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Leveraging Condition Assessment to Improve your Asset Management Plan

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1. ABSTRACT

In the summer of 2012, the City of Mount Pleasant, South Carolina hired Brown and Caldwell and PICA to perform a pipeline inspection of 4,200' of 16" Ductile Iron waste water force main. Much of this project was presented at the 2013 NASTT No-Dig in Sacramento, CA. While last year's paper was well received and garnered many follow-up questions, it was limited to describing one isolated inspection. This year's paper focuses not on a singular inspection, but on how the number of inspections can be increased to truly leverage emerging technologies for enhanced asset management.

We begin with a look at the verification of previous years' field work. This was an important step because the City wanted to verify that PICA's SeeSnake was delivery what was being reported. Next, we describe the process of how the City selected the next year's batch of pipelines to be inspected. In 2012, PICA inspected one line. By the end of 2013, PICA is scheduled to complete inspection of 2 more sections (~28,000') of critical 12" pipe. In 2014 (and possibly by the time No-Dig commences), another ~25,000' is under consideration.

This paper will very briefly describe the field work associated with these inspections. The crux of the paper focuses on why these pipelines were chosen for inspection, how the resulting data affects their future pipeline budgeting and ultimately the effectiveness of this level of comprehensive condition assessment.

2. INTRODUCTION

In the summer of 2012, Mount Pleasant Water (MPW) conducted an inspection of a 16" Ductile Iron force main using PICA's SeeSnake inspection tool. The results of the inspection allowed MPW to more effectively utilize money that had been allocated for rehabilitation of their existing pipeline. This paper briefly discusses the inspection that took place in 2012 and focuses on the aftermath of how the inspection information was used.

Mount Pleasant is located just across the Charleston Harbor from Charleston, South Carolina. With a population of 70,000 people, MPW manages 458 miles of wastewater pipes. It has two treatment plants with an average daily flow of 6.5 MGD combined and a capacity of 9.67 MGD.

Like many other utilities, Mount Pleasant Waterworks, did not give a lot of thought to its force main network system. That was until late 2009 and early 2010, at which time two force main breaks occurred. After these breaks, MPW used force main attributes information from the GIS to start its Force Main Asset Management Program.

Once this information was compiled and limited analysis was performed, MPW realized it needed to be educated on the Condition Assessment tool available to further its Asset Management Program.

MPW hired Brown and Caldwell to develop a Force Main Condition Assessment Guidance Document. The main purpose of the Guidance Document was to review the inventory of force mains, conduct a risk assessment, initiate a pilot program of the condition assessment tools on the market and provide recommended cost estimates for the implementation of a condition assessment program verse a typical replacement program. Prior to the Guidance Document MPW was budgeting approximately $300,000 annually for force main rehabilitation and replacement work. The recommendations of the Guidance Document based on the 10 highest risk force mains was a replacement cost of nearly $4M or a condition assessment program cost of $500,000.

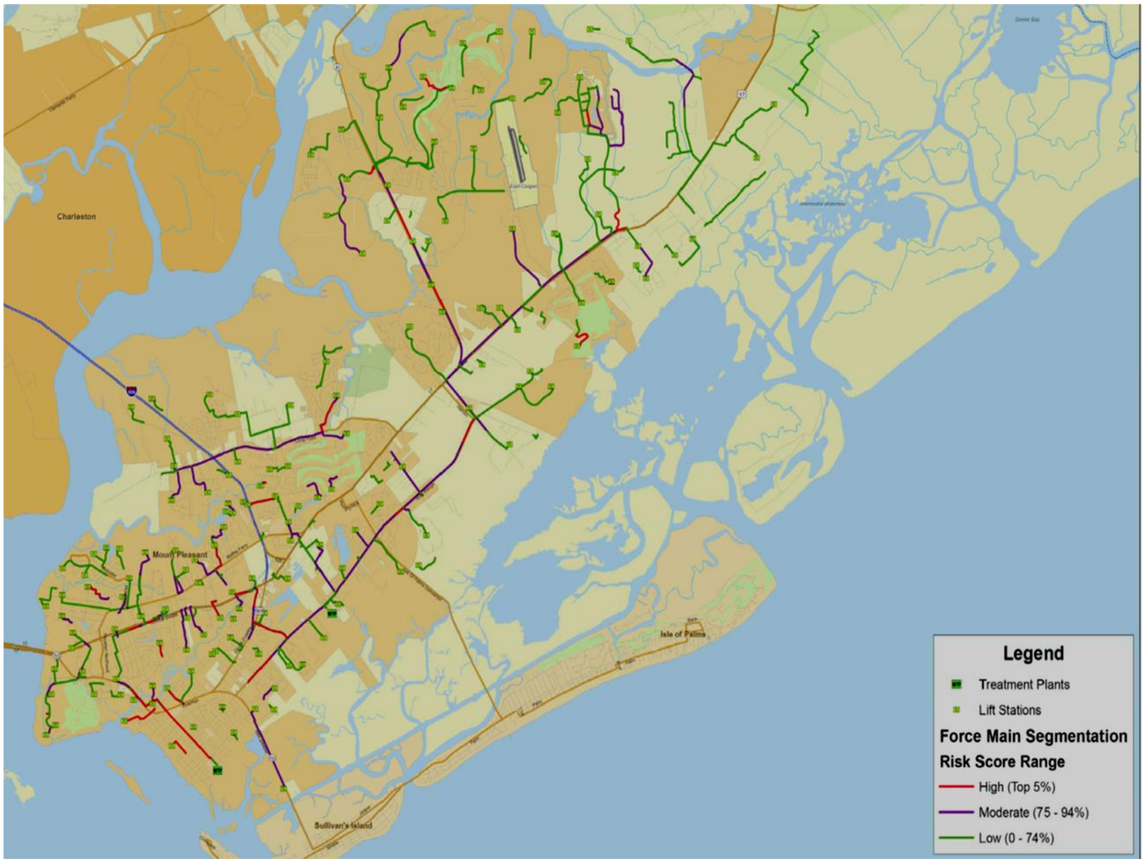

Figure 1: An overview of the MPW force main system, scored for Risk Ranking Prioritization

To confirm the benefits of the assessment program a pilot program was implemented using six different technologies; laboratory analysis, CCTV, ultrasonic, broadband electromagnetic and remote field eddy current (PICA – SeeSnake). Each technology had benefits and limitations. However, dollar for dollar the SeeSnake provide the best return on investment.

This project was a joint effort between the engineering and field staff of Mount Pleasant Water, engineering staff at Brown & Caldwell and field and engineering staff at PICA Corp.

3. INSPECTION PROCESS

The Guidance Document highlighted the 16" Simmons Rd. force main as a good candidate for inspection. The force main was assigned a high likelihood of failure as it had already experienced six crown corrosion failures. Similarly, the consequence of a large failure could lead to significant effluent spillage and inconvenience for large clients.

Figure 2: Approximation of the MPW Risk Ranking for the Simmons Road FM.

PICA was hired to employ their patented SeeSnake tool. The tool measures changes in an electromagnetic field to locate and size different pipe features, including pitting and general wall loss. Ultimately 4,200' of MPW pipe was inspected in two sections. The first section spanned ~2,940 feet from the intersection of Mill and Lucas to the intersection of Simmons Road and King Street. The second section spanned ~1,355 feet from the intersection of Simmons Road and King Street to the intersection of Simmons Road and Atlantic Street (see Figure 3). For each section, the line was emptied and the tool was pulled through using winches. While it is not necessary to dewater lines for inspection, this approach proved most efficient for the Simmons Rd. force main.

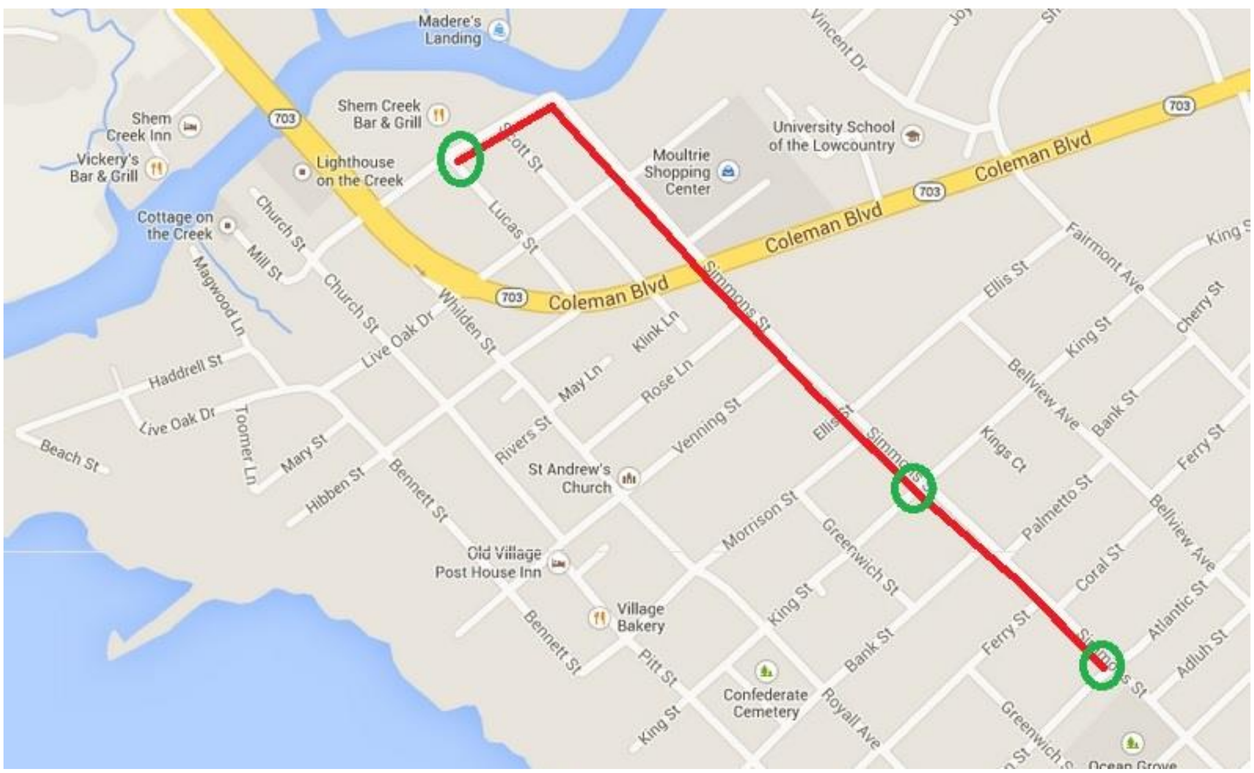

Figure 3: Overview of the pipeline that was inspected using PICA's SeeSnake tool. The Green Circles signify the excavation locations that were used for access to the pipeline. Section 1 is ~2,940 feet and Section 2 is ~1,355 feet.

For more information about the inspection process and the analysis of the data, see Garrett and Derr 2013[1].

4. EXPECTATIONS

While not incorporated into any GIS system explicitly, there was an understanding that the section of pipe near Mill and Lucas was in better overall condition than the pipe anywhere along Simmons Road. The reasoning behind this understanding was sound: The pipe near Mill and Lucas was a local low point and always under pressure. This area of pipe saw little pressure variance compared to the other pipe along Simmons Road. Furthermore, the Mill and Lucas area had not experienced any failures to date. The failures that had occurred elsewhere on the line had taken place farther downstream and likely due to anaerobic conditions caused internal corrosion.

5. RESULTS

Despite the sound reasoning of the expectations, the pipeline was found to be in almost the exact opposite condition. The pipe near Mill and Lucas was found to be heavily corroded and susceptible to failure. PICA measured eight instances of through-hole or near through-hole corrosion pits, along with a plethora of additional medium and deep-sized corrosion pits. The heavy corrosion was consistent for the first ~550 feet of pipeline. At around 550 feet from the launch pit, the deep corrosion subsided. The remaining pipe (approximately 3,650 feet) saw very little pitting, and the corrosion that was measured left at least 60% of the original pipe wall intact.

A graphical representation of the corrosion can be seen in Figure 4. Each blue diamond represents an indication of corrosion as measured by the SeeSnake tool. The X-axis depicts ~4,200 feet of inspected pipe (with blue dots near the origin representing defects near the Mill and Lucas intersection). The Y-axis depicts the depth of any given pit as a percentage of the remaining pipe wall (with blue dots near the x-axis representing deep pits/through-holes). As seen from this graphical representation, the first ~550 of force main experiences significantly more corrosion than the remaining pipe.

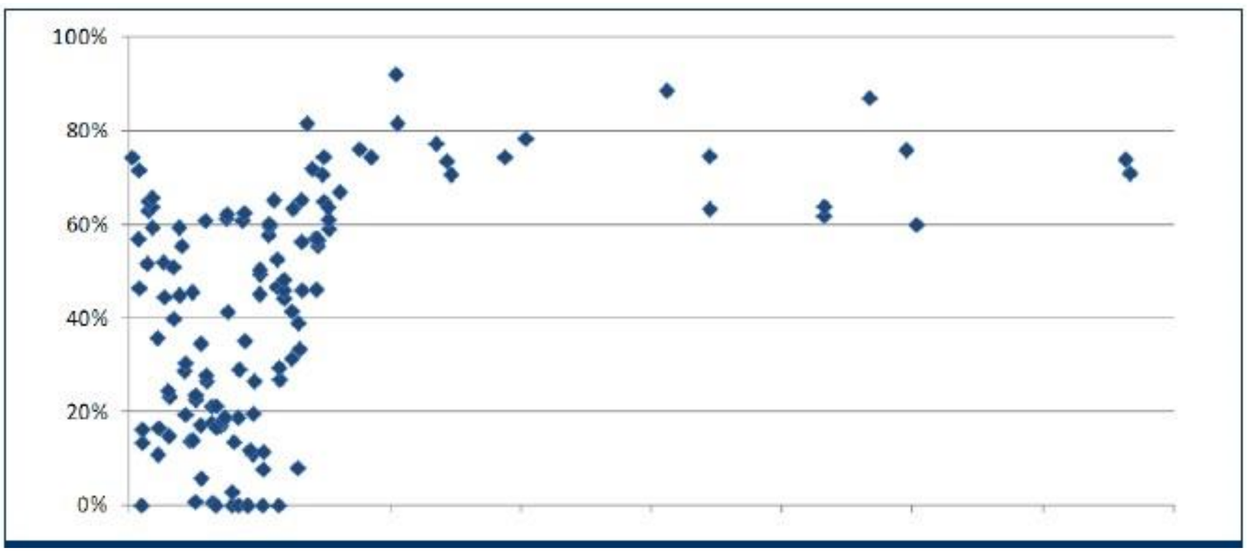

Figure 4: Location and depth of defects found in the Simmons Road force main.

6. VERIFICATION

These results were no doubt a surprise to all parties. MPW and Brown & Caldwell decided to undertake verification digs to confirm the PICA data. PICA analysts put together dig sheets and sent a technician back to South Carolina to assist in the locating of certain defects. The pipe joint labeled "Pipe 0030"had registered multiple deep defects and was located in an area that could be excavated easily.

The pipe was excavated by local construction firm, Anson Construction, and brought to the handling yard for cleaning and inspection. When the pipe was power washed, a large patch of corrosion product and soil came away revealing a 2”x 4” through hole in precisely the location indicated in the dig sheet. PICA reported the hole at 32.8” from the upstream joint in the 6:00 position. Figure 5 shows the hole at ~31” in the 6:00 position.

Figure 5: The through-hole located in Pipe 0030. While sludge and backfill had prevented any leaks here to date; the integrity of the pipe had been compromised due to corrosion.

7. CONSTRUCTING A NEW HYPOTHESIS

The results sent everyone back to the proverbial drawing board in hopes of better understanding why the corrosion was surprisingly prevalent near the low point of the line. When looking at a Google Earth view of the region, it is noticeable that the area heavily affected by corrosion is near some of Mount Pleasant’s most beautiful local scenery: the marshlands and tidal estuaries. As seen in Figure 6, the section in red corresponds to the approximately 550 feet of heavily corroded pipe. The section in green corresponds to the pipe that experienced much less corrosion. One of Mount Pleasant’s marshlands runs very near the location of this pipe. As the Simmons Road force main gets farther and farther from the marshland, the condition of the pipe gets better and better.

Figure 6: Google Earth view of the 16” Simmons Road Force Main. The red section identifies pipe that is highly corroded; the green section identifies pipe that experienced minimal corrosion.

The Project Managers suspect the soil composition in areas near the seawater has a relatively high corrosive nature and the changing tide levels also accelerate corrosion activity.

8. NEW CONSTRUCTION

Based on the PICA report, Mount Pleasant re-engineered the pipeline to bypass the areas susceptible to failure. The new installation was 20” PVC pipe and placed farther away from the marshlands. As seen in Figure 7, the new PVC pipe ties into the original Simmons Road 16” force main at the intersection of Simmons Road and Live Oak Drive, in an area that recorded very little corrosion.

Figure 7: Google Earth view of the new 20” PVC relative to the original DI pipeline. The PVC section is in blue.

9. DOLLARS AND SENSE

The force main in which the SeeSnake was piloted was programmed to be replaced in the next five years (due to condition concerns) at a cost of $4M. Results from the SeeSnake showed only parts of the force main need to be replaced and the actual replacement cost was $1.5M. MPW was able to save $2.5M.

The results of the SeeSnake inspection were so promising that MPW is embarking on a condition assessment program of all the Ductile Iron pipe in its system. It is estimated the replacement cost of these lines would be $13.5M. Because these force mains were all installed at about the same time, it is anticipated that their replacement cost would hit at the same time, over the next five years. In addition to the condition assessment program, MPW is installing valves and launch points on its force mains. This will allow for ease of condition assessment, rehabilitation when and if needed, and segmented replacements now and into the future.

10. DIKW HIERARCHY AND CONCLUSION

The DIKW Hierarchy is a system for interpreting the usefulness of different levels of understanding. DIKW is an acronym for Data-Information-Knowledge-Wisdom, with Data providing a Level-One, simplistic understanding and ultimately Wisdom providing a deep understanding. While the hierarchy's applicability is far from perfect, its application can be relevant with regard to Condition Assessment projects.

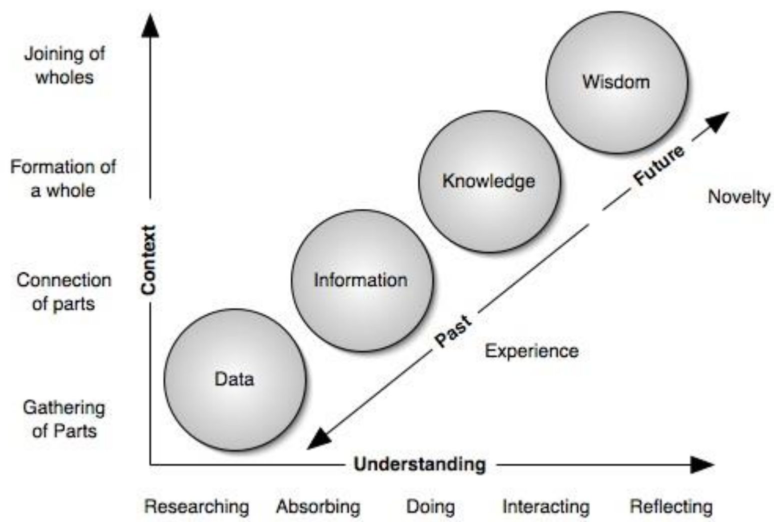

Figure 8: Relationship between DIKW[2]

With Condition Assessment, Data consists of pipe type, year of installation, and break history. Once this data is known the pipe condition can be modeled but the results have limited usefulness. Any insight is only as good as the model.

Information occurs when there is sufficient data to begin extrapolating the condition of the pipe. The value of the Information is enhanced with average wall thickness measurements, leak detection and local measurements. When combined with Data, this Information can be used to draw conclusions about the potential condition of the pipeline. The Information is more valuable than Data as there is less guesswork.

Knowledge occurs when Asset Managers have accurate measurements of the entire wall thickness of the pipeline. The SeeSnake inspection completed by MPW falls into this identification category as MPW Asset Managers *knew* the condition of the pipeline post inspection.

Wisdom is an ongoing process because it uses the Knowledge of the past to help drive future decisions. It is a dynamic concept that adapts as Data, Information and Knowledge improve. This idea can be seen with regard to the new hypothesis regarding the corrosion rates of pipes near Mount Pleasant's marshlands. While the hypothesis is not entirely robust, it provides target areas to focus future inspections and rehabilitation work. Upcoming SeeSnake inspections will be performed on a 12" forcemain that also runs near marshland. The knowledge gained during this future Condition Assessment work will then drive Wisdom in a continually evolving process.

The Simmons Road inspection is a good example of how Condition Assessment tools can be used to proactively manage aging infrastructure. Preliminary research was performed by combining local knowledge with an outside engineering specialist. This led to Risk Rankings and identification of key pipelines. An inspection technology was chosen to provide the level of information needed to make the right decisions. Ultimately the knowledge gained provided insight as to how best to manage this one specific asset.

REFERENCES

1. Garrett, Chris; Derr, Kelly. "Condition Assessment of 16" Force Main." *North American Society for Trenchless Technology, 2013 No-Dig Conference: Sacramento, California.* TM1-T5-03 (2013).
2. Clark, Don. "Understanding and Performance." http://www.nwlink.com/-donclark/knowledge/context.html