HIGH TECH in the Canyon

At Hell's Canyon along the Snake River in Idaho and Oregon, a surveying firm used laser scanning and other methods to survey sand and gravel bars in monitoring the effects of damming the river for power.

By Eron Singleton

It's 7:30 a.m., and after a full breakfast and a hot cup of coffee, my field assistant and I find ourselves powering through the belly of a class IV whitewater rapid. Our eyes are round with apprehension as we climb the cascading wall of white water from the downstream side. However, it is apparent that, to the driver of our twin-engine Bentz jet boat, this is just another day at the office. What do white water and jet boats have to do with surveying? In this case, everything.

Over the past two years, our surveying firm Glahe & Associates has had the opportunity to provide services to the Idaho Power Company, a division of IDACORP. Idaho Power is an electric utility serving areas of southern Idaho and eastern Oregon. They own and operate a hydropower complex at the south end of Hell's Canyon consisting of Brownlee, Oxbow and Hell's Canyon Dams. For several years, Idaho Power has been conducting large-scale geomorphic and environmental studies along the Snake River downstream of their holdings within the Hell's Canyon National Recreation Area (HCNRA).

Pine Bar, a sand and gravel bar typical of the sites where topographic data was collected. Among other things, Idaho Power monitors stranding pools like the one to the right.

The HCNRA encompasses about 215,000 acres and contains within its bounds Hell's Canyon, the deepest river gorge in North America. Carved by the Snake River, Hells Canyon plunges more than a mile below Oregon's west rim and 8,000 feet below the peaks of Idaho's Seven Devils Mountains. No roads cross Hell's Canyon's 10-mile wide expanse, making it an isolated and rugged area. In fact, it recently served as the backdrop for an episode of the Discovery Channel's popular survival series *Man vs. Wild*.

In the fall of 2007 and 2008, Glahe & Associates had been contracted to generate high-resolution topographic and photographic information on a number of sand and gravel bars within the HCNRA. Idaho Power wanted to collect very complete, high-accuracy 3D topographic data of local sand, gravel, and cobble bars within the Snake River Drainage. The client specifically requested laser scanning as the primary platform for data collection at these sites. Coincidentally, we happen to be one of the few surveying companies in the Pacific Northwest currently operating this type of equipment, and submitted a proposal for the project. In addition to our time-of-flight laser scanner, we deployed a reflectorless total station and a high-resolution digital camera with a fisheye lens used to collect true color information at the sites for later inclusion into web-based panoramic visualization deliverables.

Idaho Power has conducted an annual survey of many of the most frequented sand and gravel bars within the recreation area for the past several years. They are working to generate a database of high-resolution topographic information for time series deformation analysis. Idaho Power is monitoring geomorphic features throughout the Hell's Canyon reach to better understand local river processes and how they may be linked to the upstream Hell's Canyon dam complex. This topographic information also provides the physical basis for resource studies dependent on river channel morphometry. An example includes evaluating the potential of hydropower operations to strand or entrap juvenile fish in stranding pools. These are areas that can be inundated or pooled during high flow but then cut off from the main river when water levels recede. Stranding or entrapment of juvenile fish can lead to increased predation and contribute to unfavorable water temperature and dissolved oxygen conditions.

To generate high-resolution topographic data at study sites, Idaho Power is employing some of the more cutting-edge surveying and geophysical instrumentation available today. Above the water line, they are using 3D laser scanners, dual-frequency GPS, reflectorless total stations, gravity meters, and high-resolution digital cameras. Below the water line, they are using submersible videography, side scan sonar as well as single-beam and multi-beam bathymetry to generate 3D sub-aquatic topographic models. These data sets are then combined to generate a 3D surface model of the site both above and below the high water mark within a geographic information system (GIS). Collecting bar data on an annual basis allows them to track changes in overall volume and spatial distribution of material from year to year. In addition to volume changes, Idaho Power is also interested in documenting any changes in substrate and local vegetation at the study sites to monitor not only the physical but also the aesthetic metamorphosis of the study sites from year to year.

A Glahe & Associates field technician ties into a local control network with a reflectorless total station while Idaho Power employees help set up laser scanner targets.

Unique Challenges

As you can imagine, working in an area this remote has its challenges. Accommodations for the duration of the field cycles consist of two outfitters' cabins just upstream from the Pittsburg Landing boat ramp. One cabin is powered by a generator that provides brown power. We didn't have any issues with our equipment, but the power source claimed a few victims in the form of instrument batteries that would no longer carry a charge. The other cabin has no electric power, so we would power up our instrument batteries on a small portable generator with integrated power inverter. We ran our laser scanner with the generator during the day using the batteries as back-up. The upside of these establishments is that the wood stove is always warm, there is always a fisherman nearby with a good story, and they feed you like a Norske king, not to mention the spectacular setting.

All travel along the river came by jet boat, as Idaho Power operates two boats in the Hell's Canyon reach of the Snake River. They also employ their own boat drivers in addition to private contractors who have years of experience navigating the

treacherous waters of Hell's Canyon. Without a solid understanding of the river system and the many obstacles it offers, you could easily find yourself swimming through some of the best whitewater rapids in North America. At one of the local fishing guide's cabins, the wall is scattered with faded images of capsized boats that found themselves in the wrong place at the right time.

The terrain at the bottom of Hell's Canyon can also prove a challenge. The primary base of operations is a boat filled with geomatics and other measurement gear, personnel, and personal field equipment for everyone on board. Most of the work sites are either covered in slick, jagged rocks, which serve as a great place to practice your early-season ice-skating skills, or fine, light sands that like to find their way into electronic components such as laptop cooling fans. The weather can also play havoc with a day's work.

An Idaho Power hydrologist holds a level rod as a Glahe & Associates field technician collects sub-aquatic topographic transect data using a reflectorless total station from an isolated control point in the middle of the river.

Being at the bottom of the nation's deepest gorge in the fall offers the opportunity to experience gale-force winds often accompanied by rain on a regular basis. However, working in this remote region also offers the opportunity to experience nature at its best. We would commonly see elk, mule deer, black bear, and bighorn sheep so close you felt you could reach out and touch them. Three times during our last project cycle inquisitive bighorn sheep and mule deer investigated us by walking through our work area.

A Group Effort

During each deployment, Idaho Power personnel—generally consisting of a boat captain, an engineer, and a hydrologist—accompanied my field assistant and me. Once we arrived at a site, we would initially split into two groups. One group would go about finding the local area control and tying into that network via the total station. A couple of others and I would set up laser scanner targets and initiate the scanner as quickly as possible. The number of scanner setup locations varied from site to site as dictated by the overall size of the area and the complexity of the terrain.

While scan data was being collected, the person operating the total station was busy collecting transects of ground shots from the high water mark out into the water as far as the rodman dared to go in the swirling water or until he began to float away in his dry suit. Transects would later serve as a connection between the laser scanner surface datasets and the bathymetric sub-aquatic datasets for the area. In addition to collecting transects, the total station was used to collect topographic data in any part of the site that had heavy vegetation or an obstruction that blocked the line of site for the scanner. Finally, the total station would tie in the locations of the laser scanner targets, allowing us to georectify the scan data to the local control network later.

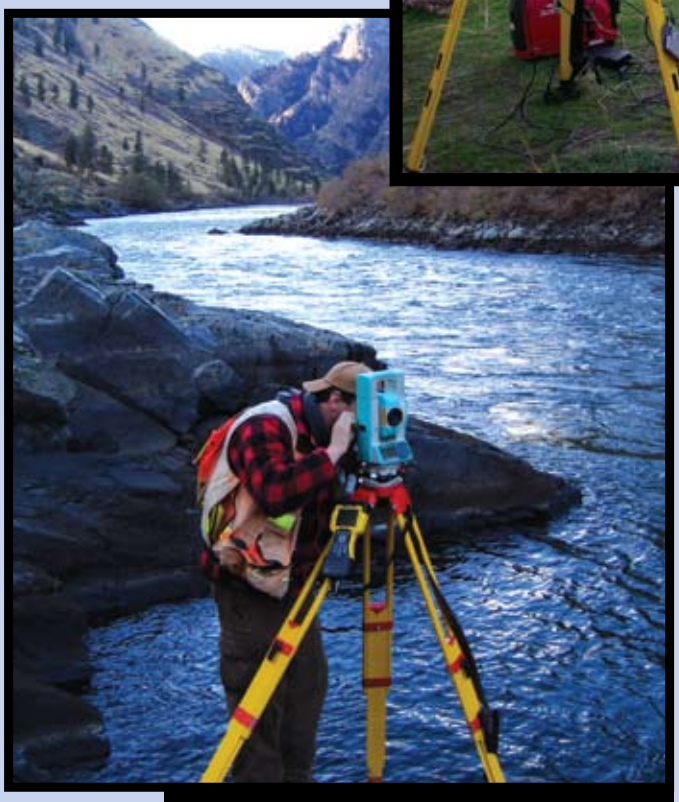
At the conclusion of every scan, we would collect high-resolution digital photography using a digital SLR, a fisheye lens, and a tripod-mounted panoramic bracket. Photographs where collected for each scan position and later post-processed into a number of digital visualization deliverables. In addition to photos collected by our firm, Idaho Power also collected photographic information pertaining to substrate particle size and distribution, which we georeferenced with our total station on site.

Evenings usually consisted of post-processing our lidar, total station, and photographic data to a point we felt comfortable with. While in the field, we like to align all our point cloud images to one another at the site. In the evening, we would also georectify the data to the local control network via the information from the total station. We could assure the client and ourselves that we were meeting the project tolerances before we ever left the canyon. We would also post-process much of our panoramic photographic information to a reasonable point just to cut down on the work done at the office.

Back at the Office

The bulk of the office work consisted of cleaning the spurious data from the point clouds via a combination of automated software-based cleaning routines, manual inspection, and data manipulation. The down side to collecting high resolution spatial data is that in unmanicured sites such as this, you also pick up light grasses and other vegetation present in addition to the ground elevations you focused on. After cleaning the raw data sets, we would produce our deliverables, which consisted primarily of gridded ASCII point files for import into a GIS. We also produced raw lidar data files, cleaned lidar files, and web-based panoramic geo-visualization deliverables using the high-resolution photographs we collected in the field.

The author confers with Idaho Power engineers while scanning a sand bar.



Collecting transect, infill, and geo-referencing information with a reflectorless total station.

I asked the leader of Idaho Power's River Engineering Group what he as a customer found to be the driver for using laser scanning on the project. He indicated that the primary reasons for using laser scanning versus conventional survey techniques for their project were based on the quality and completeness of the datasets and the pricing of the services. He indicated that for a comparable price, he could cover more area more thoroughly using laser scanning. Furthermore, he indicated that a combination of deliverables, including highly accurate and robust topographic data combined with true color photographic information, allowed for a more comprehensive understanding of the interplay between the hydrologic activity in the river system and how that is manifested in geomorphic change of the bed materials at the survey sites.

While a remote project of this nature is unique to our typical workload, it is a challenge we enjoy. Furthermore, we have found that by integrating laser scanning into our arsenal of geomatics equipment, the unique project is fast becoming more commonplace. Our spectrum of projects has broadened considerably since we began using laser scanning, and it has offered us the opportunity to branch out into arenas previously unexplored. Laser scanning has contributed to bringing in projects our personnel practically tussle over to be involved with and has proven a cost effective and highly applicable asset. We look forward to what the future may hold for us with this exciting and dynamic technology.

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