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A Tale of Two Inspections: Using Condition Assessment to Manage Force Main Assets

Chris Garrett, PICA Corp., Miami, FL
Dennis Dineer, Donohue & Associates, Milwaukee, WI

1. ABSTRACT

The Milwaukee Metropolitan Sewerage District (MMSD) services 1 million people throughout the Milwaukee area. Along with operating two main Water Reclamation Facilities, the District is charged with the maintenance of the supporting pressurized pipe systems. With the help of engineering firm Donohue and Associates, MMSD has comprehensively inspected two different pipelines by combining the services of PICA's electromagnetic SeeSnake tool and Corrosion Control Technologies' pipeline characteristic diagnostics.

The first pipeline inspected was a 12 inch diameter ductile iron processed water line that transferred effluent between Reclamation Facilities. The portion inspected stretched approximately 2,900 feet and was inspected using a free-swimming tool. Challenges included gaining access to the pipeline and achieving the required flow rates. Post inspection soil verification digs in key locations are scheduled in the near future and their results will be incorporated into the conference presentation.

The second pipeline inspected was a 24" ductile iron force main that is used to relieve capacity issues on the system at large during heavy rain events. Approximately 2,800 feet was inspected using a tethered method using winches. Challenges included timing the inspection with local weather forecasts, preparing the pipeline and retrieving the tool from a manhole. Rehabilitation options are currently being proposed to the District and will be included in the conference presentation.

The goal of this paper is to discuss the unique logistical challenges of each inspection, how these inspection results are being used to drive rehabilitation decisions, and ultimately to discuss the cost-effectiveness of these technologies.

2. INTRODUCTION

The MMSD serves 28 municipalities in the region (approximately 1.1 million people – see Figure 1). Part of MMSD responsibilities includes the maintenance of their pressurized pipes. The District has initiated a condition assessment plan for their pressure sewer assets using a variety of inspection technologies. This paper discusses the District's successful implementation of the PICA SeeSnake inspection tool through two pipelines with different diameters.

To undertake inspection of the 12 inch diameter, 2,900 feet long ductile iron pipe, two access chambers were needed to be installed along the pipeline in order to insert and retrieve the free swimming inspection tool. In addition, cleaning of this force main was undertaken prior to the inspection.

To undertake inspection of the 24 inch diameter, 2,800 feet long ductile iron pipe a tethered inspection was required. Access was established at two pre-existing structures with minimal pipe modifications required.

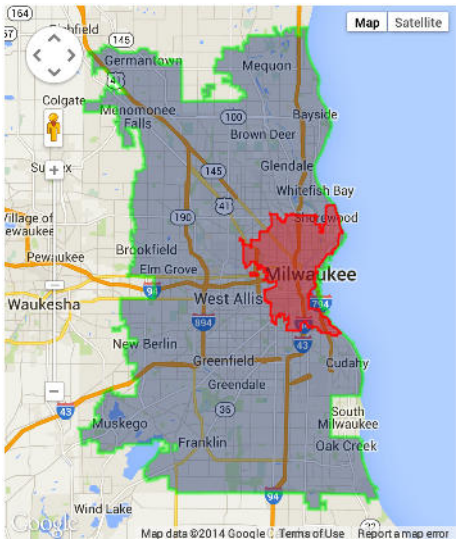

Figure 1. MMSD Coverage Area[1]

3. PROJECT ONE OVERVIEW: FREE-SWIMMING INSPECTION OF 12" DUCTILE IRON PIPE

During the winter of 2012, MMSD retained the engineering services of Donohue & Associates Inc. ("Donohue") to manage the inspection program for the 12 inch diameter ductile iron pipeline. This force main is one of four parallel pipelines that transfer fluid between the South Shore Treatment Plant and the Jones Island facilities. During 2010 one of the four pipelines had a failure and this event helped accelerate MMSD's inspection program. The purpose of this inspection was to obtain internal pipeline integrity and corrosion information on this pipeline.

Installed in 1986, this process waterline transmits effluent between Reclamation Facilities. The ductile iron cement mortar lined pipeline had an external polywrap and is outfitted in certain sections with impressed current cathodic protection. The inspected portion began near the reclamation facilities pump station and concluded in a field 3,000 feet away (see Figure 2).

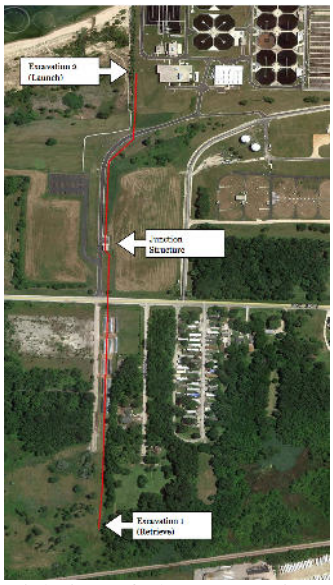

Figure 2. Arial view of Phase One's inspection area

Donohue recommended undertaking a condition assessment inspection of the ductile iron pipe to understand the extent of any metallic wall loss throughout the 3,000 foot pipe, and extraction of soil samples in various locations along the route in order to understand the active corrosion within the native soils. After a review of the as-built drawings, it was clear that a direct condition assessment could be obtained using an electromagnetic inspection tool that would be deployed through the pipeline in a free-swimming manner. Also as a part of this inspection program, soil borings and cathodic protection would be analyzed.

Donohue's extensive project team consisted of the following companies, including Grunau Company, pipeline cleaning company, Flowmore Services, pipeline inspection company, PICA Corporation, and corrosion analysis specialists, Corrosion Control Technologies Inc.

Grunau Company excavated and located the existing pipeline and installed temporary launch and receive stations (Figure 3). They also provided general field support including heavy lift capability and valve operation.

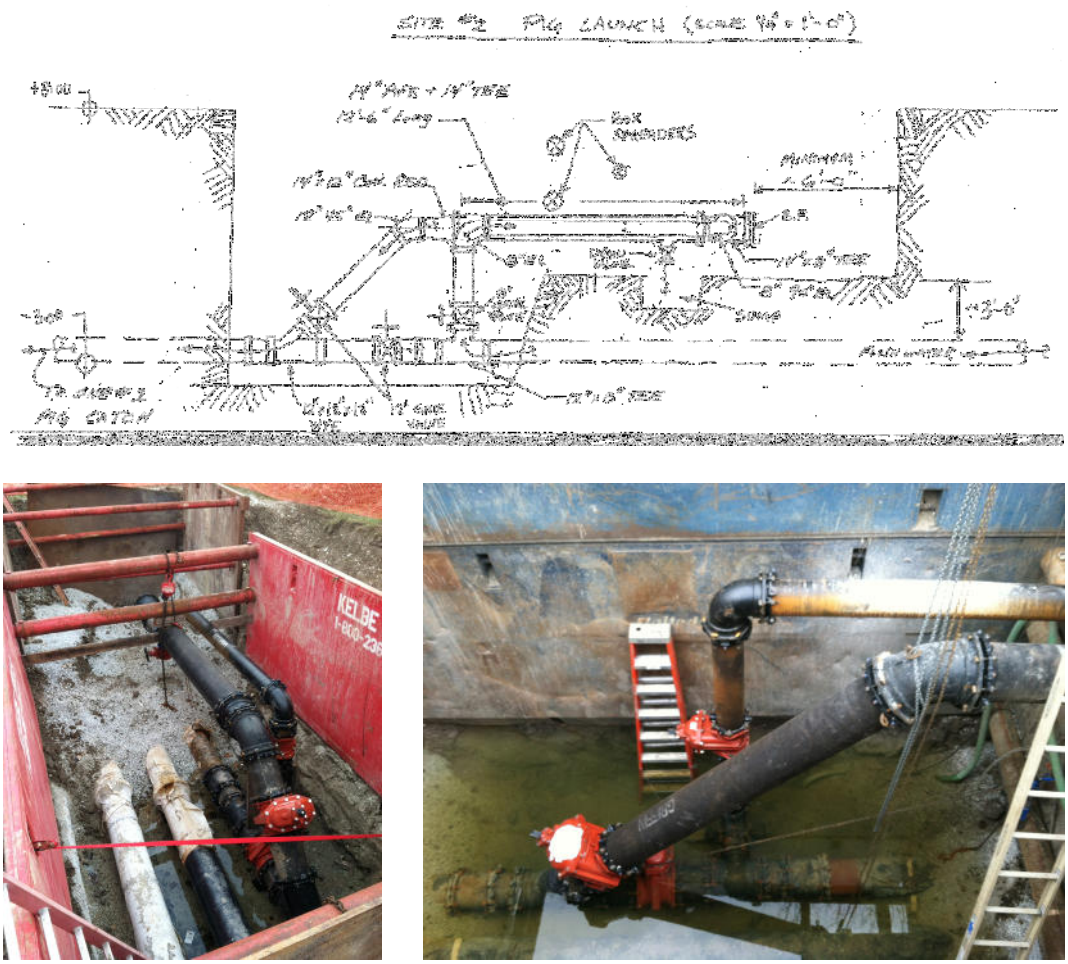

Figure 3. Sketch of launch modifications (top); Launch facility (bottom-left); Receive facility (bottom-right)

Flowmore Services specializes in pipeline cleaning and bore proving. This is accomplished by sending a series of progressively more aggressive foam swabs through a pipeline. These swabs are propelled by the flow of the pipeline. The purpose of this step was twofold. First, regular pigging of a pipeline will improve flow characteristics and prevent unnecessary build-up and blockages within the pipe. Flowmore's work was also required to ensure that the electromagnetic inspection tool could safely traverse the pipeline.

Donohue brought in PICA Corp. who specialize in the inspection of metallic pipelines using their patented SeeSnake inspection tool. The tool uses an electromagnetic technology to measure metallic wall loss of a pipe. This is accomplished by measuring changes in the electromagnetic signal as it passes through the pipe. Pipe defects are reported with respect to defect depth, axial location and clock position. The SeeSnake tool is propelled in a similar fashion as the cleaning pigs (Figure 4), albeit at a slower speed. The SeeSnake was chosen for this inspection because of the comprehensive data provided relative to other available technologies. MMSD required detailed pipeline condition assessment information because the 2010 failure on the parallel pipeline raised doubts about the condition of the other pipelines in the area.

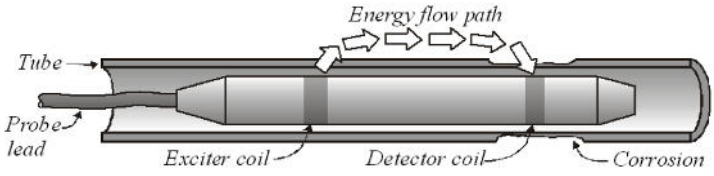

Figure 4. Illustration of the electromagnetic technology used by the SeeSnake (left); the 12" SeeSnake prior to launch (right)

Corrosion Control Technologies are corrosion specialists who assess soil samples, cathodic protection and anode systems and other pipe characteristics to generate life expectation models and make pipeline extended life recommendations.

4. PROJECT ONE: INSPECTION PROCESS AND RESULTS

During a live inspection on November 13th, 2012, PICA's SeeSnake tool was loaded into the launch barrel and propelled 2,900 feet, using the native effluent. Valves at the pump station controlled the deployment speed. After approximately 3 hours of travel, the tool arrived at the receiving location and was extracted from the pipeline. A data quality check was performed and the crews subsequently demobilized. The purpose of the data check is to verify data information collected from the tool is accurate and can be downloaded for further analysis, rather than demobilizing the tool and finding out later that the data is corrupted.

The analysis of the inspected portion of the 12" pipeline indicated the line was in generally good condition – over half of the pipes had a minimum remaining wall thickness greater than 75% of nominal wall thickness. Only 22 of the 155 analyzed pipes were in "poor" condition with a region where the minimum wall is thinner than 50% of nominal. One through-hole defect was identified at 307 feet from the launch location.

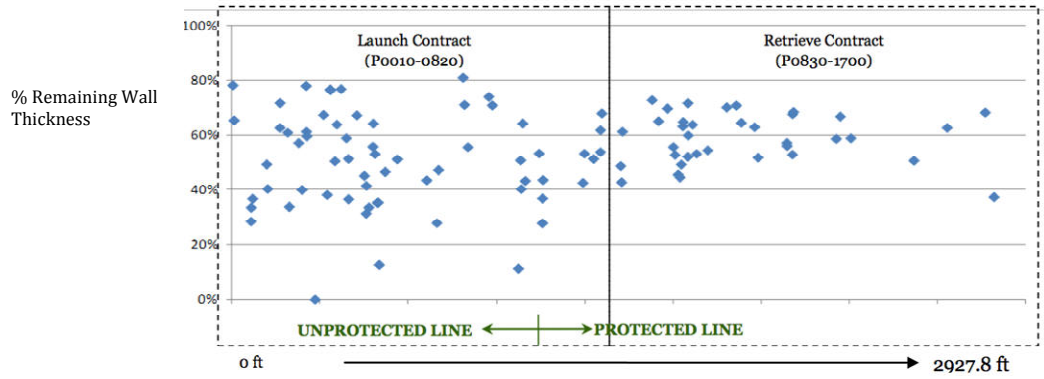

Figure 5. Graphical representation of the data from the 12” inspection. Blue diamonds denote registered defects.

5. PROJECT TWO OVERVIEW: TETHERED INSPECTION OF 24” DUCTILE IRON PIPE

In the winter of 2013, MMSD conducted another successful direct condition assessment inspection for the 24 inch diameter ductile iron forcemain. Installed in 1984, this large diameter forcemain is used only during wet-weather events to provide adequate redundancy in the system. For that reason, the line only operated 86 days in 2012, cycling 58 million gallons. The on/off nature of the pipeline catalyzed MMSD to inspect.

MMSD considered multiple technologies to inspect this pipeline, including leak detection, average wall measurements and remote field. With the SeeSnake’s success on the previous years 12” pipeline, MMSD decided to again employ that technology. The pipeline totaled 2,800 feet, running from the pump station at Greenfield Park to a manhole where the line transitions to gravity (Figure 6). The SeeSnake tool was launched out of the pump station basement and received out of the manhole. Because the forcemain is needed during wet-weather events, the fieldwork had to be carefully coordinated around the weather forecast.

Figure 6. Arial of Project Two (left); Receive manhole with winch and operator (right)

The approach to the inspection of the 24 inch diameter line was very similar to the 12 inch diameter line (metallic loss measurements, soil analysis, corrosion report) with one major difference. Whereas the 12 inch diameter was performed in a free-swimming manner, the 24 inch diameter line was inspected using winches and tethers.

PICA Corp acted as the prime contractor for this inspection, with a team consisting of: Donohue and Associates Incorporated (engineering report), MidCity Plumbing and Heating (construction work); National Power Rodding Corporation (CCTV work and laying a cable through the pipeline); and Corrosion Control Technologies Inc. (corrosion report).

In order to inspect the pipeline via tethered approach, the project team had to figure out how to get the initial tagline through the pipe. National Power Rodding Corp. was brought onto the team because of their unique ability to use

CCTV tractor-crawlers over long distances. While their primary task was to tag the pipeline, an added benefit would be the CCTV video. The video depicted an internal environment that was relatively clean and would not require any additional cleaning prior to the SeeSnake inspection. National Power Rodding demobilized from site, but not before tying off the tagline to the inside of the pipeline.

6. PROJECT TWO: INSPECTION PROCESS AND RESULTS

PICA mobilized to Milwaukee in November 2013. Once the pump station was locked out, MidCity began disassembling pipe within the pump station. National Power Rodding's tagline was still safely secured in place and PICA was able to attached their SeeSnake tool and being inspection (Figure 7).

Figure 7. Pump station piping under normal operations (left); Station modifications and SeeSnake during inspection interval

On November 19th 2013, crews mobilized to site at 7:45am and began work. The inspection itself required approximately 3 hours and crews left site before 4pm. On November 20th, the pipeline was re-inspected at a different frequency. Again, crews mobilized at 7:45am and were off-site before 3pm.

The analysis of the data collected from the Greenfield Park 24" force main indicates that the line is in "fair" to "good" condition. 36% of the analyzed pipes are in "poor" condition (<50% RW), 27% are in "fair" condition (50-74% RW) and 37% are in "good" condition (>75% RW). A total of four through-holes or near perforations were observed (Figure 8).

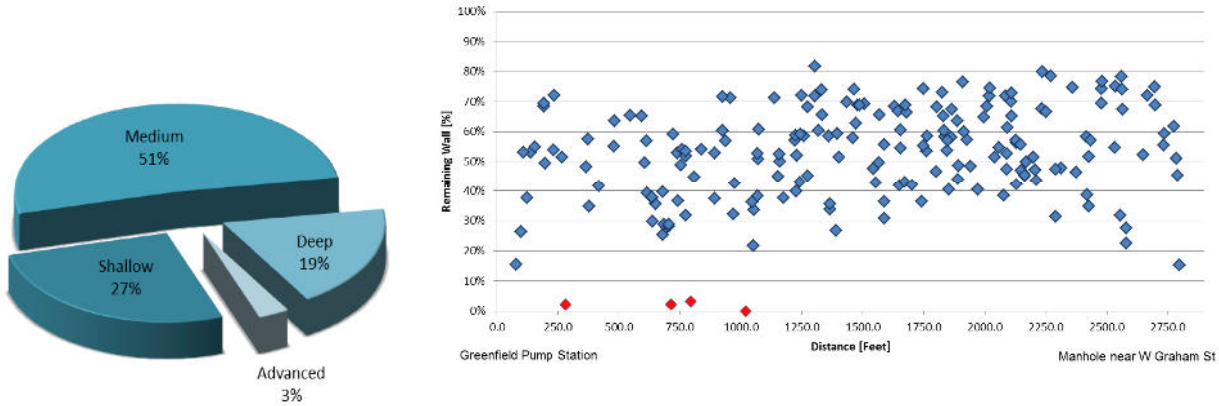

Figure 8. Pit depth distribution (left); location and depth of each pit with red diamonds signifying advanced corrosion (right)

7. COMPARING THE TWO PROJECTS AND THEIR CHALLENGES

The default approach for condition assessment projects less than 3,000' is to use a tethered SeeSnake. This approach was employed for the 24" inspection with success. The two greatest challenges for Project 2 were getting the initial tagline in place and scheduling the work around Mother Nature. National Power Rodding's crawler provided the ability to lay the tag line while also capturing video. It is likely that their services will be used again in the future.

Scheduling the 24" work required flexibility from all parties. Donohue and Associates would check the weather forecast up to 10 days in advance. While the SeeSnake work was performed, the weather was crisp, but dry. A wet-weather system was approaching as crews demobilized, but with only one pipeline to inspect, the crews completed their work safely.

Project One was originally scheduled to take place at a different location within the MMSD system. The original pipeline was confirmed to have significant blockage and would likely need significant cleaning, so a free-swimming approach was planned. After significant field reconnaissance, it was ultimately decided that the original pipeline was not a good candidate because the extent of the blockage was not well understood. A new pipeline was selected and the original free-swimming approach applied. In hindsight, a tethered approach could have been initiated on the Phase 1 pipeline. It would have been a less expensive approach. Alas, the significant blockage on the original line provided enough institutional momentum to continue on with a free-swimming inspection.

By opting for a free-swimming approach, the necessary launch and receive pipe modifications were made during neatly scheduled outages. The free-swimming inspection did require cleaning of the pipeline and added perhaps $75,000 to the total inspection cost. Going forward it is recommended that MMSD employ tethered approached on line less than approximately 3,000' and opt for free-swimming approaches for the longer pipelines where economies of scale are more easily captured.

8. CONCLUSION

When choosing between a tethered and a free-swimming condition assessment approach, there are many factors to consider outside of simply the pipeline's length. Project One and Project Two would both traditionally be designated for a tethered inspection, but institutional momentum and unknown pipe characteristics lead one project to deviate from the standard approach. While this deviation did add the need to build launch and receive facilities larger than what is typically required for a tethered inspection, and the free-swimming approach had the added cost of cleaning the pipeline. These added costs needed to be measured against the lessons learned and the need to provide control of an unknown internal pipe environment.

Having now conducted both free-swimming and tethered inspections, MMSD is well position to weigh the costs and benefits of each approach for future inspections.

9. REFERENCES

1. MMSD website; http://www.mmsd.com/about/about-us