The Numbers Do Not Lie – Reducing I/I

Christopher J. Jackson, P.E.
Project Engineer, Master Planning
San Antonio Water System
2801 U.S. Hwy 281 North
San Antonio, Texas 78212.

Trying to remediate capacity constraints on the scale in which the San Antonio Water System (SAWS) needed to for the Consent Decree (CD) requires the organization to think outside of the box. Our longest constraint, the Central Stem outfall, required SAWS to address a 10.8-mile capacity constraint within the central sewershed. During capacity alternative analysis, the flow monitoring began to show a reduction in our overall peak flows during rain events. These new flow monitoring numbers caused SAWS to examine if we could remediate this capacity constraint through Inflow Reduction.

Looking into this further, the data showed that condition improvements to the mains and manholes upstream appeared to be contributing to less flows in the 24”-72" Central Stem outfall mains downstream. In lieu of costly capital projects, SAWS began drafting a new inflow reduction plan that would include continued flow monitoring and execution of an inflow reduction plan as the best alternative to address the Central Stem capacity constraint. The inflow reduction plan focused on manholes (MHs) within the 100-year flood plain and low-lying areas, while continuing to address condition mains listed in the condition remedial measures. The MHs required an extensive effort to inspect all the MHs within the 100-year flood plain and low-lying areas. The inspections showed we had MHs with severe defects allowing direct inflow into our system, as well as MH ring and covers that were allowing water to substantially infiltrate into our system.

As a result of these finding we created two focus areas to address these issues.

- Repairing any severe defects to the MHs. These defects typically fell within a riser or cone section that was above grade and created a direct inflow point into our system.
- Replacing our old rings and covers which were discovered to not be watertight and were allowing infiltration when storm water submerged the covers.

This two-pronged approach proved successful and we have continued to see reduction in I/I within the Central Stem constraint.

We wanted to continue to build on this success and began looking at other ways to reduce I/I in our sewer mains beyond standard condition inspection and remediation. Trying to identify I/I through traditional closed-circuit television (CCTV) inspections and the pipeline assessment certification program (PACP) requires soil to be saturated for PACP defects such as infiltration gushers to be apparent. As most of our CCTV was not televised during rain event, our extensive CCTV data provide little information on the amount water infiltrating into our system through cracks, fractures, and other defects in our mains.

To overcome this, SAWS has leaned into a new technology known as focused electrode leak location (FELL). FELL utilizes an electrode ran through existing nonmetallic mains with water being sprayed circumferentially around the main. The water allows low voltage current from the electrode to pass through to the interior surface of the pipe. If there are any defects in the main, current will flow from the interior pipe surface, through the defect to ground. By measuring the current that passes through the defect, the severity of the defect can be quantified and translated to water flow in GPD. In essence, instead of measuring infiltration of water via existing defects which requires saturated soils, FELL allows us to measure exfiltration of electrical current via existing defects. Electroscan, the company we have been using to perform FELL, then is able to convert the electrical current into a measurable water flow rate assuming the ground is saturated with one foot of pressure head.

In our pilot study, FELL confirmed our suspicions that our older clay and concrete materials were allowing substantially more infiltration into the system then our newer HDPE and PVC pipes. The infiltration from our poor performing materials (clay on concrete) averaged to be 10x more infiltration than our high performing materials (PVC and HDPE), assuming saturated soils with one foot of pressure head. Even more, when comparing FELL data to our PACP data, we found our mains built with poor performing materials that were in fair condition with only minor PACP defects, were allowing substantial infiltration that we were unaware of. Based on their condition alone, these mains would typically be monitored within our CMOM program.

In 2018, we began implementing a pilot project to upgrade all the remaining concrete and clay mains in a poor performing sub-basin that was high in the Central Stem outfall sewershed. This location had good historical flow monitoring data, and we continued to monitor it closely during and after construction. The project completed in summer 2020, but we had to wait an entire year until we received a rain event heavy enough to see how the flow numbers changed. While the results are still preliminary, we have seen an approximate 25% reduction in peak flows during heavy rain events in this one sub basin alone.

Seeing the success of this project, we have begun targeting additional poor performing sub-basins, high in the sewershed, to renew the majority of the remaining concrete and clay mains. In addition to the main work, we will replace the SAWS portion of the lateral with high performing materials. Pre and post FELL inspection is also performed on each main, so we have quantifiable data showing the reduction in infiltration.

While the inflow reduction program has taken different approaches since we began it, the one constant has been using inspections and data to confirm there is a problem before moving forward with a solution. This approach is successful, and we continue to see the central stem outfall's peak flows decrease. As we move beyond the CD, we plan to continue this approach as the numbers do not lie; we have now shown you can reduce I/I.