

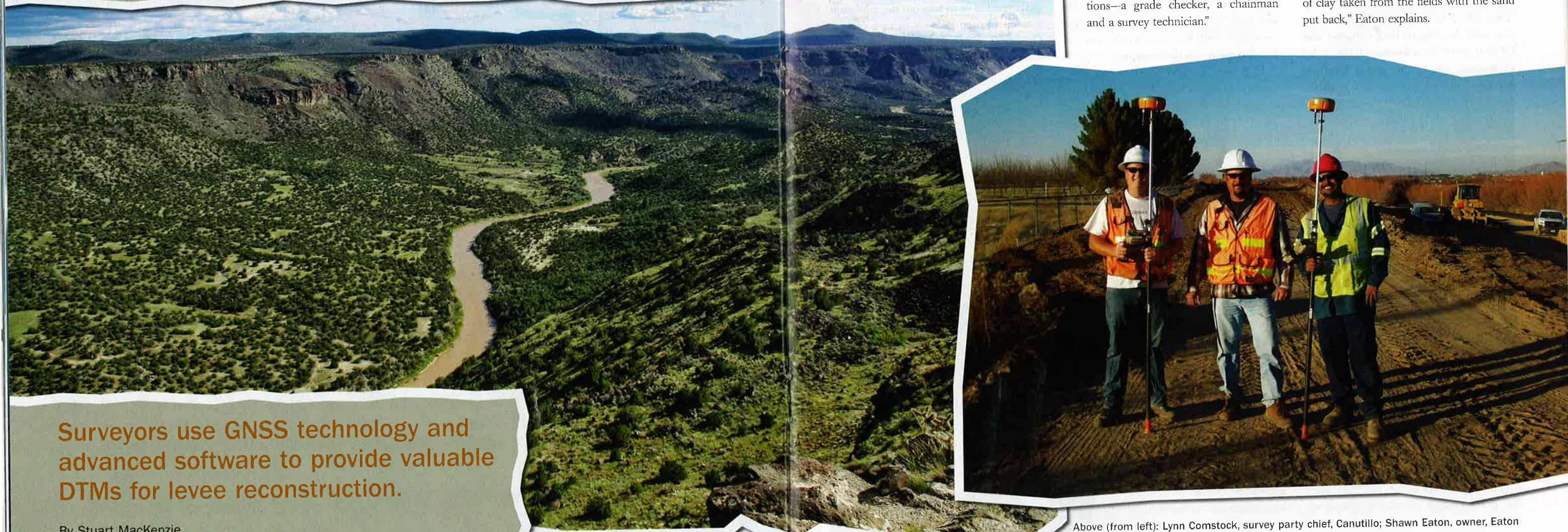
The Rio Grande River is normally calm as it meanders southward through New Mexico and down to Texas. But hurricanes and tropical depressions can bring torrential rainfalls that cause the river to rise substantially, overflowing its banks and drowning out adjacent farm fields. Levees of sand were built many years ago to protect the farmland, but those levees can erode under flood conditions.

To remedy the problem, the United States section of the International Boundary and Water Commission awarded three construction contracts in 2009 to rebuild and raise the levees to 100-year flood standards set by the Federal Emergency Management Agency. Construction is being funded by the American Recovery and Reinvestment Act of 2009.

Working under a \$19.2 million contract, Milestone Excavation Inc. is rebuilding the

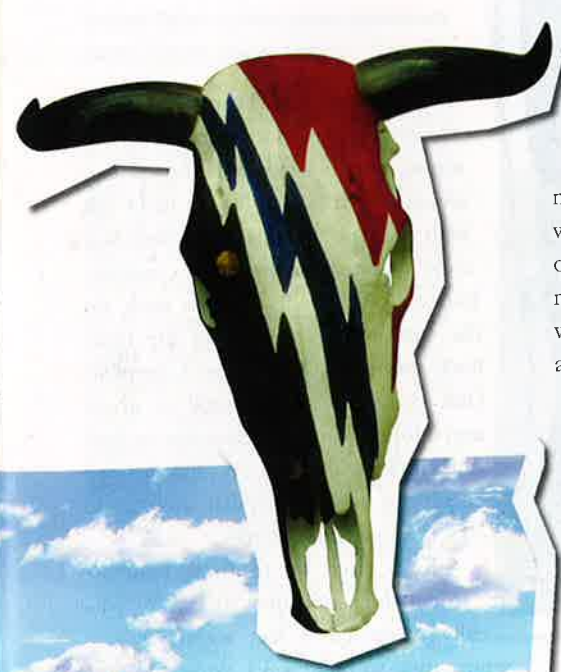
levees along both sides of a 14-mile stretch of the river near Canutillo, Texas, just north of the Texas-Mexico border. Milestone subcontracted the earthmoving to Don Kelly Construction, which, in turn, subcontracted the surveying to Eaton Land Surveying Inc. (ELS), St. George, Utah. Under a separate \$5.8 million contract, the same three firms are also rebuilding the levee along one side of a 14 mile stretch of the Rio Grande near Hatch, N.M.

# CONTAINING THE RIO GRANDE



Surveyors use GNSS technology and advanced software to provide valuable DTMs for levee reconstruction.

By Stuart MacKenzie



As with an increasing number of construction projects, the team is relying on machine control to ensure precise cutting and grading. In fact, RTK GNSS equipment and machine control has replaced much of the work that used to be handled by surveyors and grade checkers using traditional methods with stakes. "Conventionally, you would be putting fill slope stakes out there and you would have a grade checker to pull distances and grade up the slopes," says Shawn Eaton, PLS, president of ELS. "After the slopes were built, you would put trim slope stakes on the top of the slopes to cut the overbuilt slopes to grade. When the gravel was placed and was close to finish grade, blue top hubs would be placed to set the final grade of the gravel. The GNSS capability enabled us to perform each job without setting any of these stakes. I'd say GNSS and 3D machine control cut out probably three full-time positions—a grade checker, a chainman and a survey technician."

Although some surveyors might be bitter about such changes, Eaton takes a different view. As a business owner, he's embraced the transitions that technology has brought to his profession and has tried to use them to his advantage.

**Preliminary control work** and the development of the digital terrain model for the Rio Grande levee reconstruction project began in March 2010. Project engineers had decided that a clay-heavy soil, available from borrow areas close to the levees, would make suitable material for levee reconstruction. The material would be replaced with sand to mitigate any environmental effects. ELS was responsible for verifying certain control points as well as points where the levees joined into roadway river crossings. ELS also did the surveying for topographic maps of the proposed clay borrow areas. "Milestone Excavation needed the borrow areas mapped for the erosion control plan and so we could later balance the amount of clay taken from the fields with the sand put back," Eaton explains.



Above (from left): Lynn Comstock, survey party chief, Canutillo; Shawn Eaton, owner, Eaton Land Surveying Inc.; Eddie Hernandez, party chief, Hatch, N.M.



The DTMs, which ELS created using Carlson Construction software, show the alignment of the levee edges, the toe of slopes and roadway ramps.

To perform the survey work, Eaton and his crew of two party chiefs used Altus APS-3 GNSS receivers in conjunction with its Allegro data collector and Carlson SurvCE software. "I did a lot of research, and I came across Altus ads in *POB*. I liked what they had to offer," Eaton says. "I liked the fact that the Altus unit has on-board radios that could either transmit or receive corrections. And I liked that it has a SIM card slot built in, as well." The SIM card slot enables Eaton to make cellular phone connections and receive corrections over the Internet using real-time GNSS networks. Eaton says he bought four of the Altus units, mostly because they provide him with the flexibility to work either within our outside of a network.

ELS' involvement in the Rio Grande levee reconstruction project didn't end with the field control. The firm also created the digital terrain models (DTMs) for the 3D machine control that would be used for the excavation and site prep work. S & B Infrastructure, the project designer, had used aerial photography to develop the original design plans. The aerial photos were good to within a 1-foot contour interval, which worked for the overall design, says Eaton, but they were not good enough for pay quantities of earth moved. "The owner provided what they had designed for the horizontal and

vertical alignment of the top of the levee," Eaton says. "The new levee was to be 16 feet wide, or 8 feet on either side of the centerline. And the levee was to have a 3-to-1 slope to the floodway toe."

ELS used Carlson Construction software to create the DTMs. "The machine control software needs a TIN file to control the elevation, a DXF file to control the horizontal alignment, along with a State Plane Coordinate Zone file and geoid file to control the location of the project on the ground," Eaton says. "Together, those files showed the complete alignment of the project, including the edges of the levee, the toe of slopes and the roadway ramps. With this information, if the contractor needed to offset elevations or alignments, they could do that based solely on the software in the 3D machine control from the files that we had already created."

**Prior to excavation**, an ELS party chief measured cross sections of the existing levee on

Kelly Cowan, Milestone Excavation, uses an Altus APS-3 and Allegro data collector to check gravel placement while a dozer places topsoil.

100-foot stations. Then Don Kelly Construction used a process of benching to cut the sand from the existing levees, which ranged from 6 to 14 feet high. Kelly used one levee construction crew in Hatch and two levee construction crews in Canutillo, one each for the east and west sides of the river. Each crew consisted of one Caterpillar D6K dozer to cut the sand to grade and a John Deere 450 excavator to load the trucks with sand. All dozers were equipped with Caterpillar Accugrade GNSS machine controls.

Kelly used up to three benches to cut the sand down. A bench typically measured 8 feet wide. "If you were going to build a 3:1 slope and you needed an 8-foot level section below it, you would have a vertical step of 2.67 feet to have 8 feet of horizontal distance," Eaton says. "The owner, IBWC, obviously wanted us to take out the minimum amount of sand possible to save money. Otherwise, we could just take 5-foot cuts each time. That would have been faster, but it would have cost the owner more in excavated and imported materials."

Benches ranged ahead of the fill operation by 1,500 to 3,000 feet along the levee. Once the benches were cut out, ELS surveyed the cuts on the same 100-foot



Shawn Eaton verifies gravel placement while a dozer places topsoil.

stations for pay quantities. Trucks would export sand from the levee, take it to the borrow area, dump it, fill up with clay material, return to the fill area and deposit clay there. When the clay fill was completed, ELS measured the fill area on the same 100-foot stations. For the clay placement, each crew used a Cat D6N dozer. "The contractor gets paid on the amount of sand exported and clay imported," Eaton says. "We placed a minimum of 2 feet of clay on the levee. We had already done cross sections of the existing conditions with the sand benching. ELS then did an as-built of the clay to calculate the quantity of sand exported and clay placed based on those three cross sections."

According to Kelly Cowan, the owner of Milestone Excavation, the use of Accugrade machine control on the bulldozers avoided over-cutting and over-



filling the levees. Tolerances on cuts and fills were plus or minus eight hundredths of a foot. "We never had a problem with that," Cowan says. "We were always running within five hundredths."

Once the clay was finished and sloped, Don Kelly Construction built a toe drain

along the land side of the levee to prevent irrigation water from undermining the levee. The toe drain consisted of a trench, 3 feet wide by 4 feet deep, running along the landside toe of the levee. The contractor lined it with a geotextile fabric and filled it with 1 to 2 inches of gravel.

Having 3D machine control gave the dozer operators a location over every square inch of the project, Eaton says. "Whereas, when you actually stake it, you might be putting in stakes on a 50-foot station or a 100-foot station and running those points up. The only place that you have control is at those stakes and going up the stakes. But with machine control, the dozer operator can see where he is over every square inch of the levee based on the GNSS system. So the dozers are under complete control for the entire project. There is no pulling tape or hand leveling."

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Lynn Comstock uses the Altus APS-3 to collect a point atop the levee.

Throughout the project, ELS was responsible for setting up the base station, developing the DTMs, verifying that the machine control on the equipment was giving the correct results, cross sectioning the project and providing quantities based on the cross sections, staking of the right of way and structures, and providing grade checking when needed. The Altus APS-3 receivers enabled ELS to survey 42 miles of levee reconstruction with just two surveyors for the most part, though occasionally Eaton helped the two party chiefs.

For Eaton, it was a project that highlighted how surveyors can continue to bring value to projects where technology has taken over some of the more-

traditional human roles. "Technology is continually changing, and as it changes we have to change along with it," Eaton says. "We have to accept the fact that technology will continue to replace field and office staff over time. With the continued enhancement of machine control and 3D laser scanners, we will either keep up with technology or be looking for a new occupation. Every day gives us another chance to learn something new, so we must use our time to learn about new technology and figure out ways to generate new business from it."

Construction on the Hatch, N.M., portion of the project began near the end of May 2010 and was mostly completed by early March 2011. Work at Canutillo began near the end of June and was expected to be finished by the end of March.

Stuart MacKenzie is a writer who specializes in covering surveying and construction projects. For more information about ELS, e-mail [eatonlandsurveying@gmail.com](mailto:eatonlandsurveying@gmail.com). Milestone Excavation's website is [www.milestonelp.com](http://www.milestonelp.com).

For more information about Altus GNSS equipment, visit [www.altus-ps.com](http://www.altus-ps.com).

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