FLOW MONITORING ADVANCEMENTS HELP UTILITIES KEEP MORE MONEY IN THEIR POCKETS

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Abstract

In this presentation, we will describe how a Florida county used an existing contract and very limited resources to address wet weather concerns.

This county’s service area includes approximately 1,150 miles of collection/conveyance pipe ranging in size from 4 inches to 48 inches, 141 pump stations, and one booster lift station. The system collects and conveys wastewater generated in the southern portion of the county to a water reclamation facility (WRF) with an average dry weather flow rate of approximately 21 mgd.

A rainfall event recorded on June 24, 2012 exceeded the average flow by a multiplier of five. The primary discharge points to the WRF were at maximum capacity during the event and pumped debris caused more than $150,000 in damages at the WRF’s headworks. The system did not fully recover from the initial introduction of storm water until nearly a week after the event.

With an impact of this magnitude, where does one start? As staff began assessing the overall impact of the event, it became apparent that the county needed to undertake flow metering immediately to provide both clarity and focus on how to address the situation. However, with limited funding available and a fairly short wet weather season, it would be difficult to complete the necessary work in a manner that would provide useful results.

This county used an existing contract and limited resources to quickly mobilize flow monitoring crews and identify areas within the collection system that caused the greatest wet weather concern. Working with the engineer of record, the county used an innovative open channel flow monitoring approach to pinpoint the problem areas. This approach minimized the required boots on the ground and allowed for a comprehensive evaluation to be conducted in a shortened time frame.

The engineer was able to further assist the county by preparing a smoke testing protocol manual and training staff on the correct way to perform smoke testing. This investment enables the county to supply these services on its own, when and where they are needed, without hiring an outside consultant.

As a result of this flow monitoring and smoke testing process, the county has been able to address the largest storm water inflow contributors immediately and prioritize future abatement activities based on both potential wet weather flow reduction and in-house staff availability.
Introduction

On June 24, 2012, Tropical Storm Debby inundated Pinellas County, Florida’s South Cross Bayou Water Reclamation Facility (WRF) service area with 13 inches of rainfall over a 12-hour period. The WRF normally operates at approximately 20-22 mgd, but this wet weather event resulted in an average flow at the facility of 67 mgd, with a peak flow of approximately 100 mgd. The additional flow caused significant damage to the WRF’s headworks, instigated an abundance of sanitary sewer overflows, and created a system response that did not allow full recovery until six days later.

In an effort to identify which lift/pump station service areas within the South County Sewer System were more susceptible to wet weather inflow, the county initiated a wastewater flow monitoring program. Since time was of the essence and funding was in short supply, the county invoked its existing engineer of record (EOR) contract so that McKim & Creed could—within days of the rainfall event—begin identifying where excessive flows originated and developing an abatement plan to mitigate the situation.

Description of the South County Service Area Sewer System

The South County Service Area sewer system includes approximately 1,150 miles of collection/conveyance piping, ranging in size from 4 inches to 48 inches, and 141 pump stations. The system collects and conveys wastewater generated in the southern portion of the unincorporated county, as well as numerous municipalities, including Belleair, Belleair Beach, Indian Rocks Beach, Kenneth City, Largo, Madeira Beach, Pinellas Park, Redington Beach and Seminole.

The wastewater flow contribution to the WRF is measured by the county from four primary sources: the South Cross Bayou 36-inch gravity sewer, the Pinellas Park 42-inch gravity sewer, the Madeira/PS 163 force main and the Boca Ciega/PS 016 force main. Figure 1, below, identifies the influent sources at the South Cross Bayou WRF.

Figure 1. Flow Sources at South Cross Bayou WRF
The schematic below, Figure 2, identifies the connectivity of the 141 wastewater pumping stations within the South Cross Bayou WRF service area, noting that the McKay Booster pump station is a former WRF that was converted into a pumping facility when the South Cross Bayou WRF treatment capacity was increased.

**Figure 2. South County Pump Station Flow Chart**

Phase I

This project was initiated in an effort to identify which lift/pump station service areas of the South County sewer system were more susceptible to wet weather inflow than others. McKim & Creed began by dividing the South County Bayou WRF service area wastewater collection/conveyance system into 22 separate mini-basins. This enabled the county to stay within the initial project budget and deploy monitoring equipment in areas that would likely have a high susceptibility for storm water inflow. These areas were generally low lying and close to water bodies, which increased the potential for surface water flooding and higher groundwater elevations. In most cases, these mini-basins had between 35,000 and 120,000 linear feet of collection system piping. Open channel flow meters were installed at the terminus of each mini-basin.

Flow meters were also deployed in larger mini-basins that ranged in size from 150,000 to 350,000 linear feet of collection system piping. In most cases, these systems were higher in elevation and less susceptible to surface water flooding.
Flow metering was conducted in two separate processes. In the initial process, which involved the 22 mini-basins, the meters remained in place for 45 days and the monitoring was performed concurrently with rainfall gauging at four locations throughout WRF service area. The rainfall data was used to determine Rainfall Derived Inflow and Infiltration, or RDII rates. The rain

**Photo 1. Flow Meter**

![Flow Meter Image]

*Shown here is one of the flow meters used in Phase 1 of this project.*

gauges were programmed to measure rainfall accumulation in hundredths of an inch and recorded at 15-minute increments. The rainfall recorders were installed at opposite ends and at several central locations within the study area. County staff provided weekly rainfall data downloads to McKim & Creed via email in an Excel spreadsheet format.

The second flow monitoring effort was conducted at 10 additional sites, with meters remaining in place for 60 days. During the initial and secondary flow monitoring periods, three significant rainfall events were recorded. All of these events caused significant storm water inflow/RDII in most of the basins, ranging from 65,000 gallons to an excess of 1.3 million gallons.

**Data Retrieval**

During the two flow metering efforts, both remote and on-site data retrieval occurred. McKim & Creed employed a cellular remote telemetry unit (RTU)-based flow monitoring program and Telog Enterprise to retrieve and store depth, velocity and flow data. Each day, data from every site was downloaded and the depth and velocity readings were reviewed. As anomalies were
identified, McKim & Creed field staff accessed the affected flow monitoring site, determined the problem causing the inappropriate readings, and corrected the situation.

**Figure 3. Portion of Service Area within Pinellas County**

The green dots represent locations where flow monitoring equipment was installed.

Incorporating the remote data retrieval reduced the number of “boots on the ground” that were needed, thereby minimizing the overall cost to the county.

Daily data downloads from each flow monitoring site were compiled and exported to individual Excel spreadsheets. The rainfall data was then merged with the appropriate flow monitoring site to prepare hydrographs on a weekly basis.

Using the flow meter and rainfall data obtained, a flow analysis of each flow meter basin was performed. This entailed development of a synopsis that identified the following flow characteristics:

- Model Dry Day Flow
- Model Wet Weather Flow
- Rainfall Induced Inflow
- Rainfall Induced Infiltration
- Apparent Groundwater Infiltration
Phase II

As part of the second phase of the Pinellas County Inflow Abatement project, smoke and dye testing was conducted in areas that experienced the highest levels of storm water inflow. Smoke testing was used to detect specific inflow points such as storm sewer cross connections and point source inflow defects. Testing was completed in three basins that were identified as major contributors during flow monitoring. This included 288,000 LF of gravity sewer in Maderia Beach and Kenneth City, as well as a small test area in St. Petersburg.

In one basin, approximately 58 percent of the recorded storm water inflow was identified during the smoke testing effort using a defect catchment inflow approach. By performing a mass balance of flow-meter-identified inflow versus smoke-testing-identified inflow, the county is able to ensure that it has, in fact, located the significant inflow contributors and can estimate wet weather flow reduction based on abatement initiatives. Smoke testing within the remaining two basins identified 50 percent and 55 percent, respectively, of the inflow recorded during flow monitoring. An example of smoke testing form utilized by the county is presented by Figure 4, below.

**Figure 4. Smoke Testing Form Example**

<table>
<thead>
<tr>
<th>SMOKE TESTING REPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UPSTREAM MANHOLE</strong></td>
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<tr>
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<tr>
<td>DEVIATION</td>
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<td>3</td>
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</tbody>
</table>

Self-Sufficiency

As part of its cost-saving measures, the county requested a training program for members of its maintenance staff. McKim & Creed developed a training program that used a mass balance defect volume quantification approach. Field training was conducted in the field, followed by a “shadowing” program during which county crews were observed performing the smoke testing operations, preparing all the necessary field forms and completing the defect volume quantification effort.
Training also included the development of a Smoke Testing Protocol Manual, which established specific protocols to follow regarding defect location, identification and documentation, as well as whether dye testing or additional measures are necessary, and recommendations for additional field activities. The training and manual make it possible for Pinellas County to continue its inflow abatement program using in-house resources.

**Time on Your Side and Money in Your Pocket**

When faced with a serious storm water inflow challenge, Pinellas County and McKim & Creed leveraged resources and maximized time and cost efficiencies. Within approximately six weeks of the initial rainfall event, 22 flow meter sites were up and running. By the end of November 2012, both phases of flow metering were completed. Smoke testing began one week later and was completed in early January. No smoke testing was conducted during the Christmas and New Year holidays.

Incorporating a highly effective remote data retrieval system for its testing sites enabled the county to reduce the number of “boots on the ground,” which significantly reduced costs. In addition, county staff was trained so the abatement program can continue using the county’s in-house resources.

Tasks that are currently under way include:
- continuing the ongoing smoke testing effort in the areas with excessive storm water inflow,
- completing dye testing at the inflow locations identified during previous smoke testing,
- conducting manhole inflow abatement for all of the structures identified during smoke testing,
- beginning investigations in Kenneth City where wastewater infrastructure could not be located, and
- conducting flow isolations in the areas that exhibit the highest levels of groundwater infiltration.
Photo 2. Smoke Testing

Smoke emanates from a curb drop inlet during Phase 2 smoke testing.