EASY-ACCESS Land Management

By John Stenmark, LS

Cadastral surveying, including the development and management of cadastral information, provides the basis for land titling and ownership. As property values increase, the importance of the cadastre increases as well. In Utah, private surveyors and state and county agencies are seeing the value of combining cadastral management and positioning systems into a single well-coordinated effort.

With roughly three million people occupying more than 1.3 million legally defined parcels, Utah has a clear need for consistent, easily accessible land information. Like other states, cadastral information in Utah goes back for decades and beyond, with much of the information in the form of paper records kept in county courthouses. By the late 1970s, Utah had begun to implement electronic geographic information technology. In 1981, the state formed the Utah Automated Geographic Reference Center (AGRC) to coordinate the state's GIS and serve the interests of geospatial users. Since then, AGRC has emerged as a key part of the Utah's strategy for geospatial infrastructure.

Utah's efforts to create a statewide cadastral program began in 1998, with an appropriation for rural cadastres from the state legislature. Since then, the cadastral work has received more than $3.9 million in funding at both state and federal levels. The cadastral program has evolved over time and today has a strong focus on surveying. With vast reaches of public land (nearly 80 percent of the state is managed for public use by state and federal agencies), the United States Public Land Survey System (PLSS) plays a dominant role in the Utah cadastre.

Virtually every parcel in the state is described using either aliquot parts or ties to PLSS corners. Keeping track of the PLSS monuments is an enormous—and critical—task that requires accurate positioning and effective data management. One of the most effective approaches to integrating cadastral field data into a GIS is the use of active Global Navigation Satellite System (GNSS) networks—also known as real-time networks (RTN)—to provide a consistent reference frame for field data.

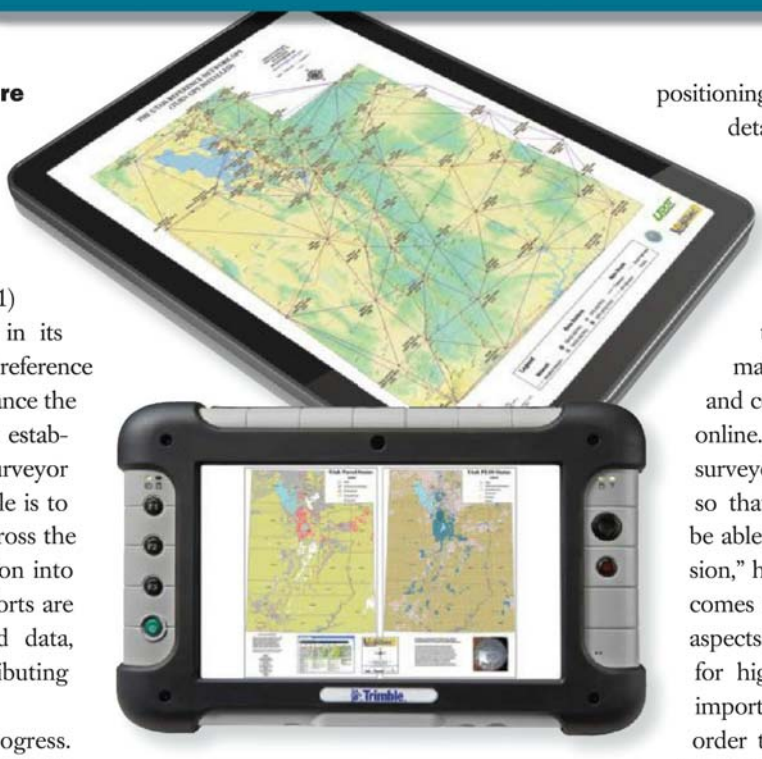
Reference Network GPS (TURN GPS), the network consists of more than 60 Trimble GPS and GNSS reference stations that provide positioning coverage for the entire state. The network also receives data from three stations of the Plate Boundary Observatory, operated by the University Navstar Consortium (UNAVCO). Based on Trimble VRS technology, TURN GPS came on line in 2007 and has approximately 300 subscribers. According to Utah State Cadastral Surveyor Sean Fernandez, PLS, 25 to 30 users access the system on a typical day for real-time positioning. TURN GPS stations also function as continuous operating reference stations (CORS), collecting and storing GNSS data for post-processing.

In addition to cadastral and property surveys, the Utah GNSS network is used by surveyors and contractors in engineering and topographic surveys, GIS data acquisition, and construction. Many users access TURN GPS to conduct RTK surveys, receiving correction data via mobile phones. In areas of limited cellular coverage, surveyors use CORS data from TURN GPS to establish local control points via static GNSS and post-processing.

The AGRC task to enhance the Utah PLSS includes recovery, restoration and preservation of section corners and other cadastral monuments. In addition to positioning, the work entails keeping detailed records. AGRC provides a web application that lets users log in to submit PLSS information. As an example, Fernandez says that a surveyor can capture the position and information for a PLSS monument and complete the monument form online. "I think it is important that surveyors evolve into a GIS realm so that they can stay current and be able to better utilize their profession," he says. "That's where AGRC comes in. We understand the legal aspects of surveying and the need for high accuracy, as well as the importance of evolving to a GIS in order to obtain good attributes on the data we are collecting. GNSS is an evolving technology, and TURN GPS is making it faster and easier to obtain precise measurements and attributes."

One of the primary benefits of TURN GPS is its function as the geodetic reference framework for the state. Surveyors performing cadastral surveys or ties to PLSS monuments can work in the Utah State Plane Coordinate System (SPC) and deliver the results directly to AGRC.

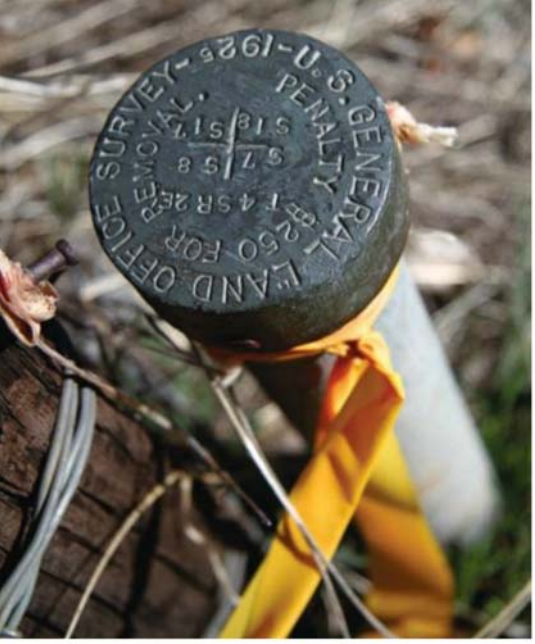
Integrated systems for positioning and cadastral information management are coming online. The new approaches reduce costs and add value to a land surveyor's service.



In 2005, the Utah legislature enacted a law to further improve the cadastral efforts within the Utah AGRC, a part of the state's Division of Technology Services. The AGRC was given the tasks to (1) create a statewide parcel layer in its GIS, (2) create a statewide GNSS reference network, and (3) densify and enhance the PLSS in the state. The law also established a position for a licensed surveyor within AGRC. The surveyor's role is to coordinate and facilitate work across the state to bring cadastral information into the GIS. The center's current efforts are concentrated on collecting field data, and on maintaining and distributing accurate cadastral information.

AGRC has made rapid progress. One of its first steps was the installation of a GNSS RTN. Known as The Utah

Opposite: James Sorrells occupies a cadastral marker near Alpine, Utah. Broad cellular coverage makes it possible to measure many PLSS corners using RTK and TURN GPS. Photo courtesy Horrocks Engineers. Above: Web-based tools provide remote access to AGRC cadastral and GNSS network information.



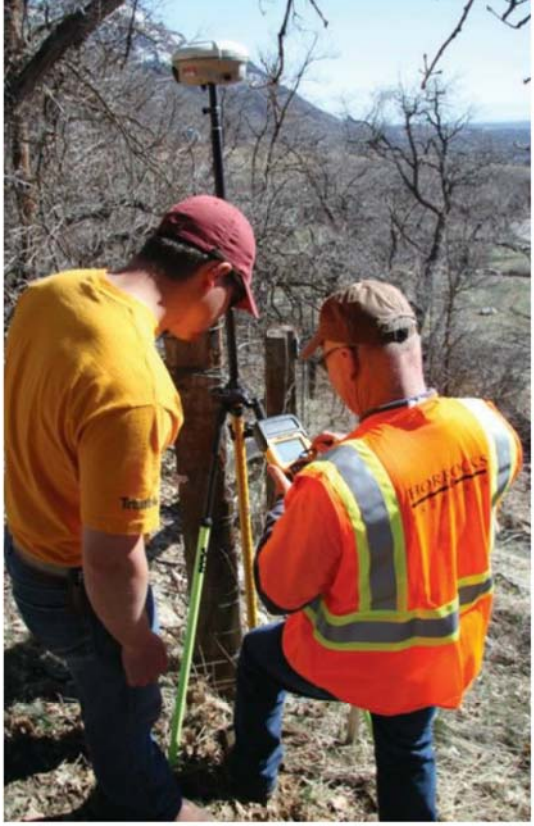
Images of monuments captured with a digital camera are attached to the position information and stored as part of the monument record. Photo courtesy Horrocks Engineers.

Lonnie Olson, field survey manager at Horrocks Engineers in Pleasant Grove, UT, says he makes frequent use of the reference system and AGRC. Horrocks Engineers does a lot of work on highway and municipal projects and needs to have accurate connections to cadastral information for access and rights of way. Using the RTN and Trimble R8 GNSS systems, Horrocks crews tie their fieldwork to the SPC, including setting up control networks on projects for the Utah Department of Transportation. "On some projects, we use a modified SPC that consists of a ground scale factor along with a translation," Olson says. "That way our numbers don't get confused with SPC values. Because everything is tied to the TURN GPS, people can easily retrace our work."

Fernandez describes the AGRC as a "one-stop shop" for geographic and land information in Utah. In addition to information about PLSS monuments, the center has gathered aerial imagery, General Land Office (GLO) notes and information from the U.S. Bureau of Land Management (BLM). "Much of what we've been able to accomplish is due to the ease of collecting the data," he says. "We have actually developed a statewide parcel layer for private ownership. We are now working to merge that with our federal and state ownership layer. Because we are now on the same coordinate frame, it's a lot easier to bring all of it together."

A large part of AGRC's funding comes from federal grants. The money is intended to clarify the boundaries between federal and privately owned lands. In some cases, counties hire third-party surveyors to go through their records, create parcel data and deliver it to AGRC. For PLSS data, either in-house county surveyors or third parties collect PLSS data and submit it to AGRC. AGRC processes the information into its database and forwards it to BLM where it is added to the Federal Geographic Coordinate Database (GCDB).

In a state like Utah, PLSS monuments receive heavy use. Incomplete or erroneous information on the location and condition of PLSS marks can be costly to both surveyors and their clients. As part of their work, Utah surveyors are required to submit monument reports to



Right: Zack Henderson (left) and Sorrells enter information at a PLSS monument. Their work was part of a survey to determine a wilderness boundary. Photo courtesy Horrocks Engineers. Below: The AGRC provides interactive access to PLSS and other cadastral records. Users can click on individual corners to get detailed information. Image courtesy Utah AGRC.

the county whenever they use a PLSS marker as part of a survey. AGRC receives and manages this information. Of the 29 counties in Utah, only a handful have websites that provide PLSS information. To provide broader access to the counties' PLSS data, AGRC developed a Web application linking its website to the county sites. For the other (mostly rural) counties, AGRC has incorporated the federal version of the Web application based on the federal GCDB. Users can access the AGRC website and view the locations of all PLSS markers in the state, and download the GIS layer files.

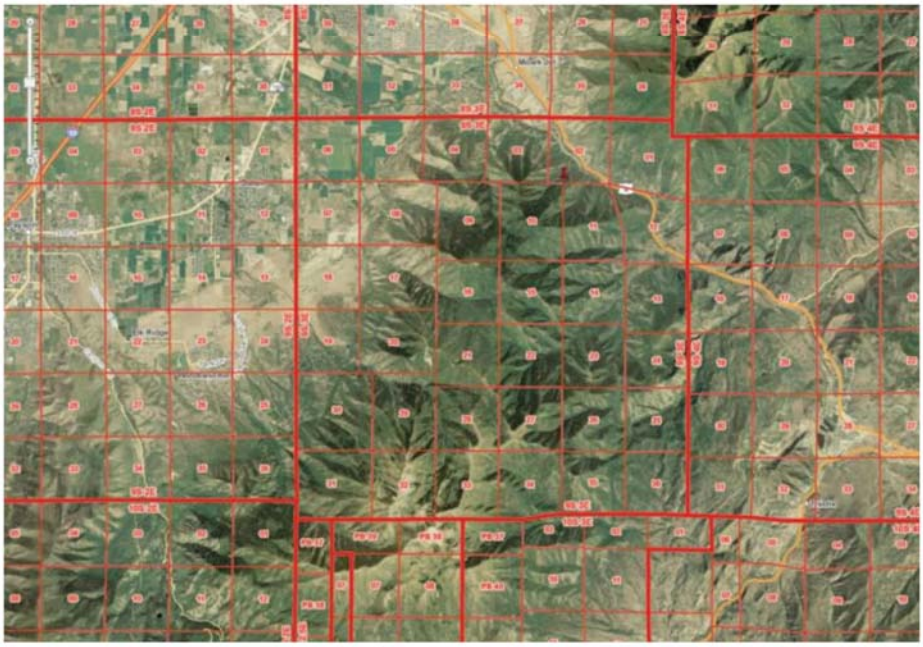
AGRC is also collecting subdivision information down to the local level. The data includes the subdivision plats with polygons, parcel numbers, addresses and locations. Beyond this, AGRC leaves the data management to the counties. County assessors or surveyors manage local information including zoning, valuations and assessments.

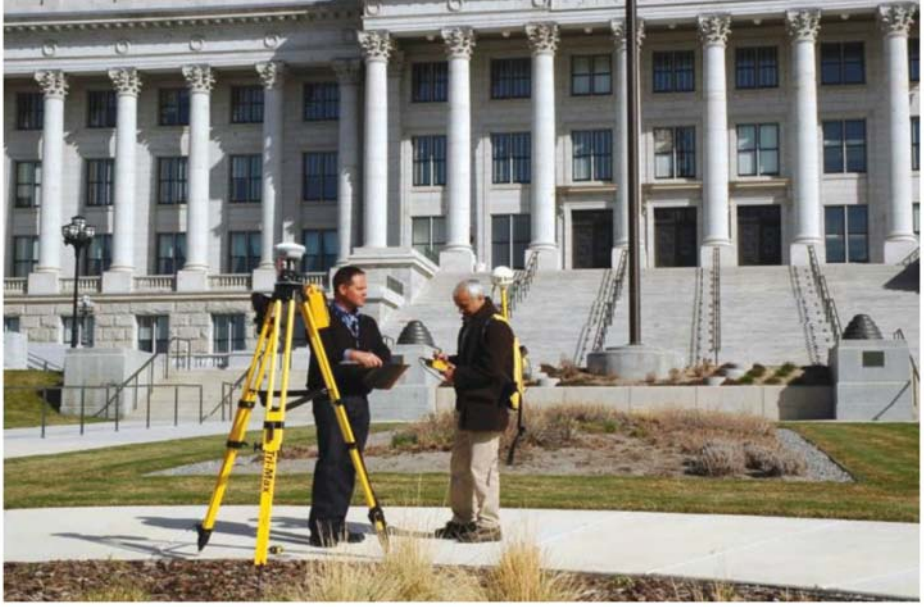
Not all field information coming into AGRC is done with survey-grade equipment. Preserving the existing monuments is important, and the accuracy of GPS mapping systems is often sufficient. Olson says that the Horrocks Engineers GIS department uses Trimble GeoXH handheld receivers in conjunction with TURN GPS to collect mapping information down to a few centimeters. Fernandez even hopes to get geocaching and recreational GPS owners into the act by collecting rough positions and photos of section corners. "We can at least have it in our database," he says. "The low-accuracy information tells us what the point is, what it looks like and a general position. Eventually we can send surveyors out to improve the accuracy."

The depth and variety of cadastral information lends itself to a GIS. In addition to managing and linking the various property records, a GIS can show the shapes and relationships between parcels. But the complexity of cadastral survey information presents challenges to GIS operators. This is especially evident in the need to match field-measured information with existing property records, tax maps and other geographically referenced information. Chris Buscaglia, product engineering lead for parcel editing in ArcGIS at Esri, explained the techniques for bringing digital cadastral information into GIS databases. He said that the parcel editor in ArcGIS provides tools to manage a parcel database along with survey information. The resulting parcel fabric contains geographic or topological information about parcels, and an array of ownership, land use and administrative records. While the GIS can record and display discrepancies in descriptions, AGRC's Fernandez says that the local entities in Utah (counties, surveyors and landowners) are responsible to resolve any gaps or overlaps in parcels.

AGRC illustrates how modern technology and a well-planned system can streamline the processes for gathering, managing and sharing cadastral information. Burton Christensen, survey manager for Sunrise Engineering in Draper, Utah, says he submits survey data directly to a county and AGRC at the same time, using a standard format defined by AGRC. The information includes coordinate data for the cadastral control and the individual monuments. Monument reports—including photos and descriptions—can be included as well. Christensen is a frequent user of TURN GPS, both for real-time corrections and in creating control for local RTK. Either way, his objective is to be able to provide SPC on any type of survey.

As part of Fernandez's one-stop concept, Christensen notes that parcel descriptions





Sean Fernandez (left) and Hussein Yazdani collect position data at the Utah State Capitol. The GNSS receiver on the tripod is measuring a geodetic control monument used to monitor the accuracy of TURN GPS. Photo courtesy Utah AGRC.

entered at the county level are shared with AGRC, and that AGRC maintains a database of all PLSS section corners in the state. "The taxpayers shouldn't pay twice for anything," says Fernandez. "We're able to bring data together across political boundaries, and the cadastral information will match up from city to city. By providing a single cadastre, we help people make better decisions based on accurate information."

In spite of the value that AGRC provides, the general public is largely unaware of the system. Beyond its cadastral layers, AGRC includes information that is used by landowners, planners and developers. The easy availability of land information helps to shorten title searches and the overall process for project planning and approval.

Looking forward, Fernandez and Buscaglia expect to see even wider access for cadastral information. As bandwidth for Internet access increases in the field, Web interfaces for cadastral data will move onto handheld data collectors. Fernandez hopes to see standard feature code libraries and procedures built into field applications for cadastral data collection. He envisions the ability for surveyors to access property records in real time, documenting updates and revisions while tying property markers directly to the geodetic reference frame. Over time, the cadastre will blend information about land usage and physical markers into the GIS layers, with a gradual resolution of gaps and overlaps between parcels. Buscaglia emphasized the importance of surveyors in the cadastral GIS, as evidenced in Fernandez's success in Utah. As more agencies adopt the model of automated, GIS-based cadastral management, it will create additional work and opportunities for surveyors with good GIS skills.

In the end, it's not much different from what land surveyors have been doing for centuries. What's changed is how they are doing it. "Construction normally can't begin until the property rights are addressed," Olson says. "When looking for information on PLSS markers, we used to only be able to get the information needed by going to counties, the BLM or GLO for notes and descriptions. Now, we can go to one place for this information, regardless of where we are working in the state. It saves a lot of time and money."

John Stenmark, LS, is a writer and consultant working in the AEC and technical industries. He has more than 20 years of experience in applying advanced technology to surveying and related disciplines. For more information about the Utah AGRC, visit http://agrc.its.state.ut.us/. More details about the Trimble VRS technology can be found at www.trimble.com. Horrocks Engineers' website is www.horrocks.com, and Sunrise Engineering's website is www.sunrise-eng.com.