IloT Transformation of Cincinnati MSD Collection System

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Existing Collection System

- 800,000+ Residents of Cincinnati and Hamilton County
- 290 Square Miles
- 7 Treatment Plants
- 100 Pump Stations
- 3,000 Miles of Sewers
- Treats 184 MG per day
- 7 Wet Weather Facilities
- 200+ Enumerated Overflows
Wet Weather Impacts

Southwest Ohio receives **41 inches of rain** per year...

Results in approximately **11 billion gallons of overflow** in a typical year

Led to a **$3.2B Consent Decree** to address the 200+ overflow points through:

- Pipe Upsizing, Storage
- Strategic Separation
- Green Infrastructure
- Dedicated WW Facilities
Familiar Functionality

Treatment plants are monitored, controlled and optimized through SCADA control systems.

- **Sensors**
- **Capacity Optimization**
- **Operations Visibility**
- **Networking**
- **HMI**
- **PLC**
- **Flow Meter**
Industrial Internet of Things

Mechanization → Mass Production → Automation → Cyber Physical Systems

INDUSTRIAL INTERNET: THE POWER OF 1%

Efficiency gains as small as 1% could have sizable benefits over 15 years when scaled up across the economic system.

Source: https://www.ge.com/digital/blog/industrial-internet-visual-journey
The IIoT Challenge

Why can’t the collection system be monitored, controlled and optimized similar to a treatment plant?

- Live operational state
- In-line storage utilization
- Interceptor capacity management
- Alerting and reporting
- Treatment plant influent projections
- High rate treatment facility operation modes
- Industrial waste hauling
At approximately $1¢/gal, the cost of operational optimization is significantly less than the typical price point for new wet weather infrastructure.

This isn’t a projection, this is actual program cost per gallon.
Most presentations are a lot of one topic

Today is a sample of many of the initiatives, each worthy of more detail.
No Central Control Room

The Smart Sewer system must be accessible to staff wherever they are.
Live Operational State

Schematic view of the collection system

Typical data for each SSO, CSO and manhole
Live Operational State

Many graphics for the entire collection system.

If you paste them together, you get an idea of the scale of it.

This is the Mill Creek Sewershed
In-Line Storage Utilization

- Underflow gate controls flow into interceptor
- Inflatable dam controls storage volume
In-Line Storage Utilization

Overflow Reduced by 178 MG In One Storm

1. WW Flow Begins

2. Dams Deflate to Avoid Upstream Flooding

3. Dams Remotely Reset by Watershed Operations

4. Dams Modulate to Maintain a Safe Storage Level
2-year study of 4 Wet Weather Facilities:

1\textsuperscript{st} Year, added real-time monitoring capabilities: \textbf{15\% improvement}

2\textsuperscript{nd} Year, added real-time control capabilities: \textbf{33\% improvement}
Smart Sewer system sends email and text alerts

- Overflow status
- Equipment availability
- Readiness for operation
- Internal component health
Reporting & Supporting Calculations

Raw Historical Data → Historical Data Export → SWMM Model input prep

Historian totalizing calculation → Unpack results into Historian → Execute SWMM Model

Export to Spreadsheet → MSD Review & Lab Sample Data → Agency Report Ready

Automating the data collection and processing has saved Cincinnati man-weeks of labor each month.
Treatment plant influent projections
High rate treatment facility operation modes

1.4 MG discharge prevented on one day

16 Miles

Mill Creek WWTP

Ohio River in flood stage
High rate treatment facility operation modes

Complex remote facility for storage and high rate treatment

High rate treatment and storage activated based on collection system conditions many miles away.
Reduced Impact by Prohibiting High Strength Discharge Upstream

1. Sewer begins to overflow
2. Restricted Conditions Set in SCADA
3. Visual Signal Activated at Customer’s Facility
4. Texts and emails sent to Drivers, Guards, Operators, etc.

From: <noreply@wsd.coc.local>
Date: April 17, 2016 at 5:42:11 PM EDT
To: <wwtspo@cincinnati-oh.gov>
Subject: Restricted Conditions

Conditions exist such that leachate cannot be accepted at the Recycling Facility. Please proceed to the Mill Creek WWTP.
Technical Challenges

- Flexible infrastructure
- Sensor cost, installation and configuration
- Communications methods
- Reference GIS and model data for each site
- New input data types such as radar data from external sources
- Analytical calculations
- Cleaning data methods on live system
Cloud Based Solution for Smart Sewer

- Flow Monitors
- WWTPs
- Rain Gauges
- Level Sensors
- Stream Gages
- Remote Facilities

Analysis
Historical
Live Data
Many Sensors Needed

- Partnered with EPA on a Sensor Challenge
- Conducted Pilots with Multiple Technology Providers
- Selected Best Proposal via Competitive RFP
- Standard RTU Capable of Multiple Types of Sensors, Secure Data Transfer with Buffering
- Integrates with SCADA, where its monitored, dispatching field crews as needed for maintenance
Lot's of network security configurations with VPN's, firewall rules and routing.
Managing Reference Data

- Max Hydraulic Pressure
- Top of Casting Elevation
- Overflow Depth
- Warning Depth
- Pipe crown elevation
- Max Dry Weather Depth
- Sensor zero Elevation
- Invert Elevation
Unique Data Sources

1,500+ data tags to hold individual radar cells as inputs to the system

Radar is displayed on HMI graphic and data stored in historian for further analysis
Analytical Calculations

• Overflow volume calculations using a SWMM model interface
  – Radar rainfall summation for CSO tributary areas
  – Boundary conditions based on river and stream conditions
  – “Soft sensor” application
• Historical rainfall analysis for rolling totals
  – Quick user view of storm intensity
• Availability of data from each sensor site
  – Drives maintenance activities
• Readiness of equipment
  – Aids with minimizing downtime and maximize response to wet weather
It takes a team of many
Cincinnati’s path to a Smart Sewer

- Massive Consent Decree Costs
- Affordability Concerns

New Approach
- Operational Optimization

Monitor and Control the Watershed
- Wet Weather SCADA

SMART SEWER
- Lower Environmental Impact
- Cost Savings
My dad says Smart Sewers help buy ice cream. Everyone needs a Smart Sewer!

Questions

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