Gull Lake Sewer + Water Authority

CONDITION ASSESSMENT OF 12” DUCTILE IRON FORCEMAIN - 33 years old

Presented by: Rich Pierson, Executive Director

piersonr@glswa.org
CONDITION ASSESSMENT OF 12” DUCTILE IRON FORCEMAIN - 33 years old

AGENDA:

- SAW - Asset Management Grant (at GLSWA - “Sharpen the SAW”)
- GLSWA - ‘Simple’ Collection System (no wwtp)- Historical perspective
- Determination of “Most Critical Asset” - 12” and 23 other ductile iron FM’s
- Methods / Challenges with inspecting force mains for Remaining Wall Thickness
- Remote Field Testing (RFT) Overview - PICA - ‘See Snake’
- Case Studies: (to determine Remaining Wall Thickness (RWT) in DI pipelines)
  - 1.94 mile 12-inch FM Inspection in Winter
  - 5 forcemains out of 23 remaining forcemains
Gull Lake Sewer + Water Authority

Condition Assessment / Investigation of 12” Forcemain
Condition Assessment / Investigation of 12” Forcemain

Gull Lake Sewer + Water Authority

Created in 1980 by the Townships of Ross, Richland, Barry and Prairieville, the Authority collects wastewater from over 2400 customers in northeastern Kalamazoo County and into Barry County, Michigan, using a network of over 50 miles of collector sewers, 36 pumping stations / forcemains and associated trunk sewers.

Wastewater is pumped to the City of Kalamazoo for treatment and final disposal.

The Authority provides complete system management, maintenance, repair and upgrades. The current service district consists of the Townships of Ross, Richland, Cooper, Village of Richland, and a portion of Charleston Township, plus the southerly portion of Barry and Prairieville Townships in Barry County.

Relatively speaking, a “Simple Sewer System” -- Relatively new: post 1982: Gravity Sewers, Manholes, Pumping Stations, Forcemains, and 2400 Connections
Gull Lake Sewer + Water Authority

Condition Assessment / Investigation of 12” Forcemain - 33 years old

- Gull Lake Sewer District - 2400 connections - Sewer only
  - 4.5 Mile long forcemain
  - Ductile iron CL-52 - Installed in 1983 - not ‘wrapped’/not cathodically protected
  - 1983 project installed Hydrogen Peroxide Vault - never used (tail end of pipe)
  - Known H2S problems 2 miles south of office - odors from Air Release Valve
  - Known H2S problems at end of pipe (4.5 miles) - odors in receiving gravity sewer
  - Pumping DOWNHILL from elevation 852 to 826 (26 feet)
  - Concern with internal corrosion of Ductile Iron Pipe
Gull Lake Sewer + Water Authority
Condition Assessment / Investigation of 12” Forcemain - 33 years old

- FM profile
GLSWA: Forcemain investigation

1982-1992
- Had odor complaints - covered manholes or added charcoal to roof vents
- No more odor complaints, out of sight, out of mind

1992 - Corrosion discovered in receiving sewer
- Found corrosion during manhole check in receiving gravity concrete sewer
- Videotaped ¾ mile of gravity concrete pipe discharging into Galesburg Trunk Sewer
GLSWA: Forcemain investigation
GLSWA: Forcemain investigation

- 1993 - Action on ¾ mile gravity
  - Slip-lining project 1993 - $203,000 for ¾ mile pipeline 18” - 24”
  - Review of Village of Augusta forcemain - 8” pvc dumping into 24” concrete pipe
  - Investigations into Galesburg (next municipality) - clay pipe, checked manholes, no observed damage
GLSWA: Forcemain investigation

- Thought the next municipality had 100% clay sewers, so no H2S damage
- Wrong! In 1980 their engineer had put ductile iron inside a casing under M-96 - this was discovered during 2016 SAW investigation.
GLSWA: Forcemain investigation

- **1992-1994**
  - Monitored receiving gravity sewer - goal of maintaining Dissolved oxygen thru FM
  - Tried Sodium Hydroxide addition at Lift Station - definitely worked, but labor intensive - (keeping wastewater in forcemain above Ph 8.2)
    - Concerned with High PH reaction on pumps, piping and wet well
  - - Tried Air addition with bubblers
    - Air locked forcemain within 30 days

- **1995-2011** Added Bioxide® feed station (nitrate product)
  - 1.2 miles upstream from discharge (from receiving sewer)
  - Focused on forcemain preservation, now that the gravity sewer was sliplined
  - $10,000 - $15,000 per year chemical costs
  - Decision to discontinue these treatments in 2011 (NPV + other testing)
  - Focus was on possible internal corrosion of our Ductile Iron Pipe
GLSWA: Forcemain investigation

Bioxide Feed Station for 12” 500,000 gal/day pipeline
GLSWA: Forcemain investigation

- 2006 - New development
  - Tied in a new 3” forcemain
  - Cut cookie - looked perfect

- 2007 - Sherman Lake pressure Sewer
  - Tied in a new 6” forcemain
  - Our 12 inch ductile iron looked perfect -
  - But.....this was an area under water, so we’d expect it to look perfect, plus at the head end
GLSWA: Forcemain investigation

- Gull Lake Board of Directors challenge - 2010 + 2011
  - 2010: Advised Board that our Forcemain from LS#1 is the Most Critical component of our system
  - 2011: We became concerned that the Authority should do more condition asm’t on Forcemains
    - We rented an electronic tester and tested wall thickness at the 15 Air Release Valves.
    - Supposed to read thickness of piping.
    - Accessed at Air Release manholes, as these were high points
    - No conclusive results, but indications that pipe was okay at high points
  - Attended 2012 WEF Collections Systems Conference
    - Reviewed Smart Ball® + Echologics® + other technologies for pipe testing - none seemed to measure wall thickness in a metal forcemain that had high and low spots
    - PICA® - Pipeline Inspection + Condition Analysis - were not at the conference
GLSWA: Forcemain investigation

- In 2012 - The Authority Board was preparing to authorize our ‘in-house’ Asset Management Plan - a five year plan
- When.....along came the SAW Grant

- SAW Grant Application
  - Budgeted $80,000 to investigate LS #1 forcemain using traditional methodologies
    - With soils analysis, excavations, cookies, etc.
  - Budgeted an additional $80,000 to investigate the remaining 23 DI forcemains.

- We were awarded a SAW Grant - $1.4 Million
  - Prein-Newhof’s Jim Hegarty forwarded GLSWA a PICA® newsletter
  - We met with PICA, received proposal, and in Aug 2014 asked DEQ to amend our budget for Condition Assessment - increase $180,000 to $426,000 Budget
GLSWA: Forcemain investigation

- We planned to do both north / south segments of FM #1 -- 2 projects

- The CHALLENGE - THE OPPORTUNITY
  - Whether to ‘Tether’ or ‘Free Swim’ the Snake
  - Forcemain pumps UP and DOWNHILL - mostly flows downhill
  - How to control the speed of the See Snake - free swimming
  - How to launch and retrieve
  - Amount to pump and haul (bypass) during the investigation
GLSWA: Forcemain investigation

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GLSWA: PICA® - See Snake Investigation

- Project scheduled for October 2014
  - August, 2014, with SAW investigation, examined retrieval manhole, discovered excessive scaling at end of forcemain
  - Attempted to clean with high pressure
    - Out came pieces of Ductile Iron pipe
  - Replacement of 240 feet at the tail end of LS #1 FM delayed project into Nov
November 17\textsuperscript{th} - 20\textsuperscript{th} - See Snake Project

November 2014 - Postponed to week of November 17\textsuperscript{th} (now known as the November Blizzard)
Out of Sight, Out of Mind, Not Out of Risk

12" Ductile Iron Forcemain Inspection in the Dead of Winter: What Possibly Could Go Wrong

Ad. Shatat, PICA Corp.
Rich Pearson, Gull Lake Sewer and Water Authority
Agenda

- Problems with inspecting force mains
- Remote Field Testing (RFT) Overview
- Introduction of RFT Tools
- Case Study:
  - 1.94 mile 12-inch FM Inspection in Winter
Problems With Inspecting Force Mains

- Difficult to take out of service due to lack of redundancy
- Pump cycles restrict consistent flows
- Access (consider static head at lift station)
- Messy
- Leaks get clogged up with effluent
- Not a lot of experience - mostly on the gravity side and not with Remote Field Testing (RFT) technology.
Remote Field Technology

- Equipped with an exciter module that emits an AC electromagnetic field.
- Energy field passes through the pipe wall, travels along the longitudinal axis, re-enters the pipe and is received by a detector array.
- Each detector in the circumferential array measures the wall thickness, creating a thickness map of the pipeline.
Graphically
Lines of Magnetic Flux

Energy Flow Path
Field Perturbations due to local wall loss

Pipe Cross Section

Liner

Pipe

Exciter

Near Field Zone

Transition Zone

Remote Field Zone

Detector
Strip chart Display & Phase-Amplitude Diagrams

Increase in wall thickness

Decrease in wall thickness
Gull Lake Sewer Water Authority
1.94 mile 12” DIP Forcemain inspection

November 16 - 20, 2014
Kalamazoo/Richland, MI
History

- Rich Pierson (Director Gull Lake Sewer and Water Authority) applied for a grant under the Stormwater, Asset Management, and Wastewater (SAW) Program, which is driven in part by safe water legislation.
- PICA was contacted by GLSWA in May 2014.
- The objective was to gain a better understanding of the condition of a 12-inch FM near Kalamazoo.
Line overview (Phase 1)

- 12 inch DIP forcemain
- 10,237 ft in length
- Multiple peaks and valleys
- Installed 1983
- Never cleaned or inspected
- Manhole discharge used as a retrieval point
Problems in the pipe

- Internal build-up and hard deposits identified in last 100’ from discharge manhole
- GLSWA attempted to clean pipe - no noticeable improvement
- Replaced final 240’ with PVC
Launch Site

- 14” launch barrel installed prior to arrival.
- Used water from a pumper truck to insert tools into the line.
- Barrel connected to the forcemain through a wye.
- Low flow rates < 1.2ft per second.
Understanding a Launcher
Pump Setup

- Two 21,000 gallon Frac Tanks setup.
- Small Flygt pump was used to bypass the lift station pumps and provide tool drive at the required flow rate.
- The Authority arranged for pump and haul of waste water during the inspection.
Cleaning and Gauging

- Cleaning Pigs took about 2 hours to complete its run.
- Looked really good.
- Launched gauge pig.
- About 15 minutes before the Gauge tool was supposed to arrive the water discharge turned very black.
- Manhole started to fill up with a thick substance.
- Couldn’t see the tool!
Due to freezing temperatures (10°F) GLSWA’s pumper truck froze so couldn’t be used

Called in local company to assist

Sludge was about 7ft deep

Almost 2500 gallons were extracted

Tool was found in manhole

SSO at Lift Station
Why all the discharge

- Since there were 3 peaks and valleys and normal flow was low (<1.2 feet/sec), it was summarized that there was not enough flow to move silt through the pipeline.
- The gauge plates indicated no bore restrictions.
- After the gauge run GLSWA now has a really clean pipe!
Inspection - Launch

- Planned launch the following day at 5 pm - taking advantage of lower demands
- Winter is still here!
Launch - First Attempt

- Used pumper truck to launch tool.
- Tool moved out of launch barrel quickly.
- An EM interference source (suspected to be the pumper truck) prevented local tracking of tool.
- Tool hung up in the launch wye and needed extra push.
Inspection Launch

- Launched again the next day.
- Changed the inspection frequency to eliminate EM interference.
- Thawed out pressure gauge and flange hardware using truck exhausts.
- Tool hung up briefly in the launch wye; the Lift Station pumps were used to give it a nudge.
- Started above ground tracking of tool to monitor tool velocity.
- Tool accelerated for about 300 yards then settled on target inspection speed.
**Inspection - Tracking - at night**

- Stakes were placed every ~500 feet
- Since it was a rural road at night with poor visibility two trucks were used for traffic control.

<table>
<thead>
<tr>
<th>ACM # 426</th>
<th>ACM # 416</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location/Media</td>
<td>Location/Media</td>
</tr>
<tr>
<td>Staked Passage Date</td>
<td>Staked Passage Date</td>
</tr>
<tr>
<td>Latitude</td>
<td>43°49'40.82&quot;N</td>
</tr>
<tr>
<td>Longitude</td>
<td>85°34'23.17&quot;W</td>
</tr>
<tr>
<td>Approximate cumulative distance from launch site (from G-arc)</td>
<td>6446 ft</td>
</tr>
<tr>
<td>Location/Media</td>
<td>Deep Crossing</td>
</tr>
<tr>
<td>Staked Passage Date</td>
<td>05/01/2023</td>
</tr>
<tr>
<td>Latitude</td>
<td>43°49'40.82&quot;N</td>
</tr>
<tr>
<td>Longitude</td>
<td>85°34'23.17&quot;W</td>
</tr>
<tr>
<td>Approximate cumulative distance from launch site (from G-arc)</td>
<td>6446 ft</td>
</tr>
</tbody>
</table>
Inspection - Arrival

- Approximately 8 hours later the tool arrived in good shape at the manhole
- GLSWA crew know their fishing.
Pipeline Inspection Summary:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Quantified Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection Length</td>
<td>10,033.28 feet (1.9 miles)</td>
</tr>
<tr>
<td># of pipe sections</td>
<td>565 (including 16 PVC sections)</td>
</tr>
<tr>
<td># of analyzed pipe sections$^1$</td>
<td>544 (excludes PVC and 5 pipes that are too short to analyze)</td>
</tr>
<tr>
<td>Average Wall Thickness</td>
<td>93% (excludes PVC)</td>
</tr>
<tr>
<td># of pipes without localized wall loss</td>
<td>189</td>
</tr>
<tr>
<td># of pipes with localized wall loss</td>
<td>355</td>
</tr>
<tr>
<td># of pipes in good condition ($\geq$65% NWT)</td>
<td>169</td>
</tr>
<tr>
<td># of pipes in fair condition (40–64% NWT)</td>
<td>171</td>
</tr>
<tr>
<td># of pipes in poor condition (&lt;40% NWT)</td>
<td>15</td>
</tr>
<tr>
<td>Total # of wall loss indications</td>
<td>1066</td>
</tr>
<tr>
<td>Total # of near TH (&lt;20% NWT)</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 1: Inspection Summary
## Pit breakdown

<table>
<thead>
<tr>
<th>Classification</th>
<th># of pits in each category</th>
<th>% of total pipeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow (≥ 65% RW)</td>
<td>692</td>
<td>65%</td>
</tr>
<tr>
<td>Medium (40 - 64% RW)</td>
<td>358</td>
<td>33%</td>
</tr>
<tr>
<td>Deep (20% - 39% RW)</td>
<td>13</td>
<td>1%</td>
</tr>
<tr>
<td>Advanced (&lt; 20 RW)</td>
<td>3*</td>
<td>&lt;1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1066</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

*Two advanced pits confirmed as air release valves with stainless steel nipples.*
Pit distribution

Defect Scatter Graph

Remaining Wall in % of nominal

Distance along FM [ft]
Pits by clock position
<table>
<thead>
<tr>
<th>Pipe No.</th>
<th>Pipe Location</th>
<th>Tavg RW (%)</th>
<th>Circumferential Wall Thickness</th>
<th>Local Wall Thickness</th>
</tr>
</thead>
</table>

- Clock positions are referenced with a North to South perspective (e.g., 3:00=West, 9:00=East).
- Entries in grey are PVC pipes.

<table>
<thead>
<tr>
<th>Start (ft)</th>
<th>End (ft)</th>
<th>Length (ft)</th>
<th>Tcircmax RW (%)</th>
<th>Tmin1 RW Location (ft)</th>
<th>Tmin1 Clock Position</th>
<th>Tmin2 RW Location (ft)</th>
<th>Tmin2 Clock Position</th>
<th>Tmin3 RW Location (ft)</th>
<th>Tmin3 Clock Position</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>5030</td>
<td>8947.62</td>
<td>8965.72</td>
<td>18.10</td>
<td>93%</td>
<td>99%</td>
<td>85%</td>
<td>24%</td>
<td>8953.66</td>
<td>9:00</td>
<td>45%  8959.47 6:30</td>
</tr>
<tr>
<td>5040</td>
<td>8965.72</td>
<td>8983.82</td>
<td>18.10</td>
<td>89%</td>
<td>100%</td>
<td>83%</td>
<td>32%</td>
<td>8969.87</td>
<td>10:30</td>
<td>34% 8971.20 1:30</td>
</tr>
<tr>
<td>5050</td>
<td>8983.82</td>
<td>9002.08</td>
<td>18.26</td>
<td>100%</td>
<td>100%</td>
<td>99%</td>
<td>25%</td>
<td>8986.27</td>
<td>3:30</td>
<td>51% 8991.45 5:00</td>
</tr>
<tr>
<td>5060</td>
<td>9002.08</td>
<td>9020.26</td>
<td>18.18</td>
<td>90%</td>
<td>96%</td>
<td>86%</td>
<td>53%</td>
<td>9019.27</td>
<td>0:30</td>
<td>57% 9009.65 5:00</td>
</tr>
<tr>
<td>5070</td>
<td>9020.26</td>
<td>9037.79</td>
<td>17.53</td>
<td>93%</td>
<td>104%</td>
<td>84%</td>
<td>59%</td>
<td>9022.09</td>
<td>10:30</td>
<td>74% 9027.60 2:00</td>
</tr>
<tr>
<td>5080</td>
<td>9037.79</td>
<td>9055.88</td>
<td>18.09</td>
<td>92%</td>
<td>99%</td>
<td>84%</td>
<td>57%</td>
<td>9046.69</td>
<td>11:30</td>
<td>62% 9048.51 10:30</td>
</tr>
<tr>
<td>5090</td>
<td>9055.88</td>
<td>9074.08</td>
<td>18.20</td>
<td>92%</td>
<td>100%</td>
<td>86%</td>
<td>32%</td>
<td>9059.39</td>
<td>6:30</td>
<td>58% 9068.01 6:30</td>
</tr>
<tr>
<td>5100</td>
<td>9074.08</td>
<td>9091.89</td>
<td>17.81</td>
<td>93%</td>
<td>104%</td>
<td>84%</td>
<td>49%</td>
<td>9082.58</td>
<td>0:30</td>
<td>56% 9081.07 1:30</td>
</tr>
<tr>
<td>5110</td>
<td>9091.89</td>
<td>9109.99</td>
<td>18.10</td>
<td>93%</td>
<td>103%</td>
<td>84%</td>
<td>49%</td>
<td>9100.88</td>
<td>5:00</td>
<td>54% 9101.47 6:00</td>
</tr>
<tr>
<td>5120</td>
<td>9109.99</td>
<td>9128.28</td>
<td>18.29</td>
<td>93%</td>
<td>101%</td>
<td>85%</td>
<td>58%</td>
<td>9114.38</td>
<td>9:30</td>
<td>61% 9116.50 12:00</td>
</tr>
</tbody>
</table>

Example of measured corrosion around 9000ft.
Displayed the old fashioned way
Data for Pipes 2660 and 2840

Pipe 2660 - Localized pitting at 6:00 o’clock
27% Remaining

Pipe 2840 - Localized pitting at 10:00 o’clock
34% Remaining
Dig Verifications

Figure 8: picture of exposed pipe with pit detected
Next Steps

Short Term:
* Replace last 1,000 ft.
* Address pipes #2660 and #2840 with deep pitting at 4726.6ft and 5052.7ft - scheduled for May 2017.
* Potentially have a look at pipes 2640 and 2850 at the same time.

Longer term:
* South 2 miles: Decided that with replacing the last 1,000 feet, plus excavation and banding pipes 2660, 2840, 2640 + 2850, we will leave this 33 year old pipe in the ground for another 15 years, then replace with HDPE or equiv.
* North 2 miles: Based on the southerly PICA results, we cancelled PICA® on the North ½ and plan to replace the north 2 miles in 10 years
# Summary of costs for 10,000 feet 12”

**Grand Total of Totals: $169,699**

<table>
<thead>
<tr>
<th><strong>PICA</strong></th>
<th><strong>GLSWA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deposit</strong></td>
<td>$2,500</td>
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<tr>
<td><strong>Mobilization</strong></td>
<td>$11,260</td>
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<tr>
<td><strong>Investigation/Report</strong></td>
<td>$69,100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$82,860</td>
</tr>
<tr>
<td><strong>GLSWA</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Engineering</strong></td>
<td>$8,919</td>
</tr>
<tr>
<td><strong>Launch Barrel</strong></td>
<td>$16,667</td>
</tr>
<tr>
<td><strong>Terra - Bypass/Haul</strong></td>
<td>$26,425</td>
</tr>
<tr>
<td><strong>GLSWA</strong></td>
<td><strong>$34,829</strong></td>
</tr>
<tr>
<td><strong>Parts + Pieces</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Staffing</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Verification Digs</strong></td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$86,840</strong></td>
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</table>