Leak Detection and Water Loss Control

Maine Water Utilities
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Leak Detection and Water Loss Control

“Utilities can no longer tolerate inefficiencies in water distribution systems and the resulting loss of revenue associated with underground water system leakage. Increases in pumping, treatment and operational costs make these losses prohibitive. To combat water loss, many utilities are developing methods to detect, locate, and correct leaks.” - AWWA
Costs for Leaks

- AWWA believes the cost in the U.S. of unbilled distributed water is on the order of $1-2 billion per year. The total cost is considerably higher when factors such as property damage are included.

<table>
<thead>
<tr>
<th>% LOSS</th>
<th>MILLION GALLONS PER DAY</th>
<th>ANNUAL DOLLAR ($) LOSS – BASED ON PRODUCTION COSTS OF $0.50 PER 1000 GALLONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>$4,600</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>$9,200</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>$18,400</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>$36,800</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>$46,000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diameter of Stream</th>
<th>Gallons</th>
<th>Cubic Feet</th>
<th>Cubic Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4&quot;</td>
<td>1,181,500</td>
<td>158,000</td>
<td>4,475</td>
</tr>
<tr>
<td>3/16&quot;</td>
<td>666,000</td>
<td>89,031</td>
<td>2,521</td>
</tr>
<tr>
<td>1/8&quot;</td>
<td>296,000</td>
<td>39,400</td>
<td>1,115</td>
</tr>
<tr>
<td>1/16&quot;</td>
<td>74,000</td>
<td>9,850</td>
<td>280</td>
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</table>

A continuous leak from a hole this size would, over a three month period, waste water in the amounts shown above.
Primary Motives for Water Loss Management

- Revenue enhancement
- Conservation of water resources
- Reduced liability risk
Revenue Enhancement/Cost Reduction

- Increased efficiency = lower costs
- No unnecessary interest expense associated with capital improvement expenditures
- Better position for requesting rate increases
Conservation of Water Resources

- Water is a limited resource
  - Regulatory agencies are choosing strategy of demand management over increasing water supplies
- Avoid exceeding draw-down limitations
- Reduce need for mandatory water use limitations
Water Loss Control

Two Main Causes for Water Loss:

– Leaks
– Inaccurate Meters / Billing

These losses inflate a water utility’s production costs and stress water resources since they represent water that is extracted and treated, yet never reaches beneficial use.
Leak Detection and Water Loss Control

• Why do leaks happen?
• How do we detect leaks?
  – Technology
    • Equipment
  – Software
• Reducing Unaccounted for Water
Types of Leaks

- Service Line
- Valve Leaks
- Supply Lines
Why do leaks happen?

- Pipe Material, Composition, Age
- Jointing Methods
- Initial Installation
- Water Conditions
  - Temperature
  - Velocity
  - Pressure
- External Conditions
  - Stray Electric Current
  - Contact with other structures
  - Frost Loads
  - Freezing Soil around the pipe

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### Water Loss In Gallons

<table>
<thead>
<tr>
<th>Leak this Size</th>
<th>Loss Per Day</th>
<th>Loss Per Month</th>
<th>Leak this Size</th>
<th>Loss Per Day</th>
<th>Loss Per Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>.</td>
<td>120</td>
<td>3,600</td>
<td>.</td>
<td>6,640</td>
<td>199,520</td>
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<tr>
<td>.</td>
<td>300</td>
<td>10,800</td>
<td>.</td>
<td>6,964</td>
<td>209,520</td>
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<tr>
<td>.</td>
<td>693</td>
<td>20,790</td>
<td>.</td>
<td>8,424</td>
<td>252,720</td>
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<tr>
<td>.</td>
<td>1,200</td>
<td>36,000</td>
<td>.</td>
<td>9,585</td>
<td>296,640</td>
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<tr>
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<td>1,920</td>
<td>57,600</td>
<td>.</td>
<td>11,324</td>
<td>339,720</td>
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<tr>
<td>.</td>
<td>3,095</td>
<td>92,880</td>
<td>.</td>
<td>12,750</td>
<td>361,600</td>
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<td>4,295</td>
<td>128,880</td>
<td>.</td>
<td>14,952</td>
<td>448,560</td>
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</tbody>
</table>
The Problem of Water Loss

• Mains leak at 400 gpm:
  – Runs for 48 hours
  – Loses about 1 million gallons

• Typical service line leak:
  – Loses 1 million gallons every 3 months
  – Runs undetected for years
  – Occurs about every 700 water services
Finding Smaller Leaks Saves More Money

- A typical leak enlarges at a constant rate over a period of 24 months.

- Identifying & repairing leaks in early stages:
  - Fewer mains breaks
  - Fewer emergency repairs
  - Amount of lost water is reduced
Reduced Liability Risks

- Pipelines are a buried asset – an increasingly complex infrastructure
- Liability is significant for cities
- Upgrades by 2020 will cost up to $1 trillion (US GAO)
- Avoid dangerous & costly mains break disasters
- Avoid embarrassing public relations scenarios
HOW DO WE FIND LEAKS?

Traditional Leak Detection Methods:

– Traditional walking survey
– “Wait-till-water-appears”
– Advanced acoustic solutions
Traditional Walking Survey

- Used for 150 years
- Limited effectiveness
- Still the primary tool by most utilities
“Wait-Till-It-Appears” Method

- 400 gpm

- Cost of water lost during 48 hours up to $4,032

- PR benefits: none

Westchester County, NY
Equipment
Advanced Digital Leak Detection Solutions

- **DigiCorr** – Digital Leak Noise Correlator
- **ZCorr** – Digital Correlating Loggers
- **DLD** – Digital Leak Detector
- **MLOG** – Network Leak Monitoring
**Principals of Correlation Technology**

- Vibration energy (sound) is emitted when a leak occurs.
- The leak sound travels away from the leak site through the fluid.
Acoustic vibrations are sensed in two ways:

- Outside of pipe using *accelerometers*; and
- Within the flow using *hydrophones.*
As the sound travels in either direction through the pipe, it will arrive at each sensor at a given time. Vibration energy (sound) is emitted when a leak occurs.

The difference between the arrival time at sensor #1 and the arrival time at sensor #2 is referred to as the time delay.

The time delay is computed using a signal processing technique called correlation.
DigiCorr

- Pinpoints leaks using digital correlation technology
- Portable, 5-minute deployment
- Rapid response; surveying
• Optimized for surveying

• Leaks are detected and pinpointed overnight in a designated zone

• Automatic digital correlation analysis among all loggers
Digital Leak Detector

- Dynamic range compression
- Hears leaks where other instruments cannot
- Precise digital filters block ambient noise
- Automatic rejection of electrical interference
- Waterproof
- Lightweight (~ 2 LB)
DLD Audio Processor Unit

- LISTEN
- VOLUME
  - Software adjustable
- FILTERS
  - Digital selection
MLOG – Network Leak Monitoring

- Leak detecting sensors mounted every 10th service near the water meter
- Maintenance-free, 15 years
- AMR or Radio communications
MLOG: Intelligent Vibration Sensor

- Ultra low-cost, waterproof sensor installed near a water meter
- Maintenance-free, 15 years
- AMR interface (or own mobile radio communication)
MLOG Installation

• Mounts to small pipes using:
  – a nylon tie wrap; or
  – an ‘O’ ring

• No field setup/calibration procedure required

• Installed near the meter, on the street side
MLOG Deployment Strategy

- MLOGs installed:
  - Every 500 feet of mains on average
  - Every 10th service on average
  - Use street corners

MLOG sensors detect leak sound thru multiple pipes: sound path can be long (1,000+ feet)
MLOGs Installed Across Network

- Leak status updated automatically after each 24-hour reading:
  - Likely leak
  - Possible leak
  - Leakage unlikely
MLOG Color Map™

- MLOG Color Map shows areas of high Leak Index:
  - 2 leaks found
  - 60 gpm water saved
  - Annual value of $60,000
Silent-Running Mains Break

- Mains leak discovered by MLOG at night
- Leak undetectable during day:
  - Usage masks sound
  - Crack closes at lower pressure
- 15 gallons per minute:
  - Worth $15,000 / year
  - 8mm gallons / year
  - 1.75% of this utility’s annual production
MLOG Detects Leaks by Sound

- Leak sound began on June 21 & was detected the next morning
- Leak alarms triggered by changing sound levels and frequency:
  - Sound level
  - High frequency sound
  - Medium frequency sound
Meter Technology and Associated Leak Detection Capabilities
Can meters help?

- Smart Meters
  - Data Logging
  - Leak Detection
  - Reverse Flow
- Reading Systems
  - Software
  - Additional Tools
iPERL Intelligent Alarms

Available for reporting:

- Can detect
  - Reverse flow
  - Tamper
  - Empty pipe
  - Leak
- Lifetime alarms
  - 6 month
  - 1 month
  - Battery failure

Condition monitoring alarms

- High temperature (-30 to 160)
- Low field (magnetics)
- High current (Too much Power)
- Glide slope (battery)
- ADC failure
- Touchread failure
- EMF range (Damaged)
All alarm conditions may be logged

- Records time of event and complete alarm state of device when event occurred
  - Allows progressive conditions to be analyzed

**Datalog**

- Interval data can be stored
  - Peak flow in interval
  - Volume in interval
- Capacity for ~1500 data points
  - 49 days at 15 minute intervals
  - 12 years at 24 hour intervals
**Meter and Data Management (MDM)**

- Meter and Data Management software is used to:
  - Interface with billing software
  - Monitor consumption
  - Analyze system
  - Identify consumption trends
  - Monitor tampering
  - Assist in leak detection
  - Analyze individual accounts, groups of accounts, or entire system
Meter and Data Management

Sample reports include:

- High / Low
- Unread
- Master Report
- Non – Route
- Malfunction
- Bad Connection
- End Point Mismatch
- Consumption
MDM Software

Future Software Enhancements:

- **Leak Detection Alarm**
  - Monitors consumption over 24 hour period
  - As it transfers reading will also send an alarm flag
  - Can only be used if leak detection is purchased in the MTU itself

- **Reverse Flow Detection**
  - Works the same as the leak detection alarm
  - Will also only work if feature is purchased with the MTU

- **Installation Report**
  - Indicates that MTU message was successfully received following new installations
UFR (Unmeasured Flow Reducer)
**UFR (Unmeasured Flow Reducer)**

The UFR captures low flow water and forces it through the meter in a way that causes nearly every drop to be registered by the water meter.
How does the UFR work?
UFR – Principle of Operation

The UFR begins to operate at very low flow rates and creates pulses of flow that the water meter can measure.

Due to the change in the mode of water flow to pulses, the UFR enables the water meter to measure low flow rates.
The UFR Operating Cycle

- UFR Closed
- UFR Still Closed
- UFR Closes Again
- UFR Opens