GIS the Survey Way

Curtis McAdams, PLS with Midland Surveying, Inc., obtains a survey-grade section corner location for a county GIS project

When a Midwest surveying and engineering firm expanded into GIS, it applied land survey methodology. Its experiences with a county and city prove it pays big dividends.

Midland GIS Solutions field technicians use V.Depth equipment to obtain accurate invert depths for a sanitary sewer projects. Using this eliminates dipping each manhole with a conventional level rod.

By Matt Sorensen and Russ Wetzel

Land surveying has been around since the beginning of time. Geographic information systems (GIS), on the other hand, is a relatively new technology. The digital data contained within a GIS is quickly becoming a primary mapping and analysis instrument for wide ranging applications in business, government, education, and many other fields. Data contained within GIS mapping systems see myriad uses such as land assessment, land survey research, economic development, land planning, and development.

Ironically, as GIS data is ideally driven by its "geographic" component, it is surprising how little emphasis early GIS development placed on data accuracy, a cornerstone of land surveying. Early use of GIS did not require a high standard for data accuracy. As geographic information systems develop, however, this trend is changing, mainly due to a large increase of use among local governments and advances in hardware and software capabilities.

Dustin Shepherd acquires survey grade coordinates for a sanitary sewer project. Surveyors play a key role in developing GIS.

Today, many users of GIS technology require a higher degree of accuracy in their data. Improved GPS accuracy capabilities, greater clarity in digital aerial photography, and higher data quality expectations are all driving this. Many GIS users are also finding their original data less than satisfactory, and many early GIS programs are beginning to integrate land surveying protocols and methodologies into their mapping system to improve the overall accuracy of GIS data.

One company in the U.S. heartland has strived to integrate accurate land surveying protocols within GIS project development. Midland GIS Solutions, in Maryville, Missouri, formed through the restructuring of Midland Engineering, Inc., a professional land surveying and mapping company with a long history in the Midwest. Today, Midland GIS Solutions, in conjunction with its parent company Midland Surveying, Inc., provides a wide range of surveying and mapping services throughout the region.

Both founders of Midland GIS Solutions, John Teale and Troy Hayes, are professional land surveyors, and three additional licensed land surveyors on staff contribute to every GIS project. The company routinely uses the expertise of land surveyors throughout the Midwest and works with local land surveyors on many key aspects of GIS project development. Midland also goes to great lengths to apply a host of available land survey research materials in support of each project. The end result: develop the most accurate GIS realistically possible from available survey research.

Phelps County Benefits in Multiple Areas

A case in point is Phelps County, Missouri. County officials approached us to develop a countywide GIS that would benefit numerous departments and contain a high degree of accuracy. Departments from the assessor's office, recorder's office, clerk's office, commissioner's office, roads and bridges, law enforcement, and the county health department were all encouraged to weigh in on what they required from the developed data. The GIS was developed toward a foundation that supported all the requested applications. The ultimate goal was to provide useful data to each department within an accurate GIS base foundation that would support growth for multiple uses.

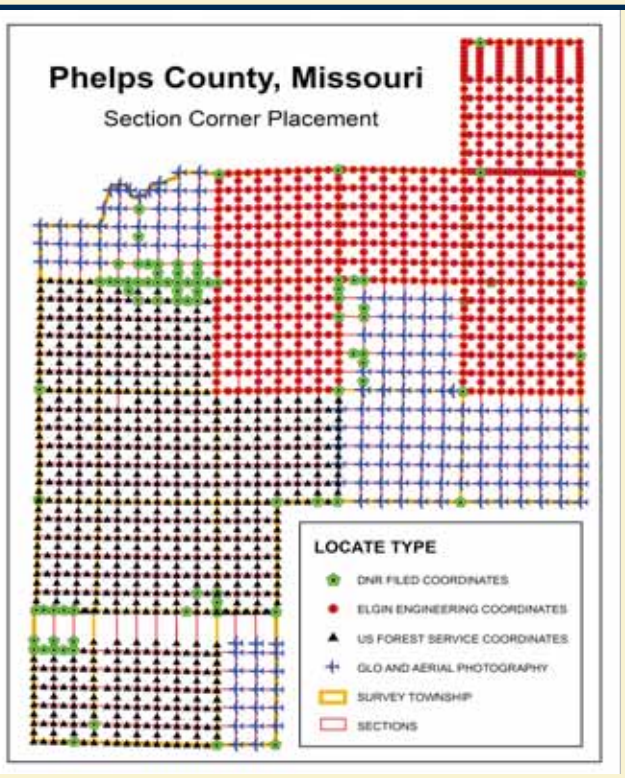
Midland GIS Solutions assimilated data developed and provided by local land surveying and engineering firm Elgin Surveying and Engineering in Rolla, Missouri. Coming into the project, Phelps County had the benefit of having numerous township and section corners already established and recorded with specific state plane coordinate values.

Additional section corner coordinates were obtained through subsequent direct GPS data collection. Registered section corner documents were obtained from the Missouri Department of Natural Resources Division of Land Survey and referenced to determine the remaining section corners. Coordinate geometry (COGO) techniques were applied within the GIS to create the quarter section, section, township, and range data layers in Phelps County's GIS program.

Other section corner locations, specifically those located within highly forested areas of the county, were determined through application of geographic measurement management (GMM) software with the direction and support of the U.S. Forest Service. This included nearly 11 townships in the forested areas where little reference existed for the section corner locations.

Finally, remaining section corners were established in the GIS using land surveying techniques referencing the original Government Land Office (GLO) documents. All the section corner coordinates, most obtained from well-defined digital coordinates, became the foundation for the GIS. Other sources included recorded subdivision plats, recorded surveys, and highway plans from the Missouri Department of Transportation (MoDOT). Reference data was also obtained from the City of Rolla's GIS, including existing quarter section line data developed by Elgin Surveying and Engineering. All this effort led to the establishment of a highly accurate GIS. Subsequent data layers developed in the county's GIS such as parcel boundaries, subdivision lots, and rights-of-way were created in similar fashion, making use of all available research material.

This map created from Phelps County's GIS indicates the type and source of information used for section corner placement



City of Belton Manages its Infrastructure

Another example where land surveying research and methodology served as the primary factors in GIS development was the City of Belton, Missouri, a rapidly growing suburb on the south edge of Kansas City. In 2003, with a population nearing 24,000 and commercial and private development steadily increasing, city leaders began actively developing a comprehensive infrastructure management system. The resulting multi-year project, involving several companies and numerous state-of-the-art technologies, represents an aggressive effort to bring Belton to the cutting edge in municipal infrastructure management.

The City of Belton turned to GIS technology to manage its growing infrastructure. The initial step was an accurate assessment of its current transportation, water, and wastewater infrastructure. The city hired Midland GIS Solutions to oversee the initial phases of the multi-tiered project. The first phase of the city's GIS consisted of developing an accurate cadastral foundation. We assembled a multi-disciplinary team of professional land surveyors, an aerial photography firm, and civil engineers to provide the required support services. By the end of 2004, Belton was well on the way to realizing its new state-of-the-art and highly accurate GIS mapping system.

A primary step in the early stages of the project involved building the GIS base map. We contracted local land surveying firm Roger L. Brenizer & Associates to provide survey-grade coordinate positions for each section and quarter-section corner within the project area. This highly accurate coordinate data was obtained through survey grade GPS and included coded attribute data describing each corner (e.g. 5/8-inch iron

bar, DNR monument, etc).

Once the section corner locations were acquired, we began work on the city's GIS base map. Extensive research supported development of the base map layers, including registered section corner documents, highway plans, and recorded subdivision plats. Additional data layers included map index grids, accurate road and railroad centerlines, detailed road rights-of-way, subdivisions, lots, blocks, water boundaries, and land ownership boundaries within the city. A comprehensive city limit boundary was also developed by referencing recorded city annexation ordinances. All this data was prepared in an ESRI ArcGIS personal geodatabase format.

The next major phase of Belton's comprehensive infrastructure plan involved the assessment and development of the city's wastewater infrastructure. We were again employed to provide precise survey-grade GPS field survey data for the wastewater utility features. GPS survey crews used a survey-grade (subcentimeter accurate) Trimble 5800 GPS receiver and TSCe data collector as well as a NetRS GPS CORS permanent base station provided by Seiler Instrument. This allowed the GPS survey crew to obtain highly accurate horizontal (x,y) coordinates for each feature and a vertical (z) coordinate for rim elevations. Captured features included manholes, lift stations, and cleanouts, totaling about 2,100.

The resulting GPS-located features were printed onto working field maps used to reference manhole locations. Each manhole was "popped," and invert depths were obtained. This task was accomplished using specialized V.depth measurement equipment. The V.depth equipment was not only designed for high accuracy, but it also greatly reduced the need to individually "dip" each manhole with the conventional level rod. Attribute data such as pipe material and diameter was also gathered and cataloged into the GIS database.

As the city's GIS program continues to develop, city personnel are realizing the increase in efficiencies with day-to-day utility infrastructure management. With a highly accurate, multi-layer GIS with extensive and detailed attribute data, the City of Belton can conduct sophisticated analyses and implement many beneficial applications. The city is truly on the cutting edge with its GIS technology.

As you can see from both GIS project examples, taking the land survey accuracy approach pays off in the long run. The trend should continue as more surveying firms take on GIS.

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