
7	8	Weekly	19	0	100%	$ 400	$ 7,600
8	10	Weekly	19	0	100%	$ 400	$ 7,600
			152	**6**	**96%**		**$ 58,400**
9	8	Monthly	4	0	100%	$ 400	$ 1,600
10	8	Monthly	4	0	100%	$ 400	$ 1,600
11	8	Monthly	4	0	100%	$ 400	$ 1,600
12	8	Monthly	4	0	100%	$ 400	$ 1,600
13	8	Monthly	4	0	100%	$ 400	$ 1,600
14	10	Monthly	4	0	100%	$ 400	$ 1,600
15	8	Monthly	4	2	89%	$ 400	$ 800
16	8	Monthly	4	0	100%	$ 400	$ 1,600
17	8	Monthly	4	0	100%	$ 400	$ 1,600
18	8	Monthly	4	1	95%	$ 400	$ 1,200
19	8	3 Months	1	0	100%	$ 400	$ 400
20	8	3 Months	1	0	100%	$ 400	$ 400
			42	**3**	**93%**		**$ 15,600**
Total			**194**	**9**	**95.4%**		**$ 74,000**

Comprehensive Cost Assessment

- Cost of truck
- Insurance
- Vehicle maintenance parts and labor
- Fuel
- Tools and materials
- Personnel labor and benefits

Productivity Savings

Net Return: Renton

Year	Units	Total Cost	Yearly Productivity Savings	Yearly Net Return
1	20	$75,900	$222,000	$146,100
2	20	$7,980	$222,000	$214,020
3	20	$11,980	$222,000	$210,020
3-Year Total	$60	$95,860	$666,000	$570,140

Year 1

Purchase Hardware, Software, Comms

Year 2

Software, Comms

Year 3

Software, Comms, Battery*

Net Three-Year Return

Battery*: Conservative Calculation: 2-years for replacement

Case 3 – Large West Coast Utility

Prior Frequency	Scheduled (One Year)	Actual	Reduction	% Reduction	Cost/Segment	Productivity Savings
Monthly	12	1	11	92%	$ 595	$ 6,545
Monthly	12	1	11	92%	$ 595	$ 6,545
Monthly	12	1	11	92%	$ 595	$ 6,545
Monthly	12	2	10	83%	$ 595	$ 5,950
Monthly	12	2	10	83%	$ 595	$ 5,950
Monthly	12	0	12	100%	$ 595	$ 7,140
Monthly	12	1	11	92%	$ 595	$ 6,545
Monthly	12	2	10	83%	$ 595	$ 5,950
Monthly	12	1	11	92%	$ 595	$ 6,545
Monthly	12	2	10	83%	$ 595	$ 5,950
Monthly	12	2	10	83%	$ 595	$ 5,950
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Monthly	12	2	10	83%	$ 595	$ 5,950
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Monthly	12	2	10	83%	$ 595	$ 5,950
Monthly	12	2	10	83%	$ 595	$ 5,950
Monthly	12	2	10	83%	$ 595	$ 5,950
Monthly	12	1	11	92%	$ 595	$ 6,545
	300	**38**	**262**	**87%**		**$ 155,890**

Scope

- 12-months
- 25 monitored hot spots
- *Monthly* frequencies
- Large city, higher costs

Extras

Three SSOs prevented

Take-away

Productivity savings & SSO prevention enhance results

Case Study 3: Net Return

Year	Sites	Total Cost	Yearly Productivity Savings	Yearly Net Return
1	25	$ 87,500	$ 155,890	$ 68,390
2	25	$ 75,000	$ 155,890	$ 80,890
3	25	$ 75,000	$ 155,890	$ 80,890
3-Year Totals		**$ 237,500**	**$ 467,670**	**$ 230,170**

Year 1

Turn-Key Services

Year 2

Turn-Key Services

Year 3

Turn-key Services

Net Three-Year Return

Case 4: JEA, Jacksonville, FL

Situation

System >3,900 miles of gravity sewer

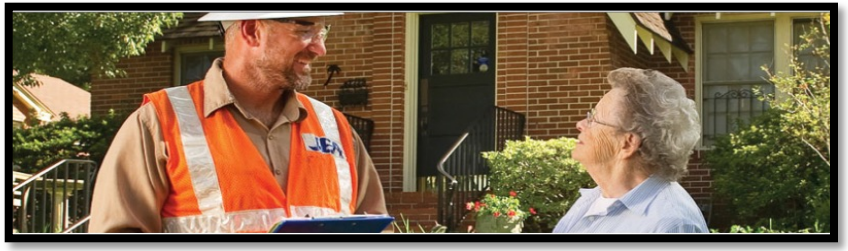
Process Regular scheduled cleaning
Quarterly, Semi Annual, Annual

Monitors 112 locations

JEA One Year Results

Frequency	# Locations	Cleaning Totals
Quarterly	70	280
Semi Annual	170	340
Annual	110	110
Scheduled Total	350	730
Actual Locations Cleaned	350	454
Reduction		276
Reduction %		37.8%
Labor Hours Saved		828
Labor Hours Cost Savings		$ 110,000
SSO Prevented	10	

JEA Take-Aways



- Smart technology enables…
  - Continuous remote site visibility
  - Drives cleaning process
- Data shared with engineering
  - Becomes resource for analytics & trends
- Added SSO prevention eliminates
  - Fines
  - Reporting and administration tasks
  - Bad publicity
- Measurable savings and return on investment

Conclusions

Optimized Cleaning with smart tech

Reduces…

- Stress on Operations
- Long-term pipe wear
- Time in the street for crews

Provides…

- Immediate performance improvement
- Fast measurable pay-back
- Opportunity to re-allocate resources
- Ongoing SSO protection
- Remote site visibility to the collection system
- Data for other purposes
- Predictability and right-frequency planning

Final Thoughts…

Ten Years Ago…

- A hypothesis was presented at the Florida Water Resources Conference
  - Could smart tech be used to drive cleaning
  - Result? No interest, just blank stairs

And since then…

Data & Results Have Transformed Hypothesis to Practice

- Hundreds of utilities employ smart tech-driven optimized cleaning overcoming:
  - Labor challenges,
  - Budget limitations,
  - Resource challenges of time

Thank You!

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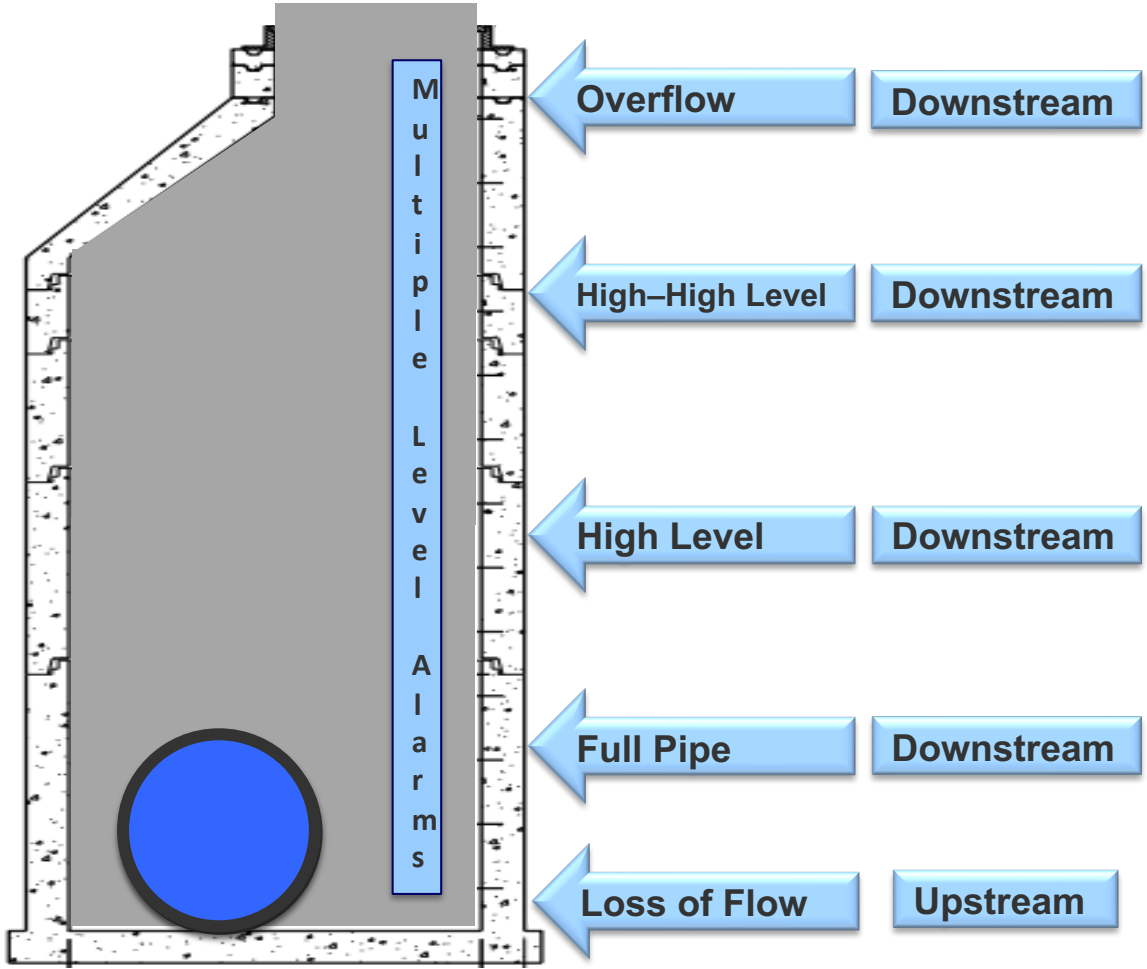
2nd Generation Technologies & Notifications

System Communication

- Multiple, redundant water level alarms
- Sensor alignment alarm / System status



Machine Learning Predicts Blockages

Key to Optimization: knowing and predicting site-conditions

- Prediction provides advanced notice - days or weeks
- Prioritization directs resources