

GIS on a Budget for Small to Mid-Size Water and Sewer Utility Districts

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Biography:

Mr. Garrett currently is Project Manager on civil engineering and survey projects at Robert G. Campbell and Associates in Knoxville, Tennessee. These projects include roadway survey and design projects and development and maintenance of Geographic Information System projects for utility district clients. Prior to joining RGC&A, Mr. Garrett served for twelve years at the Tennessee Department of Transportation in the Survey and Design Office. The final four years at TDOT, Mr. Garrett served as the Regional Survey Supervisor for Region 1.

Introduction:

A continual problem for small water and sewer utility districts is the lack of accurate maps and information about pipes that have been placed through the history of the district. Often a substantial portion of the knowledge is contained only in the memories of senior field personnel.

When a problem occurs, it is often only this single individual with the requisite knowledge to address the problem. If this individual is unavailable then much time and public goodwill is lost before the problem can be corrected.

Geographic Information Systems can help by generating accurate maps and attribute information to assist not only in emergency problem solving but also in system planning, troubleshooting customer service and asset management.

However, small to mid-size districts have been put off by the large cost of GIS implementation and tremendous lag time between GIS project implementation and delivery of a usable product. This does not need to be the case. With a modest annual budget and a long term commitment, GIS systems can be developed for utility districts without breaking the bank and provide a useful product almost immediately.

The process utilizes the wealth of publicly available GIS data for generation of base maps and then incorporation of various sources of utility district information including paper maps, personal knowledge of utility district employees and targeted field surveys.

This paper will explore an ongoing project developed by Robert G. Campbell & Associates on behalf of Anderson County Utility Board (ACUB) in Anderson County Tennessee. An initial budget of \$20,000 generated a useful system map, hardware and software.

Basis:

The Anderson County Utility Board (ACUB) is a small water and sewer district with approximately 4000 customers. The geographical boundaries cover approximately one third of the county in the central portion excluding the cities of Oak Ridge and Clinton and the community of Norris. Hallsdale Powell Utility District (HPUD) laps over from Knox County to cover a portion of southeast Anderson County. See appendix A for map of the district. Oak Ridge and Clinton operate their own utilities and Norris is served by the North East Anderson Utility District. ACUB is wholly owned by the County of Anderson and the manager reports directly to the Anderson County Commission. Day to day operations are handled by a manager, Mr. Larry Clowers, who reports to a 7 member board of directors. Mr. Clowers manages a staff of 18.

Robert G. Campbell and Associates (RGC&A) has been the engineer or record on behalf of ACUB for a number of years. In this capacity, RGC&A has performed survey and design functions for numerous water line, sewer line and water storage projects in the ACUB district. As a result, a great deal of information about the locations of district lines were contained in the RGC&A archives. This information consisted of design data and as-built data in both paper and electronic format.

Prior to development of the GIS system all records were contained in paper maps or the collective memories of ACUB staff. The maps took the form of a small scale (1"=2000') system map and various large scale (1"=50' and 1"=100') design plans and "as-built" drawings. As is common to most districts of this size, it was often difficult to ascertain the exact location of water and sewer pipelines in emergency situations.

Fire Destroys Records and Leads to Consideration of a GIS system:

In 2002, the situation became more perilous when a fire broke out in the ACUB archives and destroyed almost all

the paper records. Insurance coverage was in place for such emergencies and provided \$20,000 in funds to replace the records. The challenge to the District then was how to replace paper records which were the basis of all their infrastructure location. Clearly, at this point it became imperative to leverage all available sources of information regarding the location of their infrastructure.

One option available to recreate the lost documents was to query all engineering firms which had performed work on the District systems and obtain copies of all plans and electronic files retained by those firms. Robert G Campbell and Associates had been involved in most of the water and sewer improvement projects conducted by the District for many years and this would simplify the process of finding and making such copies. However, such a process would still be tedious, time-consuming and result in a set of records inferior to what existed previously. And, how do you then extract the information contained in the minds and memories of ACUB employees.

It was then suggested that a better option might be to begin development of a GIS system for the District. This option had the same problem of involving a tedious process of locating and digitizing old plans and it brought with it the perceived disadvantage of extreme cost. However, it had several distinct advantages. First, the resultant product would be vastly superior to the old paper records system. Secondly, a GIS solution would provide the ability to extend beyond simple mapping and provide facilities management and customer relations functions as well. Third, with some CADD training, it would be possible to extract the information contained in the collective memories of the ACUB staff.

The District decided to embark on the GIS option. The challenge then became to develop a basic GIS system that would at the outset substantially reproduce the old paper records and to do so on a budget of \$20,000.

Goal of the Initial GIS system:

The goals set for the initial implementation of the system were as follows:

1. Purchase a well equipped computer to house the GIS system. This system would need to be of above average capabilities and provide a computing base that would be able to grow with the GIS system and incorporate into the District computer system already in place.
2. Purchase GIS software that is capable of performing the base GIS functions to be implemented at the beginning but also allow for advanced GIS functions to be implemented in future expansion of the GIS system.

3. Gather existing electronic (CADD) records and merge these into a basic GIS system.
4. Gather any copies of old plans and other paper records and digitize these into the basic GIS system.
5. Incorporate Anderson County GIS information for base mapping. Anderson County GIS project was started some months prior to the ACUB project.
6. Leverage any other sources of existing GIS data.
7. Share ACUB data back to the Anderson County GIS system.
8. Deploy the basic system at ACUB office and train ACUB personnel to use the system for basic query and mapping functions.
9. RGCA would maintain backups of the system as well as provide as needed training and perform advanced GIS functions in the short term.
10. Geolocate water and sewer network to 20± feet but not including manhole elevations.
11. Reservoirs and treatment plants would not be included at this time.
12. Provide all the above for \$20,000 or less.

Components of the Initial GIS system:

The first step of the process was to purchase hardware and software to house the GIS system. Hardware consisted of a Dell Precision 360 workstation. Dell was chosen for low price and proven reliability in the RGCA infrastructure. A workstation was chosen over a desktop to provide the advantage of improved memory and graphics subsystems. These advantages would be needed to provide adequate performance when large high-resolution aerial images are added to the GIS system. The workstation included:

- 512MB of RDRAM memory (expandable to 4GB if needed)
- 80GB of hard drive storage (7200RPM IDE). The system also allows future IDE Raid implementation if needed.
- ATI Radeon dual head graphics card with 64MB video memory.
- Dual 19" CRT monitors.
- Windows XP operating system
- Hardware price tag \$2200

The choice of GIS software became a rather interesting discussion.

The ARCGIS suite, by ESRI Corporation, is the market leader. Various reports list the market share at 60%-70% of the worldwide GIS market. Additionally, ARCGIS is used in the Anderson County GIS project as well as the State of Tennessee. This made ARCGIS a desirable product for the ACUB GIS project. However, the

extreme price tag was problematic due to the limited budget for the project.

We then looked to Geographics software, by Bentley Corporation. Geographics offered several advantages. They were lower in price. ACUB, with a government discount could acquire Geographics for less than \$4000. Geographics runs on a Microstation graphics base which is in widespread use in the Civil Engineering and Surveying communities. RGCA already owned and used Bentley products so training was not an issue and additional software would need to be purchased only for the ACUB staff. And, Geographics could easily read and write ARCgis shape files.

The decision was made to implement the system on Geographics software.

Once hardware and software decisions were made, then the process of building the GIS system began.

The first step was to incorporate the base map data from Anderson County. At the time the Anderson County system consisted of only property and owners information. This data was supplied to ACUB and the ARCgis data was read into the Geographics system. This data was augmented by streams data, roadway data and aerial photography downloaded from the Tennessee Spatial Data Server. This and other sources of free data are an oft overlooked means to trim costs from a GIS startup project. Too often, an entity is sold a complete system that recreates every aspect of the GIS system rather than leveraging the existing sources of data which or often available for free. Some good sources of GIS data are:

- Tennessee Spatial Data Server - <http://63.148.169.50/>
- US Geological Survey <http://www.usgs.gov/>
- The USGS National Map Project - <http://nationalmap.usgs.gov/>
- USGS Earth Resources Data Center (EROS) - <http://edc.usgs.gov/>
- Bureau of Land Management - <http://www.blm.gov/nhp/index.htm>

While base mapping functions were ongoing we began the process of specifying the parameters of the GIS system and the various features to become a part of the system. This process included designating which features were to be included such as manholes, water valves and of course the water and sewer lines. In addition we determined what data attributes would be collected and tagged to each feature. These data attributes were items such as serial numbers, install dates, last inspection dates, elevation of manholes, etc.

It was understood from the beginning that the collection and input of much of this attribute information would be very expensive and time consuming and that only readily available attribute would be immediately tagged. For example, for water lines the size and materials were readily available and added during the digitize process. But, install dates and contractor names were not readily available. These would be left blank and added by ACUB staff as time and monetary budgets allowed.

After the data formats were specified and features configured, then began the digitizing process. The first phase of the process involved only the water distribution system. Electronic CADD information was copied into the Geographics project and attributes and features were applied. These sources of data were the easiest to incorporate but unfortunately were the least numerous. Paper plans were scanned, registered to proper orientation and then digitized using a heads up process. The process would immediately prompt the technician for attribute information upon the creation of each feature.

After all sources of plans data were exhausted there still remained approximately 40% of the water network missing from the GIS system. These remaining areas were digitized in from a large "system map" which showed the entire water network at 1"=2000' scale.

During the entire water network digitize process extensive use was made of the knowledge of the RGCA engineering staff and ACUB management staff. This knowledge provided invaluable tidbits to help fill in missing bits or fine tune the location of the various features.

Following the water network digitize process, the sewer network was started. Unfortunately, the sources of information here were very sparse. Following the same procedure as above we first incorporated electronic files then digitized paper plans and incorporated the memories of various personnel. After all this, perhaps only 30% of the entire sewer network was able to be reconstructed.

The final ongoing process was for the ACUB field level personnel to plot maps, carry them to the field and compare the maps to field evidence and personal knowledge.

Current Status of the Initial System:

The base system was completed in May of 2003. It consists of base mapping, water distribution network and partial sewer network. The computer system and data were relocated to ACUB offices at that time. The ACUB data set is considered a duplicate with the original and permanent data set housed at RGCA offices. Data updates are provided to ACUB through automated CD installations produced at RGCA offices.

Water system data was more readily available and as a result nearly 100% of the water network is mapped. It is believed that the water lines are located to within 20 feet. Field verification is on-going. Field personnel corroborate the GIS data by comparing plotted maps to field evidence and supply corrections to RGCA technicians.

Sewer system information was less available but generally of a higher quality. Only about 30% of the entire sewer network is mapped but the quality of data allowed the data to be mapped to within 10 feet or less. Most of the sewer information was contained in electronic files which could be reliably scaled and rectified to match base map data which accounts for the better quality of data.

The current system satisfies the original requirements of the system and did so for less than the \$20,000 budget limitation. We were able to replace the lost paper records with a product of better quality and tremendous potential for future expansion.

Short Comings of the Initial System:

Although the current system satisfies the need to replace the lost paper records, it is nonetheless lacking in several regards as a GIS tool.

First, the sewer system is not well represented. As noted above only about 30% of the total sewer network is mapped.

Second, in the water network, only water lines were mapped. Of tremendous need is to map the other appurtenances of the water network, chiefly the valves, meters and fire hydrants.

And, the data attributes of the various features need to be collected and filled in for all the features. As noted above, little attribute information was included initially other than pipe materials, sizes and location.

Plans and Potential for System Augmentation:

Over the course of the next several years ACUB and RGCA plan to slowly but steadily improve the GIS system. The improvements will cover the following:

- Implement computer network technology to allow the remote administration and update of the ACUB data from the RGCA offices.
- Locate by GPS methods, all the manholes, water valves and fire hydrants in the district.
- Collect and input various data attributes of all features. This process is on-going by ACUB staff.

- Monitor, check and correct data and location of features in an on-going process.
- Link the GIS system to customer and billing database to provide enhanced customer service and facilities management functions.
- Use the data to organize and automatically produce work orders for maintenance functions such as inspection and exercise of water meters and valves.
- Incorporate the newly completed Anderson County GIS data for base mapping. This system includes full property, topographic mapping and high resolution aerial photography information.
- Implement regular reporting functions to provide planning data for growth areas or possible problem areas of the water or sewer system.

Conclusions:

An initial budget of \$20,000 generated a useful system map, hardware and software. The project is expected to continue and expand for ten years or more encompassing the tasks noted above. However, the current implementation while less than the eventual desired product is nonetheless very useful. We accomplished this by working closely with the client, utilizing available existing data and providing most needed aspects of the project first with the capability to add features and functionality at a later date.

While it is true that the eventual fully developed system will cost a sizeable amount of money, if this cost can be spread out then it is easier to manage. The trick then is to provide a useable product early on and at every stage of development. Is the ACUB system the best it can be? No, but it does provide basic mapping and location service to the district and it does so at a very good initial price.

Much of the future expenditures of data entry can be absorbed into daily operating costs by utilizing ACUB staff during periods of low work load. High dollar activities such as the GPS location of manholes can be implemented in stages as budgets allow.

This should be the primary objective of a small utility GIS system. Work slowly but steadily within the constraints imposed by budget and above all provide a useful system at all points of the project.

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APPENDIX A

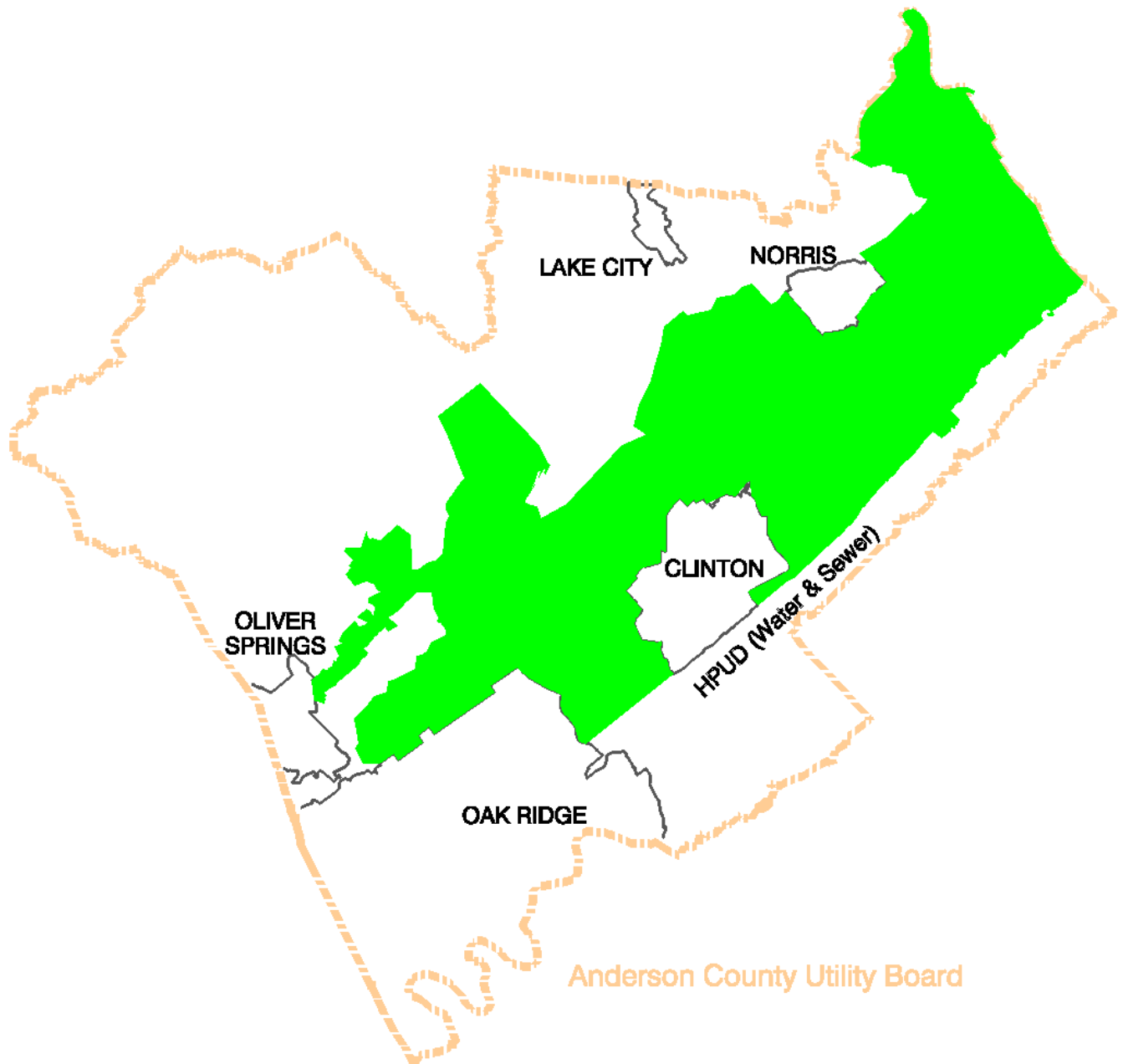


Figure 1 - MAP OF ACUB DISTRICT IN ANDERSON COUNTY