**PAPER #328**
# WATER/WASTEWATER AUTHORITY GEODATABASE DESIGN AND IMPLEMENTATION LEHIGH COUNTY AUTHORITY ALLENTOWN PENNSYLVANIA

**Authors: Lance Babbitt, Peter Godfrey**

**Abstract**
The Lehigh County Authority (LCA) located in Allentown, PA serves approximately 13,000 customers (residential, commercial, industrial) and maintains both a large network and smaller satellite systems throughout 11 municipalities within Lehigh County. This presentation will be a case study of the turn-key process LCA underwent from Needs Analysis and Implementation Plan through full enterprise-wide Arc8 implementation (as described in ESRI's Water Writes). Particular detail will be given on the water and wastewater geodatabase design, pilot conversion and prototype applications, database design refinement, conversion strategy, and implementation. Special attention will be paid to lessons learned throughout the 3-year process.

## Paper Submission

### Description of LCA
Lehigh County Authority (LCA) is a regional provider of water and wastewater services in Lehigh County, Pennsylvania. LCA currently supplies 5.2 million gallons per day of water to 13,000 residential, commercial and industrial water customers. We also transport 5.9 million gallons per day of wastewater, primarily through a regional interceptor system. Our dispersed service area covers approximately 50 square miles. LCA's 32 full-time employees work in three departments: Administrative, Capital Works and Operations. For several years, LCA has been in a service expansion mode due to high population growth in Lehigh County and an ongoing acquisition program.

Although in the past we have had some Geographic Information System (GIS) capability, it was very limited in scope because our water and wastewater infrastructure had not been available in digital format. Our ventures into GIS were sufficient to convince us that the technology could provide us with substantial benefits. Our first move was to invest in a digital base map of one of our residential developments, Ancient Oak, for use in piloting efforts. We acquired both planimetric vector mapping and digital orthophotography. The design scale of the mapping was 1 inch = 50 feet.

We decided that we needed a plan to allow us to develop the GIS System in phases and maintain a clear view of the "big picture." In 1999 we solicited proposals for consulting to develop a design for our GIS. A plan would be a requirement to convince our Authority Board of Directors of the value of investing in GIS technology.

### GIS Design Phase
The Design Phase of our GIS consisted of a combined Needs Analysis and GIS Strategic Implementation Plan (Plan). To oversee the progress of the Plan, and to gain inter-departmental buy in, we formed a team consisting of representatives from each department. We began with a complete review of our current (pre-GIS) environment. The review included documentation of our organizational structure and responsibilities, adopted policy documents, existing computer systems (hardware and software) and a complete inventory of our digital and hardcopy data sources. The hardcopy mapping of our system was limited to a schematic representation on small-scale (1" = 800') index maps, a series of valve maps for each development, and approximately 900 as-built and development drawings. There were also some CAD drawings as well as a valve and a hydrant database maintained in Microsoft Access™ and a home-grown Customer Information System programmed in the ADMINS language.

While numerous departmental interviews were undertaken, the key information gathering took place during the nine (9) business process interviews (work and data flow) that were conducted with our staff to document critical tasks and the staff and data required to support them. Realizing

that it is not wise to implement a large number of applications simultaneously, we carefully assessed the priorities. In the end, we identified 34 potential applications in three categories. Of those, we selected 5 (general purpose GIS, work order management, data maintenance, customer information, inquiry tracking) that were considered high priority based upon both organization-wide use as well as business process improvements. One of the key applications involves the ability to integrate our water system infrastructure with our ADMINS customer database.

Once we determined our priority applications, a conceptual database design was undertaken to identify the thematic data layers required to support our priority applications. Concurrent with our efforts, the local county government began the development of countywide digital orthophotography and a tax parcel data layer. This dovetailed perfectly with our plans and we were able to fund additional low-altitude photography to support our recommended 1" = 100' land base requirement. One of the recommendations in our Plan was to pilot the conversion effort in the original Ancient Oak area and then develop prototype applications to use as staff training tools and system evaluation. To accomplish this we needed a detailed database design.

**Database Design**

At the time we were ready to convert the pilot area, the geodatabase concept was new and we had concerns about being on the "bleeding edge." We also were concerned that the model and its design might be overly complicated for a utility of our size. Consequently we opted for a coverage data model as our GIS software environment was limited to ArcView 3.2a. Our database design was based on ArcINFO arc/node topology. We used line and node identifiers to differentiate the various feature classes (distribution mains, hydrant laterals, valves, hydrants, fittings, manholes, etc.). The detailed data associated with each feature type were stored in separate tables. We also developed a series of code tables. By linking and joining these tables we were able to create a complete database picture for the features.

**Pilot Development**

The size of the pilot was about one half square mile. In addition to the utility data, we also converted the tax parcels and populated them with the property IDs of our ADMINS customer database. This gave us the ability to link the water and wastewater systems to our ADMINS customer database. We also developed a shapefile with polygons covering the extent of each of the source documents. This enabled a hot link application to review scans of the source documents. The initial line work was compiled in CAD and later translated to ArcINFO™ where coverages were built and additional attribution was added.

At this time, we decided to examine the balance between the cost of GIS with the potential benefits. We conducted our own internal assessment of 17 task categories where we felt GIS could best assist us and prepared a cost/benefits analysis. We used the pilot experience to project the cost of full system conversion and added the cost of other components. In the end we, as well as our Board, were satisfied that the value of potential benefits would exceed the costs within a reasonable timeframe.

**Preliminary GIS Prototype Applications**

Two prototype applications were developed for use with the pilot data, General Purpose GIS and Customer Information. Since we were using ArcView 3.2a, the applications were developed in Avenue. Approximately _ our staff were trained in the use of the Pilot and asked to evaluate its potential. Although we could see new approaches on the horizon with the release of ArcGIS™, these early applications enabled us to introduce GIS technology to our staff to gain their "buy in", to evaluate the potential impacts on our operations and to obtain Board approval to proceed with the conversion of our entire system. Board approval to move forward with data conversion efforts was secured in the fall of 2001.

**Migration to Geodatabase Design**
With help from our GIS consultant (CDM) and our conversion contractor (BAE SYSTEMS ADR), we began to see the real benefits of migrating our database design from coverages to the geodatabase. In fact, our conversion contractor informed us that because of the inherent efficiency of converting directly into the geodatabase, they would do the conversion in the geodatabase even if we decided to stay with the coverage model and then export the data to coverages if necessary. With assistance from ESRI's Philadelphia office, the database design for the LCA geodatabase was developed. To test the concept, the pilot coverages were imported into the new geodatabase. We saw how ArcGIS™ could be used to georeference the scans of the source documents to the land base. Now we could use the source scans as a backdrop to the digitized infrastructure and view all the supplementary information on the drawings that was not digitized. Another benefit is that the network topology is built right into the data model instead of being managed independently by an external application. We found that most of the functionality contained within the two prototype applications is available within ArcMap™ and thus we were convinced that the Arc8 platform was the best way to go. The initial concern for increased complexity regarding the geodatabase model turned out to be unfounded.

**Full System Conversion**
Our complete system has now been converted and the ESRI Philadelphia assisted us with the development of some special tools to streamline the conversion to our specifications. These conversion tools will also be useful in the database maintenance phase following the conversion. We are also pleased that substantial quality control and quality assurance components are built into the conversion process due to the fact that the quality of the data is of critical importance and organizational acceptance. This includes valid value data entry controls with extensive use of range and code domains. The geodatabase is also being used to import data from our external hydrant and valve databases and improve the data quality in the process. We have recently acquired an upgrade of our ArcView license to version 8.2 that will enable us to experiment with the progressive deliveries in geodatabase format and we have dropped the coverage delivery specification completely. We are convinced that the geodatabase has enabled us to have a superior final product and has reduced the overall cost of our conversion. Our cost/benefit analysis looks even more promising than initial expectations.

**Future Outlook**
We believe that the best measure of success of our GIS implementation will be the number of eventual users. We are investing in GIS because we believe that it will help us do our job better and provide improved customer service. The only way that can be accomplished is if we provide access to the technology to as many users as possible. It is also becoming apparent that many of our applications are embedded in our geodatabase model, requiring only minor customization. We are looking forward to full implementation that will result in a system for sharing the GIS data and applications both in the office and the field. We have now moved onto the development of our distributed GIS applications using SQL Server DBMS, ArcSDE, and ArcIMS. Three of our five priority applications will be available to all our staff through the web browser. The use of the geodatabase format has not only saved us money, but has emphasized the true scaleability of this technology. Especially for an entity of our type and size.

**Lessons Learned**
The process that we have undertaken from the initial decision to explore the ability of GIS to assist our work and improve efficiency to the present when we are rolling-out browser access to the GIS data for all staff, there have been several lessons learned. The following list is included for those entities that are either considering GIS or in the process of implementation:

- Create a detailed and phased plan to guide the implementation
- Understand the technical as well as organizational impacts that integrating GIS into your organization will entail
- Pilot and prototype conversion and applications before full implementation

- Make sure that all levels of staff are involved in the design, testing, application development and evaluation to assure Enterprise-wide acceptance
- Involve members of staff in the database design to assure appropriate values
- Present frequent and understandable project updates to the governing and funding members of your organization
- Keep a open channel of communication between staff and consultants (if used) during all phases of the project(s)
- Stick to the Plan, but be flexible in your design due to the shifting technological paradigms

**Authors Information**

Lance M. Babbitt
Lehigh County Authority
PO Box 3348
1053 Spruce Street
Allentown, PA 18106
(610) 398 2503
lancebabbitt@lehighcountyauthority.org

Peter Godfrey Jr.
CDM
GIS Project Manager
1500 JFK Boulevard, Suite 624
Philadelphia, PA 19102
215.636.0600 ext 254
godfreyp@cdm.com