Benefits of Implementing a Computer-Centric Infrastructure Information System: City of Cocoa Utilities Department Case Study

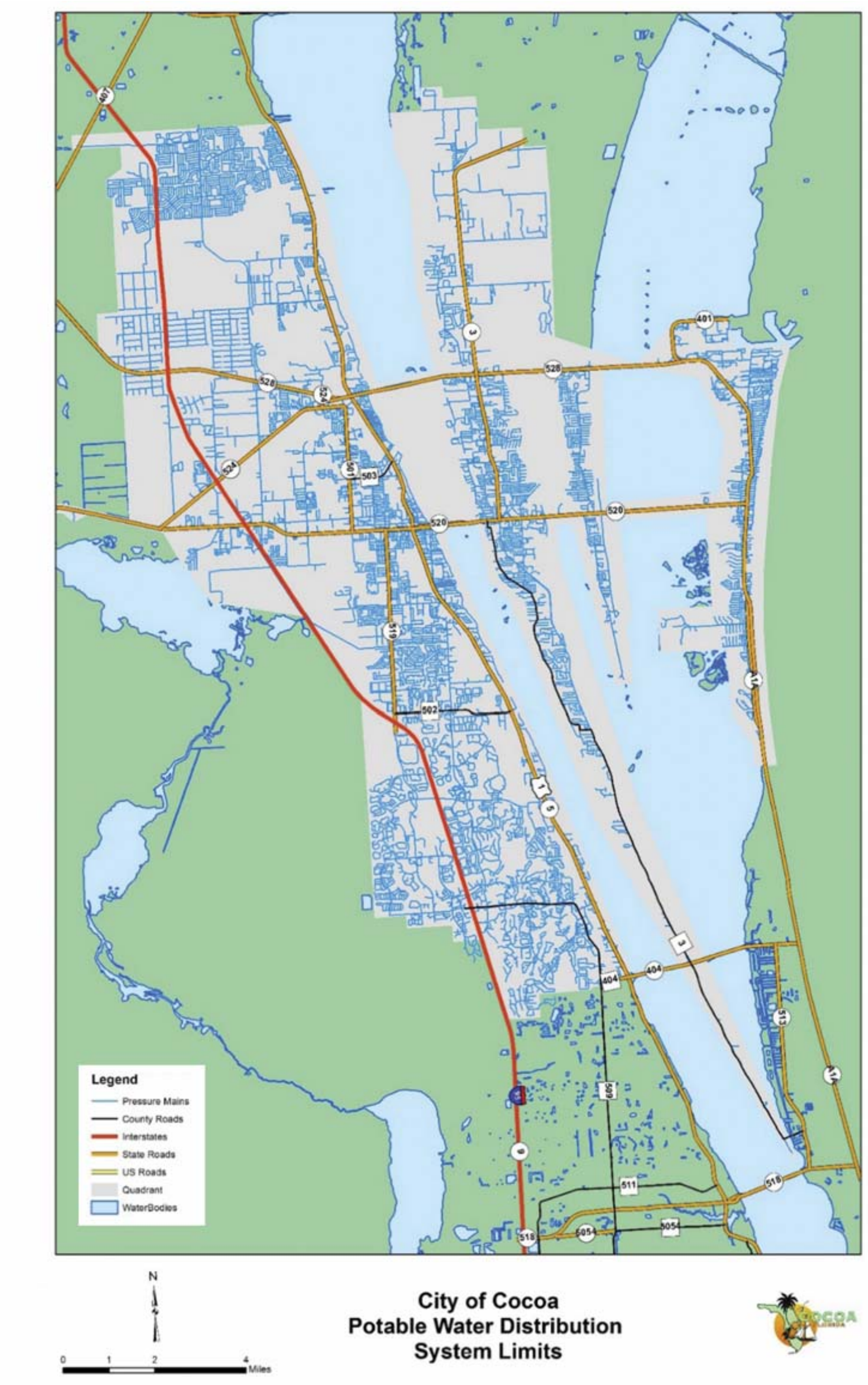

Figure 1. City of Cocoa Potable Water Distribution System

John A. Walsh,
Christopher Collier,
John Beers, Ekaterina Fitos,
and Yvonne Picard

John A. Walsh, P.E., is utilities director; Christopher Collier is field operations manager; and John Beers is supervisor II with City of Cocoa Utilities Department. Ekaterina Fitos, GISP, is a senior GIS professional with CH2M in Tampa, and Yvonne Picard, P.E., is a project manager with CH2M in Orlando.

Computer-focused technology and application systems have forever changed society. Just 10 years ago the City of Cocoa Utilities Department (utility) relied heavily on traditional paper-based methodologies to conduct water facility operations. The advent of sophisticated, portable, and powerful technology has significantly changed the procedures and processes at the utility and has offered positive results.

Background

The utility provides potable water service to over 250,000 residents in Brevard County. The City of Cocoa itself had meager beginnings. Founded in the late 1800s and incorporated as a city in 1917, within 20 years there were approximately 3,000 potable water customers and the utility was already a regional water provider serving the City of Rockledge. By the late mid-1950s, the utility expanded service to the blossoming Space Coast that eventually included Cape Canaveral Air Force Station, Patrick Air Force Base, and Kennedy Space Center. Currently, the utility serves customers from the National Aeronautics and Space Administration (NASA) to Melbourne, including the cities of Cocoa Beach, Cape Canaveral, and Rockledge. Figure 1 depicts the boundaries of the city's potable water distribution system.

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In the beginning, the utility maintained its distribution system through the use of processes common to most utilities. Field crews relied on hard-copy record drawings and miscellaneous maps that included handwritten notes. Maintenance records were also handwritten and often in an unusable format. Crews would locate the proper maps and files as part of the process of responding to a water main break or customer concern. Although common practice for most utilities, this method proved to be inefficient as the utility's potable water service area grew.

Geographic Information System Implementation

From 2006 to 2008, the city recognized that a more advanced technology approach was needed to manage its assets and decided to invest in a geographic information system (GIS) platform. The selection of the platform was based on the following criteria:

- Ease of data collection and management
- Ability to access data in the field
- Speed of data rendering

ArcPad and ArcGIS, ESRI-based software, met the city's criteria and were purchased.

Creation of the electronic rendering of the city's potable water distribution system began with the upload of previously digitized maps and was followed by hiring Cardno TBE as a contractor in 2008 to inventory the existing system. This asset survey was the crucial step in establishing a baseline of potable water assets. The baseline data became the building block against which all future asset management components would be assessed and executed. Although the utility recognized the long-term sustainability and benefit of investing in a robust enterprise GIS system, the early GIS architecture provided only basic functionality.

The ArcPad software served more as a data viewer, allowing crews the ability to view GIS data as-built, and record drawings in the field. This software did not provide the utility with the required functionality for tracking, recording, and assessing assets. In addition, it required extensive manual effort to manage the data, and Shapefiles had to be generated frequently and manually overwritten on each field laptop. The process was time-consuming and inefficient, and the utility recognized the need for a GIS-based software package that was specifically developed for, and oriented to meet the needs of, distribution and collection field crews.

After extensive research, the utility purchased and implemented infraMAP, an iWater® software with ease of use and a simplistic GIS user interface. The utility began by using the software to track and record valve exercising activities, and as part of its implementation the utility simplified workflows by leveraging GIS in the field and realized these workflows could easily be adapted for other maintenance activities. Soon after, the utility expanded the use of the software to track and record fire hydrant activities, and other departments followed by tracking their maintenance tasks. Consequently, the software provided digital and mobile GIS-based solutions for field use and served as the lynchpin for linking field data with engineering activities. This link allowed the utility to modify its data management procedures by providing a process where asset data could be easily distributed, field-verified, and updated in the GIS system.

The software is utilized by the utility to integrate GIS into a mobile platform that allows the dissemination of GIS information to field crews and managers, while providing the ability to update asset information from the field. Figure 2 illustrates the enterprise GIS versioning structure.

Primary components of this system include ArcSDE software on a SQL Server platform. An enterprise-level GIS system is required to create the versioned geodatabases that track changes and allow multiple editors of the utility's primary default database. These GIS efforts have provided a means to update, maintain, and distribute accurate asset information to employees, both in the field and in the office. Figure 3 shows the data input method utilized by the field crews.

With the implementation of GIS and infraMAP, the utility drastically altered its approach in managing vital operational information, moving away from paper to digital maps, and employing GIS-centric technology. The GIS database schema was revamped to include multiple business tables and feature classes that incorporated field data and increased functionality in managing utility assets. The most notable database changes included:

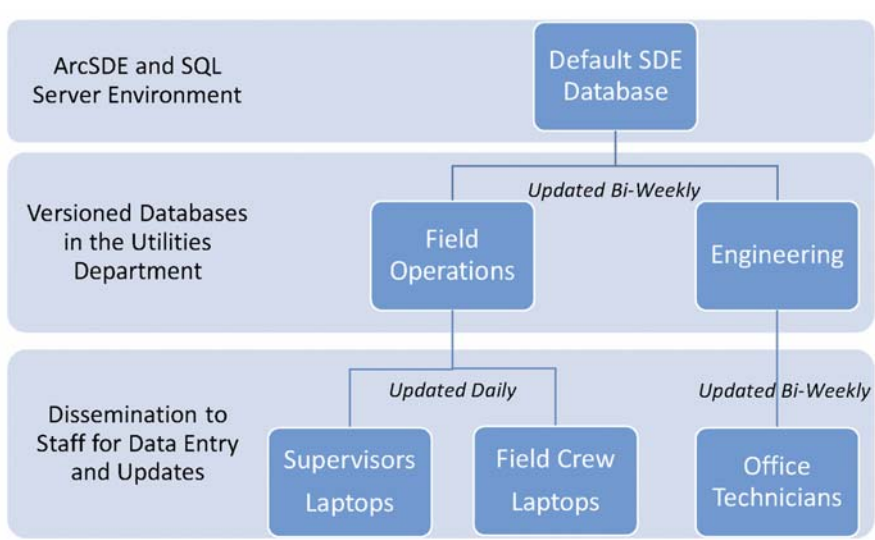

Figure 2. City Geographic Information System Versioning Structure

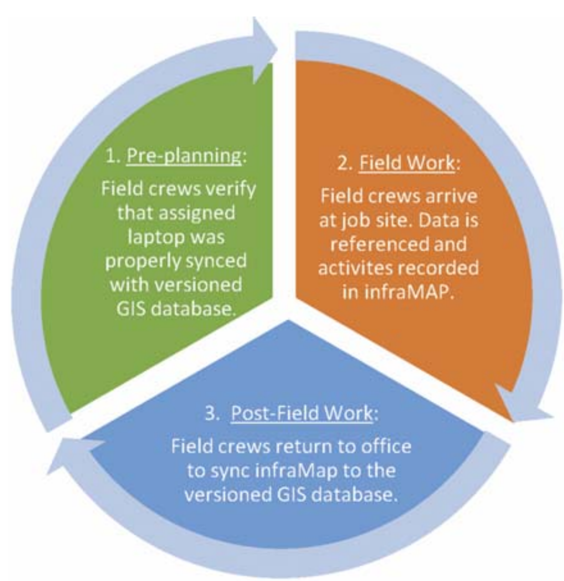

Figure 3. Data Management by Field Crews

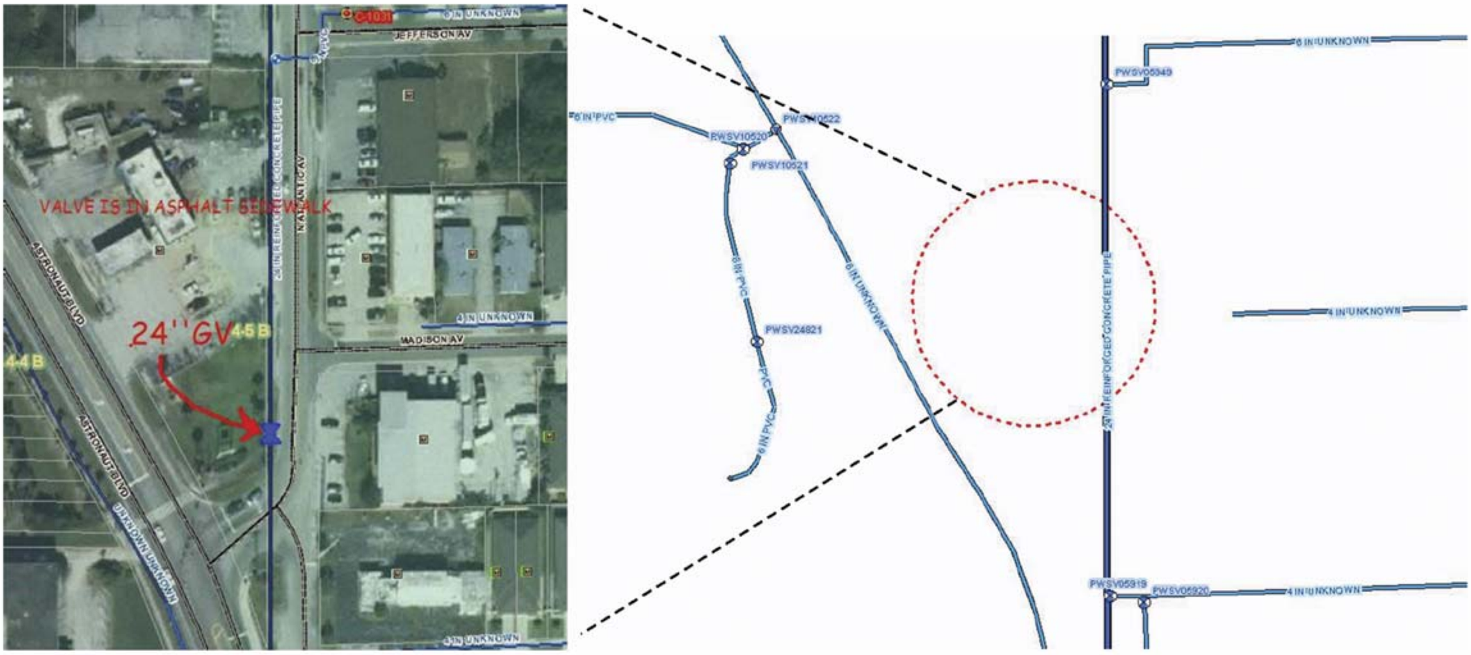

Figure 4. Field Edit of Pipe Asset

Figure 5. Field Assessment Data in infraMAP

- Inspection tables to track assessment activities (e.g., repairs, testing, valve operations/positions, and maintenance)
- Asset repair tables that maintain history on system asset failures (e.g., main, saddle, and valve breaks)
- Creation of multiple-feature classes, including water meters and backflow prevention devices
- Spatial location of parcel information with customer data
- Spatial location of customer complaints
- Relationship tables for storing of water quality data

To date, the utility has purchased over two dozen laptops and licenses of the software for use by the water facility operations field crews. This allows them to continuously update the GIS database by verifying existing data, while documenting daily repairs and water quality activities. An ongoing preventative maintenance program provides additional documentation on the condition and operability of distribution assets. Figures 4 and 5 provide examples of the data available from field activities. The benefits of providing field software and computer equipment include:

- An increase in the speed of accessing and maintaining data by field crews and supervisors.
- An assurance of the continuity of data by storing and maintaining an electronic history of repairs and assessments.
- An increase in efficiency in performing field activities.
- The ability to capture institutional knowledge in a centralized, digital format.
- Field verification of geometry and asset data that allows for a more accurate depiction of the distribution system.

Additionally, management has utilized the data from this program to identify and prioritize capital improvement projects associated with the potable water distribution system.

Improved Efficiencies

A critical benefit of the use of infraMAP can be seen in the expedited response and re-

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covery times for unplanned distribution system activities. Figure 6 shows the increase in efficiency for a typical main break. The staff recounts the example of a water main break on Merritt Island where the use of the software, with an aerial imagery background, allowed the field crew to locate a critical valve beneath a concrete driveway. The uncovering and subsequent usage of this valve to isolate the main break reduced the extent of water outages, thus reducing the number of boil-water notices by more than 100 customers. Additionally, the ability to find, uncover, and utilize this valve reduced, by six, the number of subsequent valves required to isolate the main break.

Lessons Learned

There are a few significant lessons learned by the utility during the implementation of the GIS-centric process:

1. Technology-based solutions like GIS and infraMAP allow inventory surveying, assessment, testing, and maintenance to be conducted in one single effort, which can result in a savings of both time and money.
2. The GIS schema was initially developed prior to the development of the ESRI water utility tools. The underlying field names and table structure do not take advantage of the tools, and retrofitting the database to meet these GIS standards would be too costly. Establishing a detailed, long-term GIS strategic plan prior to the design of the default enterprise GIS database would provide more options for software improvements.
3. Standard operating procedures have not been clearly defined for GIS processes, allowing for variations in editing means and methods. Developing this documentation is part of the ongoing effort to standardize and document methodology at the utility.
4. The inability through standard GIS software to create an automatic time and user stamp for editors tracking each change made to the database has generated confusion in resolving versioning conflicts.

Conclusions

The utility's long-term goal is to create a robust and versatile GIS system that offers solutions for all levels of staff, from management to field staff to contractors. To meet this goal, the utility's customer service and other departments have begun planning for continued GIS system improvements. These efforts include the allotment of resources to grow and expand GIS support within the utility, implementation of additional GIS-based applications and dashboards, and expansion of the user group, both within the utility and by its consultants and contractors.

Ultimately, by implementing a carefully planned long-term GIS strategy, utility departments can gain beneficial results in the area of inventory management, capturing and tracking institutional knowledge, public protection, and increased operational efficiencies. As demonstrated by the utility, a GIS-based infrastructure information system has a multitude of benefits and applications which, when properly implemented and utilized, can improve its operational efficiency:

- Provide centralized data storage, allowing for more efficient organization and access to data.
- Provide a location to capture, store, and disseminate institutional knowledge on assets.
- Associate ancillary files to features (e.g., plan sets, pictures, contracts).
- Implement metrics to track asset conditions, repairs or breaks, and ongoing maintenance activities.
- Establish maintenance schedules.
- Provide a method for accessing data critical to prioritizing systemwide improvement projects.
- Enhance public protection (quickly notifying residents of infrastructure repair and maintenance activities).
- Ensure that the most current and best-available data can be referenced for decision making, both in the office and in the field.
- Optimize emergency field operations.
- Facilitate map updates for presentations, public notifications, field staff, or for office use.
- Employ online mobile solutions or dashboards to manage assets efficiently.
- Facilitate customizations to meet individual needs.
- Provide GIS-formatted data for use by ancillary software programs.
- Improve stewardship of asset data.

In the future, the utility will continue to invest in GIS and its employees through the expansion of its GIS workforce, conducting a long-term GIS strategic plan and employing online functionality of its software.

ACTIVITY NO.	PRIOR to GIS Implementation — TIME in minutes			FOLLOWING GIS Implementation — TIME in minutes			GIS WITH iWATER — TIME in minutes			DESCRIPTION
	MIN	MAX	ELAPSED MAX	MIN	MAX	ELAPSED MAX	MIN	MAX	ELAPSED MAX	
1	5	45	45	5	45	45	5	45	45	1 Crew sent to field to verify location, leak, jurisdiction, and ownership.
2	5	30	75	5	30	75	5	30	75	2 Visual assessment of site. Call Sunshine One for locates. Call for additional assistance if needed (heavy equipment, additional crew, etc.)
3	20	120	195	20	120	195	20	120	195	3 Wait for Sunshine One locates. Site crew begins preparation for exposing break.
4	20	180	375	20	90	285	20	45	240	4 Expose break. Verify repair parts/requirements. Begin isolation of main. Distribute boil water notices.
5	15	120	495	15	120	405	15	120	360	5 Complete repair.
6	30	180	675	30	180	585	30	180	540	6 Restore site. Open closed isolation valves.
7	5	45	720	5	45	630	5	45	585	7 Return to office
8	10	60	780	0	0	630	0	0	585	8 Complete paperwork, i.e. FDEP notice, Customer Service notice, WQ sampling.
9	10	60	840	10	60	690	0	0	585	9 Update pipe geometry documentation.

Potential Time Savings 150 | Additional Potential Time Savings 105 = TOTAL Potential Time Savings 255

Figure 6. Improved Efficiencies