GIS Mine Post

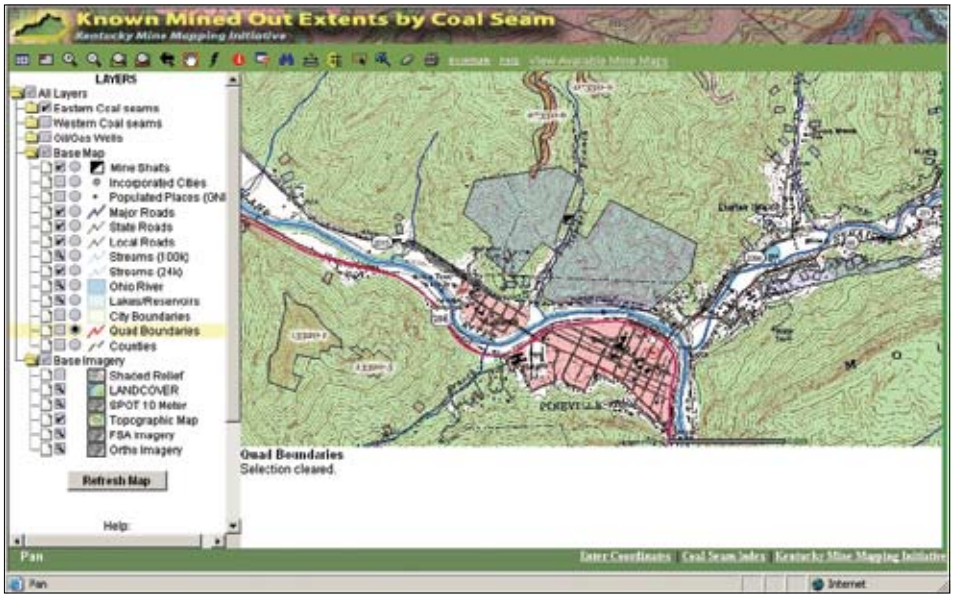
ESRI • Summer 2008 GIS for Mining

ESRI Helps Kentucky Deliver Maps of Abandoned Mines Online

Information Database Increases Mine Safety and Saves Customers Time

Keeping track of abandoned mines is no easy job—especially in a state with more than 30,000 of them. As famous for its rich coal mining history as for its horse racing, the Commonwealth of Kentucky recently launched an ambitious project: the Kentucky Mine Mapping Initiative. This initiative called for digital archiving and public access to all the commonwealth's abandoned coal mine maps. The project's goal is twofold: (1) increase mine safety by giving mining officials the cartographic information they need to conduct further mining operations and (2) save mining company officials the time and expense of physically retrieving and copying mine maps. To date, more than 20,000 abandoned mine maps have been digitally archived and made available online to the public through the Kentucky Mine Mapping Information System (KMMIS). ESRI software was used to digitize the maps and serve them over the Web to the public.

Abandoned mines pose a serious safety problem in Kentucky. Since coal deposits are concentrated in large areas throughout the state, active mines are sometimes sited adjacent to abandoned mines. The excavated areas in these old mines are often flooded with water from previous operations, so mining companies working nearby need accurate location information to prevent accidentally drilling into them and causing a blowout of pressurized water. The likelihood of subsidence (roof cave-ins) also increases near these areas over time, as water from flooded boreholes makes the earth heavier and less stable. In short, having maps of these abandoned mines helps protect miners and reclamation personnel from these dangers.



KMMIS' known mined-out extents service shows coal mines in the vicinity of Pineville, Bell County, Kentucky. They are color-coded by seam.

Until a few years ago, abandoned mine maps in Kentucky existed only in paper form. The Kentucky Office of Mine Safety and Licensing (KOMSL), the main depository of these maps, had the largest storehouse of abandoned mine cartography in the world. With more than 160,000 mine maps, it's little wonder that the office, with help from the Kentucky Department of Natural Resources (KDNR), decided to digitally archive the collection so that mining company officials and the public could finally have easy access to them.

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In This Issue

Welcome to the First Edition of *GIS Mine Post*

ESRI is pleased to launch the first edition of *GIS Mine Post.* This newsletter is specifically designed for GIS users in the mining industry and geological sciences. Our goal is to bring you real-world case studies, relevant GIS software information, ESRI news, GIS maps, and more. To subscribe to this and other free ESRI publications, visit www.esri.com/gismine post.

Matthew DeMeritt, *GIS Mine Post* editor

ESRI on the Road

Society for Conservation GIS
August 12–15, 2008
Monterey, CA, USA
www.esri.com/scgis

ESRI Health GIS Conference
September 28–October 1, 2008
Washington, DC, USA
www.esri.com/healthgis

ESRI Latin America User Conference
October 1–3, 2008
Santiago, Chile
www.esri-chile/lauc2008

World Energy Engineering Congress
October 8–10, 2008
Washington, DC, USA
www.energycongress.com

Electric & Gas User Group Conference
October 20–23, 2008
Indian Wells, CA, USA
www.esri.com/egug

ESRI European, Middle East and Africa User Conference
October 28–30, 2008
London, United Kingdom
www.esriuk.com/emea2008

IACP 2008
November 9–11, 2008
San Diego, CA, USA
www.theiacpconference.org

Adobe MAX 2008
November 16–19, 2008
San Francisco, CA, USA
max.adobe.com

I/ITSEC 2008
December 1–4, 2008
Orlando, FL, USA
www.iitsec.org

ESRI News

ArcGIS Server Code Challenge Winners Revealed at 2008 ESRI Developer Summit

The winners of the ArcGIS Server Code Challenge were announced at the 2008 ESRI Developer Summit in Palm Springs, California, on March 19. Developers were invited to post their original code samples to the ArcGIS Server Code Challenge blog so that the code could be reviewed by peers in the ESRI developer community. Prior to the summit, ESRI Developer Network (EDN) subscribers and registered attendees for the 2008 Developer Summit were asked to vote for their favorite entry based on the creativity, applicability, and originality of the code sample.

John Waterman, vice president of Geospatial Solutions at GCS Research in East Burke, Vermont, won the first-place prize of $15,000. His code sample demonstrates how ArcGIS Server can be integrated with Microsoft Virtual Earth and Google Maps. David Bouwman, senior software architect at Data Transfer Solutions in Fort Collins, Colorado, took second place and $7,500 for his ArcGIS Server Virtual Earth Tile Server entry. Vijay Sambandhan, GIS developer at Bergmann Associates in Buffalo, New York, took third place and $2,500 for his SDE Web Catalog code sample. Nianwei Liu, senior system analyst programmer at the City of Charlotte, North Carolina, received honorable mention for his entry, Google Maps Adapter to ArcGIS Server Map Cache.

You can see all the entries for the ArcGIS Server Code Challenge and download the code samples at www.esri.com/codechallengewinners.

Career Corner

Join our growing team! Work with organizations around the world to leverage the power of GIS for improved management of the earth's resources. These positions are located at ESRI's headquarters in Redlands, California.

Mining Industry Manager
An energetic and enthusiastic self-starter is needed to provide overall direction and management of ESRI's business development and marketing efforts related to products and services within the mining industry. Oversee and evaluate market research and adjust marketing strategy to meet changing market conditions.

Environmental Industry Solutions Manager
Work in the critical environmental industry, helping market ESRI's software solutions to clients worldwide. This position focuses on developing and executing comprehensive industry marketing plans and programs to grow the use of GIS in the wider natural resources sector.

Natural Resources Consultant/Project Manager
Apply your project management and industry experience to lead the design and implementation of solutions using ESRI's enterprise GIS technology. This is a challenging opportunity to work with our customers and project teams to prepare multiyear GIS implementation and migration strategies.

Learn more about these positions and apply online at www.esri.com/careers/enviro.

ArcGIS 9.3 Improves Your Entire GIS Workflow

ArcGIS 9.3 offers a complete suite of software that improves organizational workflows. With ArcGIS 9.3, users also get the benefits of an established and active user community, instructor-led and online training, and new online resource centers. The resource centers offer a unified location from which to access online help, documentation, support pages, user forums, blogs, maps, and more.

ArcGIS 9.3 comes with more tools to access data within an organization including support for Microsoft SQL Server 2008 and PostgreSQL. ArcGIS 9.3 also makes it easier to connect to and manage data from other systems via direct backward compatibility, new version management features, enhancements to geodatabase replication, and better geocoding. A new image service within ArcGIS Server also advances an organization's data management capabilities.

The new release also includes many enhancements that make it easier to create and share production-quality maps. For example, a new Disperse Markers tool allows you to spread out representation markers when they coincide. Feature attributes can be included when exporting a map to Adobe PDFs and accessed interactively by Adobe Reader users. In addition, Maplex for ArcGIS now includes better contour labeling and more control over where labels are placed inside and around polygons.

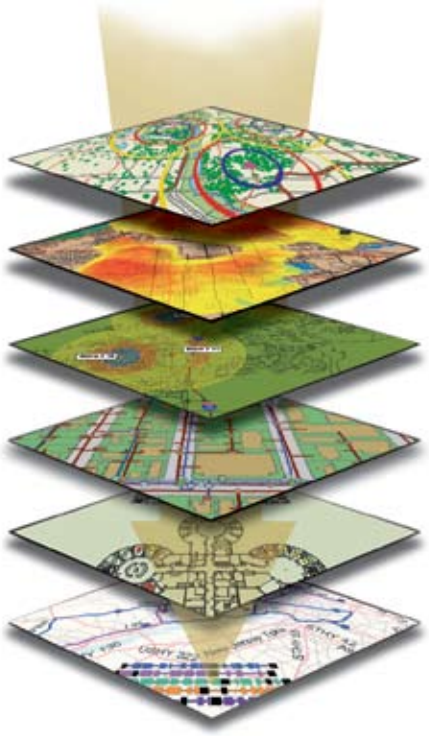
ArcGIS 9.3 makes dissemination of geographic information much easier. ArcGIS Server users can now selectively build map cache for the areas that are the most popular and enable on-demand caching to let the map cache grow as end users access the map service. ArcGIS Server 9.3 also includes a series of JavaScript APIs for mashup-style development. The ArcGIS JavaScript APIs take advantage of the new REST interface.

In ArcGIS 9.3, many modeling tools have been enhanced and some entirely new tools have been added to help users get more answers from their data. A new scatterplot matrix graph lets users explore relationships between sets of related variables, and new advanced Ordinary Least Squares and Geographically Weighted Regression tools help users understand how processes vary over space. In addition, a new vehicle routing problem (VRP) solver in ArcGIS Network Analyst generates routes for fleets of vehicles.

To learn more about ArcGIS 9.3, visit www.esri.com/whatsnew.

What Is GIS?

A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.



A GIS can be viewed in three ways:

The Database View: A GIS is a unique kind of database of the world—a geographic database (geodatabase). It is an "information system for geography." Fundamentally, a GIS is based on a structured database that describes the world in geographic terms.

The Map View: A GIS is a set of intelligent maps and other views that show features and feature relationships on the earth's surface. Maps of the underlying geographic information can be constructed and used as windows into the database to support queries, analysis, and editing of the information.

The Model View: A GIS is a set of information transformation tools that derive new geographic datasets from existing datasets. These geoprocessing functions take information from existing datasets, apply analytic functions, and write results into new derived datasets.

For more information, visit www.gis.com.

Mobile GIS Helps Geospatial Technology Firm Modernize Mining Surveys

Meridian Mapping Ltd. is a multidisciplinary company providing a wide range of services that integrate GPS, GIS, and numerous other mapping disciplines for resource-based industries. Co-owners Dugald Dunlop and Shepherd Stewart, based in Coldstream and Nanaimo, British Columbia, respectively, manage projects throughout the province in the mining, forestry, fish and wildlife, and environmental fields.

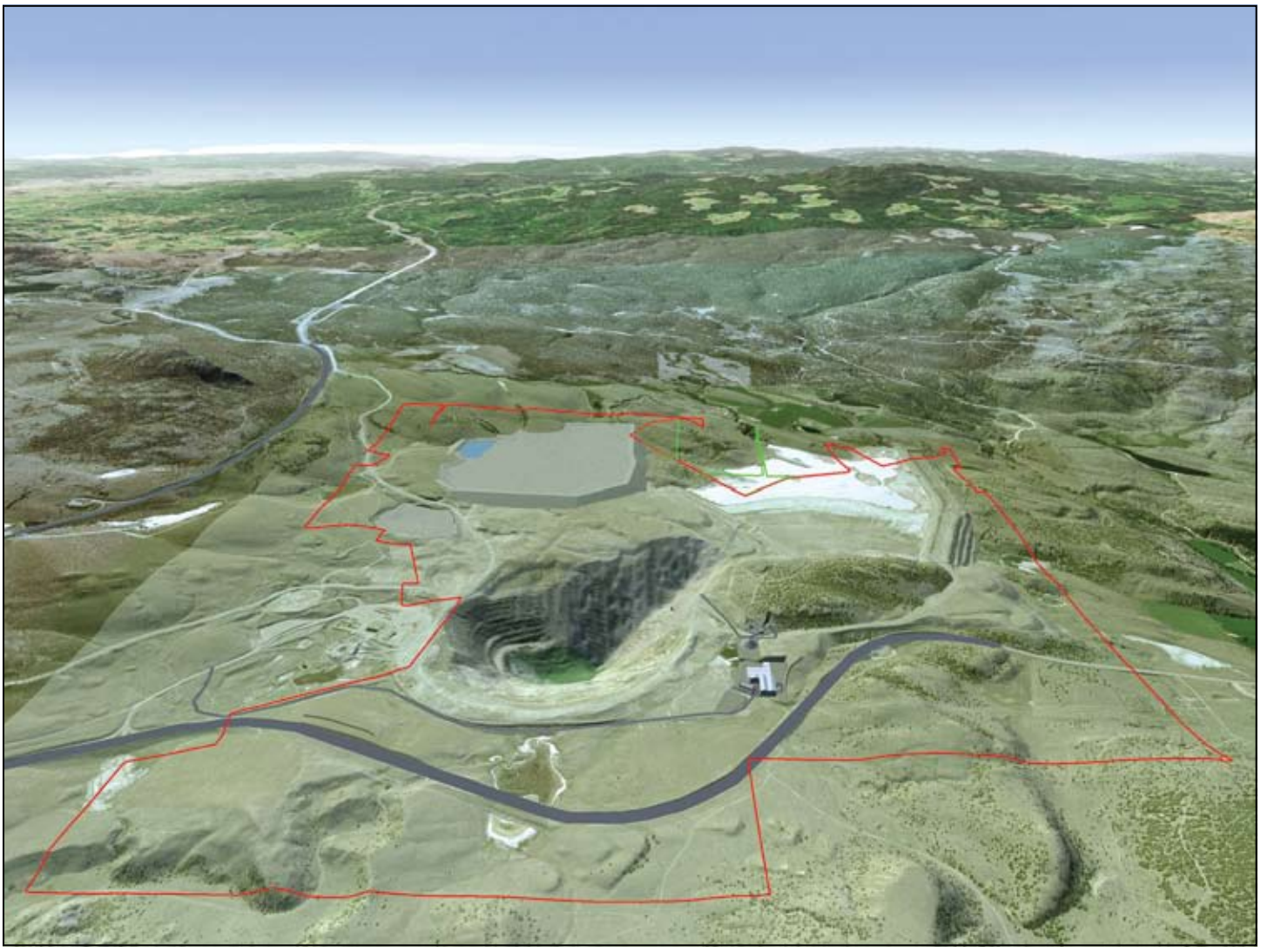
One of the company's areas of expertise is performing preliminary exploration surveys for the mining industry. The types of surveys include prospecting (looking for mineralization), geologic mapping, geochemical (soil and rock sampling), and geophysical (measuring the magnetic and conductive properties of rock). A trained geologist and GPS/GIS specialist, Dunlop serves as project manager for the exploration surveys. During the company's peak season, up to an additional 12 employees are hired including drill crews and geophysical specialists.

The results of these preliminary surveys generate drill targets. Then, using drills with diamond-tipped bits, holes are drilled hundreds of meters deep, and rock core is extracted. The core is logged by a geologist for key characteristics such as rock type and mineralization, then half the core is sent to a lab for further analysis to determine the concentration of individual minerals. As all the data collected during both the preliminary and advanced stages of exploration is location based, GIS plays an important role in its storage and management. Results returned from the lab are tied back to the GPS coordinates of the sample for plotting and spatial analysis.

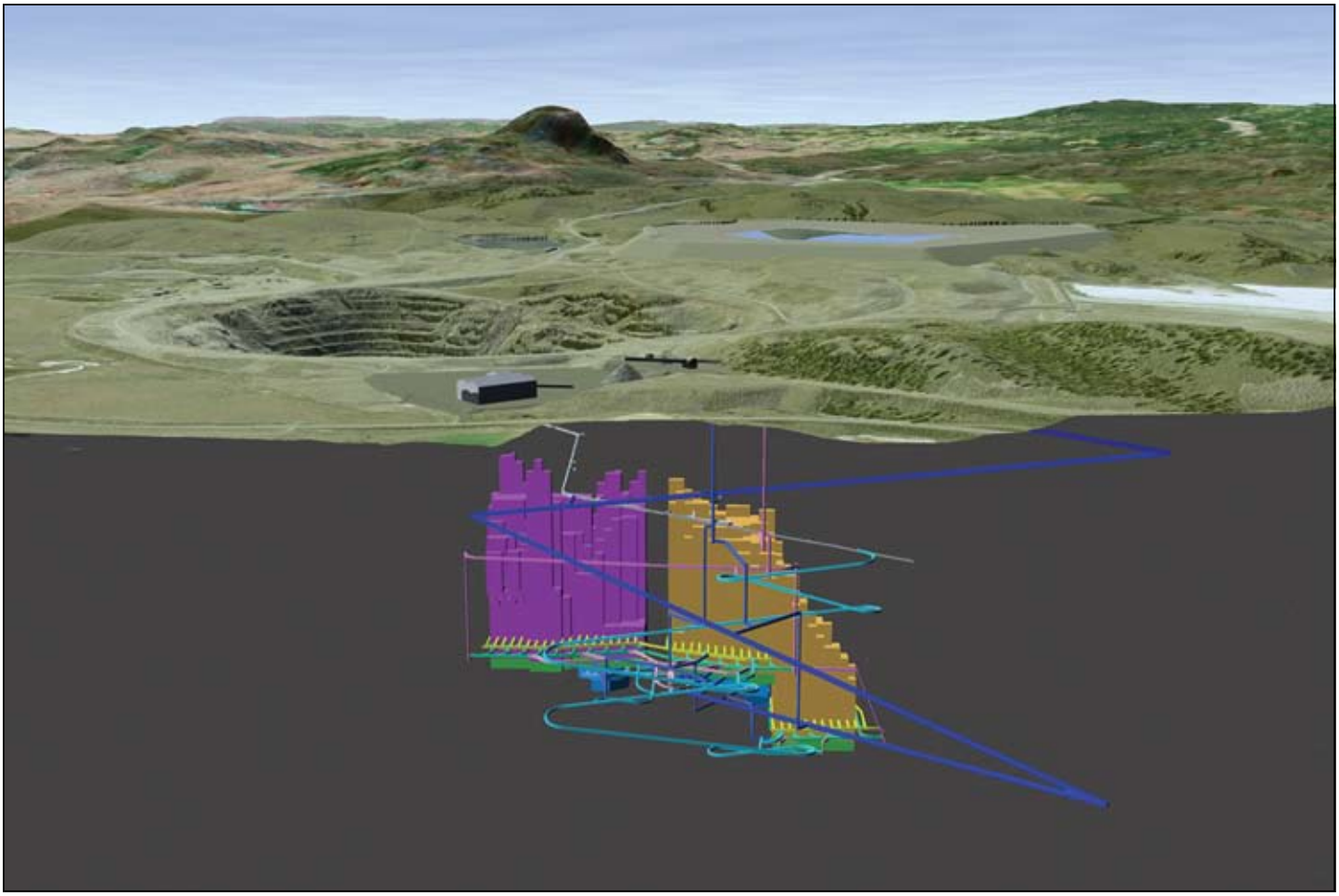
In 2007, Meridian Mapping upgraded to Bluetooth-compatible, mapping-grade receivers capable of subfoot accuracy and rugged PDAs running the Windows Mobile 5 operating system. These new devices meant increased productivity, reliability, and data security and improved ability to integrate with GIS.

In the field, Meridian Mapping uses a variety of software programs including ArcPad and Trimble's GPScorrect and TerraSync. Using ArcPad with Trimble GPScorrect, the company can use its GIS vector and raster data in its native format without going through time-consuming data translation processes. "Essentially, we are able to take our GIS system in the field with us," says Dunlop.

The company often works on mining exploration properties where there are decades of histori-



A cutaway rendering illustrates proposed underground block-caving mining at the New Gold Inc. New Afton Copper-Gold Project near Kamloops, British Columbia.



Photorealistic renderings of the New Gold Inc. New Afton site allow a bird's-eye preview of proposed development such as the tailings storage facilities, plant, and subsidence zone.

cal data such as exploration grids, sample sites, trenches, and drill holes. ArcPad allows a worker to take historical data into the field and view it relative to his or her current position. "This helps us get a better feel for the project and at the same time verify the accuracy of the historic data, updating it if necessary," adds Dunlop. "ArcView allowed us to integrate data stored in a much broader range of file formats and coordinate systems. The on-the-fly reprojection capability eliminated the time-consuming requirement to translate all data to a common coordinate system. The ability to load datasets, such as CAD drawings, in their native format practically halved our workflow, increasing our productivity."

A third-party extension for ArcGIS, GeoSoft's Target for ArcGIS, allows Meridian Mapping to view and analyze mining data within the ArcView environment. Data collected on the surface can be viewed in 3D along with data collected below the surface by drilling, underground workings, or geophysical surveys. Maps generated from the data can be viewed in plan (top down) or section (a vertical plane cutting through the area of interest) within the ArcView environment or in 3D using Target's 3D viewer. Visual and digital analysis of the data is used to direct further exploration, and the data may eventually be used to generate a resource calculation to determine the economic viability of the project.

One of Stewart's specialties is using Visual Nature Studio (VNS) software to generate photorealistic animated sequences that integrate diverse geographic data. They are an important final step in facilitating client and stakeholder visualization of a project. VNS allows Meridian to animate data in a variety of ways, displaying diverse information such as drill hole data, ore body data, planned excavations, and mine and site infrastructure. Clients find this photorealistic approach to stakeholder consultation an invaluable tool, aiding in the successful development of a mine.

"The end goal of all this work is to define a body of mineralized rock with sufficient grade and sufficient tonnage, in an accessible location with access to transportation and power, so that it is economically feasible to extract it in an environmentally responsible manner," concludes Dunlop.

Using advanced hardware and software tools, Meridian Mapping tackles what could be a difficult job with ease.

Meridian Mapping Ltd.
www.meridianmapping.ca

Contributors:
Jill Neumann
Cansel

Dugald Dunlop
Meridian Mapping Ltd.

Shepherd Stewart
Meridian Mapping Ltd.

Engineering Firm Uses GIS to Generate Cross Sections with Ease

New Application Reduces Overhead Associated with Creating Multiple Surface Views

In the field of geoscience, having accurate views of the earth's subsurface is critical. Unfortunately, generating cross-sectional perspectives of the earth's crust is a complicated affair. One cannot simply slice into the earth as if it were an onion to view its layers. Rather, precisely measured geologic data must be analyzed by trained geologic professionals and turned into imagery by a CAD technician for these views to be created. Because the complexity of creating cross sections entails the use of multiple applications, potentially by multiple workers, BGC Engineering Inc., an applied earth sciences firm in British Columbia, Canada, sought a better way to obtain the views it needed without the fiscal waste and potential for error usually associated with the procedure. The solution the company had been seeking came in the form of a new GIS application that brings the power of cross sectioning to the desktop.

With more than 100 experienced professional engineers, engineering geologists, hydrogeologists, and technicians on staff, BGC specializes in providing consulting services to mining, transportation, and natural resource sectors. As such, creating accurate representations of subsurface terrain for its clients is essential to building better and safer pipeline systems. Given the importance of delivering such imagery, engineers at the firm spend a good portion of their time creating cross sections. A best practice for viewing multiple surfaces simultaneously, the cross section is a simple way to visually convey surface and subsurface information to engineers instantly. For example, terrain analysis for pipeline design and construction often delivers critical information about soil and rock type; depth of pipe below stream crossings; and steep, potentially unstable slopes. This kind of spatial information is best delivered to the client in one visual presentation displaying many surfaces at once. Until recently, geomatics staff at BGC used a variety of applications to create the subsurface imagery their clients required. In addition, engineers and geoscientists at the company often had to rely on CAD specialists to create and edit the diagrams, which entailed going back and forth to edit scale, labels, and other details. One such solution involved a simple tool developed in-house, but it was limited in functionality and not very user-friendly; it also expended too many financial resources in company man-hours to be considered a viable solution.

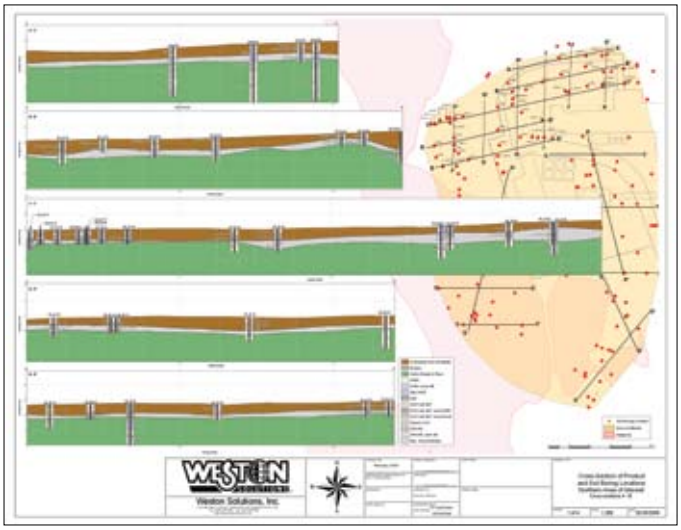
After one of BGC's analysts saw an ad for CrossView, a cross sectioning plug-in for ArcGIS, BGC decided to try the software. Created by A-Prime, a Denver, Colorado, GIS software company, CrossView is an extension to ArcGIS that radically simplifies the cross-sectioning process, allowing users to complete the entire procedure on a single desktop. Instead of having to exit the ArcGIS environment to create subsurface views, CrossView enables GIS specialists, engineers, geologists, and construction developers to handle every aspect of the process within ArcGIS itself, eliminating the need to outsource the task to a CAD technician. For a department already familiar with the ArcGIS platform, this was the ideal solution.

A GIS analyst for BGC, Matthew Buchanan spends most of his time creating maps and analyzing data for engineering clients as well as determining dam fill and basin storage capacity using 3D analysis. Generating multisurface imagery is key to these tasks but more labor intensive than it seemingly needed to be. "Cross sectioning the old way was akin to buying a Ferrari and hiring a chauffeur just to drive to the corner market once a week," says Buchanan. "In one project, I had to create a series of different dam alignment scenarios including cross-section imagery. Although CAD technicians were able to create functional diagrams for me, it was obvious there was a more expedient way to create these images within the ArcGIS platform itself and without the assistance of cumbersome software and outsourcing. CrossView was able to help me create detailed multisurface views quickly and easily within a familar workflow. It's exactly the kind of tool we were looking for, and it saves our clients money."

The integration of cross sectioning in a GIS environment has not only enabled BGC to create cross sections in record time but also has reminded BGC staff of the enormous potential of GIS in solving complex problems. Says Buchanan, "When engineers see the capabilities and cost savings of using GIS software to create professional-looking cross sections and plan maps, they will want to use GIS more often."

More Information

For more information, contact Matthew Buchanan, GIS analyst/programmer, BGC Engineering Inc. (tel.: 604-684-5900, extension 147; e-mail: mbuchanan@bgcengineering.ca), or Matt Gale, A-Prime product manager (e-mail: matt.gale@aprimesoftware.com, Web: www.aprimesoftware.com, or tel.: 1-800-MAP-DOWN).



Site map with cross sections depicting boring locations and recorded lithologies. Boring data is recorded in the field via Tablet PCs and submeter GPS. This information is later uploaded to an environmental management system that is linked to a GIS. Once the data is in the GIS environment, cross sections are readily generated. In this image, cross sections are displayed along with basemap information in an .mxd document.

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ESRI Helps Kentucky Deliver Maps of Abandoned Mines Online

The process of archiving Kentucky's mine map collection varies from map to map. Some maps are simply scanned and archived into a database, while others are given more detailed treatment by georeferencing them in a GIS software environment. "First, we scan the map using a 42-inch-wide digital scanner," says Thomas Schubert, Environmental and Public Protection Cabinet (EPPC) contractor at KOMSL. (EPPC is the state cabinet responsible for the protection and preservation of Kentucky's air, land, and water resources.) "From there, we import the file into an image program to crop and rotate as necessary. A CAD application is used to register each map and assign the x,y values in the image to a state plane or Universal Transverse Mercator [UTM] coordinate system." The map team used raster data in ArcGIS Desktop to align the TIFF file and convert it to a GeoTIFF file. (GeoTIFF is a public domain metadata standard that allows georeferencing information to be embedded within a TIFF file.)

ArcIMS is used to serve the map data to KOMSL's customers via the interactive map site at KMMIS. "The whole concept of GIS is that people no longer have to look through textual tables containing disparate data and put it all together," says Bryan Bunch, IT systems consultant at KOMSL. "ArcIMS gives our customers a graphic interface to locate and zoom in to these maps." Bunch also used ArcInfo and ArcObjects to write specific tools for the project. Prior to Kentucky's map digitization project, mining engineers had to travel to the map warehouse at KOMSL and hand select the maps they needed. Once they chose their maps, they had to make copies at the local blueprint copy facility. Since the office is in central Kentucky, the entire process could take as long as two days for engineers who traveled from the eastern- and westernmost parts of the state. "Miners used to have to make long trips to obtain the information they needed. Now that the information is online, they can just download and print the map at their location," says Schubert.

Digitizing the maps also made it convenient for coal companies, which only have to submit one map annually to KOMSL. This is because state and federal agencies are able to access the maps from the online information system. Before the Kentucky Mine Mapping Initiative, coal companies had to submit as many as five paper maps per year to several different agencies.

A mine blowout in Knott County, Kentucky, resulted in the closure of KY 80, a four-lane highway connecting Hazard and Prestonburg. The blowout was quickly located with the help of the KMMIS mine map database.

The mine map Web site has already proved helpful to agencies that regulate mine safety. In 2006, the Kentucky Division of Emergency Management simulated an earthquake that "sealed" an underground mine in Muhlenberg County. Using maps from the mine mapping site, GIS specialists from Kentucky were able to identify the opening to the mine and see a detailed layout of the site during the exercise. One of the three large screens in the Emergency Operations Center continuously displayed information from Kentucky's mine mapping site throughout the drill.

In 2005, a mine blowout flooded part of Highway 80 in Knott County. Using a map downloaded from KMMIS, the field inspector was able to immediately identify the exact location where the incident occurred. From there, he relayed location, mine seam, and coal company information to his superior by cell phone. Other surface mine inspectors were equipped with a printout of the mine map when they arrived at the blowout site later that day.

The maps are useful not only to emergency responders and mining officials but also to homeowners and landowners. Often, citizens decide to build on land that is on top of or downstream from an abandoned mine. As a result, property near these sites becomes vulnerable to the effects of subsidence and blowout, which have been known to obliterate neighborhoods and disfigure acres of land. According to the KMMIS Web site, the need for a comprehensive and accessible archived mapping system for the locations of Kentucky's underground and surface mines was reinforced by such an incident. On October 11, 2000, a slurry impoundment in a Martin County coal mine suffered a crack, releasing a torrent of noxious sludge into downstream communities and adjacent creeks. Although no lives were lost, the environmental impact and havoc that it visited on residents were extensive. The value of KMMIS is such that citizens can now be more informed about the land on which they plan to build or currently reside.

The demand for easily accessible abandoned mine cartography is evident from the 600,000 hits the Web site receives monthly—a number that is steadily increasing. KMMIS is the number-one search result for people who type "mine maps" into the Google search engine, a fact that John Hiett, program manager for KMMIS, says reflects the project's success. "The volume of hits that the Web site gets shows the enormous demand for online access to maps," says Hiett. "All we did was create the Web site, and before we knew it, we were number one on Google for people looking for mine maps." KDNR's goal is to eventually digitize the entire collection and continually update the system with new mine mapping information.

For more information about KMMIS, contact John Hiett (tel.: 502-573-0140, e-mail john.hiett@ky.gov). To access mine maps at KMMIS or learn more about the project, visit www.minemaps.ky.gov.

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To submit articles for publication in *GIS Mine Post,* contact

Matthew DeMeritt, *GIS Mine Post* Editor
Phone: 909-793-2853, extension 2930
E-mail: mdemeritt@esri.com

Willy Lynch, Mining Industry Specialist, ESRI Energy-Mining Industry Team
Phone: 303-449-7779, extension 8269
E-mail: wlynch@esri.com

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ESRI
380 New York Street
Redlands, CA 92373-8100