A Practical Sewer Network Digital Twin
It is not a PIPE dream!

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Common Collection System Challenges

Understand, manage, and mitigate risks (including asset failure, flooding, overflows)

Respond to change – new tech, regulations, climate, COVID, political change

Manage complex, fragmented information – from assets, sensors, rain gauges, and models. Capitalize on the same, up-to-date information

Capture valuable institutional knowledge to support operational decision-making

Maintain service levels at minimum cost, by optimizing processes and use of your assets

Meet targets that are increasingly visible (e.g. financial, environmental pollution etc) & be able to report on and defend decisions
What is a digital twin?

“A digital twin is a dynamic digital representation of a real-world object or system including their behaviors using data and models that enables insights and interactions to drive actionable and improved outcomes.”

SWAN
<table>
<thead>
<tr>
<th>SCADA</th>
<th>Digital Twin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Image of Current Status</strong></td>
<td>Depicts past, present and future</td>
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<tr>
<td><strong>Primarily goal:</strong></td>
<td><strong>Primary goal:</strong></td>
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<tr>
<td>monitor and control in</td>
<td>improve and support decision</td>
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<tr>
<td>real-time</td>
<td>making by synthesizing data</td>
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<tr>
<td><strong>Typically, no modeling/advanced analytics</strong></td>
<td>Advanced analytics and modeling are integral to a digital twin</td>
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<tr>
<td><strong>Mainly used for reactive operation and maintenance</strong></td>
<td>Used for <strong>reactive</strong> and <strong>proactive</strong> operation and maintenance</td>
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</table>
How can digital twins enable efficient collection system operation?

- Proactive O&M
- Monitoring Effectiveness of CMOM Programs
- Dynamic I&I Monitoring
- Prioritizing Maintenance
- Public Notifications & Regulatory Reporting
- Asset Management
- Capacity Assessment
Leverage any existing IT infrastructure & data with digital twin to enable cross-functional teams

REPORTS
FIELD DATA
WATER QUALITY
MODEL
GIS
REVERSE 911
AMI
METERS
REPORTS
FIELD DATA
SCADA
IOT
WEATHER

Management
Automate compliance reporting
Visualize cross-department data

Operations
Streamline O&M
Proactive Overflow Management
Find equipment discrepancies

Engineering
Calibrate/Validate with ease
Plan with the latest data
Automate I&I Analysis
Plug & Play Digital Twin for Sewer Systems
Growing into using Digital Twins

1. Evaluate historical performance
   - What has happened?

2. Incorporate real-time data
   - What is happening?

3. Predict trends into the future
   - When and where will it happen?

4. Optimize responses
   - How to prioritize and automate processes?

- Use the power of AI and machine learning to recognize patterns and guide your utility to optimize operational decisions.
- Look into the future and proactively address incidents before they come up and/or simply operate more efficiently.
- Evaluate what’s happening now by bringing in real-time data streams like SCADA historian, water quality, IoT, flow meters, CMMS, etc.
- Start understanding your system’s performance with your data sets that’s available now. From GIS & hydraulic model to rain gauge to flow monitor data sets.
Automate overflow notifications
Public Notification of CSO/SSO Discharges

• Several states have passed laws or guidance on public notification of CSO/SSO discharges.
• **MA** – requires public notifications no later than 2-hours after discovery of overflow event
• **CT** – requires notification to DEEP within 2-hours of discovery of overflow events.
How can you build out automatic public notifications?

Manual Method
- Manual confirmation using overflow “blocks”
- Review meter data to approximate volume
- Rely on humans to provide updates/notifications at all hours of the day

Build Yourself/DIY
- Data Management
- API connections
- Custom code
- False positives
- Cybersecurity
- Customer Support
How do we make public notifications work?

Daily Alerts
- Smart alerts based on waterCAST Sewer calculations
- Immediately find anomalies and trouble spots

Update City Website
- Automatic updates with no human intervention
- Built-in validation

Send OnSolve emails
- Reverse 911 automated via waterCAST Sewer API
- Multilingual

Report to DEP
- Manual report
- Data from waterCAST Sewer helps populate report
- Also able to do 1-click report generation and download
Multiple methods to validate readings

- Use the hydraulic model to identify anomalies and verify overflows
- Built-in validation rules to rule out false positives
- Built-in anomaly detection alerts user about erroneous readings and malfunctioning sensors
Proactive Operations and Maintenance
Identify failing assets before they get worse (or catastrophic)

- Most sewer collapses are detected after they fail or worse become catastrophic and the road collapses.
- The following example identified sewer collapse before potential catastrophic conditions.
Data-driven insights can transform your O&M

- Software is able to detect dry-weather anomalies based on correlation with rainfall events and send out alerts
- User can quickly review and analyze location of asset and timing leading up to alert
- Send a field crew out to investigate
- Continued alerts indicated an ongoing issue.
- CCTV footage revealed a collapse in the interceptor under the road.
Use data-driven insights to perform cleaning & maintenance

- Captured and preserved maintenance effectiveness
- Reduced System-wide Interceptor cleaning inspection contract by 50%
- Gained confidence in targeting efforts only on assets in-need
Automate workflows
Automating workflows reduces time-to-action

Email Alerts to Staff
- Wet and Dry Overflows
- Level Warnings
- Anomalies
- Blockages

Workorder Notifications
- Predicted Blockages
- Sensor Malfunctions
- Assets in-need of cleaning

Regulatory Reporting
- One-stop shop for data
- Monthly Reports
- After-overflow reporting
Anomaly Detection

Long-Term

Gradual changes. Harder for human eye to see, especially in short time frame.
- Sensor drift
- Cleaning/Grease Deposition

Short-Term

More sudden changes. Easier to see in manual review, but we can improve efficiency with AI based detection.
- Sensor malfunctions
- Spike overflows
- Sewer blockages
Sensor Anomalies

- Detects 4 kinds of sensor anomalies
  - Stuck Sensor
  - No Data Reported
  - Sensor Dropouts
  - Spike Overflows (short duration overflows)
- Use anomaly detections to inform maintenance.
Use ML to detect blockages/debris

- Machine learning models provide accurate predictions
- Focused on risk mitigation and vulnerabilities for overflows
- Early notification to prevent impacts
Capacity Evaluation
Why is capacity evaluation important?

- **Save Time and Money**
  - Capacity evaluation for permit requests can cost utilities a lot of money and time.

- **Leverage Investments**
  - Leverage hydraulic models created for the utility.

- **No modeling expertise required**
  - Make hydraulic modeling easily accessible for routine tasks.
Evaluate Permit Requests Quickly

- Use the following permit request information to run a capacity evaluation.
  - location of development,
  - tie-in manhole
  - peak dry weather flow
- Choose between multiple model scenarios and design storms.
- The tool runs a hydraulic model in the background to provide results.
Review Results of your Capacity Evaluation before Approving Permits

- Review results of your capacity evaluation
- Quickly assess impact on your collection system.
Takeaways

• Digital twins can enable streamlined operations and maintenance of collection systems.
• The digital transformation journey can be accomplished by taking small steps.
• Maximizing existing IT & data investments can pay long-term dividends
  • GIS, sensors, models, CMMS, etc.
• Automating routine tasks such as overflow notifications and capacity evaluations can be a small step on the digital transformation journey
Thank again to the fantastic teams at New Bedford, MA and Hartford, CT!

Any questions?

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