Trevor W. Feagin, AICP
GIS Manager
City of Tamarac, FL
7525 N.W. 88th Ave
Tamarac, FL 33321
Telephone (954) 724-1295
Fax (954) 724-2453
Email trevorf@tamarac.org

Jim VanOstenbridge
Manager of GIS Technologies
BAE SYSTEMS ADR, Inc.
124 Gaither Drive Ste 100
Mt. Laurel, NJ 08054
Telephone (856) 866-9700
Fax (856) 866-7800
Email jvanostenbgridge@adrinc.com

Improving Utility Maps, Locations and Maintenance with Custom Tools

Abstract

The City of Tamarac, population 59,430 has an enterprise GIS with a broad user base. Planimetric and Utility Maps are in a custom geodatabase and served via ArcSDE and ArcIMS to users in the City. The City, with BAE Systems ADR customized ESRI's water and wastewater data model, developed procedures and customized tools in Arc Map to standardize data entry and maintain utility networks. Using ArcSDE, the geodatabases with their domains and rules improved overall quality control and reduced the number and percentage of data entry errors and improved data validation. The data is interoperable with several CMMS packages that the City uses and may use. The result is that the maps are more accurate and interoperable, aiding in daily maintenance of the City's water, sewer, storm water and road networks. The presentation will discuss the implementation process and illustrate the wools used and identify methods to facilitate long-term maintenance and interoperability.

Introduction and Background

The City of Tamarac is just under twelve (12) square miles and is subdivided into with an estimated population of 59,430. The City has over 135 miles of public road rights of way, 30 miles of canal right of way and about 20 miles of private roads. The City has just over 243 miles of publicly maintained water mains, 181 miles of sewer mains and about 95 miles of storm water. Portions of the City are supplied with natural gas from the City of Sunrise, an adjacent municipality. The city has similar amounts of private

utilities like phone, cable and electricity. The City has 18,896 individual water accounts and 18,301 sewer and 18,561 storm water accounts.

The City began developing an enterprise wide GIS in the spring of 1995. A cost-benefit and implementation studies were developed and in 1998, then began developing 1" = 30' planimetric and aboveground utility maps in the City. After the initial delivery, the city began designing a database for a planned 2000 development of underground utility networks. In late 2002 the City obtained new color aerial photographs. In late 2003 the city began updating the City maps as well as converting the planimetric maps and utility networks from a coverage model to a geodatabase. The geodatabase contains specific customizations and refinements that reflect the specific needs of the Public Works and Utilities departments.

The updates maps are nearing completion and individual updates of the planimetric, parcel and utility maps are underway. In FY 2007, a new series of color aerial photographs will be developed and any development since the 2002 photographs will be remapped to insure over all consistency and accuracy throughout the City's base maps.

Tools and Applications

During the process of constructing utility geodatabases for the City, BAE SYSTEMS ADR developed a set of tools to enhance operator productivity and maintain high levels of production quality. At the City's request, a custom website was also developed to provide access to and awareness of the acquired geographic information resources. These tools and applications, of course, are borne of the original motives that encouraged acquisition of the enterprise GIS, the need to produce and maintain high-quality data, and to build awareness that ultimately extends the value of the investment in the enterprise GIS to the contexts of all who consume and apply these resources.

Motives for Building an Enterprise GIS

At the onset of this project City personnel faced a number of challenges, all of which revolved about the absence of a common and precise set of geographic information. Among the issues encouraging the acquisition and implementation of an enterprise GIS were…

- Difficulties encountered in locating underground utility lines
- A need for an inventory of existing infrastructure
- A concise map and listing indicating the condition of existing infrastructure
- Missing engineering plans for 30% of the City
- An expectation from paper records that over 420 miles of water, sewer, and storm water pipe were operational in the existing utility network
- The age of the system: as of 1995, 54% of the water, sewer, and storm water infrastructure was over 30 years old
- A heavy reliance on institutional knowledge
- Difficulty coordinating the availability of hard-copy geographic and engineering information resources at times of intense demand

Another issue of great concern was then and continues to be preparedness for natural or human-influenced disastrous events that require timely and effective management of City infrastructure. Given the combination of this issue with all of the conditions listed above, the cost and risk associated with building an enterprise GIS is lower than the cost and risk associated with inadequate awareness.

The true realization of value from an enterprise GIS, as with any enterprise technology, however, comes from the empowerment of people with the tools and procedures to maintain high levels of quality and timeliness in the data and a sustained perception of reliability from all who consume the systems information. As such, several departments in the City of Tamarac have quickly recognized the opportunity to reap value from their organizational investment in GIS and have sought to acquire and implement additional commercial off the shelf software that capitalizes on the enterprise GIS. With an ever growing base of consumers across the enterprise, there is an ever more important need to ensure that the information resources in the enterprise GIS remain timely and accurate.

Production and Maintenance of High-Quality Utility GIS Data

Through the course of building the utilities geodatabases for the City's water, sanitary sewer, and storm water collection infrastructures, BAE SYSTEMS ADR composed a manual containing specifications and procedures for all aspects of the conversion process. This was necessary as the production design for building and delivering enterprise geodatabases to the City required simultaneous data production efforts of multiple operators within enterprise geodatabases. For all intents and purposes, the procedures that would eventually be exercised by the city to maintain each utility database were the same as the procedures were applied to create it.

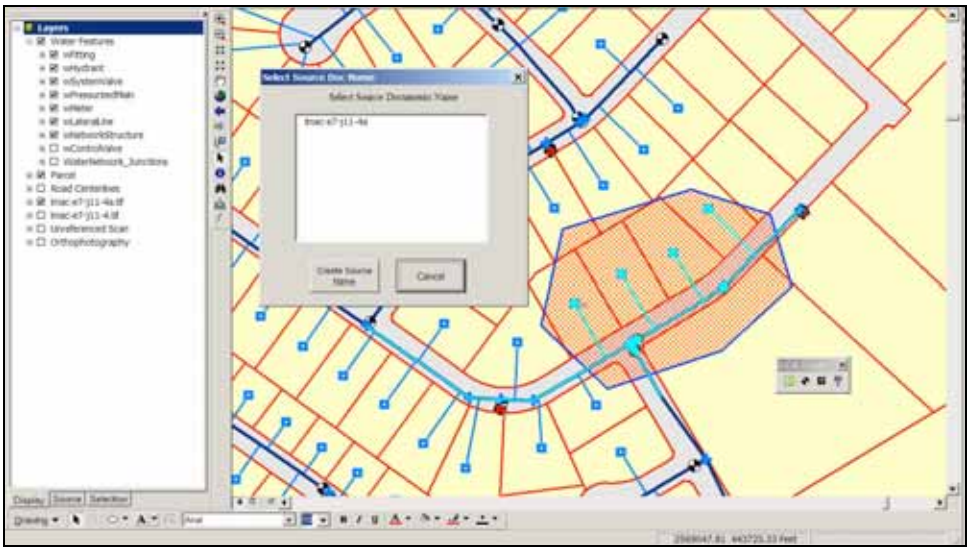
The procedure manual was a living document during the early stages of the conversion process. As procedures were clarified, opportunities were revealed to streamline tasks and enhance data reliability. This led to the development of a set of custom tools used within ArcMap and ArcCatalog that was heavily tested and applied during the process of converting the three utility networks, then deployed accompanied by the procedures manual with the completed utility geodatabases. The manual was then used as a training guide for City personnel to ensure that utility network data retained the level of quality present in the delivered geodatabases.

The tools developed for this effort included the following…

ArcGIS Component	Water	Sanitary Sewer	Storm Water	Tool Name	Tool Description
ArcMap	Π	Π	Π	Roping Tool	Populates InstallDate and SourceDocName for selected infrastructure.
ArcMap	Π	Π	Π	Fittings Tool	Populates Diameter 1,2,3,4 on Fittings from connecting pipes.
ArcMap	Π			Water service lateral tool	Add water service lateral from water meters to water mains.
ArcMap	Π			Valve tool	Populates a special FacilityID that is a concatenation of a development abbreviation and a valve sequence number.
ArcMap		Π		Sewer service lateral tool	Add sewer service lateral from cleanouts to sewer mains.
ArcCatalog	Π	Π	Π	Source scan tool	Builds pyramids for source scans.
ArcCatalog	Π	Π	Π	Ortho tool	Builds pyramids and sets projection for digital orthophotos.
ArcMap		Π		Sewer Facility ID tool	Populates FacilityIDs for Manholes and Gravity Mains within a lift station basin.
ArcMap		Π		TV Inspection Tool	Creates points on sewer gravity mains based on input from TV inspection.
ArcMap		Π	Π	Gravity Main Tool	Populates the InstallDate and SourceDocName for gravity mains using the values from the upstream manhole or inlet. I am nervous about giving this tool to the City.
ArcMap		Π		Storm Water Raster Tool	Upon selection of storm water source polygons, returns cascaded view windows for each source raster image.

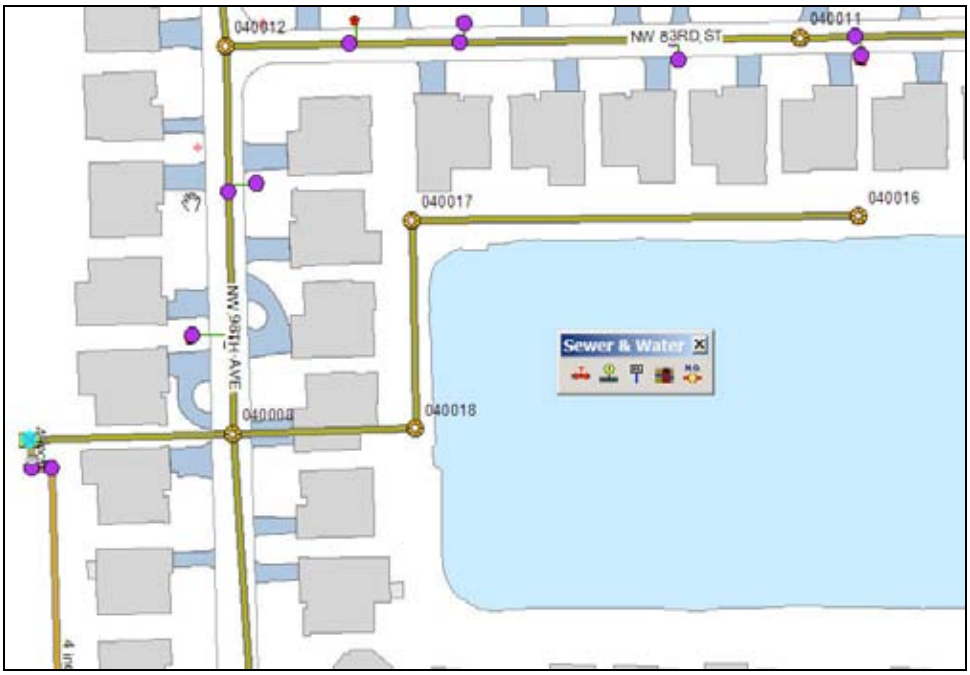
Though tool names are the same, they have been adapted to address the specific functional and structural needs of the data models for each of the three utility networks.

Below are screen shots and additional descriptions of some of the tools and their capabilities…



The **Roping Tool** automatically populates the SourceDocName and InstallDate fields for all utility infrastructure that is contained within the user-defined polygon. This speeds up the data conversion process.

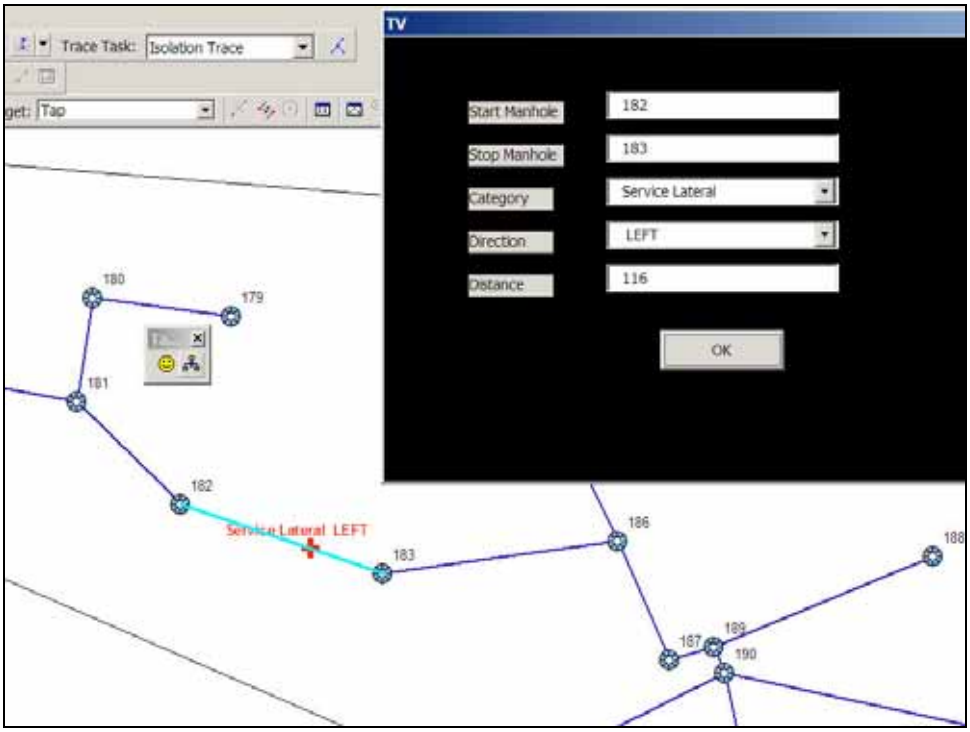
The **Fittings Tool** automatically populates up to four diameters from pipes to the Diameter1, 2, 3, 4 fields of intersecting pipe fittings, such as tees, bends, reducers, etc.



The **Sewer FacilityID Tool** populates the FacilityID field consisting of a reference to the downstream lift station and a 3-idgit sequence number – resulting numbers are labeled.

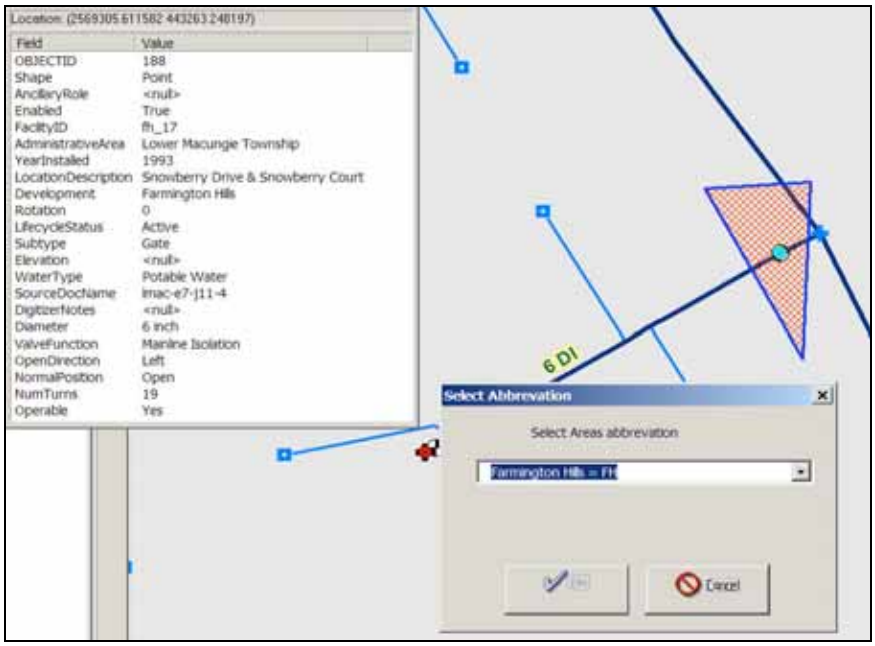
The **Water Service Lateral Tool** creates meters at the centroid of parcel polygons. This enables a rapid connection between utility infrastructure and the customer information system after geocoding the addresses attached to the parcels.

The **Storm Water Raster Tool** is an application that retrieves scanned images of source documents based on a user-defined polygon. It enables users to quickly reference engineering plan drawings within a defined geographic extent.



The TV Inspection Tool is an application that enables users to enter data from sewer TV Inspection logs including the start and stop manholes, the category (lateral, crack, root, etc.), right or left direction and the distance. The tool creates a point at the correct position.

The **Sewer Lateral Tool** creates a sanitary sewer lateral between selected cleanouts and the closest sewer main. A dogleg is added in the downstream direction as well as the fitting whose diameter fields are transferred from the main.



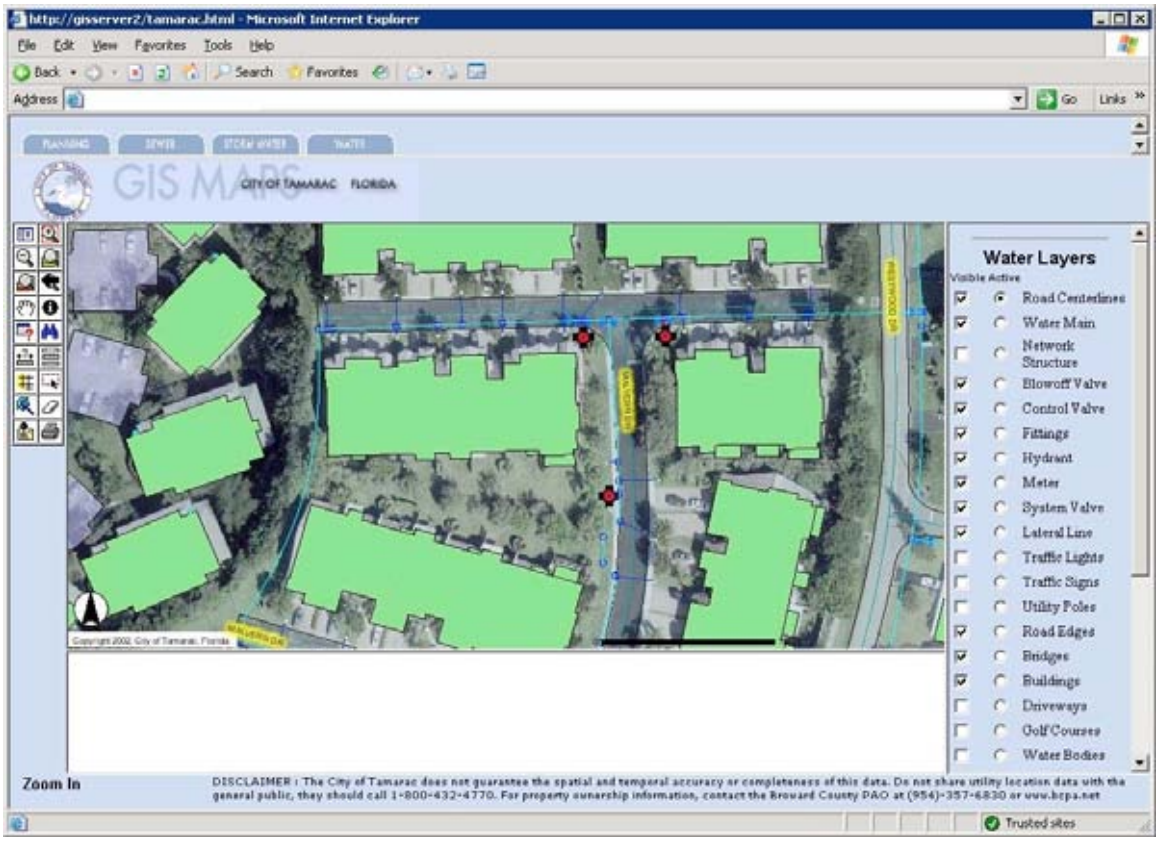
The **Valve Tool** populates a special FacilityID that is a concatenation of a development abbreviation and a valve sequence number. This creates a unique facilityID (in this case fh_17) for valves when legacy valve numbers are repeated for each development.

The **Water Service Lateral Tool** created service laterals connecting selected meters to the selected water main. This completes the connection between the water main and the customer information data that is linked to the meter.

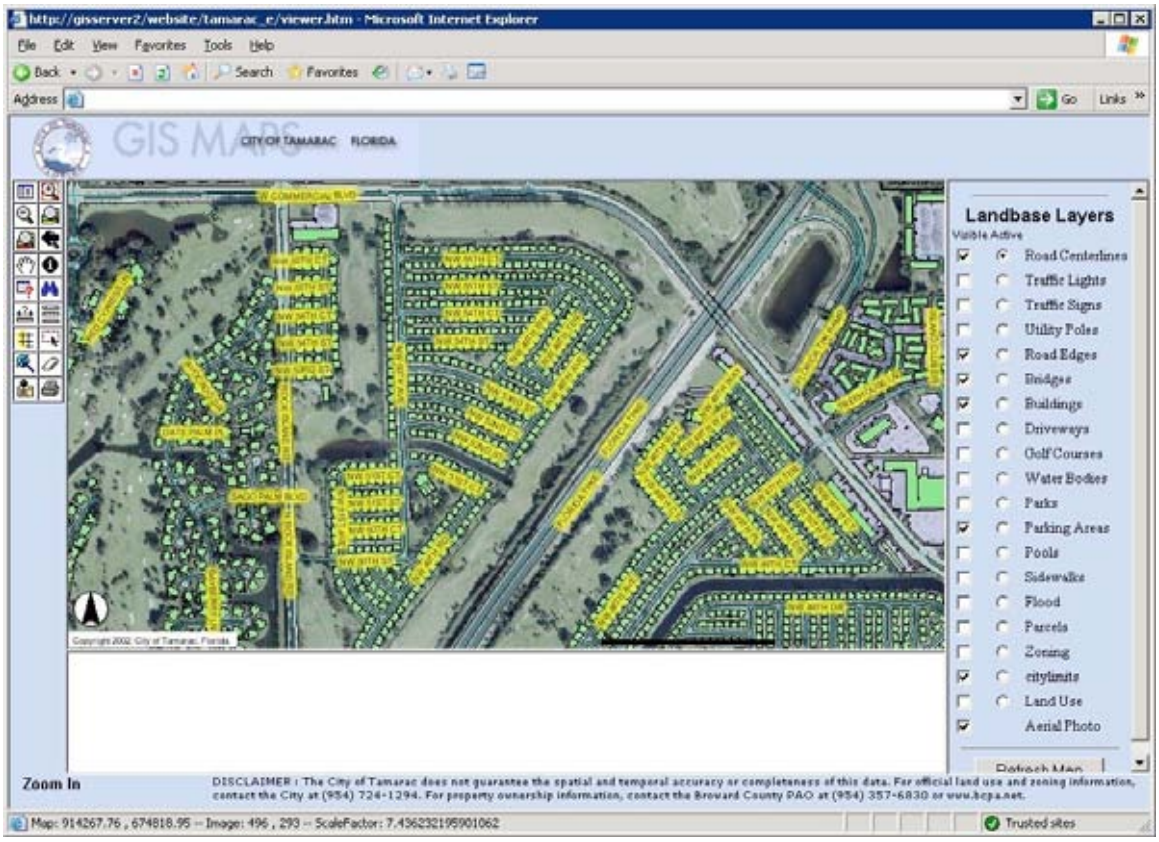
Building Awareness for a Valuable Resource

As mentioned earlier, the key to realizing the value associated with the investment in building and implementing a high-quality, well-maintained enterprise GIS is empowering people with the means to consume and apply this resource in their context. To help build awareness of the availability of this resource, the City had BAE SYSTEMS ADR construct custom websites that allowed City personnel across the enterprise to leverage this data. Additionally, the City has deployed ArcView 3.x and ArcView 9 to select users across City departments to empower them with the ability to consume and apply their enterprise GIS in a manner that meets with their context.

The website, customize from the framework of the ArcIMS HTML viewer, allows the user to focus on a specific area then change contexts by selecting different tabs on the user interface to present collections of layers that are best suited planning, sanitary sewer, storm water, or water utilities.


http://gisserver2/tamarac.html - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address
Go Links
GIS MAPS
CITY OF TAMARAC FLORIDA
Water Layers
Visible Active
Road Centerlines
Water Main
Network Structure
Blowoff Valve
Control Valve
Fittings
Hydrant
Meter
System Valve
Lateral Line
Traffic Lights
Traffic Signs
Utility Poles
Road Edges
Bridges
Buildings
Driveways
Golf Courses
Water Bodies
Zoom In
DISCLAIMER : The City of Tamarac does not guarantee the spatial and temporal accuracy or completeness of this data. Do not share utility location data with the general public, they should call 1-800-432-4770. For property ownership information, contact the Broward County PAO at (954)-357-6830 or www.bcpa.net
Trusted sites

The public access version of the website removes the tabs and publishes general use landbase layers.



These internet offers the City the opportunity to cost effectively provide access to its enterprise GIS database, allowing the consumer to make more decisions and provide feedback on how such information resources can provide additional value in the consumer's context.

Several City departments have recognized this opportunity and are currently pursuing the implementation of new commercial-off-the-shelf software systems that leverage information resources from the City's Enterprise GIS.

Third Party Software

The City has mixed results in its efforts to procure a Computerize Maintenance Management System (CMMS) that would meet the needs of the City. In 1997, the Utilities Department Developed an RFP that was not issued when the then City manager directed the Departments to use H.T.E. The City purchased H.T.E. software modules for the public works, utilities and fire departments, but the module specific data bases are not easily transferable and do not talk to each other. While a third party vendor developed a map objects based viewing software, H.T.E. does not have an effective GIS component.

In addition, there are several database and interoperability limitations that limit data entry and spatial analysis.

In a process that began in 1998, the city began designing a database that would meet the needs of the Utilities and Public Works Departments. Staff from numerous department as well as staff from BAE SYSTEMS ADR, Inc and UMI developed a series of data models for the 1998 planimetric and utility networks. As a part of developing the City's GIS needs and data base design, the Utilities and Public Works Departments examined several GIS based tools that will aid in increasing productivity and reduce time needed to get underground utility maps and locations confirmed. In 1998, ADR, Inc the City's mapping contractor recommended PipeWorks, now CityWorks manufactured by Azteca Systems. The conventional coverage based data model was modified to include unique numbers for both the H.T.E. system and City Works. These changes were subsequently folded in to the Geodatabase development and data migration to 8.x and 9.x.

inframap2005™

The city recently purchased licenses of iwater's inframap2005™, based on ArcGIS engine, aids in the exercising and recording of information about hydrants and water valves. In the past, the Utilities and Fire departments have exercised valves and hydrants, both with different schedules and different paper based recording and reporting methods. In many cases the data was not kept in as single place and there was no consistent reporting method so most of the paper records were not usable in the any of the city's CMMS. The field crews used to fill out paper reports that were given to the Engineering technician responsible for adding to the water and sewer networks. This resulted in some additional delays and the possibility of transcription errors.

Using the inframap2005™ software, utility department employees will exercise and record data about the hydrants and valves and their associated maintenance. The software is designed to incorporate GIS data collection in to the routine maintenance. The software is designed for field crews who normally would not have any computer or GIS knowledge. The data can be collected then periodically downloaded in to the geodatabase of utility networks. This process, while only used by one crew, saves several hours a day in transcription time and is creating a permanent record of the over 1989 fire hydrants and 5210 valves in the City's water system.

Ques Television reporting tool

One of the City's previously mentioned specialized tools reads data from a television tool data report. This tool allowed the transfer of discrete data along a sewer pipe from the television software to the GIS. The city uses 3.0b, the newest version 5.0 allows a seamless transfer from the TV tool to the geodatabase. Using 3.0b, very little data was transferred and that data was not added to the city wide geodatabase. The Utilities department recently selected a different TV inspection software to examine the sewer lines so the long term cost reduction and benefits from this specific tool will not be known this year.

First Look Fire Pre Planning

The Fire Department uses several programs for fire preplanning and for hurricane and disaster planning and response. These programs use the GIS as a way to locate underground valves and to guide response vehicles. The current version of First Look Pro with Map Designer is a map objects software that has basic GIS functionality built in. The street map is a shape file copy of the existing 911 street geodatabase. First look pro compares the city's street address information with the supplied USPS address data and geocodes requested locations. The GPS guides emergency vehicles to the requested location.

First Look Pro the fire pre-planning software that loads the City's map data as well as accepts images exported from the City's fire maps developed in Arc View 3.x. This program uses a variety of maps, images and plans from the Fire Department's records to develop a more comprehensive set of information about a site, any potential threats and provides a way to view building floor plans. The City has required all site and architectural plans delivered in Auto Cad format since 1998. This data was added for the first tier of critical facilities like schools, government buildings and large commercial and industrial facilities. Since the City has relatively few major disasters, this tool is seen more as a wise precaution than a general productivity enhancer. The GPS and map display when placed in all vehicles should reduce the number of wrong terms and reduce overall response times.

Mobile Utility GIS

The Utilities Department now has two lap top computers that are in field crew supervisors' vehicles. As utility network construction neared completion, the GIS Manager recommended purchasing laptops in an effort to reduce the time needed to locate utility lines. This was initially addressed via the city's intranet web page in 2003 and in 2004 monies were set aside to purchase laptops. The City evaluated tough books, but decided that the substantially higher price, poor display quality, slower processor speed and processor speed and storage limitations made them a poor choice. In 2004 the Utility Department purchased laptops and in 2005 purchased a mount. The laptops are fastened to the truck with a locking mechanism so the laptops can be carried to the site. The laptops have a copy of ArcMap and a copy of the city's geodatabase as well as copies of the over 2000 scanned and georeferenced plans. The ArcMap interface was simplified by removing unnecessary menus and by providing a set of instructions. The instructions show how to type in an address, find the appropriate water or sewer plan and view a copy of the scanned as built plan.

While only in two trucks, the locators have reduced their requests for maps and plans by between %30 and %40 of previous levels. The time to make the request and to pick up the plans costs between $33 and $40. Roughly 30 fewer work orders for this type of data were processed in a typical month resulting in an estimated savings of between $990 to $1,200 or around $11,880 to $14,400 a year. A departmental wide reduction of about 200 copies a month was reported from FY 04 and 05 at an average cost of $6 per copy.

This reduction is a combination of fewer field location based work orders and the availability of the utility geodatabase and plans on the City's internal web site. In addition, a recent request from Broward County Traffic Engineering that would have totaled 400 plans was satisfied by mailing CDs with the city' scanned plans.
The Utility Department plans to acquire two more of these units, increasing the use of the GIS data and reducing the number of map or plan requests. The Public Works Department has a similar workstation based solution and will implement a similar laptop solution in FY 06.

Conclusion

The core assertion of the effort to acquire and implement an enterprise GIS for the City of Tamarac has been to help the city do its job a little better, serve its residents and businesses more effectively, and operate more efficiently. Even in this early stage of implementation, benefits have been realized. As awareness of this resource builds and a greater number of internal and external consumers introduce new opportunities to improve services provided to our local residents and businesses by applying our enterprise GIS, we expect the value of and return on our investment to continue its upward trend.