# Using Today's Technology to Improve Asset Management & Collection System I&I Programs

Michael R.T. Low, Anthony J. Lombardi, and Famous J. Woods

## In Memoriam: Famous Javon Woods 1979 -2008

It is with great sadness that we announce the passing of our friend and colleague Famous Woods. Not only was he a contributor to this article, but he was also integral to the success of this I&I project and the associated technologies.

Famous was a very quiet and reserved person, but anyone who saw him present the paper on this project could see the total commitment he had toward the project's success. He was extremely intelligent and had a tremendous thirst for knowledge that often surprised those who did not know him well. We could not have transformed this work from its original intent to the invaluable tool that we now have without the work he did on building the technological basis on which we now operate.

For those of us who were privileged enough to know him, his loss is deeply felt. We hope that his invaluable work on this project will become a part of his legacy here at the Boynton Utility.

*Michael R.T. Low and Anthony J. Lombardi*

For the small- to medium-sized utility, asset management can seem to be a daunting and potentially cost-prohibitive endeavor. A re-evaluation of what asset management is at the basic level and careful examination of the technologies being used as part of normal operational programs may provide an unforeseen benefit.

If you simplify your definition of asset management and its core requirements, it is possible that you may already have the beginnings of a system. If you start small and combine a number of technologies, it is possible to avoid an expensive large-scale solution that is difficult to implement and sustain.

For some time, the city of Boynton Beach had been trying to develop an asset management program but was still struggling to determine an appropriate way forward. An earlier attempt at introducing a computerized maintenance management system (CMMS) had collapsed from a lack of resources and understanding of what was required to implement it. A more recent evaluation of potential CMMS solutions had identified a high cost and heavy demand on personnel.

At the same time, the city was working on an infiltration and inflow (I&I) project directed at some of its older wastewater collection systems. As the two initiatives were moving forward and after further study of how asset management could be defined, it became apparent that because of the technologies involved, the two programs were, in fact, addressing the same problem.

This article examines how, through the judicious use of the available computer technologies, it is possible to develop an asset management initiative without major investment in some of the more expensive systems used by larger utilities.

*Michael R.T. Low is the deputy utility director for the Boynton Beach Utilities Department. Anthony J. Lombardi is the maintenance manager for the department. The late Famous J. Woods was formerly the department's network administrator. This article was created from a technical presentation at the Florida Water Resources Conference in May 2008.*

### Infiltration & Inflow Program

Boynton Beach is taking steps to solve issues with its aging wastewater infrastructure. The city co-owns a regional wastewater plant with the city of Delray Beach, and after review of the average daily/monthly flows at the plant and comparing the reports to dry-weather and wet-weather events, the utility decided on a plan to reduce the amount of I&I.

The department concentrated its I&I program initiative on part of its collection system that is more than 40 years old, located mostly east of Interstate Highway 95 and along the Intracoastal Waterway in the city's downtown area. This low-lying area, the age of the system, and plans for redevelopment made the location a prime target for the first phases of this program.

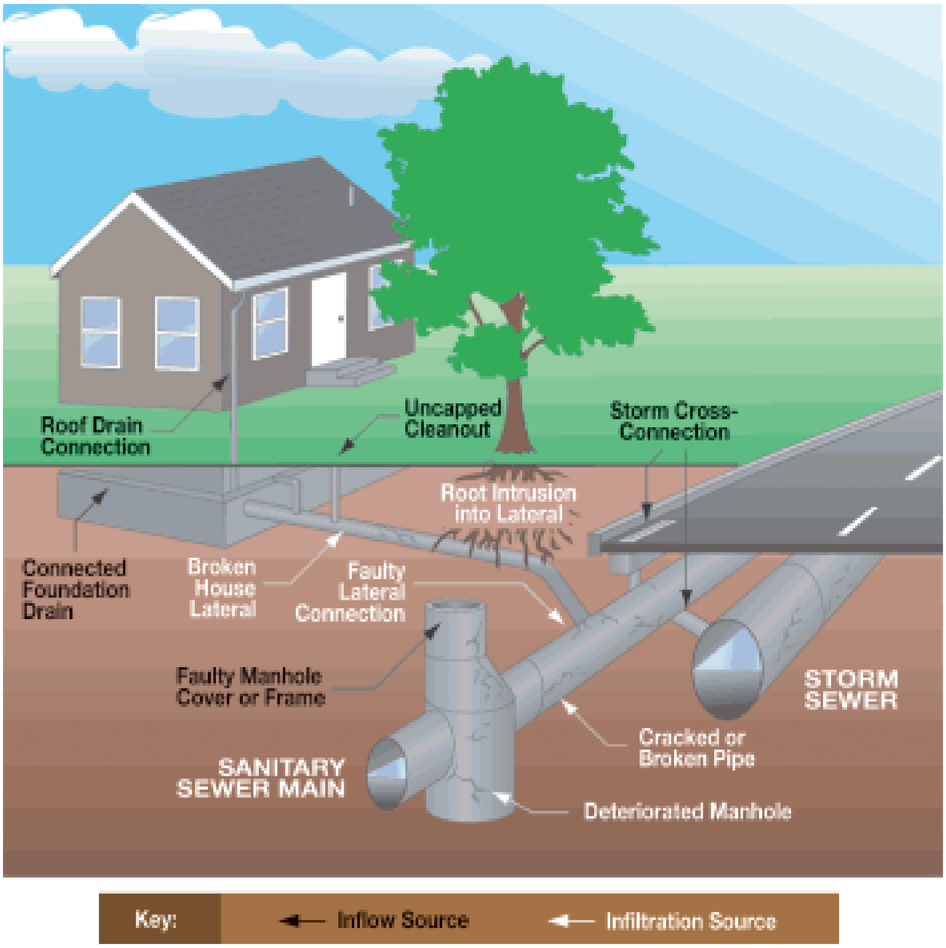
Potentially, excessive I&I can exceed capacity in the collection system, which in turn can lead to potential sewer system overflows (SSOs), system failures such as pipeline and manhole collapses, and increased treatment facility costs. The wastewater system capacity is critical to redevelopment. If I&I are not controlled, operation and maintenance costs will continue to increase and result in the reduction of services.

The cost savings achieved through reduced wastewater treatment invariably provide an adequate return on the necessary investment. Although projects such as this one may appear to be expensive, the long-term cost savings, coupled with improved system reliability, make this program very cost-effective.

Most I&I programs concentrate on cleaning and televising the wastewater gravity mains and their associated manholes. Part of the system that we inspected consisted of vitrified clay pipe (VCP) and brick manholes. We inspected the pipeline and manholes with closed-circuit television (CCTV) looking for structural defects, stormwater connections, and the condition and fit of manhole covers.

We also smoke tested pipe at predetermined locations. Examples of smoke tested areas are a combination of condominiums and apartment buildings where roof drains and parking lot drains that collect stormwater may

*Continued on page 10*




*Continued from page 8*

be connected to the system.

We applied flow monitoring devices at various lift station wet wells during various times of the day. One period of particular concern was the very early morning hours, especially at lift stations near coastal waters. We wanted to see if there was any tidal influence in the groundwater that may enter the pipeline or manhole structures. By analyzing the inconsistencies in the flow monitoring reports, we targeted specific lift station basins for inspection.

We contracted with AUI of Jacksonville to conduct the cleaning and inspection portion of our program. We have completed the first two phases of the program, which consisted of cleaning and televising approximately 250,000 feet of pipe ranging from eight inches to 24 inches and 1,100 manholes. We are continuing with a third phase that will consist of approximately 150,000 feet of pipe and 600 manholes.

Through AUI and their inspection methods, we adopted the National Association of Sewer Services Companies, (NASSCO) Pipeline Assessment Certification Program (PACP). NASSCO sets industry standards for the rehabilitation of underground pipelines. NASSCO's PACP coding enables you to have your system properly evaluated objectively through a standardization of operation and maintenance observation codes and inspection forms. Boynton Beach had no real evaluation program to properly assess the condition of the wastewater system.

## Asset Management

Asset management quickly has become one of the major topics in the utilities arena, as well as in industry as a whole. One of the problems is that there is no single definition of the term. Asset management has been interpreted as being everything from the full-blown installation of a total Manufacturing Execution System (MES) to a major CMMS and all points south.

Some have shown the system as being the total interconnection of everything from CMMS, a laboratory information management system (LIMS), a customer management system (CMS), and any associated plant control system connected to some form of enterprise resource planning (ERP) system. This is a major undertaking for any organization, let alone for a small or medium sized utility. There are many large companies who are still struggling to achieve this level of connectivity. This image has existed in various forms ever since the origins of computer integrated manufacturing (CIM) in the late 1980s.

One alternative is to install a comprehensive CMMS solution. This certainly has the benefit of concentrating on the physical assets of the organization, but it has a very large price tag attached. Not only are the large systems expensive to purchase, but a huge overhead in personnel and consulting support is needed to launch such an initiative successfully.

In addition, the long-term effort required to maintain the systems can place a heavy burden on maintenance supervision. We undertook a review of our options at Boynton Beach Utilities, and it rapidly became apparent that the start-up cost alone was well into seven figures. This came at a time when we already needed to invest heavily in our control and telemetry systems.

How does a small- or medium-sized utility proceed in order to provide its customers with the water infrastructure security needed to ensure the highest levels of service at the lowest practical cost? The basic issue raised when the concept of asset management first was developed was how to manage an aging infrastructure as the country transitions from an era of expansion to one of consolidation.

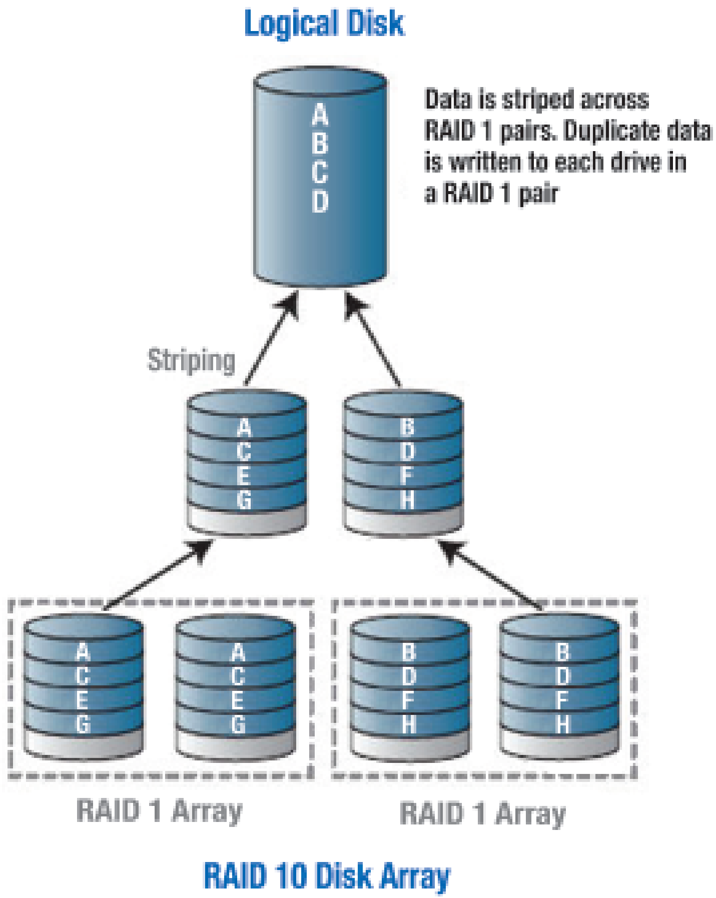
Our own service area is an example of one where a relatively large area has been developed in the last 20 years while another part is much older and undergoing redevelopment. The question asked of us is that we know what our assets are, that we know their condition, and that we know how we expect to either maintain or replace them and the associated cost of doing this.

As the utility continued to deliberate on how to proceed, some of our senior management attended the course on asset management at the 2007 Florida Rural Water Association Conference. The course was delivered by representatives from the Environmental Protection Agency, joined by speakers who had been involved with the program at the Orange County Sanitation District in California.

It was emphasized throughout the course that the essential issue was to develop an inventory of assets, determine their condition, and then provide detailed plans for how to maintain them or plan for their eventual replacement. This could be done on a small scale at first and subsequently expanded–a concept that gave us pause for thought.

The challenge for us as a medium-sized utility was how to do this, yet hold down our costs and find cheap but effective ways of resolving any issues we needed to handle. Our earlier attempts at installing a large-scale CMMS solution had suffered through lack of resources, both money and people, and it was obvious that we could not follow that path

*Continued on page 12*




*Continued from page 10*

without considerable cost. We needed to develop a plan that was simple to implement, did not need additional staff, was not too expensive, and could be started quickly.

It was also important that whatever course we took would require limited resources, both internally and external to the organization. It was at this point that we started to examine more closely what was involved with our I&I project. Was it possible that what we were attempting to do there was actually a suitable foundation for part of our asset management program? Not only that, but it was dealing with one of the hardest areas, namely underground infrastructure. Did the technology we were using meet our needs?

## The Technology

Several technologies were incorporated into our infiltration and inflow process. Until our most recent I&I project, we received line inspection video on VHS cassettes. This time, we received all video digitally in MPEG format. Line inspection reports are viewed through Cobra Information Management Systems (CIMS) software. This application allows us to view line and manhole inspection reports and link directly to the relevant video record from within the report.

All the information the CIMS software uses for reporting is pulled from a Microsoft Access database. Pipe conditions are standardized to NASSCO PACP 4.2 specifications. Utilizing this industry-accepted standard provides reporting consistency, no matter who is writing the report. Furthermore, the standardized data fields and attributes allow information to be exchanged easily between applications.

We developed a nine-digit ID number (000-000-000) to segment and identify our underground infrastructure. The first set of three digits represents the master lift station basin, the second set of three digits represents the lift station sub-basin, and the last set of three digits is the manhole number. For lift stations that bypass a master lift station and discharge directly into the regional force main, the lift station sub-basin number is the first and second sets of digits. This system works for us because none of our lift station basins have more than 999 manholes.

We surveyed and identified the manholes and assigned GPS coordinates to them. This information can be shared with a number of applications, including AUTOCAD and ArcGIS.

The data collected during this project is stored on a network-attached storage (NAS) device. Our NAS has an eight-terabyte maximum storage capacity, but to provide redundancy, some storage space has to be sacrificed.

A common method of implementing redundancy is to configure a redundant array of independent disks (RAID). In simple terms, this means spreading data reads and writes across multiple hard drives. Although you are writing to several hard drives, they appear as a single volume; RAID functionality is transparent to the end user. This is a standard fault tolerance procedure and is used on everything from personal computers to business servers.

There are many ways to configure a RAID; each configuration option is called a RAID level. We chose a combination of RAID levels 5 and 0 (RAID 50).

Although we lose some storage space for redundancy, we have more than enough space to store all of the data collected throughout this project. The average academic library contains two terabytes of data; our NAS provides us seven usable terabytes.

RAID is configured via software and controlled by hardware included in the NAS. Our NAS solution is easy to implement, costs under $9,000, and can be managed by in-house IT staff. The NAS box sits on our local area network (LAN) and can be accessed by any authorized PC.

All of our video is stored in MPEG format; therefore, any PC with a media player can view it. Any data collected uses established formats, greatly simplifying data interoperability between applications.

CIMS reports are generated from information collected in a Microsoft Access database. Access is open database connectivity (ODBC) compliant and is independent of specific operating systems, programming languages, or database management systems. We can interface the Access information with a number of different applications, including ArcGIS and AUTOCAD. Because we collected data in common, established formats, it is accessible and usable by most PCs and can be exported or imported as needed.

## Applying the Technology

The first task was to apply the new manhole numbering system to the area to be investigated. The numbers were added to field maps generated from the city's GIS map of the wastewater system, and the GPS coordinates were also acquired. With this information in hand, we had a means of identifying each of the line segments, and the inspection process could then begin in earnest.

The work progressed at a rate of around 1,800-2,000 feet per day, depending on the nature of work involved. Utilizing the PACP 4.2 system, analysis was done as the inspections took place. All data was stored locally before being collated by the contractor and transmit-

*Continued on page 14*

*Continued from page 12*
ted to us in the city.

At first we received each phase as an identically structured MS Access database, which enabled immediate review of the results. As the project has expanded, the database is being consolidated phase by phase. The data is all held on the NAS and available throughout the utility.

Here we show an example of the type of inspection report. The first report includes pertinent information on the line segment and has a direct link to the digital video of the inspection. Currently, the pipe rating is shown on a separate report, but we are working on adapting the system to show everything on one screen.

The rating system is designed to ensure that the results are all objective and do not reflect the subjective opinions of different inspectors. The rating system includes an overall score as well as a breakdown on structural defects and any blockages or other conveyance issues. Our efforts were directed toward resolving any structural deficiencies.

With the ability to both look at the ratings and then review the video reports, it was possible to develop a detailed repair plan. Our initial repair budget had been developed without all this information, but having reviewed the inspection reports, we were happy to discover that the problems were not as severe as first thought.

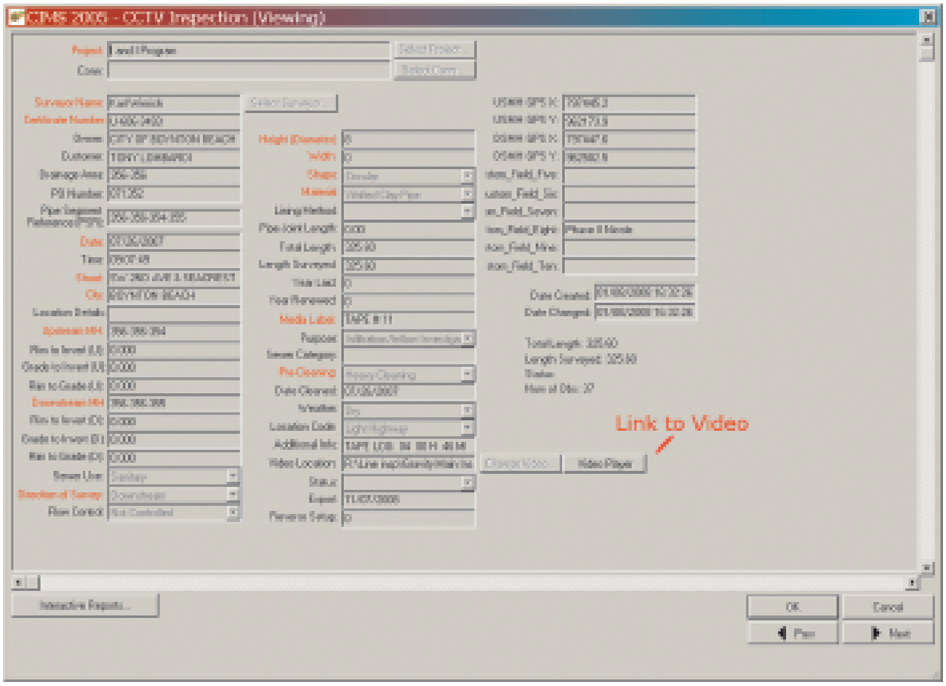
This result supports the need for an asset management program, since decisions on funding needs and rates are more likely to be accurate if based on accurate information, rather than guesswork—informed or otherwise.

## Expanding the Concept

Although the I&I project seemed to fit into the model that we were examining for our asset management program, it was of no value in isolation. It became very apparent that we needed to examine all aspects of our new programs to ensure that they also fit the model.

First, our existing two TV trucks still use the older analog technology. These trucks used are primarily for dealing with examining problems, handling smaller-scale inspection projects, or inspecting new developments and their subsequent warranty reviews. If we are to expand upon our new database, we need to modernize the vehicles and install digital technology. We also need to train our personnel to use the PACP 4.2 reporting standard to ensure uniformity within the records.

It is also important that any contractors taking video records as part of their work use the same system. One final step is needed: to enable connection to the GIS system so that we can connect directly from GIS to the individual records for the pipelines or manholes.




The wastewater system is not the only underground asset we need to evaluate. We had already started a separate initiative with the purchase of a valve turning truck. As a part of that set-up, we also installed software (iWater) that is linked to the GIS map of the water distribution system and keeps records of all of the valves in the system, along with their GPS coordinates.

Again, although this is a stand-alone system, because of the connection to GIS it is integrated into the overall data collection effort. Information is gathered in the field on a tablet PC and then uploaded for review by our CAD team before updating the GIS map.

This program was implemented before we had fully developed our thoughts around the way forward for asset management within the city. Nonetheless, it does fit the model we had developed. The software was relatively cheap and easy to use, and it enabled rapid data collection that can be used centrally by everyone in the utility.

We now have two key systems for gaining centralized information on our underground assets. We also have developed a standard for all CAD drawings submitted by developers so they can be added quickly to the base map and from there included in GIS.

There was still a hole in the plan. We needed to have some form of CMMS for the water plants and pumping stations. We have yet to make a final selection but have started evaluating a system. It is deliberately designed to be low-cost and quick to set up. The system uses a central database, bar coding of the equipment in the field, and hand-held devices that provide maintenance personnel with work instructions once the bar code is scanned. At the end of the day, the handhelds are docked for automatic system updating.

Driven by customer demand, the developers are expanding the program to integrate the maintenance element with a central record of the equipment that can be used to evaluate condition and plan future refurbishment or replacement. Although the system has not been developed specifically for utilities, it follows very closely the model that we were introduced to in the EPA-sponsored course.

One major element of the MES model, a modern telemetry and supervisory control and data acquisition (SCADA) system is still missing. By coincidence, driven by protracted problems with our telemetry system and the rapidly approaching obsolescence of the plant control system, we had developed a request for proposal (RFP) for replacing and consolidating the two elements into one modern, secure platform with a high level of reliability and with a data historian. The RFP also required the selected organization to be capable of assisting with the design of our future system network and database and reporting requirements.

The project is now well underway with the new SCADA system in place, network development underway, and the change-out of the telemetry system for the 200 remote stations in the live testing phase. The completion of the total project is some 18 months away, but we are already gaining information on the performance of the plant, which will be invaluable in deciding our future plans.

This is by far the most expensive part of the program, but again, it has been designed carefully to be based on a relatively low-cost solution. We are consolidating four separate SCADA platforms into a single system using VTS SCADA, which is scalable from small to very large systems and is in widespread use within Florida utilities.

## Conclusions

Asset management is at its core all about knowing what assets exist, knowing their condition, and having a plan for their onward maintenance or replacement. It is possible to resolve that issue in a number of ways, and the question is, "What is most appropriate for your particular situation?"

Large utilities have the ability to develop sophisticated solutions that are generally also expensive. Smaller organizations equally have a need to develop a suitable program but must keep the cost down to an affordable level. From our experience, it pays to first develop a view on how you want to approach asset management within the organization. Then you must examine each of your current or proposed programs and adjust them to fit into the asset management plan/outline.

It is best to avoid having too rigid an outline; instead, you need to adapt each element so that the overall long-term core goal is met. This approach may be criticized as being "asset management lite." We would argue to the contrary, since we are meeting all the goals, but in a unique way. Nonetheless, as a part of our ongoing evaluation of our program, we will have an external review conducted to ensure that we have properly met the overall objective.

## References


- Finding a Pathway for Sustainable Water and Wastewater Services (PDF) : Steve Albee - Underground Infrastructure Management Nov/Dec 2005
- EPA Fact Sheet – Asset Management for Sewer Collection Systems: Office of Wastewater Management - April 2002
- Beyond SCADA to Smart Utility Management: Kevin Young & Pervaiz Anwar – Brown & Caldwell Spotlight on Asset Management
- Water Infrastructure at a Turning Point – The Road to Sustainable Asset Management: American Water Works Association
- Orange County Sanitation District – Asset Management Plan 2006